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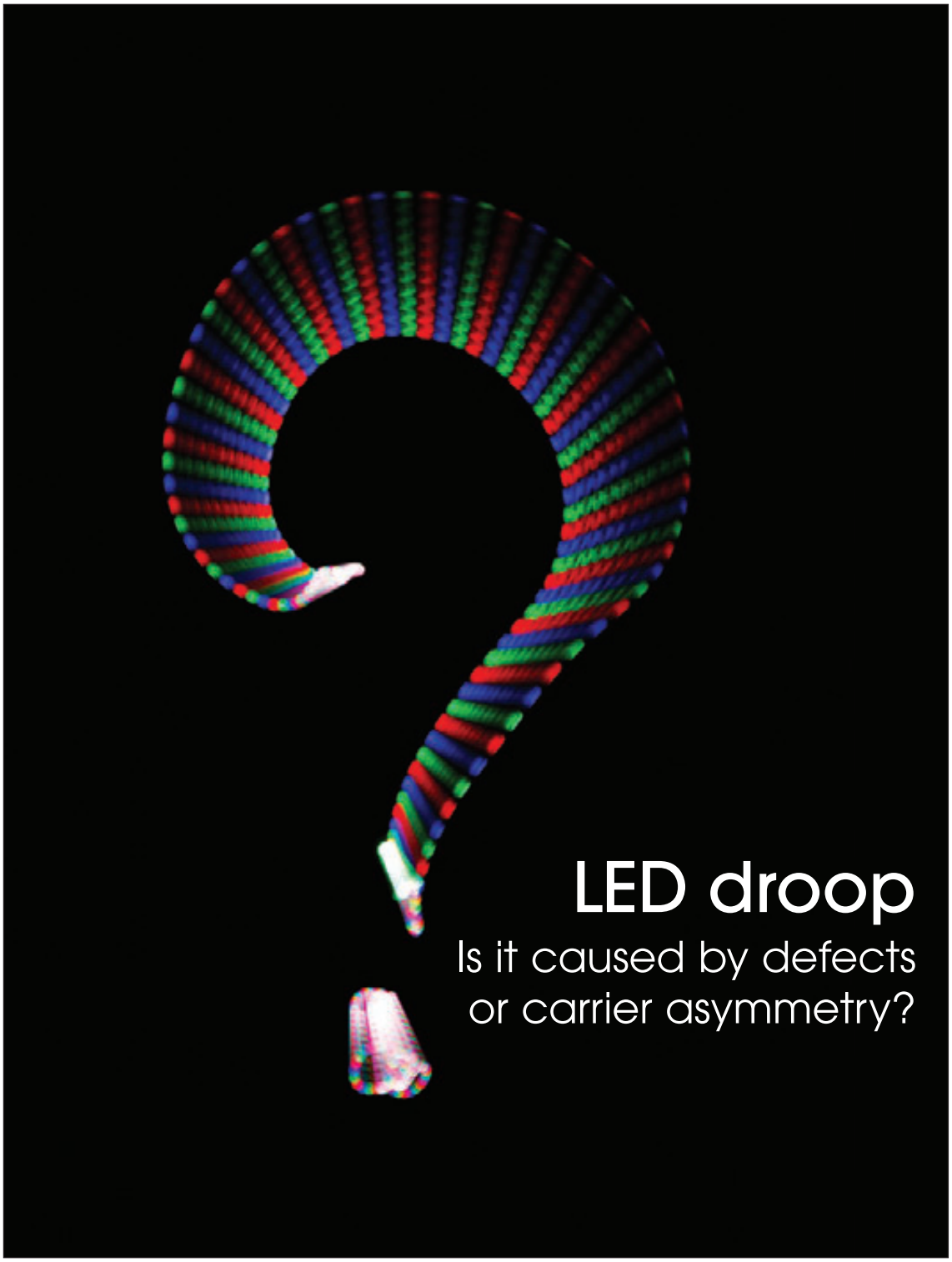

LED droop

Is it caused by defects or carrier asymmetry?

An Angel Business Communications publication

January/February 2012 Volume 18 Number 1

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Following **silicon's lead**

Throughout the twentieth century, the route to scaling silicon CMOS technology remained the same: build a photolithography tool capable of defining smaller feature sizes. But by the turn of the millennium, additional modifications were needed: The 90 nm node launched in 2002 employed some SiGe to increase the drive current; silicon-dioxide gates were replaced with hafnium oxides in 2007 to stem gate leakage; and this year, new, three-dimensional architectures will be shipped that can control current flow at the 22 nm node.

In many ways, where silicon leads, we follow. Like our bigger brother, we migrate to bigger and bigger substrates, develop tools with greater levels of automation, and try to introduce superior fab management technologies to drive up yields.

Recently, we have also mirrored their latest advance in silicon transistor architectures: At the 2011 International Electron Devices Meeting (IEDM) in Washington DC, a collaboration led by Peide Ye's group from the University of Purdue demonstrated the first three-dimensional MOSFET made with a set of foundry-compatible processes.

One of the greatest strengths of this transistor is its simplicity. It is made by depositing a single layer of InGaAs on InP, before a combination of implantation, photolithography, etching and atomic layer deposition defines the structure.

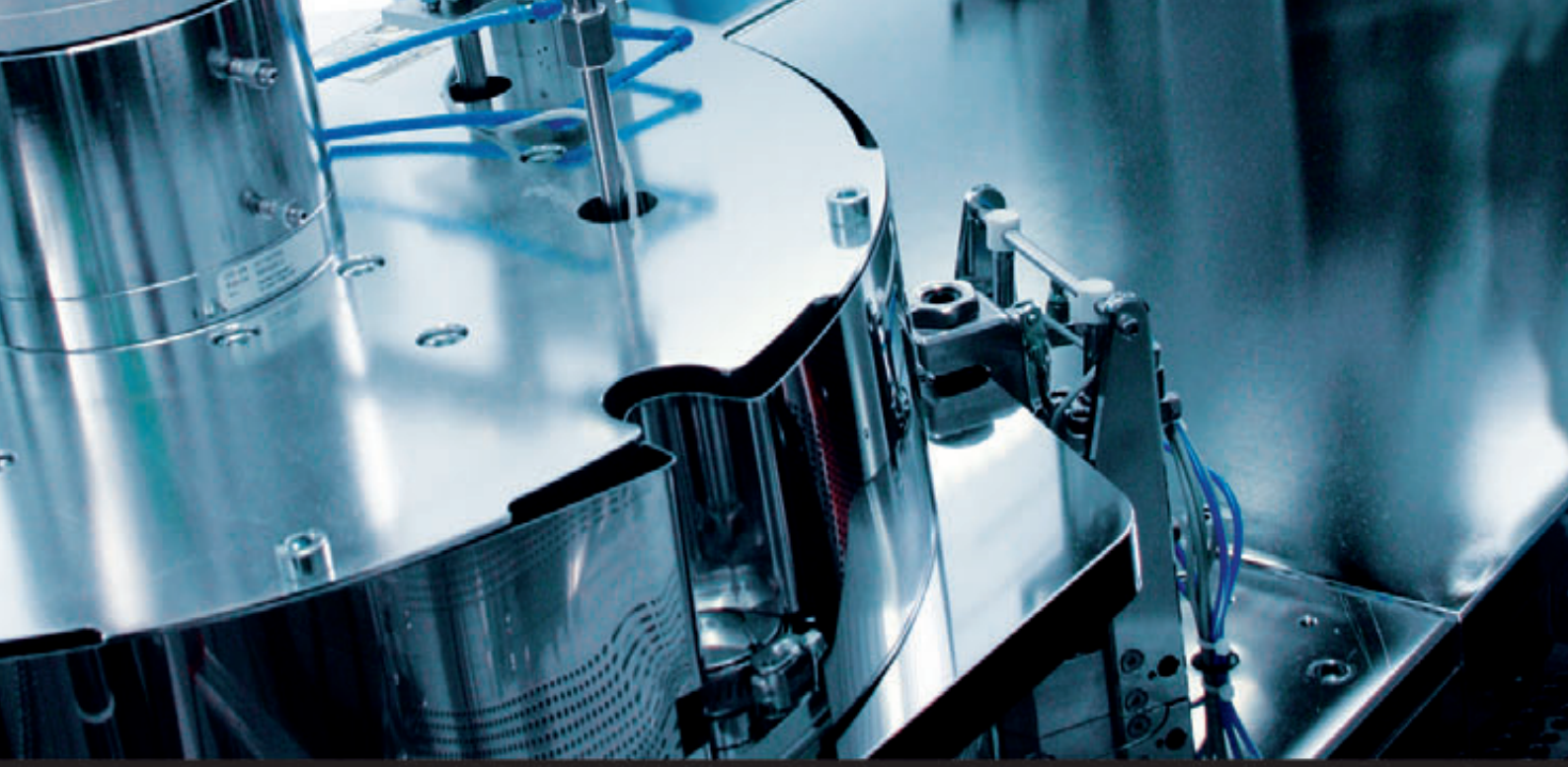
The relatively straightforward fabrication process will help this transistor to make a commercial impact beyond the 15 nm node. At these length scales, alternatives to silicon are required according to the International Technology Roadmap for Semiconductors.

Ye's transistor needs improvements to some key characteristics before it can become a serious contender at the 11 nm node but that's not its biggest challenge. If III-Vs are going to power the computers of the future, they'll need to be grown on silicon.

Intel and IQE are looking seriously at this issue, and at IEDM they presented a study comparing the quality of III-Vs-on-silicon grown by MBE – the most popular deposition technology for III-V FETs – and MOCVD. Their finding: MOCVD is at least the equal of its rival.

More details of this effort, as well as a report on Ye's work, can be found in a round-up of IEDM on page 15. However, if you want to hear directly about this work and learn of other breakthroughs in III-V devices for logic applications, consider booking yourself a seat at CS Europe 2012. This event that will be held on 12-13 March in Frankfurt, Germany, will also detail the progress of a very broad range of compound semiconductor chipmakers. Check out the list of speakers on page 21.

Richard Stevenson
Consultant Editor



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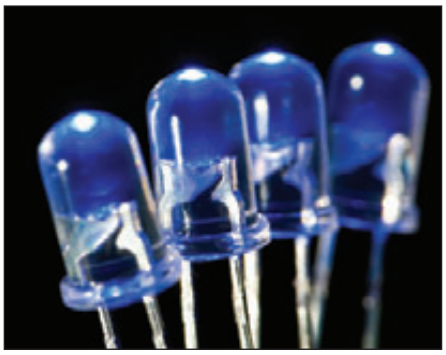
industry & technology

news

Osram's InGaN LED chips on silicon in pilot stage



RESEARCHERS at Osram Opto Semiconductors have succeeded in manufacturing high performance prototypes of blue and white LEDs, in which the light-emitting GaN layers are grown on 150mm silicon wafers. The silicon replaces the sapphire substrates commonly used until now without a loss in quality. Already in the pilot stage, the new LED chips are to be tested under practical conditions, meaning that the first LEDs on silicon from Osram Opto could hit the market in just two years.

"Our investments in years of research are paying off, because we have succeeded in optimizing the quality of the gallium-nitride layers on the silicon substrates to the point where efficiency and brightness have reached competitive market levels. Stress tests demonstrate the high quality and durability of the LEDs," says Peter Stauss, project manager at Osram Opto Semiconductors.

The company has acquired expertise over the last 30 years in the epitaxy process, the foundation for this milestone in the development of new manufacturing technologies. The German Federal Ministry of Education and Research funds these activities as part of its "GaNonSi" project network. This is a pioneering development for several reasons. On account of its widespread use in the semiconductor industry, the availability of large wafer diameters and its very good thermal properties, silicon is an attractive and low-cost option for the lighting markets of the future.

Quality and performance data on the fabricated LED silicon chips match those of sapphire-based chips: the blue UX:3 chips in the standard Golden Dragon Plus package achieve a brightness of 634 mW at 3.15 volts, equivalent to 58 percent efficiency. These are outstanding values for 1 mm^2 chips at 350 mA. In combination with a conventional phosphor converter in a standard housing – in other words as white LEDs – these prototypes correspond to 140 lm at 350 mA with an efficiency of 127 lm/W at 4500 K.

"For these LEDs to become widely established in lighting, the components must get significantly cheaper while maintaining the same level of quality and performance," Stauss emphasizes. "We are developing new methods along the entire technology chain for this purpose, from chip technology to production processes and housing technology."

Mathematically speaking, it is already possible today to fabricate over 17,000 LED chips of one square millimetre in size on a 150 millimetre wafer. Researchers have already demonstrated the first structures on 200mm.

Global nitride LED revenues fall in 2011

AFTER 60% growth in 2010, the GaN LED market is expected to fall 6% in 2011 to $8.0 billion as reported in IMS Research's latest "Quarterly GaN LED Supply/Demand Report".

The decline can be attributed to a number of factors including a widening surplus resulting in significant pricing pressure. Supply grew nearly 3 times faster than demand from 2010 to 2011, resulting in depressed LED factory utilisation levels. The LED surplus rose from a relatively healthy 7% in 2010 to 45% in 2011 and is predicted to widen further in 2012.

With both panel shipments and LED penetration below expectations and average LED prices for backlighting declining 34% on a volume weighted average basis on depressed utilisation, backlighting revenues fell 13% to $4.8 billion. ASPs for certain backlighting markets were down as much as 45% in 2011.

As a result, backlighting fell from 64% of 2010 GaN LED revenues to 59% of 2011 GaN LED revenues and are likely to continue falling on a percentage basis in the future as backlight markets become saturated and the lighting market accelerates.

LED revenues for TVs are expected to fall 5% in 2011 to $1.9B as penetration is only expected to reach 39%, down from the previous estimate of 43%.

However, the GaN LED market is expected to recover, enjoying annual growth each year from 2012 to 2015 including double-digit growth in 2013 and 2014 as the lighting market accelerates.

The 2012 market is expected to grow 5%, but still remain below 2010 levels. Backlighting is expected to be flat on slower unit growth and price reductions, while lighting is expected to be up 30% as LED lamp penetration jumps as prices continue to fall. Lighting revenues are expected to overtake TV revenues for GaN LEDs in 2012, a year earlier than previously predicted. This is a result of increasing LED lighting demand on lower pricing while reducing the LED outlook in TVs on lower penetration than previously predicted along with the use of low cost direct LED backlights in developing markets.

The low cost direct LED backlights use around half the LED die area as conventional edge backlights due to significantly reducing the brightness specification along with adopting a thicker form factor that allows wide viewing angle packages to be adopted which further reduces the number of LEDs required. While the adoption of these new low cost direct-type backlights will narrow the cost differential with CCFL LCD TVs, the thicker form factor and reduced brightness capability will narrow their appeal.

The lighting share of the GaN LED market is expected to surge from 21% in 2011 to 49% in 2016 with lighting LED revenues expected to grow more than 300% and units expected to grow in excess of 1500% over this period.

Crystal IS to merge with Asahi

THE JAPANESE global manufacturer of compound semiconductor devices, Asahi has acquired a germicidal LED technology development company As a wholly owned subsidiary of Asahi Kasei, the merger will enable Crystal IS to accelerate commercialisation of its UVC LEDs grown on AlN substrates. The effective date of the merger was December 28, 2011 but all financial details of the acquisition were not disclosed within the company press release that was issued.

"We are delighted to welcome Crystal IS into the Asahi Kasei family," commented Masafumi Nakao, General Manager of Asahi Kasei's Advanced Devices and Sensor Systems Development Centre and responsible for this agreement. "Asahi Kasei Group is committed to bringing to the global marketplace a family of products that contribute to life and living for people around the world."

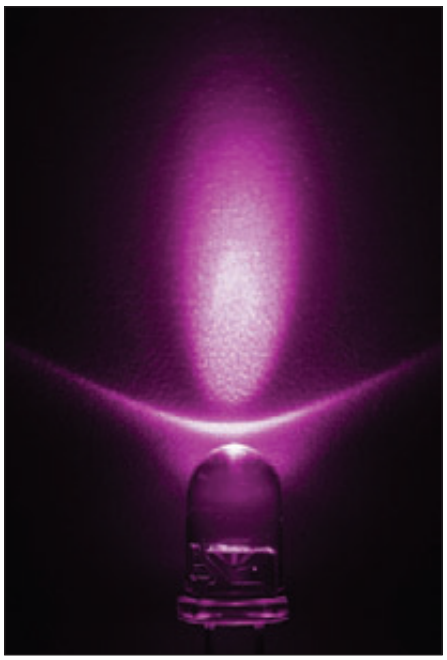
"The advances in solid state UVC technology accomplished so far by Crystal IS will allow for clean and safe disinfection to be introduced into water, air and surface applications in multiple markets".

Crystal IS will focus on R&D fundamentals and entrepreneurial business development management, while Asahi Kasei will concentrate on the product engineering and manufacturing side.

"This is a major milestone for our company," commented Steven Berger, CEO and President of Crystal IS. "Our record LED performance in development has brought interest from global customers and we are eager to create a high-quality product to meet their needs.

We recognise Asahi Kasei Group's strength as a successful developer and manufacturer of compound semiconductor devices and are confident that their support will ensure a timely and quality launch of our UVC LED business in the global marketplace."

Crystal IS has been working purely within a development mode for the last ten years,



with a history of early support from the Rensselaer Polytechnic Institute in Troy, NY, as well as continued support over the years from both regional and US government. Venture funding in 2004 and 2006 from ARCH Venture Partners, Lux Capital, the Credit Suisse/New York State Common Retirement Fund and Harris & Harris Group, helped the company to scale its research into development, and recent collaborative and strategic support from Asahi Kasei Group and San'an Optoelectronics has helped propel the company to its current operation.

"I am pleased that this ground-breaking technology platform is moving forward into the next phase of growth," said Leo Schowalter, co-founder and CTO at Crystal IS. "I couldn't be more proud of the scientists here in Green Island, New York for their commitment to success."

"We are pleased to be part of a growing high-tech area focused on advanced materials, life science, cleantech and energy. We are confident that we will continue our tradition of innovation and excellence, while also accelerating global business growth with our new owner."

LED market for LCD back-lit TVs slumps

According to the recently released NPD "DisplaySearch Quarterly LED Backlight Report", set makers are reducing the number of LEDs per TV set. This lowers brightness and moves away from the slim designs and higher picture quality that have been characteristic traits of LED-backlit LCD TVs.

"LED penetration in LCD TV was 7 points lower than our forecast a year ago, mainly due to high LED premiums. The premium for a LED backlight in a 32" LCD TV was 42% in Q4'11, although it had been expected to fall to 27%," said Yoshio Tamura, Senior Vice President, NPD DisplaySearch.

"TV makers are changing their strategies on direct LED-backlit TV. Instead of high picture quality, set makers have chosen low-power consumption with a lower price as selling points for this new type of LED-backlit TV. This will increase its competitiveness with CCFL-backlit LCD TV and even CRT TV," he continued.

The materials cost for direct LED backlights comes closer to that of CCFL backlights. NPD DisplaySearch estimates that for 32" LCD TVs, direct LED backlights cost 1.3-1.4 times CCFL backlights, as opposed to edge-lit LED backlights, which are estimated to cost more than twice as much as CCFL backlights. For 40" LCD TVs, the savings could be even greater, with low-cost direct backlights cutting nearly $40 in material costs, which could result in as much as $100 in savings at retail.

First Solar eclipses previous CdTe efficiency record

FIRST SOLAR says it has set the new world record for CdTe photovoltaic (PV) solar module efficiency, by beating its prior record of 13.4 percent. NREL confirms the cadmium telluride photovoltaic manufacturer's module has reached 14.4 percent total area efficiency

The record performance, announced at the World Future Energy Summit in Abu Dhabi comes just six months after First Solar leapfrogged the world record for CdTe solar cell efficiency with a mark of 17.3 percent. Both the cell and module record-setters were constructed using commercial-scale manufacturing equipment and materials at the Company's Perrysburg, Ohio factory.

Cell efficiency measures the proportion of light converted to energy in a single solar cell, whereas total area module efficiency measures light conversion across a production-size, multi-cell solar module, providing a more realistic assessment of real-world performance than cell or aperture-area efficiency. "This considerable achievement supports our module efficiency roadmap and demonstrates our ability to convert our record-cell technology into ongoing module-level improvements," said Dave Eaglesham, First Solar's Chief Technology Officer. "These records also underscore the tremendous ongoing potential of CdTe compared to silicon-based technologies."

First Solar updated its module efficiency roadmap in December 2011 to the increased goal of 14.5 - 15 percent average efficiency for its production modules by the end of 2015. The process improvements developed for the record-setting cell and module continue to be implemented as part of that roadmap. The average efficiency of First Solar modules increased from 11.4 percent in 2010 to 11.7 percent in 2011 and is expected to reach 12.7 percent in the fourth quarter of 2012.

"Our continuous investment in R&D has enabled the steady progress of our technology, punctuated by landmark achievements such as this," said Mike Ahearn, Chairman and interim CEO of First Solar. "Our consistent progress gives us confidence in our ability to achieve our roadmap goals, drive down costs and develop sustainable markets."

First Solar, which has manufactured more than 5 GW of its advanced thin-film modules, utilises a continuous manufacturing process, which transforms a sheet of glass into a complete solar module in less than 2.5 hours. This reduces the payback time and helps contribute to a low carbon footprint of systems using its PV modules.

The firm also implemented the industry's first comprehensive, prefunded solar module collection and recycling program. Anyone wishing to dispose of First Solar modules can request collection at any time, at no additional cost, and First Solar will pick up the modules and recycle up to 90% (by mass) of the material for use in new products, including new solar modules and new glass products.

GaAs IC market grew only 1%

WEAK wireless demand resulted in nearly stagnant growth in GaAs ICs in 2011, according to the report "The GaAs IC Market," recently published by The Information Network, a Tripoli, PA-based market research company.

"Every cell phone contains Power Amplifiers (PAs), which enable the handset to transmit voice and data back to the base station tower to route a call to another phone number or Internet address. PAs, the most critical radio frequency component in the phone are currently dominated by circuits made with GaAs," noted Robert Castellano, president of The Information Network.

GaAs ICs grew 1% in 2011 following a 36% in 2010, as a result of weak demand in wireless, cell phones and WiFi. This represents the smallest growth since a 1.7% gain in 2009. 3G handsets often contain up to five PAs, and GaAs makes up 100% of the market, which is close to $5 billion. In addition, the number of PAs per handset is growing because of: complex 3G systems, global roaming support, and data roaming support. Pricing for PA's has increased from $0.80 per handset to $2.90 currently and is projected to increase to greater than $3.50 once Long Term Evolution (LTE) and Advanced Wireless Services (AWS) spectrum emerge in advanced handsets in the marketplace. While industrialised countries are using 3G networks, today's world is a mixture of 2/2.5G and 3G networks, the heavy majority of subscribers are actually on 2G-based networks — and predicted to remain so for a number of years. Of the new handsets sold in 2010, about 50% will still be 2G. Between 70 to 80% of Skyworks' and RF Micro Device's GaAs business is in PAs. 2G handsets contain 1 PA, so it represents a sizable market. Because they aren't as advanced as 3G cell phones, particularly smartphones, silicon is making inroads in the GaAs domain. For 2011, only 90% of PAs were made in GaAs, 5% in silicon CMOS, and 5% in silicon LDMOS.

Besides the technical dynamics, Skyworks has positioned in the market by its mid-2009 acquisition of CMOS PA supplier Axiom Micro Devices. Also, in September 2009, privately held Black Sand announced the world's first 3G CMOS RF PA. Black Sand's proprietary CMOS PA architecture offers a breakthrough in combined performance, cost, battery life, and reliability for mobile devices. Other CMOS PA companies of note include Javelin and Amalfi. Another firm rumoured to be working on CMOS PAs is ACCO.

Soitec and Sumitomo Electric develop new engineered GaN substrates

SOITEC and Sumitomo Electric Industries have reached a major milestone in their strategic joint development program started in December 2010. They have demonstrated four- and six-inch engineered GaN substrates and are launching pilot production lines in Itami, Japan, and Bernin, France to enable wider market adoption. The pilot lines will initially fabricate four-inch wafers with six-inch wafer production to quickly follow to support customer demand.

These substrates are produced by transferring ultra-thin high quality GaN layers from a single GaN wafer to produce multiple engineered GaN substrates. Leveraging Sumitomo Electric's manufacturing technology for GaN wafers and Soitec's proven Smart Cut layer-transfer technology, this strategic alliance project had originally produced two-inch wafers.

Sumitomo Electric will manufacture bulk free-standing GaN substrates in Japan for shipment to France, where Soitec will apply its Smart Cut layer-transfer process to generate the final engineered wafers with the same thermal expansion as GaN wafers. The resulting wafers have low defect density, enabling the manufacturing of advanced semiconductor devices at lower costs than bulk GaN wafers.

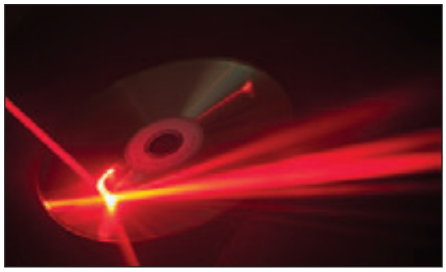
"Our partnership's successful demonstration of four- and six-inch engineered GaN substrates' scalability is a critical milestone, accomplished by applying very strong innovative capabilities from both sides," said Frédéric Dupont, vice president of Soitec's Specialty Electronics Business Unit. "The advanced substrates we are developing will allow the introduction of a new materials platform with novel and advanced functionalities."

Laser market hits the spot

THE laser market surpassed expectations in 2010 and 2011, growing 52% since the low in 2009 and setting a new record and is anticipated to exceed $9 billion by 2015. Sales for lasers slowed in late 2011 in the uncertain economic climate, but the outlook for long-term growth is still strong. Sales for 2012 are expected to be approximately flat, with growth returning in 2013 and reaching $9.4 billion by 2015. These are among the findings in the report, "The Worldwide Market for Lasers: Market Review and Forecast - 2012", from Strategies Unlimited.

Fibre laser sales in 2011 grew 114% over the 2008 level, thanks to strong sales in kilowatt lasers for sheet metal cutting and pulsed lasers for marking. IPG Photonics regained its 70% share among fibre laser suppliers with the recovery. A looming question is how many other suppliers can capture sales in the lucrative kilowatt fibre laser segment?

Strong sales in tablet computers and smartphones helped sales of laser-based



equipment for semiconductor, display, and electronics fabrication. Sales of biomedical instrumentation also helped the recovery. Military spending has peaked, but many programs that use laser-based equipment will have a long tail, or even long term growth, such as infrared countermeasures and dazzlers.

Only lasers for data storage are in for harder times, as prices decline and the world turns more toward other forms of storage. But even there, lasers show promise in enabling magnetic storage to achieve the next generation in hard drives, possibly opening a large new opportunity for lasers.

EV Group and Eulitha to make HB-LEDs more affordable

EV Group (EVG) has signed a joint-development and licensing agreement with Eulitha AG. Eulitha is a pioneer in the production of high-quality nanostructures using advanced lithography techniques. EVG will integrate Eulitha's PHABLE mask-based UV photolithography technology with EVG's automated mask aligner product platform with the goal of developing a low-cost-of-ownership (CoO) nanopatterning solution to enable the production of HB-LEDs.

According to Strategies Unlimited, the market for high-brightness LEDs is expected to grow from $11.2 billion in 2010 to $16.2 billion in 2014, driven by applications such as TV backlighting, mobile devices and increasingly by lighting. To meet this increased demand, LED manufacturers need new manufacturing solutions that can increase the lighting efficiency of their products while keeping manufacturing costs down. Through their joint-development agreement, EV Group and Eulitha will explore new manufacturing technologies that support LED manufacturers' cost and technology requirements.

Combining Eulitha's full-field exposure technology with EVG's well-established mask alignment platform provides low-cost, automated fabrication of photonic nanostructures over large areas, and supports the production of energy efficient LEDs, solar cells and LCDs. It combines the low cost, ease-of-use and non-contact capabilities of proximity lithography with sub-micron resolution—making it ideally suited for use in patterning sapphire substrates in order to enhance the light extraction (and efficiency) of LED devices.

EVG plans to offer a PHABLE-enabled EVG620 system as an extension to its well-established mask alignment system platform—giving customers an even wider choice of configuration options.

SiC devices with power conversion integrated on a single chip

RENESAS ELECTRONICS has developed a Schottky barrier diode (SBD), the RJS6005TDPP, which uses SiC, a material considered to have great potential for use in power semiconductor devices. There is strong demand for more efficient power conversion in products using power switching circuits or inverter circuits. Therefore, the diodes used in these circuits need to provide faster switching speeds and low-voltage operation. The new device also incorporates technology developed jointly by Hitachi and Renesas Electronics, which contributed to achieving approximately 40 percent reduced low power consumption compared to Renesas Electronics' existing power devices employing conventional silicon.

What's more, the RJS6005TDPP SiC SBD has a reverse recovery time of 15 nanoseconds (standard value: measuring conditions IF = 15 A, di/dt = 300 A/μs), approximately 40 percent faster than that of existing Renesas' silicon-based products. The reverse recovery time expresses the amount of time required to recover to the prescribed current value after the diode switches to the OFF state.

Renesas says that in addition, the reverse recovery time does not degrade when the temperature rises, enabling consistently low switching loss when operating in high-temperature environments. The new SiC-SBD has a voltage rating (forward voltage, VF) of only 1.5 V, lower than that of existing silicon fast trigger diode products. Also, the temperature dependency of this characteristic is small, ensuring that a stable forward voltage can be obtained even under high-temperature conditions. This means that more compact heat dispersion measures can be used.

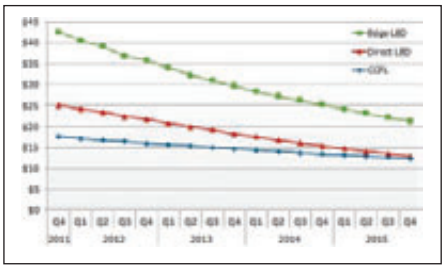


Figure 1: Backlight Cost Forecasts for 32" HD 60 Hz LCD TV Panel

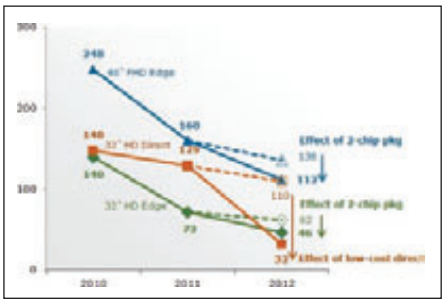


Figure 2: Forecast of LED Packages per Set for TVs

The RJS6005TDPP SiC-SBD uses a package equivalent to the industry-standard fully-molded TO-220, with which it is also pin compatible. This means that the device can easily be used as a replacement for conventional silicon diodes on existing printed wiring boards.

The firm aims to provide customers with total solutions combining MCUs and Analogue & Power devices, and become the leading power device supplier. The company plans to enhance its kit solutions and compound semiconductor devices, with the new high-voltage SiC-SBD power devices at the core, supplemented by peripheral power supply control ICs, high-performance IGBTs, high-voltage super-junction MOSFETs, and photocouplers.

The cost savings come from using roughly half as many LEDs, as well as the replacement of light guide plates, optical film, and other materials with lower cost diffuser plates and lens structures on the LEDs. The reduction in LEDs and other materials lowers power consumption, but requires a thicker profile. Brightness is lowered to 300 nits as opposed to 450 nits for edge-lit LED or CCFL, and lack of dimming reduces the contrast ratio and image quality. TV makers have been adopting 2-chip LED packages to reduce the number of packages and to reduce optical film use. The number of LED packages used per set with direct backlights is expected to be less than that of sets with edge backlights.

USCi to develop next generation SiC device with Aixtron

Aixtron has announced that United Silicon Carbide, Inc. (USCi), based in Princeton, NJ, USA has ordered its VP2400 Hot-Wall CVD tool.

The order was received in the fourth quarter of 2011 and is planned to be delivered in the third quarter of 2012.

John Hostetler, Director of Engineering at USCi, comments, "Having evaluated the market for SiC epitaxy equipment, and based upon our success with merchant SiC epitaxy vendors utilising similar tools, we have selected the Aixtron VP2400HW system for the superior quality of both n- and p-type SiC epitaxial layers."

"The versatility of the 2400 system will enable USCi to rapidly develop novel device designs. The system's ability to achieve high growth rates make it an ideal platform to develop our next generation high voltage (5-15kV) SiC devices with thicknesses in excess of 100 microns.

Aixtron Planetary Reactors are becoming the standard for high volume SiC device production and our ownership of a 2400 will greatly facilitate our production process transfer to our merchant epitaxial wafer partners," he continues.

Frank Wischmeyer, Vice President and Managing Director, Aixtron AB, Sweden adds, "Our SiC Planetary Reactor technology has continued to evolve over the past 10 years. Our extensive experience and know-how in the SiC deposition process is evident in the current design. Aixtron is pleased to partner with United Silicon Carbide as they advance SiC materials into next generation

USCi specialises in SiC devices including Schottky Barrier Diodes, JFETs, BJTs, Solid State Circuit Breakers, Power Modules, and Custom SiC integrated circuits.

Cree reveals next generation SiC based LEDs for lighting

CREE is introducing what it says is a breakthrough ; the XLamp XB-D LED.The first LED based on an innovative new Cree technology platform, the XLamp XB-D LED ushers in a new era of price-performance for lighting-class LEDs. This LED can further simplify designs, ultimately removing a key barrier to widespread LED implementation - up-front system cost.

Cree says the XB-D LED delivers twice the lumens-per-dollar of other LEDs, in the industry's smallest lighting-class footprint of 2.45 mm x 2.45 mm. The XB-D LED is 48 percent smaller than the XLamp XP package and ideal for lighting applications where high lumen density and compact light sources are required.

The innovations behind this next generation of lighting-class LEDs can enable significantly lower prices for LED lighting products by using up to three times fewer LEDs, three times fewer optics and substantially smaller circuit boards than current designs.

"Being a leader means delivering revolutionary, not evolutionary, innovation to drive the LED lighting revolution," said Mike Watson, Cree senior director of marketing, LED components.

"With this new platform Cree has fundamentally redefined the price-performance paradigm for our components customers. It's not enough to just make LEDs brighter - it's also about improving product payback and market acceptance of LED lighting."

Leveraging Cree's SiC technology, the XB-D LED delivers up to 139 lumens and 136 lumens per watt in cool white (6000K) or up to 107 lumens and 105 lumens per watt in warm white (3000K), both at 350 mA and 85°C.

XB-D LEDs are also compatible with most existing XP family secondary optics, which can speed the optical design process and create direct cost savings for existing XP family-based designs.

AQT Solar expanding with $18.7 million funding

THE SERIES B investment, which was at a higher valuation for the company than the previous round of funding, brings the total amount of capital that AQT has attracted to date to almost $40 million.

This funding round follows a year of consistent progress and growth for AQT. The company's Sunnyvale site is now operating around the clock and will have an installed solar cell capacity of more than 30MW by mid-year.

AQT cells are currently used in 100 watt CIGS modules that are being field deployed. By the end of the year, up to 180 watt CIGS modules powered by AQT cells are expected to be available in the market.

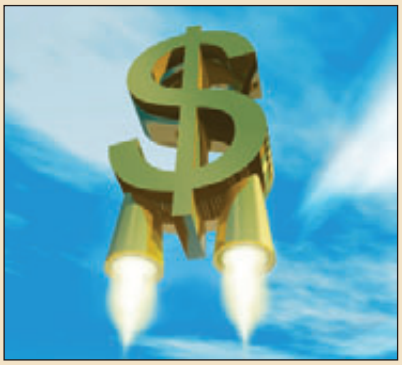
AQT's CIGS 2.0 technology allows for continuous in-line production, which simplifies and streamlines the manufacturing process, resulting in the highest projected capital efficiency in the industry, while minimising component costs.

This manufacturing pathway has resulted in the development, shipment and scaling of CIGS module product in just four years and for less than $40M in funding, making AQT the market leader in time-to-market and cost-to-market.

"Our business strategy uniquely positions us to compete and grow in an increasingly crowded, noisy and aggressive market," said Michael Bartholomeusz, CEO of AQT Solar. "AQT is laser focused on what we believe are the key elements to success in any commodity industry: leverage, cost, risk mitigation, partnerships and future proofing."

Riber revenues rocket

RIBER, a provider of MBE equipment saw €29.0 million in revenues for 2011, an increase of 40% in relation to 2010. Fourth-quarter revenues came to €10.5 million. Revenue growth for the provider was driven mainly by the increase in sales of evaporation sources, which multiplied by four over the year. This was mainly due to delivery of major investment orders aimed at setting up OLED screen production lines.



MBE system sales were up 4% in relation to 2010 at €11.5 million, reflective of the good level of sales to compound semiconductor industrial firms and research centres. In 2011, 10 MBE systems were delivered, including three production systems. The services and accessories business was down 18%, set against a slowdown in the North American market.

The fourth quarter of 2011 saw a dynamic level of commercial development. During the period, Riber received nine MBE systems orders, including one production system and eight research systems. More specifically, this growth was achieved thanks to the continued strengthening of positions in Europe and China.

On December 31st, 2011, the order book represented €19.4 million, 12% higher than the previous year. It primarily includes 15 MBE systems, with two production systems and 13 research systems. Only one system is due to be delivered after 2012.Cells and sources order book significantly decreased following the completion of investments in generation 5 OLED production lines.

IQE experience year on year growth

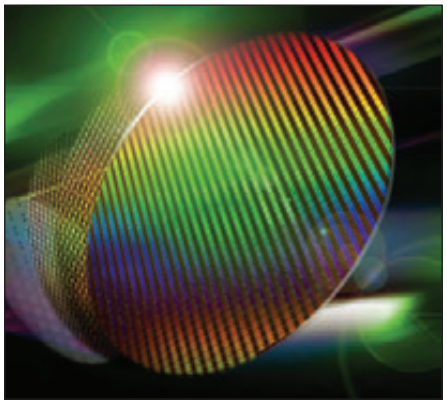
IQE, a global supplier of advanced semiconductor wafer products and services to the semiconductor industry, provides a trading update for the year ended 31 December 2011.

Full year revenues should rise by £2 million from 2010 to £75 million in 2011. EBITDA is also expected to increase and not be less than £13.7 million. Net debt is expected to be less than £4 million.

Sales grew rapidly in the first half, driven by strong double-digit growth in the Group's wireless and optoelectronics divisions.

Growth in wireless sales reflected the increasing adoption and sophistication of portable devices such as smartphones and tablets using GaAs technology. Also, increasing adoption of advanced GaN technology in high power wireless applications such as radar and infrastructure made an impact.

Growth in optoelectronic sales was driven by a wide variety of applications including



consumer, industrial and advanced high efficiency solar power applications.

As announced in October, second half sales were adversely affected by inventory corrections in the supply chain related to market share swings amongst a couple of IQE's key customers. These inventory corrections have unwound as expected, and should be fully resolved by the end of the first quarter of 2012.

The Group's long standing strategy to qualify multiple products with multiple customers across the entire supply chain went some way toward offsetting the impact of the market share shifts. As further qualifications complete the future impact of market share shifts will continue to diminish.

The firm says new product qualifications have progressed well, with significant milestones now achieved. IQE has successfully qualified its leading edge BiHEMT product with one of the top three Japanese mobile chip manufacturers, which has recently announced a major expansion programme in the smartphone market. Sales under this qualification have started to ramp, and this customer is expected to move into IQE's "top 10" during the second half.

IQE is also in the final stages of qualification of BiHEMT products with two of the leading wireless chip manufacturers globally and expects to ramp into production during the second quarter. In addition, the Group is qualifying a number of next-generation wireless products with a significant number of customers.

TriQuint advances into next generation GaN products

TRIQUINT SEMICONDUCTOR has begun work on Phase II of the Defence Advanced Research Projects Agency (DARPA) multi-year Nitride Electronic NeXt-Generation Technology (NEXT) program as a prime contractor. To date, TriQuint has received $12.67m in support of the NEXT contract.

NEXT was created by DARPA to research and develop devices suitable for complex, high dynamic range mixed-signal circuits for future defence and aerospace applications. Phase II of the NEXT program is contracted to last 18 months.

TriQuint is already exploring and bringing to market derivative devices made possible by breakthroughs demonstrated in NEXT Phase I. "NEXT devices provide game-changing technology for substantially improving performance in applications like phased array radar and communications," said TriQuint Vice President and General Manager for Defence Products and Foundry Services, James L. Klein. "The devices developed under 'NEXT' open-up applications for lower voltage GaN-based products, which achieve power densities at least four times higher than GaAs devices. The opportunities are exciting."

TriQuint Senior Fellow Paul Saunier leads the NEXT program as principal investigator. Saunier and his team reported state-of-the-art results at the 2011 GOMACTech conference in Orlando, Florida. The team achieved an Ft > 240 GHz in a GaN circuit.

DARPA's NEXT Phase I concentrated on fabricating very high frequency devices and meeting defined yield metrics. Phase II will concentrate on process development in the pursuit of increased yields while pushing the operating frequency to 400 GHz. Phase III will seek to extend the operating frequency to 500 GHz with still higher yields and reduced circuit size. NEXT research also focuses on highly-scaled enhancement-depletion (E/D) mode GaN mixed-signal devices, similar to those used in GaAs E/D MMICs. TriQuint creates the latter, with integrated digital control functionality and power handling for greater efficiency and cost-effectiveness. Beyond the NEXT activity, TriQuint is working on innovative enhancement mode power switching devices needed for ultra-high efficiency DC-DC converters integrated with RF amplifiers for radar, communications and EW systems. The technology is enabling greater sensitivity, while reducing prime power and cost.

TriQuint has been engaged in GaN research and development for the defence and commercial markets since 1999 and has concentrated on performance and reliability. University partnersinclude Massachusetts Institute of Technology (MIT) and the University of Notre Dame.

The firm was awarded the 2011 'Compound Semiconductor' CS Industry Award for the DARPA 'NEXT' program. The firm is also working on the Air Force Research Laboratory (AFRL) & DARPA E-mode GaN program to develop integrated variable drain voltage supplies for power amplifiers.

Albemarle forms new business unit for metal organics

ALBEMARLE CORPORATION'S new Electronic Materials business unit is a subgroup of Albemarle's newly renamed Performance Catalyst Solutions (PCS) division.

"As a producer of metal organics for over half a century, Albemarle has built a solid reputation on chemical expertise and experience," said Amy Motto, vice president of Albemarle's PCS division.

"With the launch of our Electronic Materials business unit, Albemarle will bring the same high level of quality and competence to the LED and solar markets. "

Albemarle's Electronic Materials business is already selling commercial quantities of ultra high purity trimethyl gallium (TMG) and triethylgallium (TEG) under its new PureGrowth brand name. The portfolio will be expanded to include ultra high purity trimethylaluminum (TMA) by early 2012 and trimethyl indium (TMI) by mid 2012. These products are used in MOCVD growth which are used to manufacture a variety of compound semiconductor chips including LEDs, solar cells and products used in the RF, telecom and power device markets.

The Electronic Materials business is built upon Albemarle's strong foundation of existing competencies in the electronics industry. In addition to the PureGrowth

portfolio, Albemarle is currently selling diethyl zinc (DEZ) to the solar panel industry and will expand its offerings to include dimethyl zinc (DMZ) in the near future.

"By expanding into the electronic-grade metal organic arena, Albemarle will be able to provide a robust portfolio of complementary products and services used throughout the electronics industry," said Jenny Hebert, global product manager for Electronic Materials.

"Albemarle will also benefit from a number of R&D and distribution synergies shared by its various business units."

Semi registers 10,000 patents

THE SOUTH KOREA head-quartered firm has invested in LED technology and increased its number of patents. The company invests 10-20 percent of its annual revenue in Research and Development, including funding of an affiliate company. The company holds a patent portfolio across a broad range of technologies and processes, including material, design, manufacturing and methodology. Notably, the company holds patent rights for Acrich, the semiconductor light source using a multi-cell architecture, as well as patent rights for deep UV LED technology. Seoul Semiconductor anticipates that deep UV LED technology will be commonly used in the future and it will be prepared to produce and sell this technology.

“With the large number of patents and cross-licenses with major LED corporations, Seoul Semiconductor has achieved technical independence and offers customers distinctive solutions not available elsewhere,” said Brian Wilcox, vice president of Seoul Semiconductor. “R&D is our future and patents heighten our competitiveness.”

According to the 2010 LED market reports issued by Strategies Unlimited, Seoul Semiconductor is the world’s fourth largest LED supplier, holding more than 10,000 patents. In particular, it owns a wide range of LED technology and production capacity in areas such as deep UV LEDs and non-polar LEDs, as well as Acrich, what the company claims is the world’s first commercially-produced AC LED.

QD Laser reveals yellow-green and orange laser modules

QD Laser and the Institute for Nano Quantum Information Electronics, the University of Tokyo developed compact laser modules of 561-nm (Yellow-green) and 594-nm (Orange) wavelengths Based on the same module platform for high-power, compact green laser modules, QD Laser and the University of Tokyo have successfully extended the wavelength band to yellow-green and orange visible colour region. These compact modules are promising for a range of applications, especially in life sciences and biomedicine use such as florescence microscopes.

QD Laser and the University of Tokyo have tuned the oscillation wavelength of near infrared single-mode lasers based on semiconductor DFB (Distributed Feedback) laser technology as well as operating wavelength of PPLN crystal for conversion to 561 nm and 594 nm, putting them together in recently developed compact modules of about 0.5 cc. The size of the module is 5.6 x 3.8 x 22 mm.

These modules successfully operate in yellow-green and orange wavelengths. Diode pumped solid state (DPSS) lasers are usually used in the wavelength of green, yellow, to orange. T

he new compact module, based on semiconductor laser technology, enables drastic compactness, high stability in power and wavelength, and high-speed modulation, providing common platform in many application areas.

QD Laser is now developing the new laser modules to contribute to the market-leading customers in addition to green laser modules, QLD0593 series.

III-Vs shine at IEDM 2011

III-V MOSFETs entering the third dimension, quantum-well FETs with low power consumption and GaN diodes and transistors that combine high breakdown voltages with tiny leakage currents all featured at the recent IEDM meeting. **Richard Stevenson reports.**

For many decades, advances in silicon have dominated discussions at the International Electron Devices Meeting (IEDM). And that's still the case today, but in recent times the number of papers reporting breakthroughs in III-V devices has swelled significantly, and it hit an all time high at the 2011 meeting.

Compound semiconductor highlights included breakthroughs in III-V logic: The world's first III-V three-dimensional MOSFET made with a 'top-down' approach; designs for quantum-well FETs that promise to reduce IC power consumption; and studies showing that MOCVD can be the equal of MBE, when forming III-V-on-silicon transistors. Meanwhile, developments in GaN included the insertion of trenches around the drain to slash leakage currents and the addition of barrier layers to boost diode performance.

Claims for the fabrication of the first III-V MOSFET produced with a top-down, foundry-compatible approach came from collaboration between researchers at Purdue and Harvard. The architecture of their InGaAs transistor mirrors that of 22 nm-node silicon MOSFETs that will roll off Intel's production line this year. The similarity of these two transistors makes the InGaAs MOSFET a strong contender for IC manufacture beyond the 14 nm node. The road map for CMOS predicts that alternatives to silicon will be needed at these very small length scales, and III-Vs are widely tipped to take over.

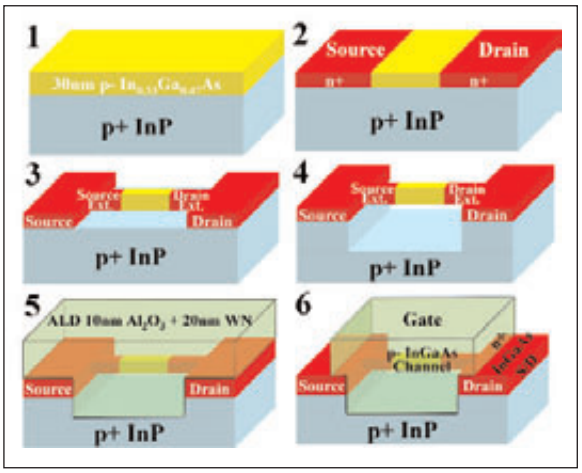


Figure 1. Three-dimensional III-V MOSFETs are produced by: Deposition of an InGaAs layer on an InP substrate by MOCVD; silicon ion implantation to form source and drain regions; creation of a nano-bridge by etching; ALD to wrap a dielectric around the channel; and gate etch

The Purdue-Harvard team is by no means the first to

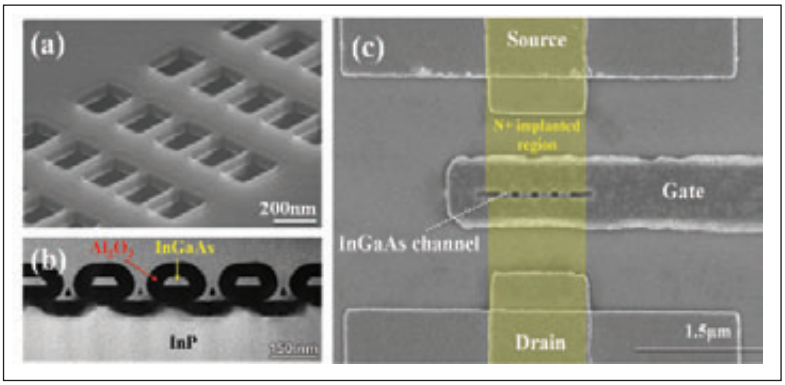


Figure 2. (a) An SEM image of the InGaAs nanowire test structures after the release process (b) Cross-sectional TEM of the InGaAs nanowires wrapped in the dielectric (c) A finished InGaAs gate-all-around FET with 4 fingers

make a three-dimensional III-V transistor: Many other research groups have already achieved that feat, but in every case they have formed nanowire structures with a 'bottom-up' approach.

"Industry has interest in that work, but not strong interest," explains Peide Ye, leader of III-V MOSFET research at Purdue University. He points out that bottom-up techniques tend to produce wires that have a random arrangement. "It is difficult to put these transistors where you want, and connect them together to form a circuit."

According to Ye, the silicon industry is far more interested in developments involving top-down approaches. That includes the lithography, dry/wet etching and atomic layer deposition (ALD) processes that he and his co-workers have used to fabricate their MOSFET. Three-dimensional transistors benefit from wrapping of the dielectric around the channel to minimize so-called 'short-channel effects'. In general, these are exacerbated as the transistor's feature sizes are scaled down, because miniaturization must include a thinning of the dielectric used for making the gate.

When the silicon industry reached the 45 nm node it departed from the traditional silicon dioxide gate, using hafnium dioxide instead to temper short-channel effects. At the 22 nm node these effects are even more severe, so chipmakers are turning to three-dimensional transistors

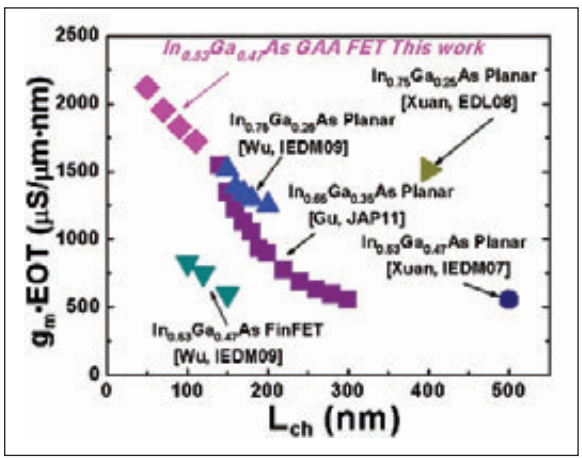


Figure 3. The gate-all-around FETs set a new benchmark for transconductance at short gate lengths, indicating their potential for making high-speed logic circuits

to address this issue. These three-dimensional devices enshroud the channel with a dielectric to control current flow. "It's the same story happening with III-Vs, because the device physics is, in principle, the same," says Ye. His student, Jiangjiang Gu, took two years to figure out how to make a gate-all-around III-V MOSFET. He focused on finding a simple approach to making this device that would employ processes suitable for use in a silicon foundry.

Device fabrication begins with MBE growth of a 30 nm-thick InGaAs layer on p-doped InP. Implanting silicon ions creates source and drain regions, and a lithographic process forms nanowire InGaAs channels (see Figure 1).

Anisotropic wet etching with hydrochloric acid removes InP, including that beneath the InGaAs channel. This is only successful when the channel is aligned along the [010] direction, an orientation that produces undercut etching.

ALD, which is a 'super-conformal' process, wraps the channel in a 10 nm-thick coating of Al_2O_3 and then surrounds it with a WN gate. A second lithographic step selectively removes part of the WN layer, allowing contacts to be made to the source and drain regions.

The MOSFETs that result have been produced with either one, four, nine or 19 InGaAs nanowire channels (see Figure 2). Using multiple wires allows the researchers to not only study their uniformity, but also increase total current delivery.

High values for transconductance and drain current showcase the promise of these devices for forming high-speed logic circuits. Devices with a 50 nm gate length have a transconductance of 710 μS/μm, revealing that scaling to small dimensions is not detrimental to transistor performance (see Figure 3). "With our planar devices, after 150 nm you are out of control," says Ye.

Drain current, which has been normalized by the perimeter of the wire to allow fair comparison with results for planar structures, peaks at 1.17 mA/mm for a 'hero' device. "That's a very high current – higher than the III-V bottom-up work."

Typical values for sub-threshold swing and drain-induced barrier lowering for a device with a 50 nm gate length are 150 mV/dec and 210 mV/V, respectively. These values are too high, and Ye admits that progress is needed: "The interface is difficult and there is still a lot of engineering work to be done. The sub-threshold slope needs to come down to 65-70."

Reducing the power

Another advantage of III-Vs over silicon is their greater potential to reduce the power density in logic circuits. III-Vs promise to work at lower operating voltages, which must be introduced as feature sizes are scaled to prevent a dramatic increase in the power density within

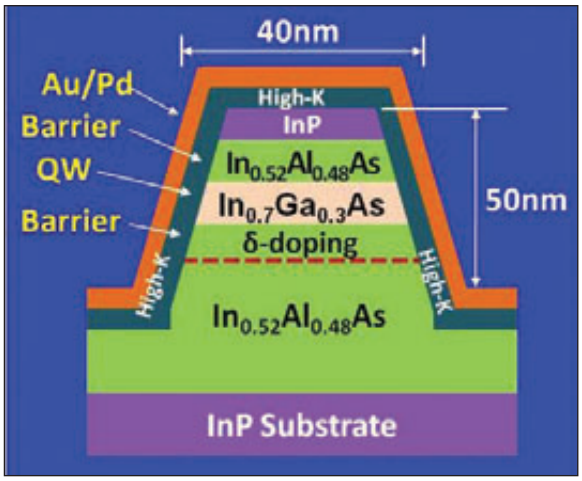


Figure 4. Multi-gate quantum-well FETs have been developed in Suman Datta's group at The Pennsylvania State University. These transistors can operate at very low voltages

the chip. Lu Liu, a graduate student in Suman Datta's group at The Pennsylvania State University, points out that the obvious applications for low power chips are in battery-powered electronics goods, such as lap-tops, tablets, cell-phones and cameras. However, they can also prevent chip overheating that can lead to premature device failure. Although bolting powerful cooling fans onto CPUs and graphics cards can address this, it's a workaround that leads to an increase in energy consumption.

A far more attractive option is to build circuits from devices requiring considerably lower operating voltages, such as less than 0.5 V. Such devices require higher 'on-currents' and a higher ratio between the 'on' and 'off' currents. This is possible by replacing silicon with materials with higher mobilities: InGaAs for NMOS and germanium for PMOS. To suppress short-channel effects, multi-gate structures are needed, such as the one used by Purdue and Harvard. In Datta's group, efforts in this direction have led to the development of classical and non-classical Multi-gate Quantum well FETs (MuQFETs) employing a 14 nm-thick $In_{0.7}Ga_{0.3}As$ well (see Figure 4).

"We consider the classical MuQFET to be a good candidate for sub-14 nm CMOS and beyond," says Liu, who explains that the non-classical variant promises to play a role at even more extreme length scales, when the number of electrons passing through the transistor starts to approach unity. "Non-classical MuQFETs in Coulomb oscillation mode are used to realize few and ultimately single electron computing with quantum dots."

Liu and his co-workers have built classical MuQFETs with a 40 nm fin width and non-classical variants with split gates separated by 80 nm. The former can deliver a drive current in excess of 100 μA/μm at a drain-source voltage of 0.5 V, and the latter can operate in coulomb blockade mode at 4.2 K (see Figure 5). With device scaling, operation in coulomb blockade mode should be possible at room temperature.

The Pennsylvania researchers have also put forward a hybrid logic architecture for sub-250 mV operation, using the pairing of classical and non-classical MuQFETs. "Current complementary logic is not suitable," explains Liu, "because of the lower current drivability and the low ratio of 'on-current' to 'off-current' in coulomb blockade mode." So he and his co-workers used binary decision diagram logic to build logic circuits and harnessed negative differential resistance (NDR) to build static memory systems.

Using device models that are well calibrated to these experimental efforts, the team found a 50 percent reduction in minimum energy for logic compared to silicon CMOS. When they used this silicon benchmark for memory, they discovered a 75-fold reduction in dynamic power.

MOCVD verses MBE

If III-V devices are to be used in ICs beyond the 14 nm node, they will have to be formed on large silicon substrates that can be processed in today's foundries.

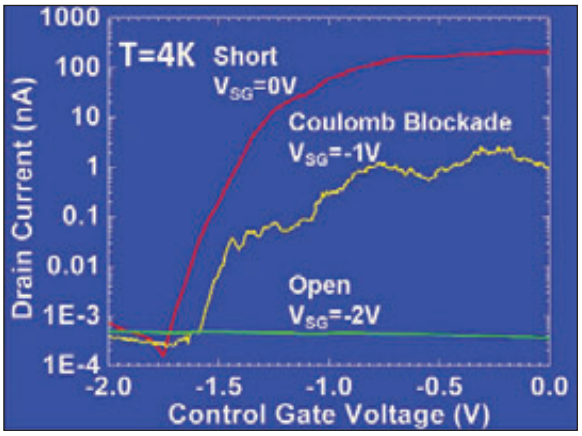


Figure 5. Non-classical multi-gate quantum-well FETs developed in Suman Datta's group at The Pennsylvania State University deliver reconfigurable operation at 4.2 K. The three modes of operation of this transistor are: V_{SG}= 0 V, tunnel barriers collapse and the device behaves as a classical multi-gate quantum well FET gated by the control gate (short mode); V_{SG}= -1V, the split-gates moderately deplete the one-dimensional multi-gate quantum-well FETs, resulting in 2.5 MΩ tunnelling resistance, and the control gate modulates the coulomb island leading to single electron transistor operation (coulomb blockade mode); V_{SG}= -2V, the split gates heavily deplete the multi-gate quantum well FET fin resulting in only background leakage current (open mode)

However, it is challenging to form high-quality III-V layers on silicon, due to a significant difference in lattice mismatch and a fundamental difference in polarity between the substrate and epilayers.

To address this several research teams have learnt how to grow III-V buffer layers on either blanket or patterned silicon wafers. These efforts have been performed primarily by MBE, which offers excellent process control. However, this deposition technique is line-of-sight and non-selective, characteristics that pose challenges for process integration and conformal growth on non-polar, three-dimensional devices. MOCVD is a more promising growth technology for making III-V transistors on silicon, thanks to its strengths of selective area growth and deposition on three-dimensional structures. There have been very few efforts in this direction, but at IEDM 2011 a partnership between Intel and IQE claimed to report the first direct comparison between III-V-on-silicon transistors grown by these two rival deposition techniques. Their conclusions: The material quality of the epilayers deposited by MOCVD is comparable to the best films grown by MBE, and the Hall mobility in the channel of the MOCVD-grown III-V-on-silicon transistor at room-temperature is as good as that of the 'gold-standard' – an MBE-grown, III-V transistor formed on InP.

Researchers from Intel and IQE began by comparing the performance of InP films deposited on native substrates by MBE and MOCVD. Multi-frequency capacitance-voltage curves using TiN metal gates and $TaSiO_x$ dielectrics deposited by atomic layer deposition revealed that MBE and MOCVD can form InP layers with a low mid-gap density of interface states. The team's next step was to produce $In_{0.7}Ga_{0.3}As$ QW FETs with a high-*k* dielectric on InP. Again, MOCVD-grown devices were the equal of those made by MBE: Both transistors delivered similar values for sub-threshold swing and produced comparable plots of 'on-current' as a function of 'off-current'.

To compare the two deposition techniques for growth of III-V QW FETs on silicon, the researchers selected 75 mm (100) silicon substrates with a 4° off-cut. According to them, they employed the thinnest buffer ever reported: 0.5 μm of GaAs, followed by a 0.7 μm-thick graded layer of $In_xAl_{1-x}As$ and a 0.1 μm-thick $In_{0.53}Ga_{0.47}As$ bottom barrier. The graded ternary features an overshoot of indium concentration to x=0.7, before the composition is brought back to end at x=0.52. Doing this ensures full relaxation in the buffer and means that the bottom barrier is lattice-matched to a 50 nm-thick, $In_{0.53}Ga_{0.47}As$ QW.

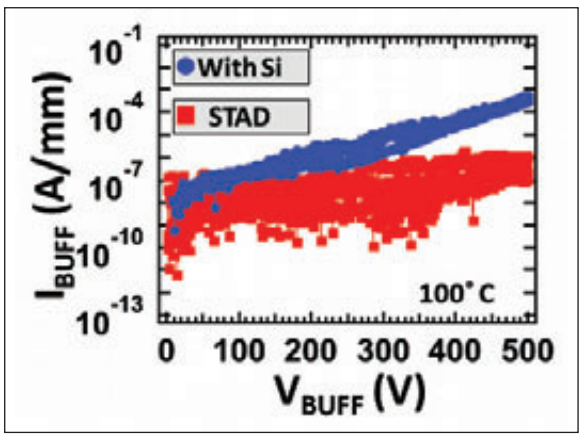


Figure 6. At imec researchers have developed GaN double-heterostructure FETs that feature a silicon trench around the gate. This unique feature improves the buffer leakage current by up to three orders of magnitude

Atomic force microscopy (AFM) reveals that the GaAs buffer grown by MOCVD is slightly smoother than its MBE-grown cousin. Its material quality is also better, according to X-ray diffraction. And scrutinizing the interface of silicon and GaAs with cross-sectional TEM reveals yet another advantage of MOCVD: Defects are confined at the interface, rather than spreading through the layer.

These characterization techniques have also been used to assess the quality of full epitaxial structures. AFM measurements reveal that the MBE-grown sample is slightly smoother than its MOCVD-based rival, and X-ray diffraction measurements indicate that the material quality of the $In_{0.53}Ga_{0.47}As$ bottom barrier and quantum well are very similar in both samples. Inspection with the TEM indicates a complete lack of defects in the samples grown on InP, and a defect density of 2 x 10^9 cm^{-2} in both silicon-based samples, which had defects typically 50 nm by 100 nm in size. Hall measurements reveal very promising values for the carrier mobilities of the MBE-grown III-V FETs on silicon. At 300 K, mobility was typically 8000 cm^2 $V^{-1}s^{-1}$, and at 77 K it exceeds 22,000 cm^2 $V^{-1}s^{-1}$.

GaN FETs with thinner buffers

An entirely different class of III-V-on-silicon transistors were discussed in a paper by Puneet Srivastava from imec: GaN double-heterostructure FETs featuring a Silicon Trench Around the Drain (STAD) contact. The merit of this novel device is the combination of a 2 kV breakdown voltage and good performance at elevated temperature, despite the use of a relatively thin buffer.

With conventional GaN-on-silicon HEMTs, the high breakdown voltage stems from a thick buffer layer – typically 7 μm to realise a 2 kV blocking voltage. If the buffer is much thinner than this, the transistor prematurely fails through interfacial conduction across the AlGaN-silicon interface. Thick buffer layers prevent this but present their own problems, such as strain in the epiwafers that can lead to bowing of the wafer and even crack formation. Previously, imec's researchers had managed to realise high breakdown voltages with buffers just 2 μm-thick by removing a small region of the silicon substrate between the source and drain contacts.

"With this technique, we achieved a high breakdown voltage of over 2 kV," says Srivastava. "But the devices suffered from enhanced self-heating, because there is

no silicon substrate under the gate region [where the heat is generated]. With the STAD approach, the silicon substrate is still under the gate electrode, which has improved thermal performance."

These novel FETs were formed on silicon (111) substrates, because this orientation has a smaller lattice mismatch with AlN than silicon (100). After the epitaxial stack is formed, which features a 3 nm-thick $Al_{0.45}Ga_{0.55}N$ barrier, a 150 nm-thick GaN channel and a 2 μm-thick $Al_{0.18}Ga_{0.82}N$ buffer, the substrate is thinned to 125 μm and trenches are formed around the drain contact with reactive ion etching.

To assess the performance of these transistors, the team also produced control devices without a STAD. The breakdown voltage of these devices saturated at 650 V, while the breakdown voltage of the STAD FETs increased with gate-drain distance, exceeding 2 kV for a separation of 20 μm. The transfer characteristics (I_{DS}-V_{GS}) revealed no change in threshold voltage with the introduction of a trench around the drain contact, indicating no deterioration to the two-dimensional electron gas (2DEG) channel. High-temperature performance of the STAD FETs was assessed by measuring the buffer leakage at 100 °C. The team found that this leakage is several orders of magnitude lower than that of the control at 500 V (see Figure 6).

Barriers supress leakage

A novel GaN architecture has also been developed at Panasonic to deliver low reverse-leakage current, fast recovery times, and a breakdown voltage of 600 V. This diode could be used in power supply circuits, including those fitted to hybrid electric vehicles.

In these types of applications, silicon incumbents will compete with SiC and GaN variants in the power switching market. One of the key differences between the two wide bandgap diodes is that GaN has a lateral configuration, while the configuration in the SiC device is vertical. A lateral configuration is superior, according to the Panasonic team, because it has an inherently lower capacitance.

"We believe the area of the top electrodes is the dominant origin of capacitance," says Panasonic's Tetsuzo Ueda. "By minimizing the area of the top two electrodes, we can reduce the total capacitance with the lateral configuration. We are attaching the electrodes directly to the 2DEG, so we believe we can reduce the area sufficiently."

Panasonic's novel diode features triple junctions of AlGaN and GaN on a silicon substrate (see Figure 7). The undoped multi-junctions behave as an insulator when the device is under reverse bias, thanks to balancing of the fixed polarization-induced charges at the top and bottom surfaces. This structure, which Panasonic refers to as the 'Natural Super Junction', does not require precise control of the doping, and a low operating voltage and contact resistance is possible by applying Ni/Au anode and Ti/Al cathode contacts to the sidewalls of the junctions.

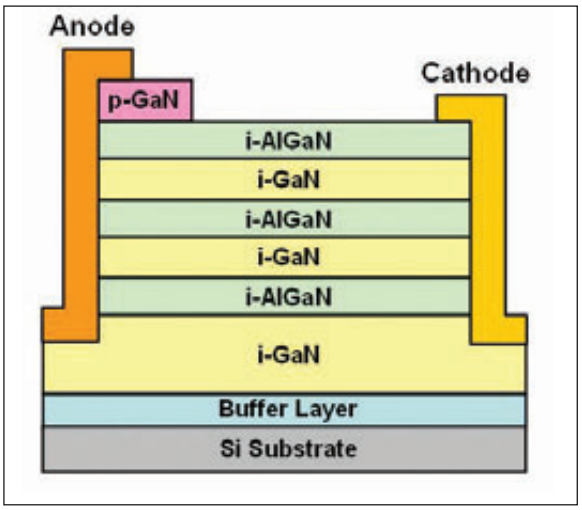


Figure 7. Engineers at Panasonic have developed a variant of the natural superjunction diode that includes a p-GaN barrier controlling layer, which supresses leakage current

This particular structure suffers from a high leakage current, which prevents high operating voltages. But the engineers at Panasonic have recently developed a way to combat that by adding a p-type GaN blocking layer. Simulations show that with this addition the depletion resulting from the p-GaN layer increases the tunnelling distance, thereby supressing the tunnelling currents and the reverse leakage current.

The paper presented by Panasonic researchers at the IEDM meeting in Washington detailed devices with this architecture, which were formed using MOCVD. These devices were compared with commercial SiC diodes. This effort determined that the GaN multi-junction diode has a significantly lower capacitance than its SiC rival, produces a blocking voltage up to 600 V and delivers 18 A at 1.5 V. Boost converter circuits have been built with Panasonic's diode and a GaN-based, normally off GIT, which has an on-state resistance of 100 mΩ and a breakdown voltage of 600 V. Operating at 100 kHz, the efficiency of this convertor exceeds 98 percent, outperforming the combination of SiC Schottky barrier diode and silicon free-wheeling diode that can drive the GaN-based GIT.

Panasonic is starting to try and exploit the commercial promise of this diode, which outperforms its SiC rival in terms of circuit-level efficiency and enables a reduction in component count.

This novel GaN device detailed at IEDM by Panasonic, plus that described by imec and the advances in III-V transistors reported by many groups, highlights the promise of the compounds to exceed what is possible with silicon. And at IEDM 2012, it's a sure bet that they'll be many more announcements echoing this theme.

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Defining the next steps for the Compound Semiconductor Industry

It's an incredible time for our industry, which is mulling over many important questions. How is the GaAs architecture in mobile devices going to evolve to enhance connectivity? Is the growth of CPV strong enough to grab a significant share of the solar market? When will LED lightbulbs start to generate significant revenues? Will nitride laser production switch to growth on semi-polar and non-polar substrates, and how can such materials be made? Can III-Vs help to maintain Moore's law beyond the 15 nm node?

Speakers at this 2 day meeting include leading analysts in the compound semiconductor sector, representatives of the biggest GaAs foundries in the world, and leaders of the top LED and nitride laser manufacturers. There is also a session dedicated to the development of III-Vs on CMOS that includes speakers from Intel, SEMATCH and imec.

Dr Andrew Nelson
IQE
President and Chief Executive Officer

Topic:
Conference Chair

Dr. John Atherton
WIN Semiconductors
Associate Vice President

Topic: Building a successful III-V pure play foundry

Dr. Michael A. Briere
International Rectifier
Job title

Topic: Commercialization of GaN on SI based Power Devices

Robert Chau
Intel Corporation
Technology and Manufacturing Group Director

Topic: III-V on Silicon: challenges and opportunities

Dr. Markus Behet
Dow Corning
Global Market Manager Power Electronics

Topic: Advances in wide bandgap semiconductors for power electronics

Dr. Matty Caymax
Imec
Chief Scientist

Topic: European efforts to develop III-Vs on 200 and 300 mm silicon

Asif Anwar
Strategy Analytics
Director – Strategic Technologies Practice

Topic: Compound Semiconductor markets: Current status and future prospects

Professor Iain Black
Philips Lumileds Lighting Company
VP WW Manufacturing Engineering, Technology & innovation

Topic:
Perspective of an LED manufacturer

Dr Mike Czerniak
Edwards,
Product Marketing Manager, Exhaust Gas Management

Topic: Holistic approach to MOCVD vacuum & abatement

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Topic: Ammono's ammonothermal method to make GaN substrates

Dieter Liesabeths
SemiSouth Laboratories,
Vice President Sales & Marketing

Topic: Markets and applications for SiC transistors

Iain Thayne
University of Glasgow
Professor

Topic: The Integration of silicon CMOS with III-Vs

Dr Mariane Germain
EpiGaN
Co-Founder & CEO

Topic: Large diameter GaN-on-Si epiwafers for power electronics

Dr. John Palmour
Cree
Co-founder and CTO, Power & RF

Topic: SiC and GaN electronics

Jan-Gustav Werthen
JDSU
Senior Director, Photovoltaics

Topic: The CPV market following the acquisition of Quantasol technology

Todd Gillenwater
RFMD
VP of Technology and Advanced Development

Topic: Tomorrow's RF chips for future mobile devices

Sanjay Raman
DARPA
Program Manager, DARPA/Microsystems Technology Office

Topic: An overview of the DARPA DAHI program

Peide Ye
Purdue University
Professor of Electrical and Computer Engineering

Topic: III-V 3D transistors

Dr Richard Hill
Sematech
Project Manager of SEMATECH's Front End Processes Program

Topic: III-V on 200 mm Si for VLSI

Dr James W. Raring
Soraa Inc.
VP of Laser Engineering

Topic: III-Nitride Lasers Based on Nonpolar/Semipolar substrates

Dr Schwyn- Thoeny
Evatec
Senior Process Engineer

Topic: Damage – free deposition on LED devices

Professor Rik Jos
NXP Semiconductors
RF Technology Fellow & Innovation Manager

Topic: GaN the enabler for true SDR

Dr Philippe Roussel
Yole Developpement
Senior Project Manager

Topic: Wide bandgap device market update

Philip Smallwood
IMS Research
Lighting Market Analyst

Topic: The market for LEDs in lighting

Dr Michael Lebby
Translucent Inc.
General Manager & Chief Technology Officer

Topic: Scalable solutions (GaN-on-Si and Ge-on-Si) using rare oxide buffer layers

Mr. Bryan Bothwell
TriQuint Semiconductor
Strategy and Business Development Manager - Foundry Services

Topic: Achieving GaN & GaAs RF design success through product & foundry innovation

Dr. Thomas Uhrmann
EV Group (EVG)
Business Development Manager

Topic: Temporary bonding: An enabling technology for RF and power compound semiconductor devices

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T: +44 (0)2476 718970 E: stephen.whitehurst@angelbc.com

CSindustry awards2012

From backlighting TVs to empowering mobile devices and harnessing the sun's energy, compound semiconductor chips are playing an ever increasing role in modern life. This is set to continue, but who had the biggest breakthroughs over the last 12 months? Which pioneering companies from around the globe created the best opportunities for the compound semiconductor industry?

The CS Industry Awards will recognise the success and development along the entire value chain of the Compound Semiconductor industry from research to completed device. The Awards will focus on the people, processes and products that drive the industry forward. Compound Semiconductor has created the CS Industry Awards to recognise the vital individuals and companies that enable a company to achieve success in a competitive global market.

The categories represent key areas where challenge met innovation. The CS Industry Awards are a platform that allows the compound semiconductor industry to judge and make their voices heard about the people and products and practises serving this industry.

The CS Industry Awards will remind us what is good about the industry – the people who drive it with their technical expertise and customer orientated perspectives.

Nominations are open to all companies, individuals and organisations within the CS industry and voting will occur through Compound Semiconductor online and print services.

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Substrates, & Material Award
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Shrinking cooling demands for **surveillance detectors**

Surveillance is increasingly performed with unmanned aerial vehicles fitted with infrared imaging systems. These long-wavelength, high-performance detectors require substantial cooling and draw a lot of power from on-board batteries. But these demands could be reduced with Sofradir's new generations of mercury cadmium telluride detectors that promise to operate at higher temperatures, thanks to improvements in passivation layers and device architectures. **Richard Stevenson reports.**

It is incredibly beneficial to slash the cooling demands of any device. One of the biggest gains that follows is that a smaller, cheaper and lower weight unit is then good enough to provide device cooling. On top of this, power consumption is reduced, because the new cooler either draws less power or consumes less cooling fluids.

One family of devices that it is essential to cool are solid-state infrared detectors – fail to do this and the dark current is far too high for the acquisition of good-quality images. Cooling to cryogenic temperatures is mandatory for the three most common types of high-performance, infrared detector, which are based on InSb, mercury cadmium telluride (MCT) and quantum well heterostructures formed from the GaAs family of materials.

Traditional InSb detectors are relatively straightforward to build, but they suffer from two major weaknesses: The focal plane of the detector has to be cooled to 77 K, and its response is limited to a narrow spectral range of

just 3-5 μm. It is possible to increase this detector's operating temperature to 150 K by switching from bulk InSb to more complex structures that include InAlSb and are grown by MBE. But this technology is in its infancy, and it is currently very challenging to manufacture detectors with this approach.

QWIPs is based on a far more mature materials technology, GaAs-based heterostructures. However, the sensitivity of a QWIPs detector is not as high as that for MCT, which can operate over a far wider spectral range. These II-VI devices can be tuned to cover the visible, or to detect radiation classified as short wave (1-2.5 μm), medium wave (3-5 μm), long wave (7-10 μm) or very long wave (around 14 μm).

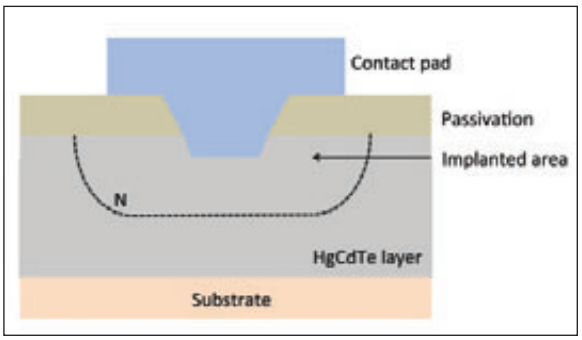
One of the biggest downsides of the MCT detector is its cooling requirement. Although this is not as severe as that for conventional InSb detectors, commercial MCT detectors do require cooling to 80 -130 K, with the exact figure depending on the operating wavelength – it is higher for shorter wavelengths. It is possible to reach these temperatures with Stirling coolers, which operate just like refrigerators and use helium gas. And if cooling is required for a single, very short time, a Joule-Thompson cooler can be used, which involves the release of a high-pressure gas from a vessel.

Military demands

The biggest market for the MCT detector is the military, where it is often employed for surveillance. When these detectors are fitted on tanks, carriers, destroyers, submarines, fighter planes and helicopters, trimming the size, weight and power consumption of the detector's cooling system is not necessarily a big deal. But it can make a major difference to the range of unmanned aerial vehicles (UAVs), pilotless planes that can have a wingspan of just a few metres.

Today, the power drawn by the cooler from a set of batteries typically exceeds that required to run the detector, but it should be possible to start re-dressing this balance by making detectors that can operate at significantly higher temperatures. One company that is trying to do just this is the French firm Sofradir, which is headquartered close to Paris and has its development and production facilities in Veurey-Voroize, a town within France's 'infrared valley'. Spun off from CEA-Leti in 1986, Sofradir has a clear long-term plan for increasing the operating temperature of its wide range of commercial MCT detectors.

The company's standard technology combines an optimised passivation process with high-quality substrates and epilayers to yield detectors with operating temperatures up to 120 K. In future, the company plans to launch detectors with an inverted doping structure that can operate at up to 150 K, followed by more complex epitaxial designs that will drive down dark current. These more sophisticated structures, which will require a switch of growth technology from liquid phase epitaxy to MBE, should lead to operating temperatures of 200 K.



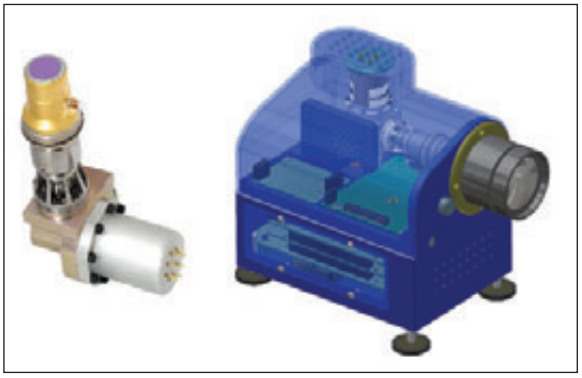
Sofradir's standard 'n-over-p' mercury cadmium telluride detector

Efforts to improve the performance of MCT detectors are carried out in partnership with CEA-Leti. "We have had a long, historical relationship, and in 2003 we set up a joint lab with CEA-Leti to share our R&D," explains David Billon-Lanfrey, Vice President of R&D, technology and products at Sofradir. "[CEA-Leti] gives us a lot of new ideas and a lot of expertise, in terms of technology. We bring the needs of the market and industry constraints. It's one thing to do one demonstrator – it's another thing for our infrared technologies to turn production at large quantities."

A key requirement for any high-quality detector is that it has very few defective pixels. According to Sofradir, the proportion of defective pixels should be less than 0.5 percent. Unfortunately, as operating temperature rises, the ratio of defective pixels to good ones increases, due to various forms of noise. Engineers at Sofradir and CEA-Leti have reduced the proportion of defective pixels by driving down the density of defects and dislocations in the MCT layer through improvements in substrate quality and epitaxy.

"Passivation layers are also playing a big role," adds Billon-Lanfrey, because improvements to the passivation layer suppress the current leakage out of the device.

Sofradir is keeping the details of this improved passivation process under wraps, but it is willing to disclose the benefits brought to device performance. In 2010, more than thirty MCT detectors were made using a range of processes. Through optimisation of the passivation



Sofradir has demonstrated its superior passivation technology in its Scorpio detector, which is fitted to a camera for demonstration

process and epitaxial growth, the maximum operating temperature for these detectors – which featured 384 by 288 pixels with a 15 μm pitch and had a cut-off wavelength of 5 μm at 80 K – increased from 90 K to 120 K.

More recently, Sofradir's engineers have started to apply these improvements to the company's Scorpio detector, which has 640 by 512 pixels and a 5 μm cut-off wavelength. This detector's operating temperature has increased from 90 K to 120 K and the power required for cooling has halved.

Unmanned aerial vehicles (UAV) may be fitted with mercury cadmium telluride detectors that provide infrared images over a vast spectral range. The cooling system for these detectors draws heavily on the batteries fitted to the UAV. However, this demand can be reduced by raising the operating temperature of the detector through switching from the traditional 'n-over-p' design to a 'p-over-n' variant, or by introducing more complex epitaxial layers. The Scan Eagle UAV pictured here weighs 40 lbs, has a ten-foot wingspan, is invisible to radar, can fly over a designated battle space for up to 15 hours and can transmit real-time imagery directly to its home link

" We go from something like 3.5 W to 1.7 W, depending on the size of the components," says Billon-Lanfrey. The company took this to the SPIE Defense Security and Sensing conference held in Orlando last April. At this gathering its main rival was a form of InSb-based detector featuring an InAlSb or InAsSb barrier layer and sporting an operating temperature of up to 150 K.

However, according to Billon-Lanfrey, the higher operating temperature came at the expense of an inferior cut-off wavelength, which suppressed the dark current. "In the temperature range we are looking at, the maximum emission is in the four-to-five micron band. With a cut-off at four microns, there aren't enough photons to achieve good image quality in poor weather conditions."

Inverted architecture

Another aim for the French outfit is to demonstrate a 'p-over-n' MCT detector in 2012. "We expect to have a focal plane temperature of between 150 K and 170 K," says Billon-Lanfrey, who adds that it will take roughly another two years before this technology is used in production.

Switching from the conventional n-over-p MCT detector to a p-over-n variant enables a substantial increase in operating temperature by cutting dark current by one-to-two decades. The fabrication of such a device requires far greater modification of the production process than that which occurred during the introduction of a superior passivation process. But the engineers at Sofradir don't have to start from scratch. That's because they and their colleagues at CEA-Leti started to develop a p-over-n technology for long-wavelength detectors in 2003, which is now used on the Scorpio LW that has a 9.5 μm cut-off wavelength.

Sofradir is continuing to develop its p-over-n technology for long-wave detectors and apply it to medium-wave cousins. Billon-Lanfrey believes that this should enable the production of medium-wave detectors operating at up to 150 K. To reach even higher temperatures will require the introduction of more complex architectures that may incorporate a barrier layer. Today CEA-Leti is working on the development of this technology, which requires a shift from liquid phase epitaxy to MBE growth of the epilayers.

The plan is to demonstrate this form of detector in 2014-2015 and start production two years' later. If Sofradir can hit these goals and its near-term targets, it will deliver significant improvements in the performance of infrared detectors throughout the remainder of this decade. Commercial success appears destined to follow, giving those working in the infrared valley yet more achievements to be proud of.

Speeding up GaN for biomedical sciences

Biomedical diagnostics and next-generation optical data storage require ultra-fast bursts of blue and purple laser emission. Complex, cumbersome and bulky Ti:sapphire lasers are providing these pico-second pulses today, but it would be preferable to use a simpler, cheaper and far more portable GaN chip that we are now developing through a European future and Emerging technologies project, say **Dmitri Boiko from CSEM.**

If you step into a life-science laboratory, you'll probably see a large optical bench crowded with expensive, bulky equipment for time-resolved fluorescence measurements. The make up of this kit will vary from lab to lab, but on the bench you'll possibly find photomultiplier tubes and a scanning confocal microscope. Nestled amongst some of these items will undoubtedly be a Ti:Sapphire laser oscillator, emitting a steady stream of pulses that could last for a few picoseconds, or maybe even a fraction of that time.

This Ti:Sapphire laser is a complex, cumbersome contraption that is assembled from several units. And snuggled up next to it, taking up yet more space, will be a frequency-doubling component, because this laser emits in the infrared and biological samples and dye markers absorb in the blue-green.

At the heart of Ti:Sapphire laser sits a Ti:Al_2O_3 crystal, a medium that must be pumped by a powerful green laser source. Unfortunately, semiconductor lasers emitting in the green are still in their infancy, so the tried and tested approach in today's labs is to use either a Nd:YVO_4 or Nd:YAG laser, pumped by an infrared diode. But the emission from the neodymium-based laser, while having the virtue of being efficient, is also in the near-infrared – to be precise, it's at 1064 nm. So it has to be frequency doubled in a second-harmonic generation (SHG) unit to provide the green pump beam for the Ti:Sapphire oscillator.

Putting this into simpler terms, the generation of ultra-short pulses requires three lasers – a semiconductor laser diode, a Nd:YVO_4 laser and a Ti:Sapphire laser – plus two SHG frequency conversion units. Working in combination, these lasers and frequency doublers are incredibly inefficient – a 50 W output from the diode laser is converted to just a few milliwatts of blue-green light. Running costs are also high, partly because there are steep bills for maintenance and repair. Given all this,

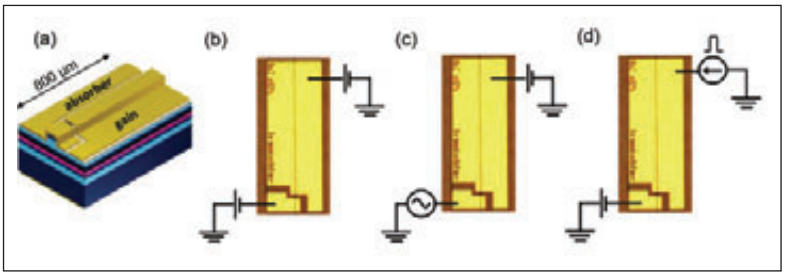


Figure 1. Multiple section cavity arrangement (a) and driving conditions for operation in self-starting mode-locking (b), active mode-locking (c) and superradiance (d) regimes . Figure show images of Femtoblue devices grown and processed by researchers at EPFL. The cavity design is made by researchers at CSEM, LPI and UCAM

the obvious question to ask this: Is there an easier way to generate blue-green picosecond pulses?

Nitride solutions

Well, there isn't a unit that you could buy off the shelf for doing this today – but there soon could be. That's because it has been recently shown that is possible to generate really short pulses with a GaN-based laser, which has the great attribute that its spectral range is a perfect match for the absorption spectrum of many organic components. This wide bandgap source also has many key advantages over the Ti:Sapphire incumbent, including low cost, small size and maintenance-free operation. These characteristics enable the GaN laser to provide the first portable source of blue-green ultra-short pulses, opening up the opportunity for a portable, time-resolved fluorescence measurement system to be placed at the point of care for biomedical diagnostics.

Within Europe we are trying to create such a laser through a project called FemtoBlue, which is funded through the European Commission. This effort, which kicked off in September 2009 and is backed by € 2 million of funding, is drawing on a diverse set of talents held by researchers at six institutions: The Swiss innovation and research institute CSEM, which is co-ordinating the project; Fraunhofer IAF; EPFL; the Lebedev Physical Institute of the Russian Academy of Sciences; the University of Cambridge; and the Technical University of Berlin. The mission for this multi-national team is to create an ultra-fast semiconductor laser diode that produces sub-picosecond optical pulses in the blue and violet spectral range.

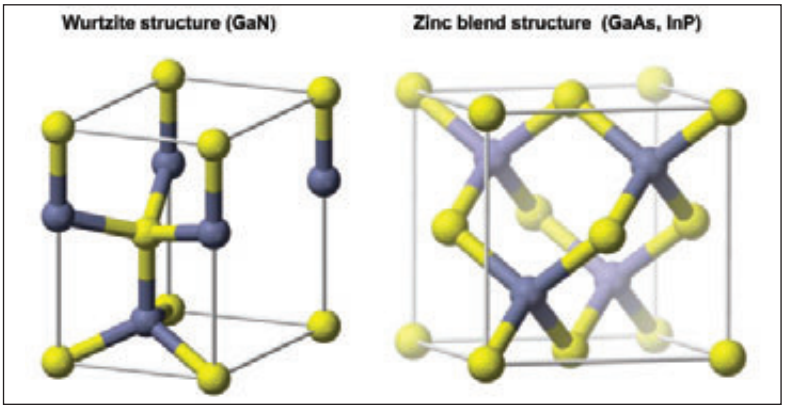


Figure 2. Wurtzite lattice structure of nitrides (left) and Zinc blende lattice structure of conventional III-V compounds (right)

If successful, the benefits could extend beyond activities in the biological sciences. Blue and violet lasers with ultra-fast pulses could unlock the door to a new, three-dimensional optical data storage disc technology that replaces the Blu-ray standard. Other possible applications include multiphoton nano-processing and nano-imaging (see "Further Reading" for details).

Our development of ultrafast GaN lasers is not the only work in this field. A Japanese collaboration between Sony Corporation and Tohoku University's New Industry Creation Hatchery Center has recently reported the output of 2 ps pulses with a peak power of 20 W and a 1 GHz repetition rate from an external-cavity, multi-section laser diode.

By feeding this output into a semiconductor optical amplifier, this research team has boosted peak power to 300 W. Their approach is markedly different from ours, using a relatively large laser system rather than a monolithic cavity design, but it provides another example of the capability of GaN lasers for providing pico-second pulses in a spectral range suited to biomedicine.

Forming ultra-short pulses

The good news for anyone trying to develop pico-second GaN lasers is that they don't have to re-invent the wheel. Instead, they can exploit all that has been learnt in the evolution of arsenide and phosphide lasers that deliver ultra-short optical pulses. With these AlGaAs and InGaAsP lasers, it has been possible to realize a wide variety of ultra-fast dynamic regimes by applying multiple p-contacts to the top of the device (see Figure 1).

In these modified lasers, one section is positively biased to provide optical gain, while another section takes on the role of a saturable absorber, which is driven as a photodiode with negative bias. With this design, lasing characteristics are governed by the driving conditions for each cavity and its geometry. Through a complex interplay of numerous phenomena, lasing is possible in eight different dynamic regimes, three of which produce ultrafast pulses.

By applying an appropriate combination of applied voltages, the laser can operate in a self-starting passive mode-locking regime. Operating in this fashion, researchers at University of Cambridge have produced a InAs-GaAs quantum dot source emitting pulses with a

peak power of 2.25 W, a duration of 0.35 ps, and a repetition rate of 16.8 GHz that is set by the cavity roundtrip time. Applying a tapered waveguide and a longer cavity, researchers at the University of Dundee and Alcatel-Thales III-V Lab have demonstrated a peak power of 15 W, and a pulse duration of 0.8-1 ps at a repetition rate of 10 GHz. Self-mode locking does have the downside of a relatively high timing jitter for the generated optical pulses, but this can be addressed by applying a periodic modulation to the absorber at the pulse repetition rate. Do this and the laser operates in the active mode-locking regime.

A vastly different form of laser output is also possible, which is referred to as the Dicke superradiance regime – it involves spontaneous emission of a solitary coherent optical pulse. Prior to the emission of this pulse, the active region must be densely populated with a non-equilibrium of electron-hole pairs. Creating this condition in a GaAs laser enabled researchers at Lebedev Physical Institute to produce pulses with a peak power of a few hundred watts and a width of just 180 fs, operating in a pulse-on-demand mode.

Bridging the gap

It is tempting to think it would be easy task to transfer the technology used to create ultra-short pulses in GaAs-based and InP-based lasers to blue and violet GaN lasers. But that's not the case. One must realize that although the requirements for making red and infrared femto-second monolithic semiconductor lasers have been known for more than 20 years, practical realisation of such devices is not that advanced – industrial developers of such sources are, in general, still refining these sources in their labs. The reality is that there are very few commercial monolithic mode-locked laser products on the market – we know of only one industrial company offering such a product in reasonable quantities.

One major distinction between the nitrides and their more traditional III-V cousins is a significant difference in their set of intrinsic characteristics. For example, nitrides have a higher effective hole and electron mass. This not only limits the available output power in a GaN laser, but also restricts its pulse width to 30-50 ps (assuming that a conventional design is used and the device is operated in the gain switching regime). However, the large effective hole mass might offer advantages for (quasi-) continuously pumped femtosecond mode-locked GaN lasers, thanks to a high density of hole states. The reality is that this work is in its infancy, and there is a whole spectrum of unanswered questions concerning ultra-fast carrier dynamics in InGaN alloys.

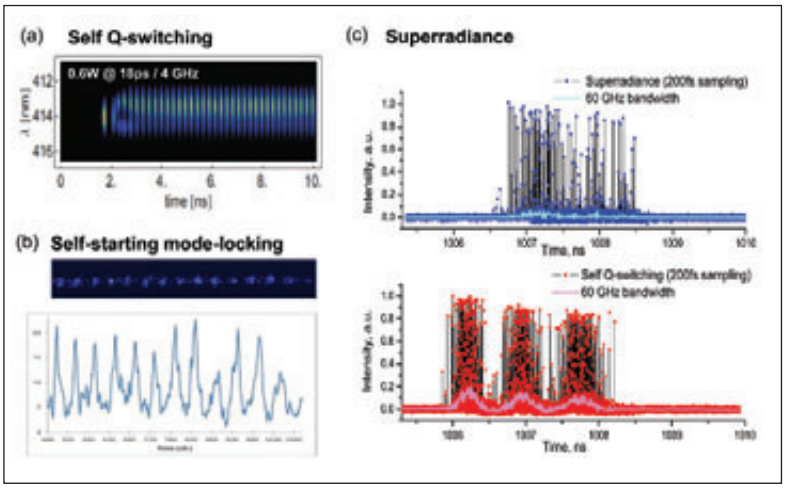


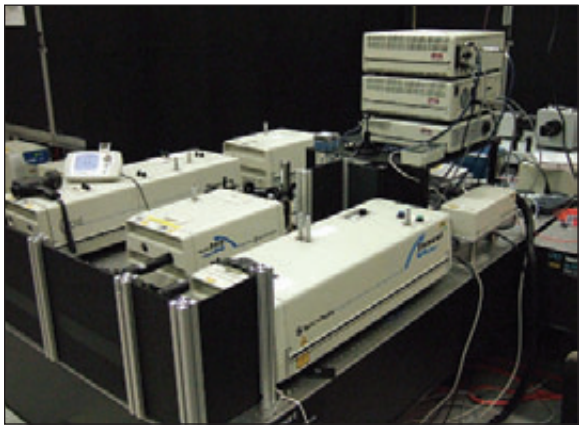
Figure 3. (a) Q-switching performance measured by researchers at Fraunhofer IAF revealed generation of 18ps pulses of 0.6 W as seen on a spectrally resolved streak camera trace. (b) Pulse train detected by researchers from Lebedev Physical Institute on single-shot streak camera, obtained when multiple section InGaN/GaN laser was driven under self-starting passive modelocking conditions. Pulse width is 7 ps, repetition rate is 32 GHz. (c) Features of superradiant emission (top) vs Q-switching (bottom) detected in the laboratories of CSEM using ultrafast detector and sampling scope. As opposed to Q-switching, narrow-width optical pulses with a high jitter in the superradiance regime disappear after a low pass filter at the bandpass of detector has been applied in data processing

Another distinguishing feature of the nitrides is that they have a wurtzite crystalline symmetry, which is markedly different from the zinc blende symmetry associated with conventional III-V materials (see Figure 2). T

he wurtzite crystal structure is responsible for an internal spontaneous and piezoelectric polarization field, which pulls apart the electrons and holes in nitride quantum wells, reducing carrier overlap and quashing radiative efficiency. If the well is too wide it can eliminate optical gain in this active region and thereby prevent lasing.

To realize mode-locking and superradiance in any class of semiconductor laser, the device must contain a suitable saturable absorber. Fortunately, it is relatively easy to form this in a monolithic-cavity with multiple contacts. In conventional III-V devices, tweaking the reverse bias voltage of the absorber section provides control of saturable absorption and output pulse parameters via the quantum confined Stark effect (or Franz-Keldysh effect in bulk active layers). In this class of laser, increasing the negative bias produces a red-

To realize mode-locking and superradiance in any class of semiconductor laser, this device must contain a suitable saturable absorber. Fortunately, it is relatively easy to form this in a monolithic-cavity with multiple contacts



Ti:Sapphire lasers, which are widely used in biomedical labs, are large, complex contraptions. This photographic image is courtesy of Mircea Cotlet from Brookhaven National Laboratory

shift in the absorption edge, and in turn a gradual increase of modal absorption.

With a nitride laser it's a very difference story, due to competition between the quantum confined Stark effect and the built-in polarization field. Increases in bias initially lead to a reduction in absorption, because the external field just offsets the internal built-in field – only when the voltage is cranked up is the necessary level of absorption realised.

When the influences associated with the nitrides are accounted for, we have found that we are able to build pico-second lasers that behave as one would expect. Our preliminary results that have been acquired with a streak camera reveal a train of periodic pulses from our laser when it is driven in a passive mode-locking regime (see Figure 3). We can also drive our laser in a different manner, so that its emission resembles the regime of superradiance. According to measurements with our sampling scope, our laser produces red-shifted, high amplitude pulses with a large jitter, features indicative of superradiance. Measurements of pulse width and efforts to optimise the production of pulses are on going.

Further reading

FemtoBlue project website: http://femtoblue.epfl.ch
R. Koda et al. Appl. Phys. Lett. ***97*** *021101 (2010)*
Peter P Vasil'ev, Rep. Prog. Phys. ***72*** *(2009) 076501*
D. A. Parthenopoulos et al. Science ***245*** *843 (1989)*
S. Kawata, et al Nature ***422*** *697 (2001)*

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New markets beckon for **miniaturized LEDs**

Miniature LED arrays produce incredibly bright, colourful displays that are suitable for many applications. Opportunities include exposing resists; confining and manipulating cells; and probing and controlling genetically targeted cells, says **Jim Bonar from mLED.**

The LED is, in general, getting bigger and bigger. Until recently, the most common dimensions for an LED were 300 μm by 300 μm, a size that can generate enough light for backlighting the displays of handsets, laptops and other screens. But the killer applications for this decade and beyond, general lighting, requires far higher light levels, and this means chips with sides of at least 1 mm.

Making chips bigger, however, is not the only route to increasing the number of applications that LEDs can serve. New markets also beckon when the device's dimensions are reduced substantially, so that its sides are less than 100 μm. Some markets can be addressed with single emitters of this size, but most of the opportunities require a battalion of them that form an LED array. These can be used to expose resists, confine and manipulate cells, play a role in measurements of fluorescent lifetimes, aid the acquisition of depth-resolved microscopic images and help to build direct-write photolithography systems.

One of the most exciting opportunities of all is in optogenetics, a nascent field in neuroscience that involves using high-speed optical methods to probe and control genetically targeted cells with intact neural circuits. Miniature LED arrays could help 1.5 billion sufferers of neurological disorders, such as Alzheimers, Parkinsons, depression and chronic pain. In addition, there are opportunities for miniature LEDs in visible light communications. This technology has already realized data transmission rates of up to 1 Gbit/s from a single pixel at 450 nm, using on-off keying non-return to-zero modulation.

At mLED, which is headquartered in Glasgow, UK, and was founded in July 2010, we are starting to tap into the many exciting opportunities associated with miniature LEDs. One of our core strengths is our exclusive licence that allows us to exploit patented research from Martin Dawson's group at the Institute of Photonics (IoP), University of Strathclyde. The IoP has been at the forefront of research on micro-pixellated LEDs for more than a decade, and during that time it has demonstrated many technical achievements in this area, in collaboration with partners at several UK universities, including Edinburgh, Glasgow, St. Andrews and Imperial College London. In particular, the IoP group has pioneered the use of these micro-pixellated sources in optical microsystems.

Our mission is to create a range of industry-leading, high-brightness micro-displays that can be controlled by computer to provide pattern-programmable sources. We aim to work alongside system integrators, first developing prototype capabilities and then scaling up to production volumes. This way, we can provide bespoke designs that address specific applications and enable products to get to market fast. To make this happen, efforts have focused

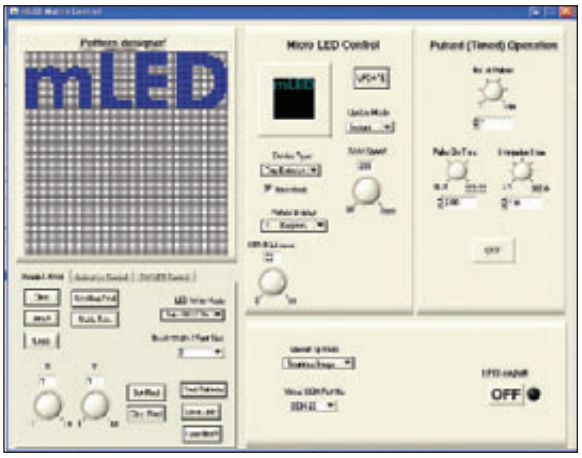

Figure 1. Graphical user interface for matrix addressable 64x64 demonstrator array, permitting simple installation and turn-key operation for the customer's specific application

on taking a patented technology and turning it into a robust commercial product. This quest has been aided by securing access rights to facilities at the West of Scotland Science Park in Glasgow. Here we can access a range of equipment dedicated to III-V manufacturing and development. This allows us to reduce variations in our processes and minimize capital expenditure. In addition, this approach reduces the risk of cross-contamination and process instability, while the standard process flows and building blocks that we have established give us the opportunity to scale to high-volume production.

Shrinking the size of LEDs

At the heart of our displays are high-density arrays of miniature GaN LEDs, which can span the ultraviolet through to the blue and green (recent research at the IoP, however, shows that it is also possible for GaN LEDs to even emit in the green-yellow and amber – see the box "Stretching GaN beyond the green"). These arrays are the foundation of a high-brightness monochromatic GaN microdisplay or 'pico-projector' technology, which can be used to form full-colour micro-displays with the addition of pixel colour conversion

The LEDs in our arrays are typically just 2 μm to 80 μm in diameter. To form these devices, we use a series of processing steps that were developed at the IoP. These involve the growth of a GaN LED epiwafer on sapphire,

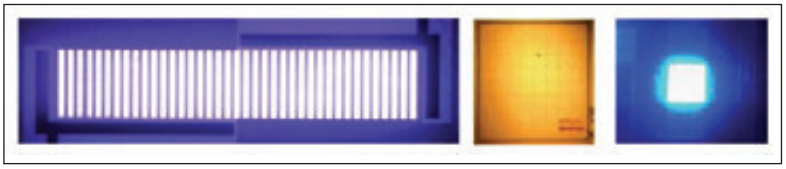

Figure 2. A number of device configurations highlighting the flexibility of the technology. (a) 128 microLED stripes each 20 μm x 500 μm on a centre-to-centre spacing of 23 μm. (b) 200 μm x 200 μm checkerboard device with pixel edge separation of 2 μm and (c) a magnified view of a single pixel in operation

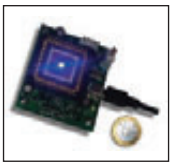

Figure 3. 8 x 8 individually addressable microLED array demonstrator unit operating at 450 nm

which is processed into an array of pillars with a combination of photolithography and etching with an inductively coupled plasma.

As with conventional LEDs, a flip-chip architecture holds the key to far higher light extraction efficiency. This is realised by adding several layers to the processed epiwafer: An n-contact; a silicon dioxide insulator layer; and then a highly reflective, common p-contact. After the devices are formed, chemical mechanical polishing reduces the thickness of the sapphire substrate.

Efforts at the IoP demonstrate that it is possible to make thousands of miniature LEDs into arrays that are collectively addressable and have a total active area equivalent to that of one 'conventional' LED chip. With this passive matrix approach, only 2*N* contacts are required for an *N* x *N* matrix. Using this, back in 2004 IoP demonstrated a 128 x 96 passive matrix device with 12 μm x 16 μm pixels on a 20 μm center-to-centre spacing. Occupying an active area of 3 mm x 2 mm, displays based on blue and green devices were produced with a luminance in excess of 30,000 Cd/m^2 (This is brighter than today's state-of-the-art micro-displays based on organic LEDs, a technology described in the box "What are the alternatives?").

We have improved the performance of these displays with matrix-addressing schemes that are suitable for high-resolution applications. All pixels along one column share a common anode and all pixels along one row share a common cathode. We now offer a turn-key 64 x 64 demonstrator unit. This light engine is supplied with a simple-to-use graphical user interface, offering the ability to interface easily with a host of system applications.

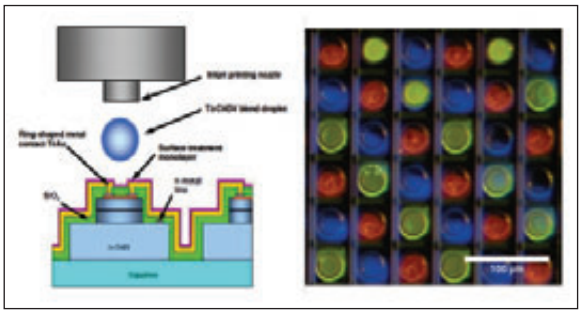

Figure 4. Colour conversion process for ultraviolet microLED emitter array using direct inkjet processing

It is also possible to address every pixel individually. We can do this with our bespoke CMOS backplane technology and flip-chip bonding techniques, which combine to control the output power of microLEDs. By employing a novel device arrangement, heat-sinking improves, opening the door to increased current density handling. Thanks to the possibility to use emission through the polished sapphire substrate (inert window), devices can be used in close proximity to an object, or the microLED emitter plane can be optically relayed/ imaged. Alternatively, aligned microlenses can be monolithically integrated and formed in the sapphire substrate.

Driving the arrays

To drive these pixels, we use a CMOS design based on standard low-voltage 3.3 V logic. However, we have developed a technique for the driver array that enables biasing above or below ground prior to an excitation signal being applied by the driver. This means that for higher output power density applications each diode can be biased at voltages greater than 5 V to allow the LED to be driven at high currents and therefore provide higher output power. LEDs can be driven continuously, or with excitation pulse widths that can be as short as just 300 ps (FWHM). A collaboration involving the IoP and other universities integrated such devices with arrays of single-photon avalanche diodes, and in 2010 the partnership claimed that it had made the smallest reported solid-state microsystem for fluorescence decay analysis.

Flexibility of the lithographic mask design enables the manufacture of various structures, including micro-disc, micro-stripe and chequerboard arrangements. Applications requiring structured illumination can be catered for with a stripe configuration, and high fill factors in excess of 98 percent are possible with chequerboard structures. We currently offer a turn-key 8

Stretching GaN beyond the green

Researchers at the IoP, in collaboration with colleagues at Peking University and Epilight, Shanghai, have recently fabricated GaN LED micro-arrays emitting in the yellow-green and amber.

Producing GaN LEDs operating in this spectral range is very challenging, because the high indium content required in InGaN quantum wells emitting in the yellow and amber tends to produce material imperfections that hamper light emission. To overcome these issues, the researchers have produced LEDs containing an electron reservoir layer that increases radiative recombination and cuts electron overflow.

Yellow-green and amber LED epiwafers were grown by MOCVD on sapphire substrates. The shorter-wavelength variant features a two-period electron reservoir layer with interlaced 3 nm-thick $In_{0.12}Ga_{0.88}N$ and 10-nm thick GaN, and an active region with a six period multiple quantum well – 3 nm-thick $In_{0.3}Ga_{0.7}N$ wells and 10-nm thick GaN barriers. The design for the amber LED had a 65 nm-thick, 5 period electron reservoir with interlacing layers of $In_{0.18}Ga_{0.82}N$ and GaN, and a five-period multi-quantum well with 2.5 nm-thick, $In_{0.4}Ga_{0.6}N$ wells.

Epiwafers were processed into LED arrays with 10 by 10 pixels, each with a diameter of 40 μm. A typical pixel in the yellow-green LED array emits at 560 nm, has a turn-on voltage of 3.2 V and a peak output power of 100 μW. This corresponds to a maximum power density of 80 mW mm^{-2}. In comparison, the 600 nm amber LED pixels turn-on at 3.8 V and have a typical peak output power of 55 μW, corresponding to a maximum power density of 44 mW mm^{-2}.

x 8 microLED demonstrator unit for system integration. The IoP has also fabricated arrays with colour conversion, realised by integrating photocurable nanocomposites and polymer blends onto the micro-LEDs. These are added by ink-jet printing, and convert ultraviolet or blue output of the array into a 'RGB' display. This team of researchers has also demonstrated self-aligned direct writing and colour conversion with a colloidal quantum-dot nanocomposite. In this case, the ultraviolet microLED cures the nancomposite in registry with the underlying pixels, and is then down-converted by this composite film.

Many applications have minimum levels for brightness, and if the lumen output exceeds this figure, so much the better. Our LEDs are outstanding in this regard, with power densities in excess of 3250 mW/mm^2 per pixel produced by 8 x 8 individually addressable 14 μm emitters operating at 450 nm. In comparison, conventional high-brightness LEDs are typically 700 mW/mm^2.

Our miniature LEDs have operated at a current density of 18 kA/ cm^2 when driven in DC; that's two orders of magnitude higher than that for high-brightness LEDs. Operating at this very high current density does not require any specific heat-sinking arrangements, and junction temperatures are low, thanks to the architecture of our arrays. What's more, there is still room for further improvement in the performance of arrays of miniature LEDs: We are currently developing more efficient light extraction techniques that will boost lumen output and enable this technology to target the general lighting market.

One area where our novel LEDs could soon start making an impact is the field of optogenetics. Neurological disorders affect more than one in five people across the world, and the total bill for treatment exceeds $1 trillion per year. Drugs, neuromodulation, surgery and talk therapy are all used today either to improve or control a patient's condition. However, in future, optogenetics may be added to that list. Although optogenetics research is at an early stage, rapid progress is being made. Our devices have a great deal to offer here, because they can deliver light of the required wavelength at sufficiently high power densities using very high switching speeds. We plan to launch specific products for this growing market over the next 24 months, and also investigate other opportunities for LED arrays. Their success will highlight that making LEDs smaller, just like making them bigger, opens the door to new and lucrative applications for these solid-state emitters.

Figure 5. Advanced processing equipment used in the formation of microLED arrays.

"What are the alternatives?"

The market for micro-displays is well established, with several technologies competing in this arena. This includes spatial light modulators (SLMs) based on digital micro-mirror devices (DMDs), which have proven to be very successful for projection and now pico-projection systems. They have some highly desirable attributes, being able to form high-resolution full-colour micro-displays and operate at high modulation frequencies of several kHz. However, there are certain applications where micro displays based on DMDs - as well as those incorporating LCDs and organic LEDs – are not ideal.

DMDs, like other SLM technologies such as LCDs, are based on switching matrices that require external light sources and associated optics. Thus, a key drawback of the DMDs and LCDs is low efficiency, which stems from image patterning created by redirecting unwanted light out of the excitation field (micro-mirrors can only switch between an 'on' or 'off' state). According to mLED, there are several applications where, on average, only 20 percent or less of the pattern is illuminated. In other words, 80 percent of the incident light is 'lost'. These losses result in unwanted heating, plus the need for bulky cooling systems requiring battery power. The upshot is a limit for maximum power that can be transmitted through DMDs, which is particularly stringent for ultraviolet applications, as absorption at the mirror causes local heating issues.

Displays made with organic LEDs are significantly different from those based on DMDs and LCDs, because they use an emissive technology. Some of their strengths include a flexible, lightweight display, and the promise of low-cost, high-volume manufacture. However, organic LED displays can only serve a narrow range of applications, due to several limitations. These include low levels of brightness; short product lifetimes, due to short lifetimes of the intrinsic materials; and poor reliability, because the materials can oxidize and are sensitive to ultraviolet light.

Further reading
Choi et al, IEEE Electron Device Lett. ***25*** *277 (2004)*
J. McKendry et al. IEEE Photonics Technology Lett. ***21*** *811 (2009)*
B.R. Rae et al. IEEE Transactions on Biological Circuits and Systems ***4*** *437 (2010)*
J. McKendry et. al. IEEE Photonics Technology Lett. ***22*** *1346 (2010)*
K. Deisseroth et. al. Journal of Neuroscience ***26*** *10380 (2006)*
D.E. Moorman et. al. Nature, News & Views ***458*** *980 (2009)*

Setting a new benchmark for **hydrogen delivery**

Purified hydrogen is an essential ingredient in the MOCVD processes used to manufacture LEDs, power devices and photovoltaics. Moves toward larger reactors and bigger wafers are increasing the demand for more and more ultra-pure hydrogen from increasingly reliable, compact sources. Fulfilling this need is a novel palladium technology developed by **Power and Energy, says the company's Stuart Bestrom.**

Sales of MOCVD tools have exploded over the last twenty years, leading to a vast increase in the number of chips produced by this technique. But the approach for purifying the hydrogen gas that supports this form of epitaxial growth – a palladium membrane purification technology – has stood still.

This lack of progress on the hydrogen front is a significant concern for LED chipmakers, who continue to migrate to more complex and demanding processes involving ever-larger chambers and ever-bigger wafers. Sensitivity to oxygen and carbon contamination goes up and up, hydrogen flow rates have recently tripled for the largest MOCVD reactors, and flow changes during the process recipe runs can surge from 0 to 300 standard litres per minute (slpm) with no transition period. The traditional palladium purifiers were never designed to handle these new process recipes and they have a number of inherent limitations in durability, quality and cost. This has prompted some users, particularly those in large fabs in China and Taiwan that are particularly keen to cut costs and work with higher flow rates, to consider alternative purification technologies.

These chipmakers are finding a solution to their needs in a palladium membrane technology developed by Power and Energy of Ivyland, PA, in cooperation with the US Department of Defense (DoD). The DoD pursued this development to serve its needs for pure hydrogen to power fuel cells (see box "Hydrogen fuel cells"), but the results of the project have proven successful in semiconductor applications as well.

The resulting palladium membrane technology that we have developed at P+E is the most significant innovation in gas purification in over 20 years. One of the biggest breakthroughs is a doubling-to-trebling of capacity per purifier compared to traditional palladium purifiers. This larger capacity means that a new LED fab requiring 12,000 (slpm) of hydrogen to support 50 MOCVD reactors needs only three of our gas cabinet-sized purifiers. If traditional purifiers were used, six would be needed, and each would have a much bigger footprint.

Reducing size also has additional benefits, because it

cuts power consumption and other facility costs. What's more, the micro-channel palladium membrane technology at the heart of this new system has been proven to greatly improve durability: It provides uninterrupted purification for years of continuous operation. These advancements eliminate contamination, yield loss and downtime caused by hydrogen purity variability in compressed, cryogenic and generator sources.

Working with hydrogen

It is only possible to fully appreciate the benefits of our palladium technology after understanding how a conventional hydrogen purifier works, and the demands that are placed upon it. Conventional hydrogen purifiers have been widely used where hydrogen of the highest purity has been demanded, in order to yield MOCVD-grown wafers and crystal ingots of the highest possible material quality.

These conventional purifiers draw on palladium's unique properties to act as a catalyst (see Figure 1). Hydrogen gas molecules dissociate into atoms upon contacting the surface of the palladium membrane that is held, along with all the other parts of the purifier, at 400 °C. At this temperature, hydrogen atoms are small enough to readily diffuse through the membrane, driven by differential hydrogen pressure across the interface. No other material is small enough to diffuse through palladium, so impurities such as water, oxygen, nitrogen, carbon dioxide, carbon monoxide,

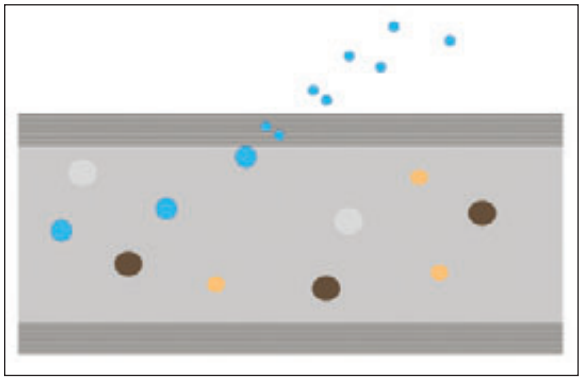

Figure 1: Palladium membrane tubes provide the unique ability to only allow hydrogen molecules to pass through to the pure side. When the feed gas is brought into contact with the inner wall of the palladium-silver membrane, molecular hydrogen (shown as blue spheres) dissociates into atomic hydrogen and is absorbed into the metal lattice. Other molecules, such as methane, nitrogen, water, carbon monoxide and carbon dioxide (shown as brown and grey spheres) are too large to pass through the membrane. While diffusing through the lattice, individual hydrogen atoms share their electron with the palladium in the metal

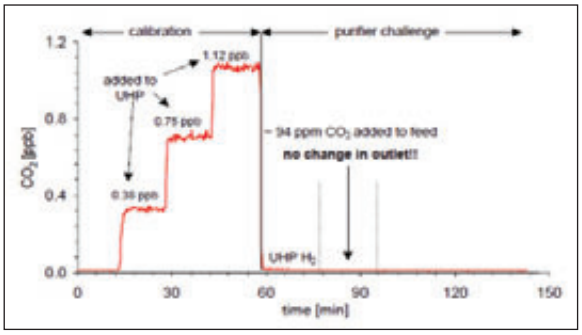

Figure 2: A palladium purifier is challenged with up to 94 ppm of CO_2 with no change in outlet purity. Outlet purity is below 50 ppt

hydrocarbons and rare gases remain on the inlet side of the membrane. The solid barrier provided by palladium results in no breakthroughs. This contrasts with catalysts and getters, which rely on chemical reactions on reactive surface areas under controlled conditions.

Palladium technology also offers the unique ability to remove high-ppm levels of impurities from a cylinder source gas without detriment to purifier lifetime or outlet H_2 purity (see Figure 2). Other methods of hydrogen purification, such as regenerable catalysts and heated zirconium getters, are intended for removal of low ppm impurities, and the purifier lifetime is directly dependent on the incoming impurity and flow rate. This robust capability makes palladium purifiers ideal for compressed cylinder and generator sources where the gas quality can vary significantly from day-to-day.

Hydrogen can be supplied as either a compressed gas, a liquefied (cryogenic) gas or it can be generated on site. The purity of gas varies widely, depending on the source and specific region. Liquid hydrogen is usually the most pure form of this gas, and it is typically between six and seven 'nines' purity – in other words, total impurities are 1,000-100 ppb.

However, liquid hydrogen is not available in Taiwan, Korea and China, the three countries where most new high-volume LED and photovoltaic fabs are located. In these fast-growing regions, fabs must rely on compressed and generator sources, which can include a great deal of variability in the purity of compressed and locally generated hydrogen. Typical sources are water, natural gas or propane, and costs associated with generating hydrogen in this manner are high, due to substantial power requirements.

Chipmakers that use high-purity hydrogen must have a contingency plan that can be brought into action when the primary source is unavailable due to maintenance or unforeseen downtime. One option is to use an industrial

or chemical plant in these emergencies, but that means a compromise in gas purity. For example, a facility with onsite storage of 99.999 percent hydrogen may be forced to use 99.99 percent backup hydrogen on rare occasions. Purification systems have to be designed to deal with these contingencies, so that the final gas purity is unaffected by changes in the quality of the sources. Palladium purifiers can ensure that all impurities are removed from the hydrogen, whether typically present or the result of an unusual event.

Innovative membranes

Through the support of a series of Navy, Army and DARPA research contracts over a period of eight years, we have developed hydrogen purifiers based on a unique micro-channel palladium-alloy membrane configuration. This technology is commercially available and highly reliable, thanks to automated membrane test and inspection methods and advanced manufacturing technologies.

Our unique membrane structure is based on an 'inside-out' design. It features a 'micro-channel', in which the hydrogen enters the inside of the membrane tube (see Figure 3). This palladium tube has an inner 'return tube' that is inside and concentric with the membrane. With this design, hydrogen diffuses out into a passivated stainless steel chamber while a small volume of hydrogen continuously sweeps all impurities to a bleed line.

Thanks to improvements in weld and brazing methods, quality inspection, and membrane assembly design, our micro-channel architecture can deliver a dramatic increase in durability compared to conventional designs. Stress on the membrane is reduced, eliminating the need for a supporting spring. In addition, hydrogen recovery is enhanced with the micro-channel. This enables efficient recovery, even with low concentrations of hydrogen from reformed fuel streams. We have been working with our vendors to improve the alloy and tube drawing processes. These efforts, which reduce impurities and physical defects, have yielded a more uniform alloy with fewer micro-defects. The upshot is more reliable membranes.

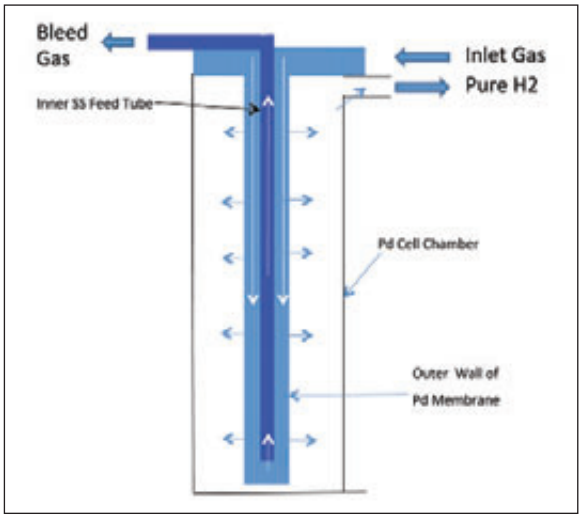

Figure 3: Power and Energy's inside-out micro-channel palladium purifier with vacuum brazing and laser weld improves durability over previous designs using traditional welding techniques. The welding of palladium to stainless steel will weaken the joint when performed with traditional weld methods. Using laser welding improves repeatability and long-term durability

Power and Energy's hydrogen purifier features a novel micro-channel membrane with an 'inside-out' flow path

The durability and lifetime of our palladium-based hydrogen purifier has been improved through more stringent quality control that pre-emptively screens out material defects. To realise this, we have developed a proprietary membrane inspection station for identifying and eliminating substandard membranes at the earliest possible stage. Each membrane is tested under extreme conditions, before being individually subjected to a helium leak-test prior to acceptance into inventory. With our configuration, the palladium membrane tubes undergo an advanced, computer-controlled vacuum braze process. This ensures precise, repeatable brazing of each membrane. The membrane assembly is then laser welded into an electropolished and passivated stainless steel manifold.

Using this design allows axial and radial expansion and contraction without restriction, reducing stress on the membrane tubes. Each membrane is held in an array that prevents it from ever contacting its neighbours. In contrast, traditional palladium purifiers allow

H_2 Source	Delivery	Typical Purity	Regional Availability	Large Volumes	Hydrogen Cost	Capital Cost
Compressed	Trailers, Cylinders	99.9%-99.999%	▲▲	▼	—	▼
Cryogenic Liquid	Tanker / Storage Tank	99.99999%	▼[1]	▲	—	—
Generator	Steam Methane Reformer (SMR)	99.9%-99.999%	▲▲	▲▲▲	▼[2]	▲▲
	Electrolysis of Water	99.999%	▲▲	▲	▲[3]	▲▲

1. Availability is limited to several regions including North America, northern Europe and Japan.
2. SMR requires availability of Natural Gas
3. Electrolytic H_2 generators consume large quantities of electricity

membranes to move freely against each other, thereby contributing to long-term stress of the tubes. Preventing membranes from coming into contact also leads to a free flow of gas and prevents tube damage.

To demonstrate the practical benefits of our palladium technology, we have developed automated, accelerated-life-testing systems to replicate extreme operating conditions. Membranes were pressure- and temperature-cycled to simulate the stresses possible from long-term operation. The goal was to confirm a minimum cycle lifetime of 10,000 – equivalent to 10 years with 3 on/off cycles per day. This benchmark, which is well above typical operating conditions, is always met with membranes that pass incoming inspection (see Figure 4). In fact, some membranes that failed inspection still show excellent lifetimes. This means that our inspection methods may eliminate 'good' membranes. However, they ensure that no accepted membranes fail the cycle test.

We subjected our sample membranes to thermal cycling to validate flow performance and stability over time. The result: Confirmation of the effectiveness of our membrane test methods to identify and remove membranes with micro-defects prior to assembly.

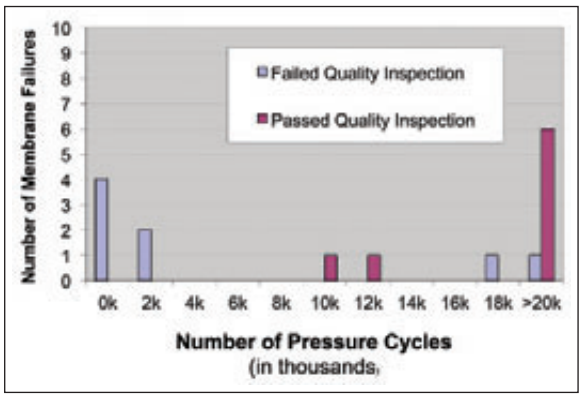

Figure 4: Membrane life cycle test confirms 10,000 cycle minimum lifetime for all membranes that passed new inspection procedures

Encouragingly, our test also showed that the new micro-channel membranes provide improved durability under the most hostile operating conditions. Our 9000MZ and 9000MS high-flow purification systems are now incorporating the new membrane. These purification systems have been manufactured with production and quality procedures that ensure a consistent operating environment with stable operation for many years. The compact array of membranes provides a high flow capacity in a very compact package. A single vessel measuring 6" x 24" that previously purified up to 200 slpm can now flow 600 slpm. The compact package also reduces power consumption, and in addition it allows savings in required floor space and HVAC sizing, important considerations for the larger semiconductor fabrication facilities in Asia.

Through analysis of raw materials, assembled systems and resulting outlet gas purity, it has been possible to improve the quality of the hydrogen supply so that impurities are consistently below 0.1 ppb (100 ppt). This exceptional level of purity predominantly stems from proprietary manufacturing processing for preparing and passivating stainless steel, which have reduced sources of carbon and moisture that can contribute impurities downstream of the palladium membranes. Thanks to this advance, we can now guarantee a start-up purity of less than 100 ppt for all impurities. In comparison, typical specifications from traditional palladium purifiers offer impurities of less than 1 ppb, and this is only assured after a lengthy start-up purging at a minimum 20 percent of rated flow.

Benefits associated with our micro-channel technology are by no means limited to LED chipmakers: They are also a great assistance to producers of photovoltaics, polysilicon devices and fuel cells. Improvements in the performance of all these devices are eagerly anticipated, and our hydrogen-purifying technology should help to unlock that promise throughout the remainder of this decade.

Hydrogen fuel cells

The Department of Defense is interested in developing high-quality hydrogen sources for fuel cells. These devices are incredibly energy efficient, and can generate twice as much energy per gallon of fuel as combustion-based generators. The challenge is that military fuel supplies are high in sulphur contamination, an impurity that drags down fuel cell performance. A better, more durable method for separating hydrogen for fuel cells is needed to unlock the door to auxiliary powering of vehicle, plane, ship, platoon and field installations.

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It's an incredibly intriguing time for our industry, which is mulling over many important questions. How is the GaAs architecture in mobile devices going to evolve to enhance connectivity? Is the growth of concentrating photovoltaics strong enough for it to grab a significant share of the solar market? When will LED lightbulbs start to generate significant revenues? Will nitride laser production switch to growth on semi-polar and non-polar substrates, and how can such materials be made? And can III-Vs help to maintain the march of Moore's law beyond the 15 nm node?

Insights into all these important questions will be given at CS Europe 2012. Speakers at this two-day meeting include leading analysts in the compound semiconductor sector, representatives of the biggest GaAs foundries in the world, and leaders of the top LED and nitride laser manufacturers. On top of that, there is a session dedicated to the development of III-Vs on CMOS that includes speakers from Intel, SEMATCH and imec.

Don't miss out on your chance to find out where the compound semiconductor community is heading over the next few years. Places are limited, so book today.

Conference Chair: Dr Andrew W Nelson, President and CEO, IQE

Markets and III-V CMOS - Morning 12th March

Compound Semiconductor Markets: Current Status and Future Prospects - Asif Anwar, Director – Strategic Technologies Practice, Strategy Analytics

The Market for LEDs in Lighting - Mr. Philip Smallwood, Analyst, IMS Research

Wide Bandgap device market update - Dr. Philippe Roussel, Senior Project Manager, Yole Développement

European efforts to develop III-Vs on 200 and 300mm silicon - Dr. Matty Caymax, Chief Scientist, Imec

An Overview of the DARPA Diverse Accessible Heterogeneous Integration (DAHI) Program - Sanjay Raman, Program Manager, Defense Advanced Research Projects Agency, DARPA/Microsystems Technology Office

The Integration of silicon CMOS with III-Vs - Professor Iain Thayne, University of Glasgow

III-V on 200 mm Si for VLSI – Dr. Richard Hill, Project Manager, Sematech

III-V 3D Transistors - Peide Ye, Professor of Electrical and Computer Engineering, Purdue University

LEDs, lasers, PV and electronics - Afternoon of 12th & all day of 13th March

Keynote Speaker: III-V on Silicon: Challenges and Opportunities - Robert S. Chau, Intel Senior Fellow, Intel

SiC and GaN Electronics - Dr. John Palmour, Cree co-founder and chief technology officer Power & RF, Cree

Ammono's ammonothermal method to make GaN substrates - Dr. Robert Dwilinski, President, CEO, Ammonno S.A.

Tomorrow's RF chips for mobile devices - Todd Gillenwater, VP of Technology and Advanced Development, RFMD

Building a Successful III-V Pure Play Foundry - Dr. John Atherton, Associate Vice President, WIN Semiconductors

Scalable "on-silicon" solutions (GaN-on-Si and Ge-on-Si) using rare oxide buffer layers – Dr. Michael Lebby, General Manager & Chief Technology Officer, Translucent Inc.

III-Nitride Lasers Based on Nonpolar/Semipolar Substrates - Dr James W. Raring, VP Laser Engineering, Soraa Inc.

Markets and Applications for SiC Transistors - Dieter Liesabeths, Vice President Sales & Marketing, SemiSouth Laboratories, Inc.

Perspective of an LED Manufacturer - Professor Iain Black, VP WW Manufacturing Engineering, Technology & Innovation, Philips Lumileds Lighting Company

The CPV Market following the acquisition of Quantasol technology - Jan-Gustav Werthen, JDSU, Senior Director

Commercialisation of GaN on SI based Power Devices at International Rectifier - Dr. Michael A. Briere, International Rectifier

GaN the enabler for true SDR - Professor Rik Jos, RF Technology Fellow & Innovation Manager, NXP Semiconductors

Holistic Approach to MOCVD vacuum & Abatement - Dr. Mike Czerniak, Product Marketing Manager, Edwards Vacuum Ltd

Advances in Wide Bandgap Semiconductors for Power Electronics - Dr. Markus Behet, Global market manager, Power Electronics, Dow Corning

Large diameter GaN-on-Si epiwafers for power electronics - Dr. Marianne Germain, Co-Founder & CEO, EpiGaN

Achieving GaN & GaAs RF Design Success through Product & Foundry Innovation - Bryan Bothwell, Strategy and Business Development Manager - Foundry Services, TriQuint Semiconductor

Damage free Deposition on LED devices - Dr. Silvia Schwyn Thöny, Senior Process Engineer, Evatec Ltd

Temporary Bonding: An enabling technology for RF and power compound semiconductor devices - Dr. Thomas Uhrmann, Business Development Manager, EV Group (EVG)

There will be a networking dinner and the CS Industry Awards 2012 on the evening of March 12th.

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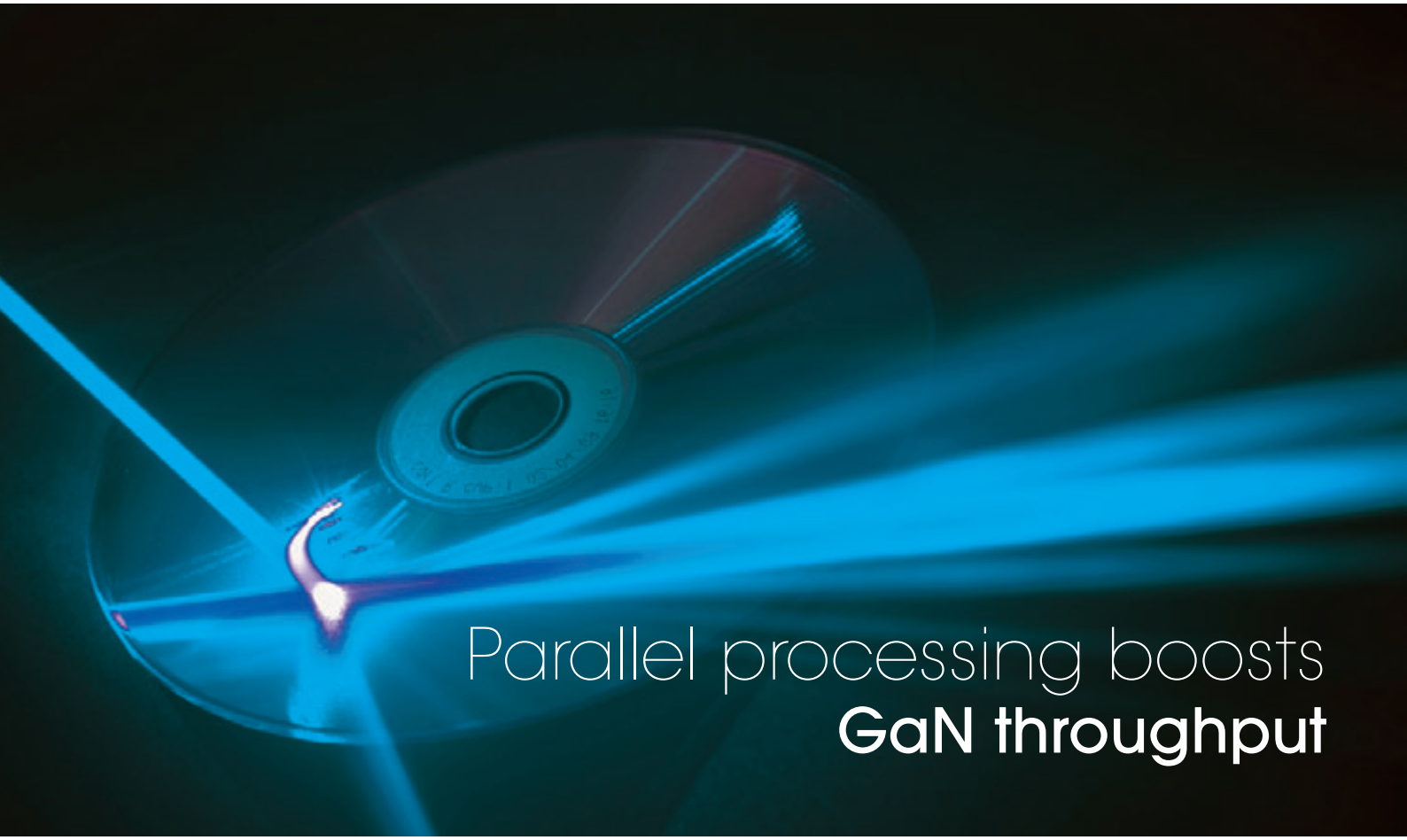


Parallel processing boosts GaN throughput

GaN lasers perform at their best when grown on a flat native crystal that combines low dislocation densities with a high enough free carrier concentration to ensure a strong refractive index contrast between device and substrate. Making such a foundation in reasonable volumes with acceptable growth rates is tough, but we believe the most promising approach employs high nitrogen pressure and liquid gallium to form very high quality, free-standing crystals on an array of HVPE-grown seeds, says **Michal Bockowski from the Institute of High Pressure Physics, Polish Academy of Sciences, in Warsaw.**

If you want to make Blu-ray lasers with high yields, fabricate blue and green LEDs that set a new benchmark for brightness or produce incredibly high performance electronics, then you should build your device on a GaN substrate. Such a foundation has many benefits: So long as the defect density in this crystal is low, it should be possible to deposit nitride films with high material quality; there should be no bending and cracking of the material in the device, because differences in lattice constants and thermal coefficients of expansion between substrate and epilayer are low; and the device will benefit from the great set of intrinsic characteristics associated with the wide bandgap material that underpins it. GaN also has great thermal conductivity, an asset for all classes of device; and it is also great at dissipating heat, which helps to bolster the performance of electronic devices.

The major drawback of GaN is its high cost: A 2-inch diameter substrate retails for several thousand dollars. This high price stems from the difficulties associated with forming high-quality crystals of GaN. Melting the material requires extreme conditions – nitrogen

pressures of 6 GPa and temperatures of almost 2500 K – a combination of conditions that prevents the growth of GaN from its stochiometric melt, which is the method used to make silicon and GaAs boules.

A handful of alternative methods have been developed for making GaN crystals, including HVPE deposition on foreign substrates and the growth of GaN in solution. All these approaches have their weaknesses – either in material deposition rate or crystalline quality. Minimizing these drawbacks holds the key to making affordable, high-quality GaN, and at the Institute of High Pressure Physics we believe that we have developed a novel approach that can do just that: It involves using a high nitrogen pressure solution to convert multiple GaN seed crystals grown by HVPE to free-standing GaN. Reliable blue and violet lasers have been formed on these high-quality crystals.

HVPE: Pros and cons

Today HVPE is the most common approach for manufacturing GaN substrates. This involves crystallization from the vapour phase at ambient pressure, with GaN deposited on a foreign substrate through the reaction of ammonia with gallium chloride at temperatures of about 1300 K. Etching, laser lift-off and self-lift-off techniques can all be used to remove the nitride film from the foreign substrate – typically sapphire or GaAs – and yield a large-diameter, free-standing GaN substrate.

This technique has a relatively fast growth rate of up to 500 μm per hour, but suffers from a phenomenon known as parasitic nucleation. Superfluous GaN nucleation takes place within the reactor, often leading to uncontrolled changes in crystal growth conditions during the crystallization run, such as variations in the flow rate of reactants. Reducing growth time prevents degradation to the crystal, but this limits the thickness of HVPE-grown GaN to typically below 1 mm.

Another drawback is that the material quality degrades, due to either introduction of donors, such as silicon or germanium, or the addition of an acceptor, iron. This makes it difficult to produce highly n-type or semi-insulating substrates, thereby limiting the typical free-carrier concentration for free-standing GaN to 10^{18} cm^{-3}.

Deposition on a foreign substrate enables the growth of large-diameter GaN crystals, but these suffer from lattice bowing. This stems from significant differences between the lattice constant and thermal expansion coefficient of the foreign substrate and the nitride film (see Figure 1). When GaN is grown by HVPE on sapphire, the bowing radii of crystallographic planes is below 10 m. This relatively low number means that there is little benefit in using HVPE-grown GaN as a seed for subsequent crystallization runs. It is possible to overcome these issues and grow crystallographically flat, free-standing

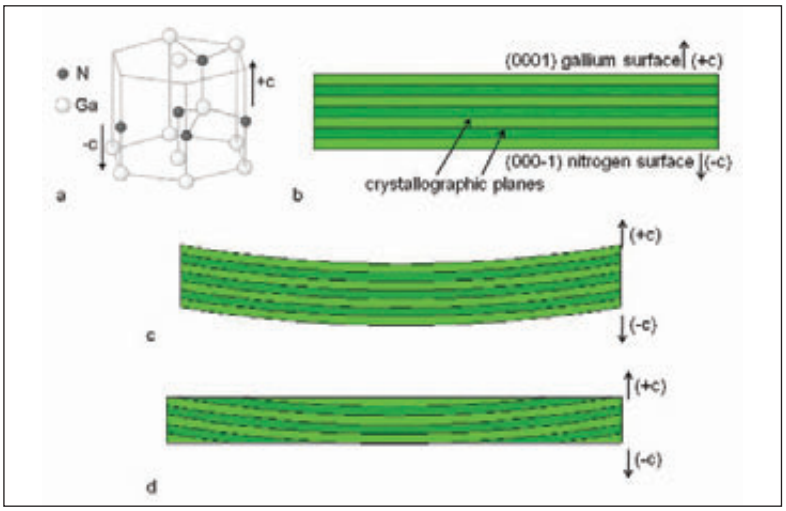


Figure 1. (a) Simplified scheme of GaN wurtzite structure with nitrogen and gallium atoms' positions; one can distinguish two polar directions +c and –c and therefore two polar GaN surfaces: gallium (0001) and nitrogen (000$\bar{1}$), respectively. (b) schematic view of typical orientation of a single crystalline GaN substrate; crystallographic planes are flat. c) schematic view of the crystallographic planes in GaN lifted-off from sapphire giving a curvature. d) schematic view of the crystallographic planes in GaN substrate. Although the substrate can be geometrically flat it is not flat from crystallographic point of view

HVPE-GaN by switching the growth mode during the HVPE process from a flat one to a rough one. But there is a penalty to pay: inversion domains that hamper subsequent epitaxy (see Figure 2 for details).

The best HVPE 'free-standing' GaN technology has been developed by Sumitomo Electric Industries. This Japanese firm can produce very good quality, free-standing GaN crystals of up to 6 inches in diameter via deposition of this wide bandgap semiconductor on GaAs wafers. The curving of GaN is not that severe, thanks in part to the similar thermal expansion coefficient of this material and GaAs. In addition, Sumitomo's growth process aids the fabrication of crystallographically flat substrates – it is based on selective growth of the nitride, followed by re-growth on the surface containing large inverse pyramidal pits (a process described as either Dislocation Elimination by Epitaxial growth with inverse-pyramidal Pits (DEEP), or an Advanced variant known as A-DEEP). With this method the crystal is grown in the controlled rough growth mode, probably with presence of the inversion domains.

Sumitomo's crystals feature 400 μm wide stripes that have alternating regions with defect densities of typically 10^4 cm^{-2} and 5 x 10^8 cm^{-2}. High-quality lasers for Blu-Ray players are manufactured on these crystals by positioning the chips on low defect density stripes that are free from inversion domains. Due to the growth and re-growth of

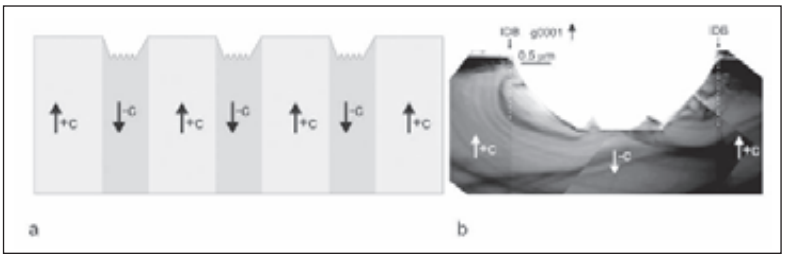


Figure 2. a) Schematic presentation of inversion domains in a GaN crystal. They can appear during the rough growth mode (rough growth front) in HVPE technology and hinder the subsequent epitaxy, since a polarity of the (0001) surface is mixed. b) TEM photograph of the inversion domain grown by HVPE (courtesy J. Smalc-Koziorowska)

pits, the free-carrier concentration in Sumitomo's substrates is relatively high – about 5 x 10^{18} cm^{-3}. With HVPE-based approaches, impurities are built into GaN in an anisotropic way (see Figure 3), and the growth of pits occurs in semi-polar directions.

When sapphire is used instead of GaAs as a foundation for making GaN free-standing substrates by HVPE, the best results are obtained with a flat-growth mode and a technique known as Void Assisted Separation (VAS). With this approach that has been pioneered by Hitachi Cable, growth proceeds on a sapphire substrate coated with an ultra-thin layer of MOCVD-deposited GaN and nanometric titanium nitride. 3-inch GaN substrates with a homogeneous dislocation density of about 10^{6} cm^{-2} can be formed by this technology. Free -carrier concentration is typically 10^{18} cm^{-3} and the lattice bowing radius is below 10 m.

Solutions for GaN?

It is also possible to form GaN crystals from solution in supercritical ammonia. This approach, which is known as the ammonothermal method, is analogous to hydrothermal crystallization of quartz or oxide crystals such as ZnO. However, ammonia is used in the place of water. One of the biggest drawbacks of the ammonothermal approach is that it is very slow: Growth is at best 0.1 mm per day. It is also necessary to secure high-quality GaN seeds that can initiate growth and find a suitable 'mineralizer' to aid dissolution of GaN.

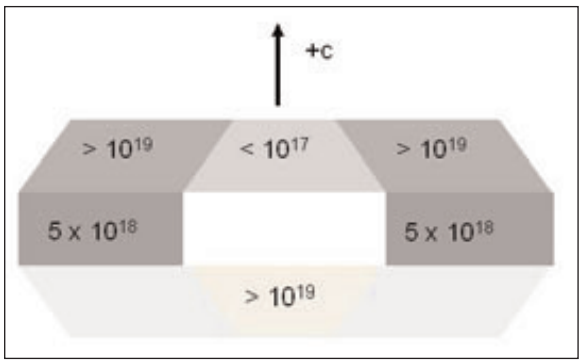


Figure 3. Free carrier concentrations in HVPE material for various directions. Growth on semi-polar planes leads to enhanced incorporation of oxygen and high electron concentration (courtesy I. Grzegory)

The world-leader in this technology is our neighbour, the well-known Polish company Ammono. This firm manufactures 1 cm^2 and 1 inch crystals and is on the road to start the production of 2 inch variants. These crystals have many great attributes: They are extremely flat, with bowing radii of the crystallographic planes reaching up to 100 m; defect density is of the order of 10^{4} cm^{-2}; and free carrier concentration does not exceed 2 x 10^{19} cm^{-3}. This material has already provided a good foundation for making high-power lasers by various groups, including the Polish company TopGaN.

Another way to grow GaN is from solution, using gallium-sodium mixtures held at temperatures from 700-900 °C and a nitrogen pressure of up to 5 MPa. Osaka University has trail-blazed this approach, and produces bulk single crystals that are a few millimetres thick, have a diameter of up to 3-inch, and exhibit a defect density of the order of 10^{5} cm^{-2}.

Piling up the pressure

But if low defect density is the primary goal, then by far the best approach is the High Nitrogen Pressure Solution (HNPS) method. Dislocations of just 10^{2} cm^{-2} can be realized via a direct synthesis reaction between a liquid of gallium and nitrogen held at up to 1800 °C, and nitrogen at pressures of up to 2 GPa. A spontaneous reaction yields hexagonal platelets typically 1 cm^2 in size, which make a good foundation for laser diodes.

We are the pioneers of this growth technology, and our experience of making lasers on these hexagonal platelets in conjunction with our spin-off company, TopGaN, has enabled us to determine the most important characteristics for GaN substrates that are used for making laser diodes. Our findings are that GaN crystals must have: High structural quality, including a bowing radius exceeding 20 m and a dislocation density below 10^{6} cm^{-2}; and high electric conductivity with free-carrier concentration of more than 5 x 10^{19} cm^{-3}, because this enables the preparation of a low-resistance ohmic bottom laser diode contact and also makes the GaN substrate 'plasmonic', aiding optical confinement (more about this later).

The HNPS approach yields GaN of great quality, but crystal size is small and material throughput is low. So to address these issues, we have recently developed a method for growing GaN that we call multi-feed-seed (MFS). This involves the conversion of free-standing HVPE-grown GaN crystals to free-standing HNPS GaN, which has a much higher quality than the seed material. The great strength of this approach is that it yields several GaN crystals from one run – what's more, all of

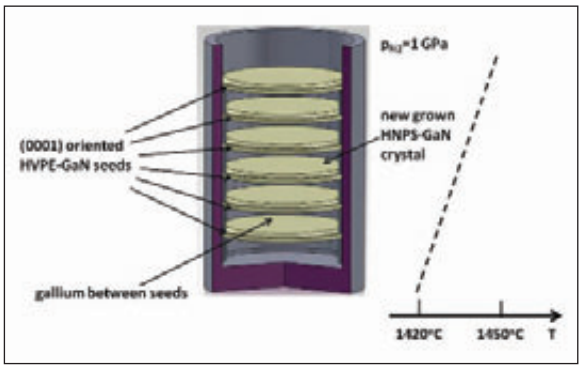


Figure 4. The MFS configuration, including a section of the crucible. The free-standing (0001) oriented HVPE-GaN substrates are positioned vertically, with liquid gallium discs between them. The temperature gradient applied to the bottom side of HVPE-GaN crystals causes them to partially dissolve in liquid gallium, leading to the supply of atomic nitrogen to the solution. Nitrogen is then transported in the liquid gallium by convection or diffusion to the underlying seed where the crystallization takes place

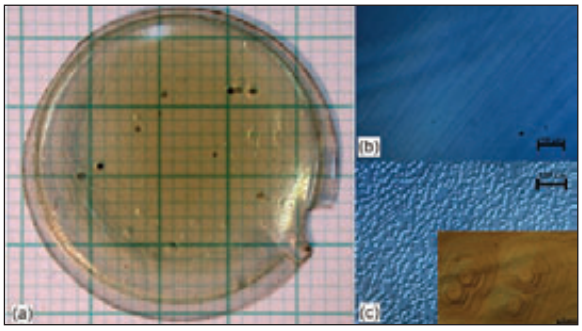


Figure 5. a) Crystals grown with the MFS configuration are typically stable and macroscopically flat. Two types of morphology are noted: b) macrosteps and c) hillocks

these crystals satisfy our criteria for laser manufacture.

Production of this material begins by positioning several (0001)-oriented HVPE-GaN seeds in a vertical stack, separated by liquid gallium (see Figure 4). The lowest seed is placed above the bottom of the crucible and the distance between individual seeds can be varied. Under nitrogen pressures of typically 1 GPa an axial temperature gradient is applied along the crucible, leading to overgrowth of seeds on their (0001) surface. On each seed, liquid gallium is dissolved from its lower (000$\bar{1}$) surface, and atomic nitrogen is supplied into the solution, where it is transported to the underlying crystal. In other words, each seed is overgrown and dissolved at the same time, but at a slightly different temperatures varying from 1420 °C to 1450 °C.

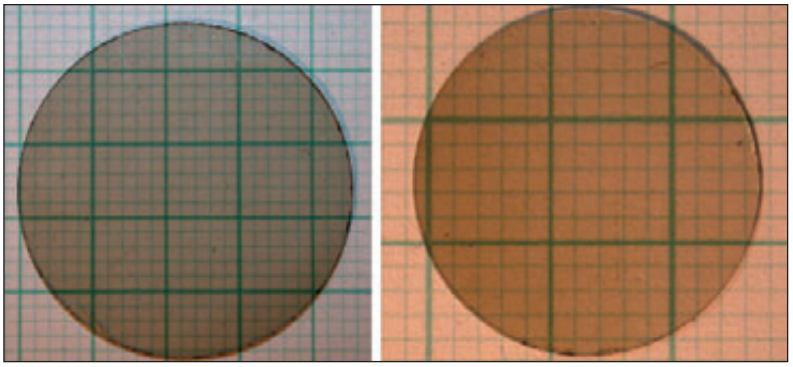


Figure 6. HNPS-GaN crystals used as substrates for making laser diodes

The upshot of all this activity is the formation of stable, macroscopically flat crystals (see Figure 5 for a typical example). Pinholes are visible on the bottom (nitrogen surface) of the seed, but absent on the surface of the pressure-grown material. The temperature gradient that's applied during the process determines the growth mode and surface morphology.

If the temperature gradient is large, growth rates of 5 μm/hour are possible, leading to macrosteps on the surface, plus voids and gallium inclusions within the crystals. Reduce this gradient and the density of voids and inclusions decreases from 10^3 cm^{-2} to 100 cm^{-2}, growth rate falls to 1 μm/hour or less, and hillocks are formed on the surface. GaN crystals made by our MFS process are far better than those made by HVPE. However, this can only be appreciated after residual HVPE-GaN is taken away from the nitrogen surface of the crystal. Benefits include an increase in the bowing

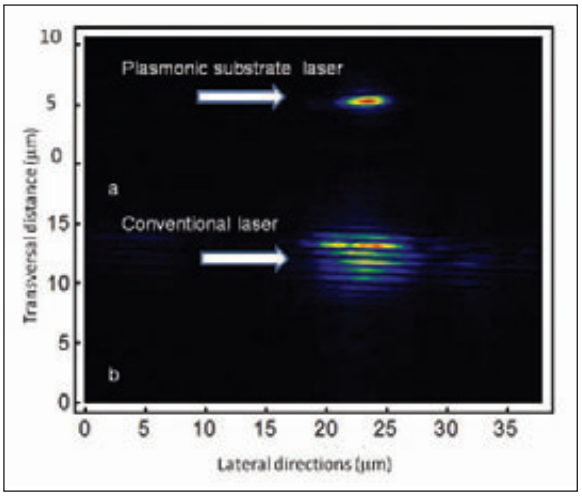


Figure 7. Near-field distributions for plasmonic MFS-HNPS-GaN and conventional HVPE GaN substrates. Note that for the plasmonic crystal, (a), the optical mode is well concentrated around the active region, but for conventional substrate, (b), an optical mode extends several microns into the substrate (courtesy P. Perlin and K. Holc)

radius from 2 m to 30 m, which results from the removal of the HVPE substrate, a step that helps to release stress in the HNPS-grown GaN.

We have fabricated 500 μm-thick GaN using our MFS technology. Lasers made on this platform, which was formed after 500 hours of crystallization emit at 390 nm to 440 nm, have a typical threshold voltage of 4.5 V at 2.5 kA/cm^2 and have a lifetime of up to of 5000 hours. Defect-selective etching reveals that the dislocation density in the laser diode is below 5x10^6 cm^{-2}. It is about one-fifth of that value in the substrate.

One way to improve laser performance is to increase the refractive index contrast between device and substrate, because this suppresses optical mode leakage into the substrate and optimises the optical mode in the active region. It is possible to do this with our 'plasmonic' GaN substrate, which has a free carrier concentration up to 7x10^{19} cm^{-3}, and is produced using growth temperatures of 1440 °C (see Figure 7). This approach is superior to using a conventional GaN substrate and adding a thick AlGaN layer or an AlGaN super lattice beneath the active region to prevent light propagating from here into the substrate. Go down this more common route and strain increases in the epistructure, leading to macroscopic bowing, cracking and the creation of misfit dislocations.

The only major weakness of our approach is its slow growth rate. However, we believe that this can be increased to 50 μm/hour by increasing nitrogen solubility in gallium through the addition of sodium or lithium impurities into the solution. We plan to try this in the coming months.

Further reading

Technology of Gallium Nitride Crystal Growth, ed. by D. Ehrentraut, et al. (Springer-Verlag, Heidelberg, 2010)

K. Motoki, SEI Technical Review ***70*** *28 (2010)*

P. Perlin et al. Proceedings of the SPIE The International Society for Optical Engineering. (2011) 7953: 79530I

The environmental cost of the compound semiconductor elements

Elements such as mercury, arsenic and cadmium are known to cause a number of life-threatening diseases. However, the compound semiconductor industry is generally aware of the risks that are posed, and workers in this industry should not be unduly concerned about their health, say **Keith Torrance and Helen Keenan from The University of Strathclyde.**

Compound semiconductors provide engineers with an almost infinite palette of materials that can be exploited for an ever increasing range of analogue devices and opto-electronic components. Their intimate relationship with their chemistry is best illustrated by the popular nomenclature of three-five and two-six compounds, reflecting their position in columns II to VI of the periodic table (see Figure 1). As the chemistry of elements within a column is generally similar, the ease of substitution between gallium, aluminium and indium within III-V compounds partly explains their versatility. It also helps explain the behaviour of these elements within the environment, and in some instances, within biological systems.

This article will review the environmental chemistry of the elements that are commonly used in compound semiconductor wafers. The elements that make up compound semiconductors are naturally present in soils and groundwater in trace amounts, generally related to the underlying geology. Of these, zinc, aluminium and selenium are essential 'minerals' for good health, with deficiencies causing various health problems in animals and humans.

The non-essential elements may be non-hazardous, but many of the constituent elements of compound semiconductors are known to be toxic and even carcinogenic if consumed in food or drinking water or inhaled as particulates. Specifically, arsenic, cadmium, mercury, selenium and antimony are classified as priority pollutants under the US Federal Clean Water Act. In

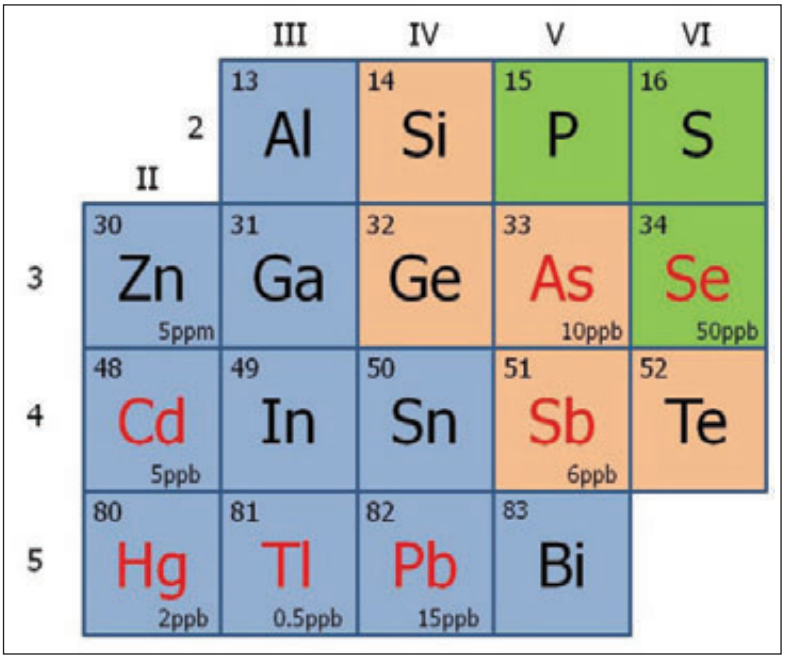


Figure 1. Part of the periodic table showing the main constituent compound semiconductor elements. Elements considered toxic are in red, with US EPA maximum contaminant levels (MCL) for drinking water given, where available

recent years, the relationship between geology and public health has been investigated. Geochemical maps have been compiled for most of Europe, showing the concentrations of selected toxic metals in soils and stream sediments; the UK has already been mapped in detail. Anomalies or hot spots may be related to localized mineralization; for example, lead and zinc ore veins in Derbyshire or to past industrial use (see Figure 2). Lead and antimony distribution in soils can often be correlated with traffic density as a result of the legacy of ethyl lead additives in petrol before their use was restricted.

Elements such as mercury, arsenic, cadmium and antimony can be derived from both natural and anthropogenic sources and are of concern in the environment because of their toxicity. Metal mining and smelting of metallic sulphide ores are the primary sources of mercury, arsenic and cadmium in the environment. Exposed sulphide minerals in mine waste spoil heaps, such as pyrite (Fe_2S), quickly oxidise to soluble sulphates, resulting in acid mine drainage from run-off, with characteristic 'yellow boy' precipitation (see Figure 3).

The low pH of mine waters can mobilise arsenic and zinc, among other metals, leading to on-going pollution of surface waters and ground waters long after a mine has closed. Compared to heavy industry, compound semiconductor fabrication uses relatively small amounts of toxic materials and has a good track record of managing hazardous waste. A recent inspection report by the UK Health and Safety Executive on the control of hazardous materials within semiconductor Fabs reported satisfactory arrangements, but did highlight some poor handling of GaAs wafer waste during lapping operations [1].

The behaviour of metals in the environment has been much studied as the link between anthropogenic discharges of lead, cadmium, arsenic and chromium and public health have been more clearly defined. Following incidents such as Love Canal, NY and Times Beach, MO, legislation was introduced in both the United States and the European Union to address the legacy of past industrial activity and promote the remediation of contaminated brownfield sites, especially CERCLA "Superfund" legislation in the United States.

Although heavy industries such as steel manufacture, chemical production and ore processing account for the overwhelming instances of contaminated land, legislation to limit the use of potentially hazardous metals can still impact the semiconductor industry. The ROHS legislation [2] introduced in the EU in 2002 to restrict certain metals, such as lead, mercury and cadmium, in electronics is a good example of this.

Semiconductor substrates such as GaAs, InP and CdTe are stable, insoluble in wafer-form and resistant to oxidation under normal pH and temperature. It is likely that packaged devices will remain intact for many years in electronic waste consigned to landfills; incineration presents a more direct pathway to the atmosphere and the environment.

However, GaAs wafer processing generates large volumes of solid and liquid waste[4] that exceeds regulatory discharge levels and must be treated in the fab or disposed of as hazardous waste to landfill at significant cost. Another consideration is the end-of-life management of electronics and PV and the fate of toxic elements they contain. The behaviour of metals in soil is complex, as the form of the metal (element, inorganic compound or organic compound), oxidation state, pH of the soil and reduction/oxidation potential all influence toxicity and mobility.

Exposure pathways must be present before a contaminant represents a potential health risk; sophisticated models estimate exposure and determine whether a metal in a contaminated soil poses a risk and whether a brownfield site can be developed safely.

II: zinc, mercury and cadmium

Mercury has a long history as an environmental pollutant. It first came to attention in the 1950's with the identification of clusters of neurological cases diagnosed around Minamata in Japan, which became known as Minamata disease, although the toxic nature of mercury had long been appreciated. Minamata disease was found to be caused by the consumption of organic mercury compounds in seafood.

It was ultimately determined that the source of the pollution was the Chisso chemical factory, which released untreated wastewater directly into the Shiranui Sea. Methyl mercury was produced by Chisso as a by-reaction from the production of acetaldehyde using mercury sulphate as a catalyst. Organic mercury compounds are considerably more toxic than inorganic forms and rapidly accumulated in shellfish, which became biomagnified further up the food chain as organic mercury compounds are retained in tissue. At least 1,700 people died as a result of this incident.

The main anthropogenic inputs of mercury into the environment are from coal-burning power stations and the use of mercury in artisan gold mining. Elemental mercury is mixed with crushed ore, often by hand as shown in Figure 4. Mercury dissolves any gold present in the ore to form an amalgam, which can be recovered by evaporating off the mercury, usually with poor recovery rates. UNIDO estimates that a thousand of tonnes of mercury enter the environment each year from artisan gold mining worldwide[4].

Cadmium is a toxic metal that can be present in high concentrations in soil contaminated by mining, smelting and metal finishing. As a minor component of zinc ores, cadmium can substitute for zinc in the mineral sphalerite (ZnS) and was often discarded in spoil heaps around mines. The village of Shipham in Somerset, England, has elevated levels of cadmium in soil as a result of historical lead and zinc mining dating back to medieval times.

Although the average intake of cadmium is relatively high, epidemiological studies have found no evidence of health risks to the population, probably because locally grown produce represents a small percentage of resident's diets [5].

Itai-itai disease is caused by cadmium poisoning, often from the consumption of crops grown in soil contaminated with cadmium, which causes severe joint pain and softening of bones. This was first diagnosed in Toyama prefecture, Japan, and linked to cadmium discharges into the Jinzu river from mining upstream. Irrigation of paddy fields with cadmium-rich river water exacerbated cadmium intake in diets composed mainly of rice and fish. Toxicologists believe that cadmium interferes with proteins that contain zinc due to the similarity in size between the zinc and cadmium ions. Cadmium remains in the body for a long time because there is little metabolism and it is only slowly excreted.

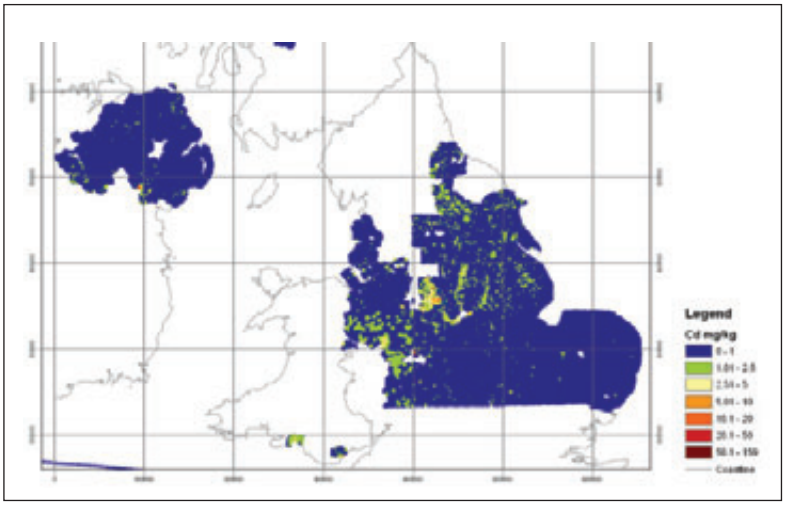


Figure 2. Geochemical map of central England and Northern Ireland showing cadmium levels in soil. (British Geological Survey)

Zinc is essential as a trace element for biological functions. Nevertheless, the US EPA has set a secondary maximum contaminant level of 50 ppm in drinking water. Inhalation of zinc oxide fumes by metal workers can cause a temporary condition known as 'zinc chills' which produces uncontrollable shaking in an individual; a favourite trick played on apprentice plumbers. Zinc is not thought to have any long-term health effects; indeed zinc may limit the uptake of cadmium from soil and vegetables and provide some protection. Disturbingly, both the US and UK

Figure 3. Acid mine drainage at Rio Tinto, Spain, showing characteristic 'yellow boy' deposits of iron hydroxides. (Photo - Carol Stoker, NASA)

Exposure to white phosphorous was responsible for one of the most unpleasant occupational diseases that afflicted match makers in Victorian England. 'Phossy Jaw' (phosphorus necrosis of the jaw), is caused by the deposition of white phosphorous within the structure of the jawbone, causing the bone to become abscessed and loose its rigidity

Figure 4. Artisan miner in Tanzania mixing mercury by hand with crushed ore to extract gold. (Photo credit: Antony Benham, NERC)

governments conducted "Cold War" tests from 1953 – 1964 to model biochemical dispersion using zinc cadmium sulphide (ZnCdS). Over 4,600 kg of fine material was released into the atmosphere at selected points from aircraft and ships in the UK alone. ZnCdS was selected as an agent because fluorescent particles could be easily detected using UV lamps and the distribution mapped. It was concluded that these tests did not significantly add to the cadmium burden in the soil [6].

III: aluminium, gallium and indium

The chemistry of gallium and aluminium is also very similar; gallium is extracted from smelting of aluminium ores. While aluminium is very abundant in the earth's crust (8 percent by weight): gallium is relatively rare. Although there are no documented health effects of gallium, aluminium has been linked to some medical conditions, including (controversially) Alzheimer's disease[7].

Suffice to say that exposure from natural sources dwarfs any potential impact from compound semiconductor processing. Indium is a relatively rare element in nature and is also believed not to pose any serious health risk.

V: phosphorus, arsenic + antimony

Inorganic phosphorous is an essential element for life, accounting for approximately 1 percent by weight of the average person. Elemental phosphorous exists as several allotropes, including red and white phosphorous. Exposure to white phosphorous was responsible for one of the most unpleasant occupational diseases that afflicted match makers in Victorian England. 'Phossy Jaw' (phosphorus necrosis of the jaw), is caused by the deposition of white phosphorous within the structure of the jawbone, causing the bone to become abscessed and loose its rigidity. This process is accompanied by excruciating and debilitating pain[8]. This terrible affliction could be easily eliminated by providing adequate factory ventilation or by switching to the safer red phosphorous allotrope, but it took concerted action by factory 'match-girls' to force through basic safer work practices in 1888.

Arsenic is universally recognised as synonymous with poison. Its nefarious properties were well known in antiquity and arsenic trioxide ('white arsenic') has been used as deadly poison ever since; 180 mg is a lethal dose[9]. It occurs as inorganic and organic compounds, with the former being considerably more toxic. It has several valence forms, which have different toxicities. The As^{-3} species is the most toxic form and is encountered in the fab most commonly as gaseous arsenic hydrides used for epitaxy, which require special handling. The trivalent form, (As^{+3}), is approximately fifty times more toxic that the pentavalent species (As^{+5}) and is significantly more soluble in water. GaAs chemical polishing waste streams, being highly oxidised, contain arsenic almost entirely in the As^{+5} form and consequently are less toxic than lapping and grinding waste streams. It has been shown that GaAs wafer lapping and grinding waste streams contain significant amounts of soluble arsenic, predominantly in the trivalent form and should be handled with care.

The different behaviour and toxicity of arsenic at different oxidation states has significant environmental consequences. Arsenic can be released into groundwater if naturally occurring pentavalent aersenic in sediments is reduced to the trivalent form and unbound from iron and manganese minerals. Tens of

millions of people worldwide, especially in Bangladesh and India, are exposed to elevated levels of arsenic in drinking water from wells tapping groundwater in young sediments. Chronic exposure to arsenic causes arsenicosis and increases the risk of a range of unpleasant skin and bladder cancers. Exposure is not restricted to the developing world; many areas of North America have groundwater with elevated arsenic levels that must be treated before distribution.

Antimony is also highly toxic, but compared to arsenic, it has lower mobility and bioavailability. As stibnite (Sb_2S_3) is often an accessory mineral in lead and zinc ores, smelting is the primary source of anthropogenic releases into the environment. A recent health concern has been from the leaching of antimony from polyethylene terephthalate (PET) water bottles; antimony is used as a catalyst in the manufacture of some PET. Japan has banned the use of this type of PET for food packaging.

VI: selenium and tellurium

Selenium is an unusual element in that it is an essential element at low concentrations, but toxic at marginally higher levels so that the safe range of daily intake is relatively narrow (40 μg – 400 μg day^{-1}). This is in contrast with other essential elements such as copper, which has a tolerable range over six orders of magnitude. Health effects can be correlated to low amounts of dietary selenium (Keshan disease and Kashin-Beck disease) or excessive selenium in drinking water (selenosis), with livestock particularly vulnerable[10]. However, there is evidence that selenium might mitigate the toxicity of mercury and minimise the risk of eating fish as a staple food source within at-risk populations.

Summary

Compound semiconductor wafer processing poses a low risk to the health of fab workers, provided they are properly handled and their processing waste is disposed off according to local regulations. The elements that make up these compounds have a significant environmental impact and are recognised as priority pollutants in water resources, largely as a result of past industrial land uses such as mining. There is a growing awareness of the potential health impacts from these metals and various international groups are working on proposals to minimise the discharge and use of some of these elements, especially mercury. Although the semiconductor industry is responsible for only a very small fraction of these releases, pending environmental agreements may restrict the future use of some semiconductor materials.

	Element	Principal minerals	USEPA MCL	Possible health impacts
Essential trace elements	Zinc	Sphalerite (ZnS) Smithsonite ($ZnCO_3$)	50 ppm	'Zinc shakes'
	Selenium	-	50 ppb	Selenosis Keshan disease
	Phosphorous	Apatite	Not specified	Phossy Jaw
	Aluminium	Bauxite	50 – 200 ppm	Alzheimer's disease risk (?)
Non-essential trace elements	Mercury	Cinnabar (HgS)	2 ppb	Minamata disease
	Cadmium	Greenockite (CdS)	5 ppb	Itai-itai disease Kidney damage
	Antimony	Stibnite (Sb_2S_3)	6 ppb	
	Arsenic	Arsenopyrite (AsFeS)	10 ppb	Arsenicosis
	Tellurium	-	Not specified	Unknown

Table 1. Summary of main compound semiconductor elements and possible health risks

References

(1) *Health & Safety Executive (2010), 'Report by the Health and Safety Executive on the control and Management of Hazardous Substances in Semiconductor Manufacturers in Great Britain in 2009.', Technical Report, Health and Safety Executive.*
(2) *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32006L0012:EN:NOT*
(3) *K. Torrance et al Semiconductor Today **4**(4), 66 - 68.*
(4) *M. Veiga et al. (2004). Protocols for Environmental and Health Assessment of Mercury Released by Artisanal and Small Scale Miners, Report to the Global Mercury Project: Removal of Barriers to Introduction of Cleaner Artisanal Gold Mining and Extraction.*
(5) *R. Philipp et al. International Journal of Epidemiology **11** 257 (1982)*
(6) *P.Elliot et al. Occupational and Environmental Medicine **59**, 13 (2002),*
(7) *T. Laten et al. Brain Research Bulletin. **55** 187 (2001)*
(8) *J. Emsley The 13th Element. New York : John Wiley and Sons (2000)*
(9) *ATSDR (2010) Medical Management Guidelines for Arsenic Trioxide. http://www.atsdr.cdc.gov/mhmi/mmg168.ht*
(10) *R. Fosdyce (2005) Selenium Deficiency and Toxicity in the Environment. In: Selinus, O. et al. (eds.) Essentials of Medical Geology. Amsterdam : Elsevier. 417 – 433.*

Carrier asymmetry blamed for LED droop

A mix of modelling and experiment creates a strong case for carrier asymmetry as a primary cause of LED droop.

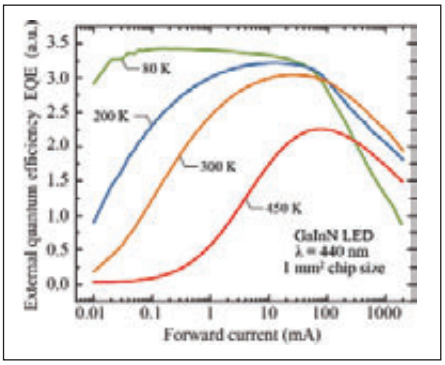
CARRIER asymmetry has been added to the growing list of conjectures to account for droop, the decline in the efficiency of GaN-based LEDs at high current densities. This potential cause of droop is being put forward by a team from Rensselaer Polytechnic Institute, New York, and Samsung LED, Korea. Their claim for asymmetry as the cause of droop followed modelling device behaviour in p-n junctions and measurements of LED output at various carrier densities and temperatures.

The researchers also concluded that LED droop starts to kick in when conductivity in the p-side due to electron injection equals the conductivity due to the holes present in that layer. This condition, which the team refers to as high-level injection, creates an electric field on the p-side that increases leakage and droop.

Two factors are responsible for the severe carrier asymmetry in GaN LEDs: A very high ionization energy of the common hole dopant, magnesium, which leads to a low hole concentration; and a far lower mobility for holes than electrons.

The team studied the effects of this asymmetry in a very simple structure, a GaN p-n homojunction, using the commercial software APSYS.

They found that high-level injection produces: A voltage drop that is not confined to the depletion region but extends to a quasi-neutral region; and an LED series resistance that leads to deviations from the expected exponential current-voltage behaviour.



Droop occurs at far lower current densities when the device is cooled

What's more, the team uncovered theoretical evidence for the dependence of the recombination location on carrier symmetry. When a junction had equal doping on both sides, the recombination location is shifted just 1.6 nm to the p-side; but this rises to 18.3 nm when n-doping is far higher than p-doping.

To study droop in real devices, the team measured the LED's external quantum efficiency. Unpackaged 1 mm by 1 mm thin-film chips that were grown by MOCVD – which featured a typical AlGaN electron blocking layer and had an exposed nitrogen-face that was roughened to increase light extraction – were driven at currents from 0.01 mA to over 1000 mA at temperatures ranging from 80 K to 450 K. Devices were driven in a manner designed to minimize self-heating. At 80 K, LED droop kicks in at a very low drive current and is more severe than it is at higher temperatures. That's because the asymmetry in carrier concentration is relatively high, due to the incredibly low free hole concentration at this low temperature. "In addition to this, Shockley-Read-Hall recombination is minimized at 80 K, so the peak efficiency at very low currents is very high, making droop effects more easily recognized," says Fred Schubert from Rensselaer Polytechnic Institute.

Measurements of the LED's current-voltage characteristics reveal a deviation from exponential behaviour. This occurs at the onset of high-level injection, which takes place when droop starts to kick-in. The team argues that this high-level injection produces a build-up of electric field in the p-type region, leading to enhanced electron leakage and a shift in the recombination region into the p-side. Schubert has previously argued that droop is caused by polarization fields, which lead to electron leakage out of the active region. "The common link between these two claims – asymmetry and polarization fields – is leakage of electrons over the EBL or, equivalently, lack of hole injection into the active region," says Schubert. According to him, electron leakage and a lack of hole injection may be viewed as two sides of the same coin, because every hole that is not injected will lead to the leaking out of an electron.

"We believe that polarization fields play a significant role in *c*-plane GaN LEDs, including their role in letting electrons leak out of the active region," says Schubert. "However, our and others' efforts in reducing the polarization fields – by polarization matching and non-polar growth – have not reduced the droop to zero." For this reason, Schubert and his co-workers have concluded that there must be another cause for LED droop: Carrier asymmetry.

Another popular conjecture for LED droop is Auger recombination, a non-radiative process involving three carriers. Researchers in this camp are trying to pin down the exact form of Auger recombination, with mechanisms involving phonons and alloy-disorder in the quantum wells receiving recent support. "Due to the very low carrier concentrations at which droop occurs, as well as the temperature dependence of the droop behaviour, we believe that even these newly-proposed forms of Auger recombination are very unlikely to cause significant droop in GaN/GaInN LEDs," argues Schubert.

Another conjecture for droop, which has been proposed by Joerg Hader from the University of Arizona, is density-activated defect recombination (see page 53). Schubert can't rule this out, but he points out that in a recent paper by Hader and his co-workers, those researchers revealed that density-activated defect recombination overestimates the internal quantum efficiency at very high currents, which is probably due to carrier leakage and non-capture. Schubert's team is now working on complementing its model with analytical expressions to predict the conditions for when droop occurs. "We hope that this will allow us to gain a general understanding of the droop so that we can understand and predict trends with respect to temperature, bandgap, and the asymmetry of electron and hole properties."

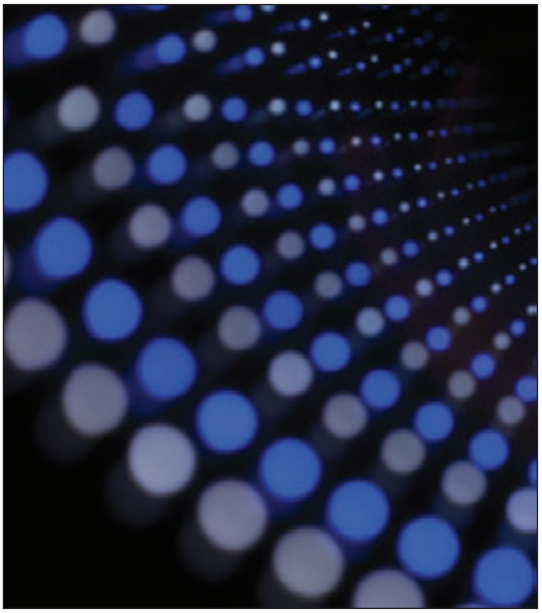
D. Meyaard *et al.* Appl. Phys. Lett. **99** 251115 (2011)

Defects could account for LED droop's temperature dependency

Calculations unveil two problems with the Auger theory for LED droop. This recombination mechanism is far too weak, and it has a temperature dependence that fails to tally with experimental results.

A US-German collaboration has put forward more theoretical evidence to support its claim that density-activated defect recombination (DADR) could account for droop in GaN-based LEDs.

The team from Nonlinear Control Strategies, the University of Arizona and Philips University Marburg has included terms that can be responsible for droop – the decline in LED efficiency as the current is cranked up high – in calculations on device efficiency at temperatures from 100 K to 400 K. In general, in this regime the warmer the device gets, the weaker the droop causing mechanism becomes.



Reasonably good fits to experimental data are possible with the DADR model. With a model that accounts for droop with Auger recombination, however, it is only possible to replicate real data when the Auger recombination coefficient is about two orders of magnitude higher than the highest value produced by calculations. What's more, the variations of the droop causing mechanism with temperature do not follow the generally assumed increase in Auger loss strength with temperature.

In other words, this recent theoretical work, which involves radiative loss calculations that include higher excitonic terms, indicates that Auger recombination is not the primary cause of LED droop.

In the DADR model, at low current densities carriers are localized in regions with very few defects. But as the current increases, more and more carriers spill over into regions with strong defect recombination.

Energetic barriers separate these two regions, and carriers move between them via electron-electron scattering, which is more prevalent at high electron densities. Consequently, droop is stronger when the electron density is higher.

"The strength of electron-electron scattering becomes weaker with increasing temperature," says Joerg Hader from Nonlinear Control Strategies and the University of Arizona. This occurs because at higher temperatures there is a reduced probability of finding electrons with an energy close to the bandgap – more occupy higher energy states.

Hader and his co-workers have used their DADR model to fit graphs produced by other researchers, which detail LED efficiency at various drive currents and temperatures. Experimental results generated with a blue-emitting LED fabricated by Nichia and a green cousin made at Osram Opto Semiconductors were used in the theoretical study.

The DADR model contains two recombination processes involving defects: Schottky-Read-Hall (SRH) recombination, which is associated with crystal defects, such as threading dislocations; and DADR recombination.

"We don't know what the defects are that are involved in DADR," admits Hader. He says that they could be the same defects that are responsible for SRH recombination, but in this case they only contribute to droop at higher current densities, due to the energy barriers. Another possibility is that they are V-pits. "While we are not sure, they seem to fit the DADR picture."

According to Hader, findings reported in a recent paper by Guan Sun and co-workers from Lehigh University (Appl. Phys. Lett. **99** 081104 (2011)) support the DADR hypothesis. In that experimental work, the researchers uncover two decay times in InGaN/GaN quantum wells. One that is relatively slow and has a time scale typical for SRH recombination; and another that is faster, and has a time scale similar to that expected for DADR recombination.

"Moreover, through spectral analysis they conclude that the SRH-like decay originates from localised states and the fast decay happens at elevated densities when carriers start to occupy delocalised states," says Hader.

Fred Schubert's group at Rensselaer Polytechnic Institute, in collaboration with Samsung LED, published a paper in early 2011 detailing the temperature dependence of the strength of droop (D.S. Meyaard et al. Appl. Phys. Lett. **99** 041112 (2011)).

According to Hader, that work focuses on LED behaviour above room temperature, which is a regime where carrier leakage is expected to become more significant as the device gets hotter. This expectation was found to be the case by this US-Korean team.

"We don't take that as a contradiction of our results," says Hader, "since we look specifically at situations where leakage is not significant – low temperatures and low-to-medium currents."

J. Hader *et al*. Appl. Phys Lett. **99** 181127 (2011)

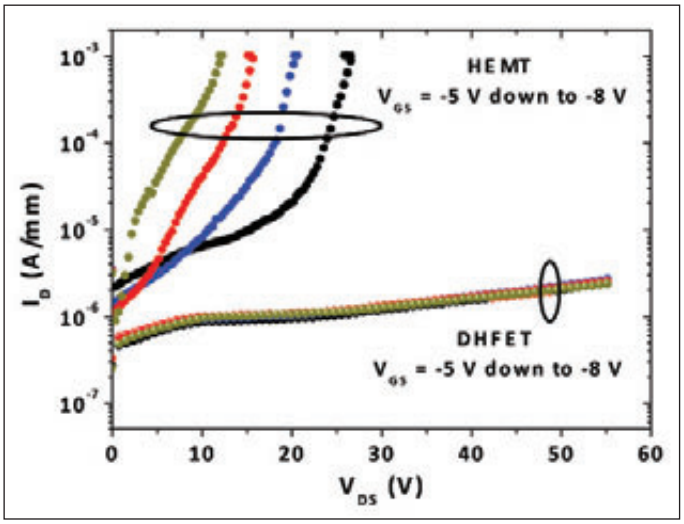
AlGaN back barrier aids HEMT scaling

Forming double-heterostructure FETs with an AlGaN barrier improves electron confinement, leading to a higher drain bias.

RESEARCHERS at the Institute of Electronics, Microelectronics and Nanotechnology in Villeneuve d'Ascq, France, claim to have built the first ultra-short nitride HEMTs with an AlGaN back barrier. "The uniqueness of this work comes from highly scaled, ultrathin barrier AlN/GaN devices suitable for high frequency GaN-on-silicon operation and high-voltage operation," says lead author Farid Medjdoub.

The AlGaN back-barrier HEMTs, which have a 0.2 μm gate length and a 1 μm separation between the gate and drain, operate at cut-off frequencies in excess of 50 GHz, deliver twice as much current as standard nitride HEMTs and produce a high blocking voltage.

Superiority over standard HEMTs stems from better electron confinement, which allows the transistor to be biased at a higher voltage. Medjdoub and his co-workers fabricated their HEMTs on 4-inch, high-resistivity silicon (111) substrates. MOCVD was used to form a standard HEMT, which acted as a control, and the slightly more complex double heterostructure FET that had an $Al_{0.08}Ga_{0.92}N$ buffer acting as a back barrier.



The superior electron confinement produced with the AlGaN back barrier is clearly evident in plots of drain current as a function of drain-source voltage. This graphs compares the performance of 2 x 25 μm^2 AlN/GaN-on-silicon HEMTs and DHFETs in the sub-threshold region, using gate-source voltage sweeps of -5V to -8V and 1 V steps

According to Medjdoub, it is no more difficult to grow a high-quality AlGaN buffer than one made of GaN. "In term of growth, the challenge is definitely the achievement of high AlN quality [for the top barrier]. This provides huge polarization and results in extremely high current density," says Medjdoub. He and his co-workers primarily attribute the high-quality of their 6 nm AlN barrier to the *in-situ* growth of a 3 nm-thick SiN cap that prevents strain relaxation. Ohmic contacts have been formed directly on top of the AlN barrier by etching the SiN layer and depositing a Ti/Al/Ni/Au stack. Nitrogen implantation isolated the devices, and deposition of a 50 nm-thick SiN film by plasma-enhanced CVD, followed by e-beam lithography, defined a 2 μm gate length.

Plasma etching removes SiN under the gate, and electron-beam lithography adds a Ni/Au gate to create transistors with a 50 μm device width and gate-source and gate-drain spacings of 0.3 μm and 1 μm, respectively. These are passivated with a 100 nm-thick film of SiN. Evidence for the improvement in electron confinement with the addition of an AlGaN back-barrier is provided by plots of the drain current verses source-drain voltage (see Figure). The addition of this ternary back barrier enables operation of the device with a drain voltage of 50 V or more.

Introducing the AlGaN barrier also led to an increase in cut-off frequency from 44 GHz to 52 GHz, and a hike in the maximum oscillation frequency from 68 GHz to 91 GHz.The French team has noticed a thermal limitation with the 8 percent aluminium, AlGaN back barrier. "We plan to reduce the aluminium content to less than 5 percent in order to significantly improve the thermal management while maintaining excellent electron confinement," says Medjdoub. "Then, we expect to achieve, for the first time, GaN-on-silicon high power in the millimetre range."

F. Medjdoub *et al.* Appl. Phys. Express **4** 124101 (2011)

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News Digest Contents

LEDs

Seren to provide its novel LED technology in India

The firm's technology is a fresh approach to increasing the amount of light created at the very heart of a white high brightness nitride-based LED

Fusion IP has announced that Seren Photonics Ltd (Seren) has signed its first collaboration agreement that includes terms to bring its unique LED processes to market.

Seren uses a novel procedure to bring together low cost mass manufactured blue HBLED structures and nano-science to achieve a white HBLED with superior performance compared to current state-of-the-art products.

The brightness (efficacy) of current HBLEDs range from 60 to 120 lumens per watt (lm/W). Seren says adoption of this procedure could see mass manufactured HBLEDs with efficacies of around 200 to 260 lm/W.

Under the terms of the agreement, which was signed with a major, undisclosed, LED manufacturer, Seren has given exclusive rights to its technology for certain lighting applications in India. The chosen partner has entered in to a collaboration agreement with Seren, which when successfully concluded, will allow the partner to take a licence for manufacture of product incorporating Seren's processes.

Fusion IP, a university IP commercialisation company that turns world class research into business, has a 48 % shareholding in Seren.

Godfrey Ainsworth, Seren's Chairman, announcing the deal said, "We estimate that the first sales of manufactured product, incorporating our technology, will start as early as 2013 and lead to an increasing royalty stream, as our partner brings our process in to full production and their own manufacturing capacity increases. We look forward to working closely on the collaboration and to achieving a successful tech transfer during 2012 to our first manufacturing partner."

"This is the first of many commercial agreements we hope to conclude for Seren and it really demonstrates the potential of our unique approach to enhance light creation from LEDs. This agreement is for just one application in one territory in the world. We are already in discussions with a number of our manufacturers around the world and expect to see further agreements made in a number of territories in 2012/13. Clearly, the potential value to the company of engaging with the right manufacturing partners is very significant", he concluded.

David Baynes, CEO of Fusion, added, "This is another great example of the value of the technology in our pipeline. Seren clearly has the potential to become an extremely valuable portfolio company and we look forward to more deals in the future, as the Company rolls out the technology into other sectors and other countries across the world."

Fusion IP plc (Fusion) was established in 2002 to commercialise university-generated intellectual property. It has long-term exclusive agreements with two of the UK's leading research intensive universities, the University of Sheffield and Cardiff University, giving it exclusive access to a combined R&D spend of over £ 185 million a year.

Fusion's first agreement was a ten-year exclusive arrangement with the University of Sheffield, giving it the right to commercialise (through the creation of spin-out companies and licensing) research, owned by the University, initially in the area of medical life sciences. This agreement was expanded in July 2008 to include all non-life science research-generated IP such as energy, engineering and electronics. Fusion has

significant shareholdings in a portfolio of University of Sheffield spin-out companies including Simcyp, Magnomatics, Diurnal and Phase Focus.

In January 2007, Fusion completed a ten year exclusive agreement with Cardiff University, also giving it the right to commercialise (through the creation of spin-out companies) Cardiff University's research-generated IP. Fusion has significant shareholdings in a portfolio of Cardiff University spin-out companies including Mesuro, Asalus and MedaPhor.

On 2 December 2009 Fusion announced that it had raised approximately £3.2 million through a fund raising and that as a result, IP Group held approximately 19.8% of Fusion. Fusion has also entered into a Co-Investment Agreement with IP Group, in which IP Group has the right to acquire for cash, 20% of Fusion's equity in any new portfolio company. As Fusion normally owns 60% of any new portfolio company at start-up, IP Group's shareholding would normally equate to a 12% stake in the new portfolio company.

Fusion IP also has a Memorandum of Understanding with Finance Wales, the provider of commercial funding to Wales-based SMEs, which outlines a strategy of co-investment in opportunities arising from the Cardiff Agreement.

On 8 November 2011 Fusion announced that it had raised approximately £5 million through a fundraising with existing and new institutional investors. As a result of this IP Group holds an interest in approximately 26% of Fusion.

Soitec completes acquisition of Altatech

The acquisition will provide Soitec access to specific equipment necessary to deliver its LED strategy. It will also support manufacturing ramp up of its new Plug&Sun stand-alone mini solar tracker system

Soitec, a manufacturer of revolutionary semiconductor materials for electronic and energy industries, has successfully completed its acquisition of all of the outstanding shares composing the capital of Altatech Semiconductor S.A.

Altatech Semiconductor was a privately held French company located in Montbonnot-Saint-Martin near Grenoble, France. Altatech, created in 2004 by a group of semiconductor professionals, currently develops highly efficient, cost-effective technologies and equipments for new applications in emerging markets.

The final purchase price was set to € 15 million. The acquisition was financed partly in cash and partly using Soitec stock, purchased by BNP Paribas Exane on the market. This was completed under the share buy-back program approved by the shareholders during the combined ordinary and extraordinary meetings held on June 24, 2011. Selling shareholders are bound by certain holding requirements for the portion of the purchase price to be paid in Soitec stock.

Soitec's products include substrates for microelectronics (most notably SOI : Silicon-on-Insulator) and concentrating photovoltaic systems (CPV). The company's core technologies are Smart Cut, Smart Stacking and Concentrix, which is based on III-V multi-junction cell technology. Applications include consumer and mobile electronics, microelectronics-driven IT, telecommunications, automotive electronics, lighting products and solar power plants for large-scale utilities.

Osram LEDs illuminate Jerónimo Martins supermarkets

Luminaires from Arquiled, featuring the Oslon SSL LEDs, are now in all of the food retail group's new stores

The Jerónimo Martins Group is among the first European retail companies to equip its new stores entirely with innovative LED lighting.

This move will save the company 50 percent of its lighting energy costs, thanks to Osram Opto's Oslon SSL LEDs and the intelligent light management system of the luminaires supplied by lamp manufacturer Arquiled.

The Jeronimo Martins Group has been using the luminaire concepts from Portuguese manufacturer Arquiled in its new stores since spring 2011. The first LED-based lighting systems were installed in a newly opened Recheio store in Torres Vedras, a rapidly growing region north of Lisbon.

Photo: Arquiled/Osram

Arquiled opts to fit its LED luminaires with Oslon SSL light emitting diodes: energy efficient lighting solutions for supermarkets

The lighting in both the shop and the outdoor areas is being seen as a model and reference for the chain's other stores. The next project is already being planned for a store in Tavira, Portugal, where Arquiled will likewise incorporate products from Osram in its special lighting concept, aiming to achieve the highest quality of the LEDs used.

"Apart from the performance and efficiency of the products, which are unparalleled on the LED market, another winning feature of the LEDs from Germany is the excellent local support we receive," says Arquiled's CEO, Rafael Abelha Santos, explaining the background of the partnership.

The Jeronimo Martins Group also elected to use luminaires from Arquiled and high-quality LEDs from Osram Opto for its outdoor lighting in the area of the parking lots and around the integrated gas stations.

Photo: Arquiled/Osram

The Jerónimo Martins Group uses Arquiled luminares fitted with Osram LEDs to illuminate parking lots and gas stations

The Arquicity street lamps are equipped with light sensors and can adapt their brightness automatically to changing situations. The combination of intelligent light management and the low energy consumption of the LEDs will slash energy costs.

"The technical properties of the LED technology will help to achieve considerable savings on power consumption and offer numerous advantages in terms of installation and maintenance, too. That means we save three different resources: power, time and

money," said Antonio Sousa, Osram Opto Semiconductors Portugal.

The project began with a detailed analysis of the retail chain's lighting requirements. Based on the results, Arquiled developed a luminaire concept to meet the special needs of supermarkets. LED lighting not only offers the advantage of a long service life and the associated low maintenance costs, but is also ideal for direct product illumination.

LEDs generally emit very little thermal energy and do not heat up the objects they are illuminating. They can hence be positioned closer to products without damaging them.

Three Arquiled modules are to be used at the Jerónimo Martins in Tavira: the Arquiway, a module comprising 4 Oslon SSL LEDs; the Arquistore, with 72 Oslon SSL LEDs per luminaire; and finally, Arquishelf luminaires, which will provide special shelf lighting with 56 Oslon SSL LEDs, illuminating products in the ideal colour temperature and displaying them at their very best.

North Carolina Water Reclamation Facility chooses Cree LEDs

The 45 Cree THE EDGE LED area luminaires are providing significant reductions in energy usage and costs while dramatically improving visibility and overall safety

As part of a city-wide goal to reduce energy usage and improve night time visibility and overall facility safety, the South Durham Water Reclamation Facility installed energy-efficient LED lighting from Cree.

The new Cree lighting simultaneously addresses the facility's competing exterior lighting requirements – the need to improve safety and light levels and the need to reduce energy usage and maintenance costs.

"This lighting project delivers multiple benefits," said Joel Reitzer, director of the City's General Services Department. "Not only were we able to increase visibility and provide our workers with a safer, more productive work environment, but we also reduced our energy consumption by nearly 64 percent for the fixtures that were replaced with the new Cree lighting. It really is a 'win-win' for the City's bottom line and ultimately, Durham's environment."

The South Durham Water Reclamation project was part of an overall effort by General Services, Community Development, Water Management and the City-County Sustainability Office to reduce energy use in the City.

Forty-five Cree THE EDGE LED area luminaires were installed in the processing area and at the front gate of the South Durham Water Reclamation Facility. The Durham facility operates 24/7 and monitoring of the system often occurs at night.

"The City anticipates significant maintenance savings in both material and labour with the new Cree lighting," Reitzer continued. "After installing Cree LED lighting, we are realising a significant reduction in energy usage and savings in energy costs while dramatically improving visibility and overall safety. The installation and lighting costs are short-term, but the energy savings, lower maintenance costs and safety benefits will endure."

"Facilities with 24/7 operation have unique lighting requirements," said Al Safarikas, director marketing, Cree lighting. "Cree is committed to developing innovative LED lighting solutions that address the diverse needs of our growing customer base. For the South Durham Water Reclamation Facility, Cree provides energy savings, reduced maintenance, and the illumination needed for night time productivity and safety."

The City of Durham utilised federal grant funds

from the American Recovery and Reinvestment Act through the U.S. Department of Energy's Energy Efficiency and Conservation Block Grant Program to fund the $106,000 lighting project. The installation was completed in April, 2011.

Compact super-thin ChipLEDs from Vishay Intertechnology

The aluminium indium gallium phosphide and indium gallium nitride LEDs come in white and a range of colours for backlighting applications

Vishay Intertechnology has unveiled a series of super-thin, ultra-bright LEDs in what the firm says is the smallest SMD 0603 package.

The new VLMx1300 series of LEDs uses an innovative ChipLED technology, paving the way for smaller end products with higher performance, more flexibility in design, and enhanced applications. The 0603 VLMx1300 LEDs will serve in small-scale, high-brightness products that must work reliably in demanding environments.

New VLMx1300 series ChipLEDs (photo courtesy of Vishay Intertechnology›s photostream)

All LEDs in the VLMx1300 series are mounted on highly reliable PCBs measuring 1.6 mm x 0.8 mm x 0.55 mm and have an extremely wide 130° viewing angle. Available colours include super red, soft orange, yellow, yellow green, true green, blue, and white. Using ultra-bright AlInGaP and InGaN technologies (depending on colour), the colour LEDs have a luminous intensity as high as 450 mcd at a forward current of 20 mA and a maximum forward voltage of 3.8 V.

Blue is available with a protection diode that provides ESD immunity up to 8,000 V. The white LED has a maximum luminous intensity of 180 mcd at a forward current of 5 mA and a maximum forward voltage of 3.15 V. The table below lists characteristics by part number.

The VLMx1300 ChipLED series› low profile, brightness and reliability make the colour versions ideal for backlight applications including keypads, navigation systems, cellular phone displays, displays for industrial control systems, miniaturized colour effects, and traffic displays. The white version works well in backlighting for telephone and fax, audio and video equipment, office equipment, indoor and outdoor message boards, and flat backlight for LCDs, switches, and symbols.

The devices are available in 8 mm tape on a 7 in. diameter reel grouped by luminous intensity and wavelength to ensure an even appearance in end products. They are compatible with IR reflow soldering and compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC. VLMx1300 LEDs are lead-free and are suitable for lead-free soldering.

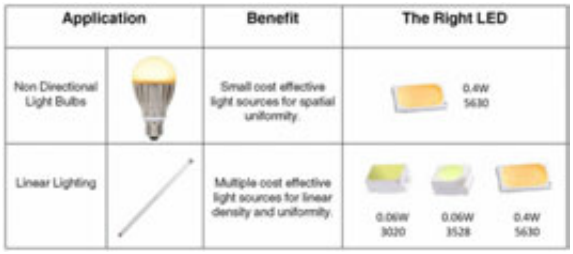
Samples and production quantities of the new ChipLEDs are available now, with lead times of eight weeks for larger orders.

'The right LED' for the right application

Everlight is offering ‹smart binning› for its Shuen and Shwo high power LED series

Everlight Electronics, a player in the global LED

industry, announces a series of low/mid power LEDs especially suited for use in solid state lighting. The new Low/Mid Power LED family has the ability to provide customers a total solution for lighting applications.



The right LED for the right application (Source: Everlight)

General Lighting is an interesting and broad market segment. For any individual segment of lighting there are multiple categories and subcategories with different requirements and functionalities. Outdoor lighting encompasses street lighting, tunnel lighting, parking lot lighting, landscape lighting, as well as a slew of other applications.

Indoor Lighting encompasses replacement bulbs, down lights, light bars, etc. As an example, replacement bulbs are further categorized down to directional bulbs, decorative bulbs, and omni-directional bulbs. Furthermore, directional bulbs are sub categorised into MR16, PAR, AR111, etc.

With a bit of application based marketing, «The Right LED» can be paired with the appropriate applications to provide the best performance and quality. Everlight›s recent announcement of its Low/Mid Power LED series is directed towards light bar replacement and omni-directional bulb applications.

This series consists of 0,06W, 0,2W, 0,4W, and 0,5W products with efficiencies of >100lm/W. These LEDs are of different form factors; 3020 and 3528 (0.06W), 5050 (0.2W), and 5630 (0.4W and 0.5W) package sizes.

The 3020 and 3528 (0.06W) packages are ideal for light bar applications. Many of these small packages can be densely packed onto a linear heat sink to provide the required light uniformity of linear solutions. As a result, a linear LED light bar can emulate the appearance of traditional fluorescent tubes.

What›s more, because these are small, low power LEDs, the minimal thermal dissipation of linear fixtures is sufficient in maintaining a low substrate temperature as well as a low junction temperature within the LED, resulting in better performance and lifetime. To increase the advantage of using low power LEDs and improve overall light quality in the fixtures, Everlight can offer 200mcd/bin for intensity uniformity and 0.1V/bin for more consistent electrical design.

The most recent market trend and direction for the general lighting market is towards cost conscious, consumer price acceptable replacement A-bulbs. It is predicted that 257 million A-bulbs will be sold worldwide in 2013. With current price and performance pressures, the Mid Power 5630 (0.4W and 0.5W) package is aggressively surpassing traditional COB and high power LED light sources as the preferred package type for A-bulb applications. 5630 packages have superb lm/$. This is derived from the combined resources of the backlighting and the general lighting market. This shared capacity results in stable quality and commercial competitiveness over other types of LEDs.

In addition, the balance of lumens output, power consumption, and package size allow the 5630 to optimally spread light and heat by spatially distributing the LEDs uniformly in the dimensional confines of an A-bulb.

All Everlight Low/Mid Power LEDs follow ANSI binning, have a wide range of CRI values, and are undergoing LM80 testing. Everlight says its flexibility in low/mid power LEDs in packaging, binning and chip selection gives engineers more options in creating unique lighting fixtures with acceptable prices.

Everlight is fostering closer working relationships between its R&D, Sales and Marketing teams to meet and exceed our customer›s expectations in both product offering and technology. Everlight›s Low/Mid Power LED Series are expected to satisfy the fastest-growing global LED lighting market.

The low power Everlight LEDs have a power consumption of 0.2W or less. The mid power LED power consumption is 0.5W or less.

The LEDs will be exhibited at «Light + Building 2012», Messe, Frankfurt between 15 and 20 April 2012 at stand H41/K10.

Power LED samples are available upon request and are currently in mass production.

OCReef.com reveals new X-Series Cree LED aquarium lights

The aquarium fish pet supply store, offers a new line of LED aquarium lights, to give fish hobbyists the most advanced products from the LED innovator

OCReef.com is introducing the Cree X-Series LED Aquarium Lights.

This is one of the first aquarium supply stores to incorporate Cree's line of 3 watt LEDs into aquarium light fixtures. These light systems will provide a balanced spectrum for photosynthetic corals, invertebrates and for freshwater planted biotope aquariums.

Cree LED Aquarium Light

"The advances and advantages of LEDs over traditional Metal Halide lighting, are creating a groundbreaking demand for products like this. We do our best to keep them in stock and readily available," said David Francis, Director of Operations for OCReef.com. "Our customers will see significant colour improvements in their corals and fish with these lights."

Cree has offered high-performance LEDs to the lighting industry for decades, however, when OCReef.com decided to start incorporating them into their light fixtures, this made for an aquarium light in a class all its own. "We really hit this one out of the ball park," said David. "The most popular tank size in our industry holds 50-90 gallons, and the small footprint of 24 inches fits over most aquariums perfectly; for aquariums of 90 gallons that are 48 inches in length, two units will work nicely. The lights are powerful enough that customers don't need to give their lighting needs another thought."

Light is a major component for the proper care and survival of a saltwater coral reef aquarium.

LUXEON K LEDs for downlighting

The arrays are engineered to support rapid development of downlight and retrofit bulb solutions where quality of light and efficacy are essential

Philips Lumileds LUXEON K's illumination grade array charts a new direction for downlights and retrofit bulbs.

The firm says they make solutions able to come to market more quickly and at a price that drives market adoption.

LUXEON K arrays

LUXEON K arrays provide thousands of lumens of light output and will be available in three different CCTs with a typical CRI of 85, and with five configurations of 4-24 emitters per array, in early Q2 of this year.

"LUXEON K extends our portfolio of illumination grade LEDs engineered to optimise end-user satisfaction of specific applications," said Rahul Bammi, VP Marketing at Philips Lumileds. "For downlights and retrofit bulbs, LUXEON K provides a unique approach that delivers the highest, most consistent quality of light in an easy-to-implement array. Our hot testing and specification at 85°C, and freedom from colour, flux, and Vf binning, makes LUXEON K the simplest of LEDs to specify and use."

With a CCT of 2700K, 3000K and 4000K, the LUXEON K has a guaranteed minimum CRI of 80 and is typically 85. The typical flux at 700 mA is 620 to 4455 lumens. At 350 mA, Tj at 85°C and 3000K CCT, the LED emits over 100 lumens per Watt.

With hot testing and specification at 85°C, the modules have freedom from binning in a single 3-step MacAdam Ellipse colour space. The LEDs have no flux bins and no Vf bins.

Companies interested in LUXEON K can receive updates on availability, sampling, and specifications by sending an email to Philips Lumileds LUXEON@Philips.com or by contacting Future Lighting Solutions, LUXEON@futurelightingsolutions.com. The new

Opto Diode reveals wide-emission, high power IR LEDs

The aluminium gallium arsenide LED features a wide-emission angle for coverage over a large area and extremely high optical output (minimum 30, typical 40 mW) with peak emission wavelength at 850 nm

Opto Diode, a division of ITW, and a member of the ITW Photonics Group, is introducing the first of a family of three new infrared (IR) emitters.

OD-850 W AlGaAs LED

The new OD-850W device is an upgrade and replacement for Opto Diode's OD-880W IRLEDs, offering nearly double the output power, added stability, and much less degradation. Additionally, the 850 nm wavelength is more closely matched to the peak response of photo transistors and opto integrated circuits, making them ideal for industrial control applications such as photoelectric controls and opticalencoders.

Hermetically sealed, the standard TO-46 package is designed with gold-plated surfaces and welded caps, for added durability. The IR LED offers optical power of 40 mW typical at 100 mA, continuous forward current at 100 mA and peak forward current at 300 mA (absolute maximum ratings at 250 C). The storage and

operating temperatures range from -400 C to 1000 C with a maximum junction temperature of 1000 C.

Available and shipping now, the OD-850W IR LEDs are priced at $2.80 each for a minimum order of 100 pieces.

New instruments for LED characterisation

Instrument Systems is launching a new series of CCD array spectrometers and a current source. Both have been specially designed to assess LEDs

The CAS 120 series of measuring instruments has been specifically developed for price-sensitive applications in spectral light measurement, such as LED production or quality assurance. Although costs have been reduced, technical innovations deliver even higher levels of reliability.

The CAS 120 is an optical spectrometer which analyses the spectral characteristics of light radiation. Having additional optical probes and absolute calibration turns this type of measurement system into a spectroradiometer.

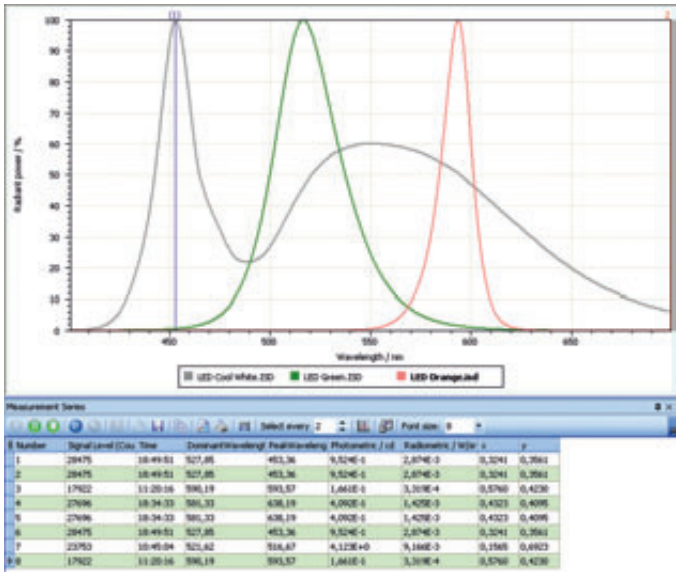
CAS 120 CCD array spectroradiometer

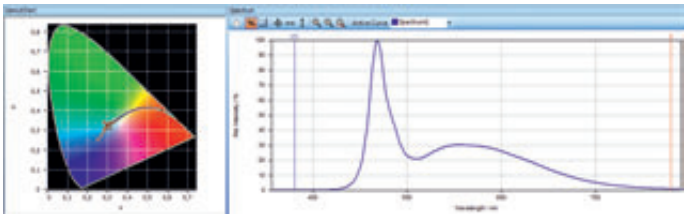
A Crossed Czerny Turner Spectrograph with back-illuminated CCD detector forms the core of the spectrometer. This means that the CAS 120 guarantees exceptionally low stray light and a very high level of optical precision.

Cost-intensive cooling of the CCD detector with 2048 x 14 pixels was deliberately omitted for the CAS 120. Instead, the temperature of the CCD detector is recorded each time a spectrum is measured, and an innovative algorithm automatically corrects the signal.

The newly developed filter wheel with density filters OD 1 to OD 4 comes without any mechanical position switches and always guarantees exact filter positions. It expands the total dynamic range of the CAS 120 to 8 decades, enabling the measurement of low and high light intensities without manual intervention in the test procedure.

The CAS 120 is equipped with a USB interface and a TTL trigger I/O. The hardware trigger permits synchronisation with other instruments which is essential for exact measurement results during fast production testing.





Examples of data from a CAS 120 spectroradiometer shown on SpecWin Pro analysis software

Instrument Systems supplies a DLL and a LabVIEW driver for use in production environments and at automated measurement stations. SpecWin Pro and SpecWin Light spectral software packages have been developed for a wide range of laboratory applications with functions for analysis and documentation of test results.

The firm is also marketing the LSM 350 4-quadrant source and measurement unit specifically designed to meet the requirements for production testing of LEDs and LED wafers. High test speeds and the multi-channel capability make the LSM 350 an attractive solution for supplying current or voltage to LEDs with low to medium power output.

LSM 350 basic module in bench enclosure

High test speeds and the multichannel capability make the LSM 350 an attractive solution for supplying current or voltage to LEDs with low to medium power output. Combination with high-precision array spectrometers from Instrument Systems creates a complete solution for optical and electrical testing carried out on LEDs.

As a bipolar current and voltage source, the LSM 350 offers all functions necessary for testing LEDs fast. The automatic polarity test feature can be used for single and multi-chip LEDs. Dedicated measurement ranges permit particularly precise testing at low forward currents of 1 µA, and measurement of reverse currents in the nA range.

The modular concept includes an option to measure breakdown voltages up to 40 V. Very short settling times reduce the test cycles by up to 40% compared to those of most standard current sources.

The LSM 350 is fully integrated in the LED Tester. The turnkey system with the high-precision array spectrometers in the CAS 140CT or CAS 120 series allows test routines to be set up with fully automated testing and binning of LEDs and for testing LED wafers. The associated software permits a large number of different functions and evaluation options.

System solution for LED Tester

North Carolina streets light up with Cree LEDs

The firm's LEDway luminaires are replacing more than 3,600 antiquated street lights in Asheville

Taking steps to improve energy efficiency and reduce its overall carbon footprint, the City of Asheville has initiated North Carolina's first large-scale deployment of LED street lights.

There are 3,643 LEDway street lights from Durham-based manufacturer Cree, being installed, with projected savings of $260,000

annually.

In the initial phase of the project, completed in June 2011, 730 street lights in Asheville's River District and Kenilworth neighbourhoods were replaced with 67-watt to 195-watt LEDway luminaires, estimated to save the City $45,000 in annual energy costs. An additional 2,913 LEDway street lights are currently being installed, and the City anticipates saving 50 percent of current energy use and maintenance costs due to the LED upgrade.

"Upgrading to LED street lights allows us to decrease energy consumption, increase energy efficiency and contribute to the sustainability of our community," said Maggie Ullman, energy coordinator for the Asheville Office of Sustainability. "This exciting initiative helps affirm Asheville's role as a leader in carbon footprint reduction."

Asheville's city-wide street light upgrade project complies with the City Council's 2008 lighting ordinance, designed to reduce glare and light pollution. In 2009, Asheville City Council unanimously approved using Energy Efficiency and Conservation Block Grants, part of the American Recovery and Reinvestment Act (ARRA), to fund efficiency initiatives, including the first phase of the street light replacement. The revolving fund rolls energy savings back into the city's green and efficiency initiatives.

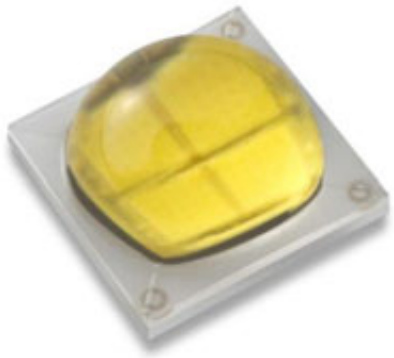
Progress Energy, which serves the City of Asheville, provides N.C. Utilities Commission-approved rate tables to its customers that choose LED street lights. In addition to helping its customers understand the energy cost savings of LED technology, Progress Energy provides the option of renting or owning LED lighting fixtures.

"As more municipalities commit to replacing outdated, inefficient lighting with the support of their local utilities, LED adoption and consumer awareness continue to increase," said Christopher Ruud, president of Ruud Lighting, a Cree Company. "We applaud the City of Asheville and Progress Energy for working together for the benefit of its citizens demonstrating the growing trend of cities and municipalities working together to join the LED lighting revolution."

Lumileds launches LUXEON M LED for lighting

The LED, grown on an aluminium nitride substrate, is designed specifically to simplify solution design and reduce costs

Philips Lumileds' latest offering provides the optic control and quality of light required by outdoor lighting applications as well as high-bay and low-bay lighting solutions.



LUXEON M simplifies design and lowers cost of outdoor and industrial lighting solutions with Freedom From Binning and leading performance

"LUXEON M performance fundamentally lowers the cost and design complexity for a wide range of applications in the outdoor and industrial markets and equips lighting fixture designers with a source that allows them to meet the ever increasing demands of customers and regulators," said Rahul Bammi, VP of Marketing for Philips Lumileds.

LUXEON M will release with three different

CCTs, 3000K, 4000K, and 5700K each with specified minimum CRI of 70. Each part is hot tested and specified at 85°C and delivers Freedom From Binning. LUXEON M will be broadly available in the second quarter of this year.

These LUXEON M LEDs exhibit more than 900 lumens at 700 mA and 85°C junction temperature. With an efficacy greater than 120 lm/W at 350 mA, the 12 Volt / 8 Watt package is grown on an AIN substrate.

Using Philips Lumileds' latest die and phosphor technologies, LUXEON M is hoped to deliver the industry's best lumen/$ that can be realised using low cost, readily available drivers, optics and boards for design simplicity.

QD Vision picks up 2011 SEMI award for North America

Quantum dots are expected to deliver improved colour and better energy efficiency at lower cost for a range of products, including displays and solid state lamps

The developer of nanotechnology-based optical products for displays and solid state lighting received the 2011 SEMI Award for North America for its pioneering work to commercialise quantum dot (QD) technology.

QD Vision was honoured for the significant progress it made on the integration and manufacturing processes essential to the commercialisation of QD technology. Quantum dots are expected to deliver lower cost, higher energy efficiency and greater wavelength control for a wide range of products, including lamps, displays and photovoltaics.

The recipients of the award are Seth Coe-Sullivan, Chief Technology Officer; Jonny Steckel, Director of Chemistry; John Ritter, Executive VP of Product Development and Operations; and Vladimir Bulovic and Moungi Bawendi, Science Advisory Board members. All five of the recipients have been with the company for at least 5 years, and as a group have invested more than 60 years into quantum dot technology.

"The commercialisation of quantum dot technology, led by the team at QD Vision, opens the door to new generations of products in lighting, displays, and photovoltaics," said Bill Bottoms, chairman of the SEMI Award Advisory Committee. "They offer greater wavelength control, improved colour purity and greater energy efficiency than any existing alternative. Quantum dots hold the promise of replacing the technologies we use in those areas today."

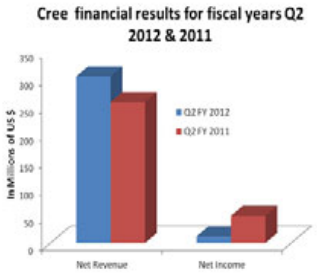
QD Vision says it was the first company to sell quantum dot-based products, which were integrated into general illumination lamps introduced in 2009 at LightFair International. For displays, quantum dot technology will improve the colour quality of LCDs, and subsequently become the emissive element in electroluminescent displays. In 2011, QD Vision demonstrated quantum dot device efficiencies that eclipse those of OLEDs and LCDs.

Discovered in the early 1980s, quantum dots are semiconductor nanocrystals that glow when exposed to current or light. After many years of research, in the early 1990s their commercial potential began to be recognised and universities and companies began seeking patents. Quantum dots are differentiated from LCD and OLED technology in their delivery of bright, pure tuneable colours and low power consumption for displays and lighting, as well as the potential for improved efficiency for photovoltaics.

Cree net income slashed 76%

On the plus side, quarterly revenues rise significantly through Ruud Lighting acquisition

Cree has announced revenue of $304.1 million for its second quarter of fiscal 2012, ended December 25, 2011.



This represents an 18% increase compared to revenue of $257.0 million reported for the second quarter of fiscal 2011. GAAP net income for the second quarter of $12.1 million, or $0.10 per diluted share, decreased 76% year-over-year compared to GAAP net income of $49.8 million, or $0.45 per diluted share, for the second quarter of fiscal 2011.

Financial results for the second fiscal quarter reflect the inclusion of Ruud Lighting for the entire period. Ruud Lighting was acquired in the first quarter of fiscal 2012 approximately one month before quarter-end.

“Our second quarter results demonstrated the strength in our expanded lighting product line with strong growth in sales of both indoor and outdoor products,” stated Chuck Swoboda, Cree Chairman and CEO. “While the business environment remains challenging, our results demonstrate that our strategy is working. Our future business outlook remains very optimistic based on our belief that innovation drives payback, payback drives LED lighting adoption and adoption expands the market for both Cree and our customers.”

Business Outlook:

For its third quarter of fiscal 2012 ending March 25, 2012, Cree targets revenue in a range of $290 million to $310 million with GAAP gross margin targeted to be 34% to 35%. The GAAP gross margin targets include stock based compensation expense of approximately $2.2 million.

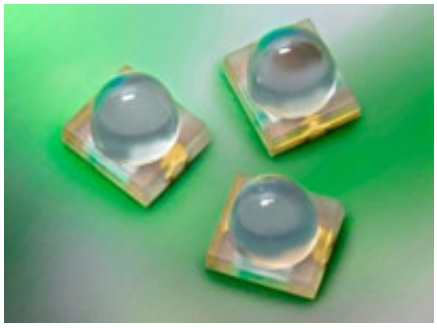
Operating expenses are targeted to increase by approximately $3 million to $4 million on a GAAP basis. The tax rate is targeted at 13.0% for fiscal Q3. GAAP net income is targeted at $4 million to $12 million, or $0.04 to $0.10 per diluted share. The latter target is based on an estimated 116.4 million diluted weighted average shares.

Focus in on Avago’s AlInGaP and InGaN LEDs for cameras

The compact devices which use aluminium indium gallium phosphide technology and indium gallium nitride materials provide high-performance auto-focus in the dark

Avago Technologies has unveiled two series of compact LEDs that reduce space requirements for designing auto-focus auxiliary flash functionality into digital cameras.

The new ASMT-FJ70 and ASMT-FG70 devices are available in one of the market’s thinnest, smallest-footprint packages for LEDs with the brightness needed for auto-focus functionality in dark settings.



The ASMT-Fx70 LEDs are available in a tiny,

environmentally-friendly 3.6 (L) by 3.2 (W) by 3.4 (H) mm surface-mount package that helps meet market demand for thinner digital cameras. The LEDs use a clear, non-diffused lens to provide high luminous intensity within a narrow radiation pattern, providing smooth, consistent optical performance for precise auto-focus functionality. The ASMT-FJ70 devices are orange and the ASMT-FG70 devices are claimed to be the industry's first green auxiliary flash LEDs in this size range.

"Digital cameras continue to shrink in size while growing in functionality and capacity, and our new auxiliary flash LEDs address this challenge by allowing designers to pack in greater functionality per square inch of the camera," said Francis Khor, director of marketing for the optoelectronics products at Avago. "The Avago ASMT-Fx70 LEDs provide the best of both worlds, as they offer a small design footprint without sacrificing auto-flash performance."

The ASMT-FJ70 devices use AlInGaP material technology and feature a 12 degree viewing angle, while the ASMT-FG70 devices use InGaN material technology and provide a 14 degree viewing angle.

Both technologies have very high luminous efficiency, producing high light output over a wide range of drive currents. The narrow viewing angles deliver the long distance illumination and narrow beam pattern required for auto-focus auxiliary flash functionality.

The two modules come in a lead-free and RoHS 6 compliant package and will be shipped in tape and reel to facilitate pick and place manufacturing. The operating temperature range is -40° to +85° C.

U.S. Pricing and Availability

The orange ASMT-FJ70 LEDs are priced at $0.45 each in minimum quantities of 10,000 pieces, and the green ASMT-FG70 LEDs are priced at $0.60 each in minimum quantities of 10,000 pieces. Samples and production quantities are available now through the Avago direct sales channel and via worldwide distribution partners.

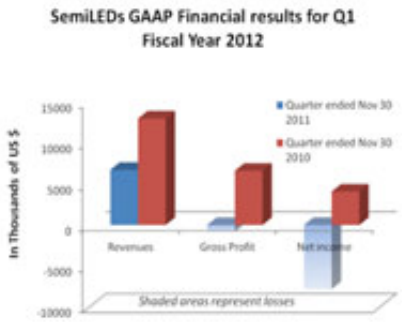
SemiLEDs revenues almost halved

Although the developer and manufacturer of blue, green and UV LED chips and LED components has suffered from poor market conditions, it will continue to pursue the indoor lighting market

SemiLEDs Corporation has announced its financial results for the first quarter of fiscal year 2012 ended November 30, 2011.

Revenue for the first quarter of fiscal 2012 was $6.7 million, a 48% decrease compared to $13.0 million in the first quarter of fiscal 2011.

According to a the conference call hosted by SemiLEDs executives, LED chips accounted for 30% of revenues while LED components were higher at 45%. The remaining 25% of revenue was attributable to mainly luminaires whose manufacturing were outsourced by the company.



«Our strategy of pursuing the indoor lighting market has already proven fruitful as demonstrated by our financial results. While we achieved sequential revenue growth of 27% and we are pleased with our first quarter results, not much has changed, the industry remains very challenging. We believe the steps we are taking will allow us to weather the storm and position us well for when the industry

recovers,» said Trung Doan, Chairman and CEO of SemiLEDs.

GAAP net loss attributable to SemiLEDs stockholders for the first quarter of fiscal 2012 was $7.7 million, or a loss of $0.28 per diluted share, compared to GAAP net income attributable to SemiLEDs stockholders of $3.8 million, or $0.11 per diluted share, for the first quarter of fiscal 2011.

GAAP gross margin for the first quarter of fiscal 2012 was negative 12%, compared with 51% in the first quarter of fiscal 2011. Operating margin for the first quarter of fiscal 2012 was negative 95%, compared with 38% in the first quarter of fiscal 2011. Margins marginally improved from the fourth quarter of fiscal 2011 due to managing expenses.

The Company›s cash and cash equivalents were $74.0 million at the end of the first quarter, compared to the prior quarter ending balance of $83.6 million. Cash used in operations was $3.5 million in the first quarter of fiscal 2012.

Financial Outlook

For its second quarter of fiscal 2012 ending February 29, 2012, SemiLEDs expects revenue in a range of $7 million to $8 million with GAAP net loss attributable to SemiLEDs stockholders of $7.6 million to $7.1 million, or a loss of $0.28 to $0.26 per diluted share, based on an estimated 27.4 million diluted weighted average shares. GAAP gross margin is expected to be negative.

SemiLEDs discussed its financial results in a conference call on 11 January 2012.

An audio replay of the conference call is available until Friday, January 13, 2012 at 11:59 p.m. Eastern Standard Time and can be accessed by dialling

888-203-1112 (from the U.S.) or 719-457-0820 (from outside the U.S.)

and entering the replay pass code 1543778.

A replay of the webcast will be available on the Investors section of the Company's web site for approximately 90 calendar days.

Philips Lumileds has a new CEO

Pierre Yves Lesaicherre succeeds Michael C. Holt and will report directly to Philips Lighting's acting Chief Executive Officer Frans van Houten

The LED manufacturer has appointed Pierre Yves Lesaicherre as CEO of Philips Lumileds, effective immediately.

Pierre Yves Lesaicherre, new CEO of Philips Lumileds

"Pierre Yves' tremendous experience at NXP Semiconductors, most recently as Senior Vice President & General Manager of the business lines Microcontrollers & Logic, make

him uniquely qualified to lead Philips Lumileds into the new world of lighting," said Frans van Houten. "I'm confident Pierre Yves will drive Philips Lumileds performance and actively shape the fast changing LED illumination market," he added.

"At the same time I also thank Mike Holt, Lumileds' first CEO, who for more than a decade has led the company as it invented and introduced high power LEDs and opened entirely new lighting segments. Mike is retiring to enjoy more time with his family," continued van Houten.

Pierre Yves Lesaicherre joins Lumileds with more than two decades of experience in the semiconductor and component industry. He lives in Silicon Valley and speaks multiple languages including French and Japanese.

LED fab equipment spending to drop 18% in 2012

Worldwide LED manufacturing capacity is however expected to reach two million wafers in 2012 (4" equivalent per month), a 27 percent increase over 2011

Following a massive 36 percent increase in equipment spending in 2011, worldwide LED manufacturing equipment spending is projected to decline 18 percent in 2012, according to the latest Opto/LED FabWatch and Forecast from SEMI.

After several years of rapid capacity expansion driven by high-brightness LEDs (HB-LEDs) used in TV backlighting applications- reinforced by lucrative government incentives and economic development funding in China - a 40 percent decline in world MOCVD purchases in 2012 will reduce overall LED equipment spending for the first time in over five years.

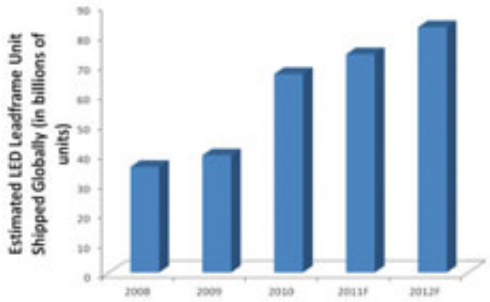
Spending for non-MOCVD equipment, however, particularly in lithography, etch, test and packaging equipment will increase in 2012, as manufacturers optimise their production lines and improve their product designs.

While HB-LED demand continues to grow in solid state lighting, HB-LEDs used in LCD TV backlighting units - presenting approximately 40 percent of the total HB-LED market - failed to reach growth expectations in 2011.

Total TV unit sales missed growth targets and the penetration of LED backlighting as part of total LCD TV unit sales did not reach the levels that many experts predicted. LEDs used in solid state lighting, currently totalling approximately $2.5 billion, may exceed $30 billion by 2020, according to many estimates.

"Similar to other microelectronics industries, LED manufacturing capacity and technology investments will vary year-over-year, but will correspond with the long-term demand driven by key applications; in LEDs, this will be primarily solid state lighting," said Tom Morrow, executive vice president, Emerging Markets Group, at SEMI. "Future equipment and capital spending will drive LED cost reduction through larger wafers, automation and dedicated equipment specifically designed to improve to LED manufacturing yield and throughput."

Regional equipment spending shows China continuing to lead with an expected $719 million planned for 2012, followed by Taiwan ($321 million), Japan ($300 million) and Korea ($260 million). Taiwan will continue to lead in capacity at 25 percent of the world LED capacity, followed by China at 22 percent of world LED capacity. In regards to new fabs, SEMI recorded 29 new LED fabs in 2011. For 2012, SEMI forecasts 16 new fabs coming online next year.



Looking at the back-end of the LED market, the recent Global Semiconductor Packaging Materials Outlook by SEMI and TechSearch Inc. shows very strong growth in LED leadframe shipments. Following the 69 percent unit shipment growth in 2010, LED leadframe shipments are estimated to increase by another 10 percent in 2011. In 2012, shipments are forecasted to reach almost 83 billion units shipped. Data are based on shipments reported by sixteen leadframe suppliers.

The SEMI Opto/LED Fab Forecast tracks over 250 Opto/LED fabs activities worldwide, with detailed information on fab construction and equipment spending, key milestone dates, capacity and ramp up schedule, and more.

Market for sapphire may be dominated by China

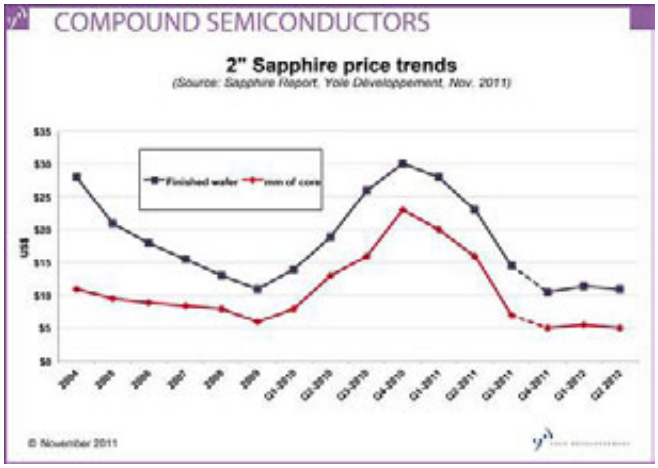
In the last 18 months, more than 40 of the 50 new entrants which have announced intentions to enter the sapphire market (applicable to LEDs) are located in China

Following the massive material shortage in 2010, sapphire material and finished wafer prices remained high throughout early 2011 according to Yole Développement's "Sapphire Market" report.

The situation was aggravated as wafer and LED manufacturers preparing for a massive intake of LED in the LCD TV market started building up sapphire inventory for fear that supply might remain short.

But a softer than expected LED TV market and an increasing sapphire capacity coming from established vendors worked together to rapidly bring supply and demand back into balance this summer. This has triggered a fast drop in wafer prices that have now returned to their pre-shortage levels.

While sapphire demand will pick up in late 2011 and early 2012, additional capacity from new entrants is expected to enter the supply chain and keep 2" prices at their historical lows for the foreseeable future.



"Yole Développement forecasts this low pricing to keep on running for the next coming months," says Eric Virey of Yole Développement.

Coupled with significant volume growth, the sapphire material shortage experienced through 2010 and early 2011 have created a window of opportunity for new entrants. In the last 18 months, more than 50 companies have announced their intention to enter the industry and would bring the total number of potential participants in this market to close to 100. More than 40 of those new entrants are located in China. Looking at midterm, adding up the capacity plans announced by those newcomers leads to a figure corresponding to almost 3x actual demand, a situation unlikely to actually materialise.

Most of the new entrants have little to no prior experience in sapphire crystal growth and wafer manufacturing. While the availability of "turn-key solutions" from various growth equipment suppliers has lowered the barrier to entry, reaching and sustaining high quality and high yields in sapphire crystal growth still requires significant expertise.

The learning curve can be steep for newcomers to reach yield levels on par with established tier one manufacturers. Wafer finishing also requires unique expertise and could prove challenging for companies with no prior experience. Beyond wire saw manufacturers offering efficient slicing solutions and process, not turnkey solution are available for wafer finishing.

The 2010 pricing environment was very forgiving and allowed some new entrants to achieve comfortable margins despite low yields and subpar technology. Yole Développement calculated that many of those new companies have production cost in the $6 - $10 / mm of 2" core and will therefore lose money at the current market price.

At the same time, established vendors with higher yields, large volumes and a more favourable product mix including large diameter wafers can achieve production cost < $5 that will allow them to maintain positive margins and weather the storm. Midterm, Yole Développement expects that this situation will weed out the weakest players and trigger the withdrawal of many potential new entrants.

"The sapphire substrate industry, driven by LED applications, was initially developed based on a 2" diameter platform. Companies like Lumileds and Nichia were the first to move to 3" around 2003 while Osram pioneered the adoption of 4" shortly after. Due to the large concentration of MOCVD capacity in Taiwan, and the current ramp in China, 2" is expected to remain the dominant platform through 2012", explained Eric Virey.

However, many established Taiwan based epitaxy companies are transitioning from 2" to 4" while some technology leaders in Korea, the United states and Europe have already made great strides in the their 6" conversion. Long term, a question mark remains regarding the economics of 8".

But R&D has already started and Yole Développement believes that recent improvements in sapphire growth and slicing technologies could enable a cost of ownership that in time will be compatible with the adoption of the platform.

Intematix to fight back against MCC lawsuit

The firm is denying any infringement of MCC's nitride red phosphor patent

On December 20th, 2011, Mitsubishi Chemical Corporation (MCC) filed an infringement lawsuit in Seoul Central District Court against U.S. company, Intematix Corporation and Korean distributor, GVP, to prevent them from importing and selling MCC's phosphor products.

MCC claimed that they have infringed a red phosphor patent in Korea (No. 816693) which is owned by MCC and the National Institute of Material Science.

The Korean patent No. 816693 relates to a nitride-type red phosphor commonly known as CASN and SCASN (with a general chemical formula CaAlSiN3:Eu). The phosphors can be used in LEDs, lighting equipment, image displays and other goods where this type of phosphor is required.

MMC says CASN and SCASN are the only red phosphors to be used in LEDs due to high brightness and reliability.

In response to the lawsuit, Intematix has announced that the patent infringement claims filed by MCC against Intematix in Seoul, Korea

are entirely without merit.

Intematix is confident that its red nitride products do not infringe any valid claims under Mitsubishi's red phosphor Korean patent. Intematix intends to vigorously defend itself against any such claims.

In addition, Intematix believes that the Mitsubishi patent is invalid and intends to commence an invalidation proceeding against Mitsubishi.

Mitsubishi Chemical sees red on phosphors

The firm has filed infringement for its nitride red phosphor patent ; these materials can be used in LEDs, lighting equipment, image displays and other goods

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Bridgelux overwhelms the LED lighting market

The firm says new customers, technology innovations and additional funding will enable the LED manufacturer to seize market opportunities

Bridgelux has reported that market conditions and its recent achievements ideally position it for additional growth and leadership in 2012.

The company's revenue grew by 792% from FY 2006 to 2010, and Bridgelux expects to see an additional 100% year over year growth by the end of 2011. During the past year, the company raised $76 million in additional funding, added several noteworthy customers, introduced innovative products and technology and received numerous industry awards.

The LED luminaire market is poised for dramatic expansion, with analysts predicting growth of 40% (CAGR) through 2015. Recognising its potential, prominent financial and strategic investors cast their vote of confidence in the market overall, and Bridgelux in particular by investing a total of $76 million in the company this past year.

"We're seeing significant increases in adoption and demand for LED lighting in many sectors and regions. In fact, we've experienced a 300% unit volume growth in LED array sales in the past year alone, dramatically increasing our market share while also delivering well over 100M high power LED chips to enable new and innovative product designs," said Bill Watkins, Bridgelux's Chief Executive Officer.

"Going forward, Bridgelux is extremely well positioned to meet rising demand: we're well funded, have some of the industry's most innovative technologies and product designs, and have established strong strategic partnerships."

Retail and hospitality are among the most

promising near term sectors for the LED lighting market, with growth (CAGR) from 2010 to 2015 predicted to be 59% for retail and 54% for hospitality. Geographically speaking, Europe in particular has great market potential, with analysts predicting 101% (CAGR) growth from 2009 to 20153.

Bridgelux recently expanded its customer base in all of these sectors, adding to both its hospitality and retail customer base with installations at The Sheraton Hotel at D-Cube City in Seoul, Intersport Austria in Klagenfurt, the Dior fragrance booth at the "Galeries Lafayette" in Paris, Coop Adriatica stores in Italy, and over 40 Manor department store locations throughout Europe with several more installations scheduled for the first quarter of 2012.

Cree HB-LED for elevated outdoor video screens

The Screen Master C4SMT LED is designed with a 20 degree tilted viewing angle

Cree is marketing its new Screen Master C4SMT and C4SMD 4mm LEDs for high brightness applications.

The superior brightness and far-field pattern matching, combined with the packaging technology, should enable Cree LED customers to deliver a better viewing experience for its audience and achieve lower system and operating costs than previous generations of LEDs.

"With the introduction of the world's first high brightness LED with a 20 degree tilted viewing angle, Cree continues to push the boundaries of innovation," said William Tang, director of operation, Lighthouse. "The C4SMT LED is ideal for installations with viewing points below the screens."

The C4SMT and C4SMD are the two brightest LEDs in Cree's high brightness P2 oval LED family. Cree believes the C4SMD offers the brightest performance at zero degree intensity and the C4SMT offers the brightest peak intensity performance at a -20 degree angle. Both LEDs are designed to maintain a tight and consistent viewing experience across the entire viewing angle and far field pattern of the LED, allowing for an even viewing experience for the end customer from different angles and viewing positions.

The C4SMT is claimed to be the world's first commercially available high-brightness LED with a tilted -20 degree viewing angle, optimised for outdoor video screens and digital billboards that are installed higher than the viewing audience. Designed to have its brightest point below the horizon, the C4SMT LED minimises wasted light and can save up to 32 percent in power consumption compared to a standard through-hole oval LED with a zero degree viewing angle.

"Cree is continuing to set the bar for LED innovation and expanding product offerings to meet the burgeoning outdoor video screen market's needs," said Mike Watson, Cree, senior director of marketing, LED components. "Cree's relentless focus on high-brightness LED innovation has produced the first IPX5-rated water-resistant SMD LEDs, the first IPX6/8-rated SMD LED optimized for ease-of-manufacturing, and now, the first angled LEDs, which can revolutionise the large-screen viewing experience."

Screen Master C4SMT and C4SMD high-brightness LEDs are commercially available now.

Electrical resistance could be transformed

Studies on electric friction in gallium arsenide could be useful in the future for designing more efficient and faster electronics and finding new

tricks to reduce electrical resistance

Researchers at the Max-Born-Institute, Berlin, Germany, have observed the extremely fast onset of electrical resistance in a compound semiconductor by following electron motions in real-time.

When you first learned about electric currents, you may have asked how the electrons in a solid material move from the negative to the positive terminal. In principle, they could 'fly' through the solid, without being affected by the atoms or other charges of the material.

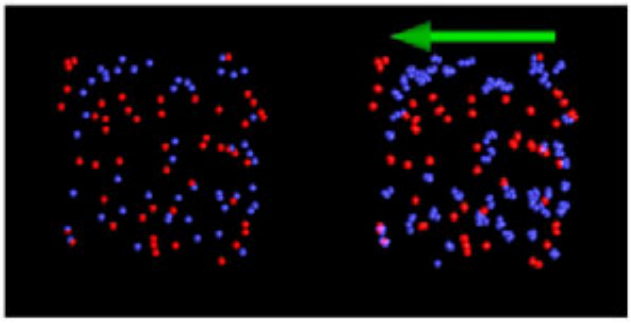
Under normal conditions this doesn't tend to happen because the electrons interact with the vibrating atoms or with impurities. These collisions typically occur within an extremely short time, usually about 100 femtoseconds (10-13 seconds, or a tenth of a trillionth of a second).

So the electron motion along the material, rather than being like running down an empty street, is more like trying to walk through a very dense crowd. Typically, electrons move only with a speed of 1m per hour; they are slower than snails.

Although the electrons collide with something very frequently in the material, these collisions do take a finite time to occur. Just like if you are walking through a crowd, sometimes there are small empty spaces where you can walk a little faster for a short distance. If it were possible to follow the electrons on an extremely fast (femtosecond) time scale, then you would expect to see that when the battery is first turned on, for a very short time, the electrons really do fly unperturbed through the material before they bump into anything.

This is exactly what scientists at the Max-Born-Institute in Berlin recently did in gallium arsenide (GaAs). Extremely short bursts of terahertz light (1 terahertz = 1012 Hz, 1 trillion oscillations per second) were used instead of the battery (light has an electric field, just like a battery) to accelerate optically generated free electrons in a piece of GaAs.

The accelerated electrons generate another electric field, which, if measured with femtosecond time resolution, indicates exactly what they are doing. The researchers saw that the electrons travelled unperturbed in the direction of the electric field when the battery was first turned on. About 300 femtoseconds later, their velocity slowed down due to collisions.



Optically generated electrons (blue balls) and holes (red balls) show random thermal motion before the terahertz pulse hits the sample (left). The electric field (green arrow) accelerates electrons and holes in opposite directions. After the onset of scattering, this motion is slowed down and results in a heated electron-hole gas, i.e., in faster thermal motion. (Image copyright MBI)

These experiments allowed the researchers to determine which type of collision is mainly responsible for the velocity loss. Interestingly, they found that the main collision partners were not atomic vibrations but positively charged particles called holes. A hole is just a missing electron in the valence band of the semiconductor, which can itself be viewed as a positively charged particle with a mass 6 times higher than the electron.

Optical excitation of the semiconductor generates both free electrons and holes which the terahertz bursts, our battery, move in opposite directions. Because the holes have such a large mass, they do not move very fast,

but they do get in the way of the electrons, making them slower.

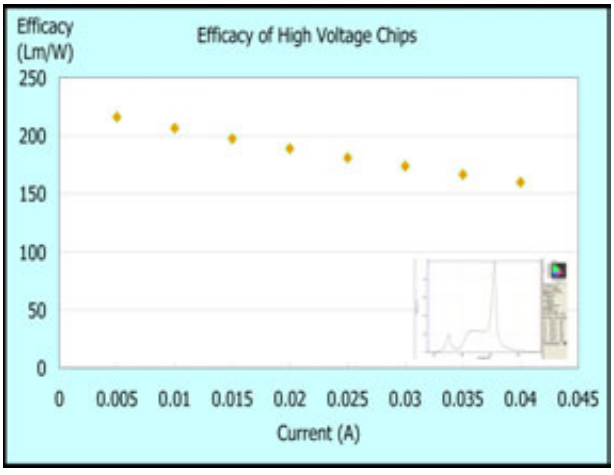
Such a direct understanding of electric friction will be useful in the future for designing more efficient and faster electronics, and perhaps for finding new tricks to reduce electrical resistance.

Further details of this work has been published in the paper,"High-Field Transport in an Electron-Hole Plasma: Transition from Ballistic to Drift Motion", by Bowlan et al, Phys. Rev. Lett. 107, 256602 (2011).

Epistar's high voltage chipset breaks efficacy records

With its higher CRI, and competitive lm/$, the direct red platform is suited for use in warm white applications in retrofit, professional lighting, and luminaires

Epistar Lab has successfully developed a warm white efficacy of 216 lm/W at an operating current of 5 mA and CRI of 87 Ra at CCT of 2700K. Under a typical driving current of 15mA (or about 1 W operational equivalent), the luminous efficacy of 197 lm/W was achieved.



Epistar Lab's new record adopts several technologies in high voltage chips. These include a novel substrate transfer process, lower MQW light absorption and a structure for increasing the photon extraction efficiency. Improvements have also been made on current spreading uniformity, the MQW structure and IQE and lower forward voltage.

Prevaled Light Engines up to 70 percent more efficient

Osram has expanded its portfolio of LED light engines

Osram's latest Prevaled LED Light Engine range now offers up to 70 percent more efficiency. The products of the Prevaled Core Eco Z2 line attain a module efficiency of up to 108 lumen/watt (lm/W).

With its LED Light Engines, Osram offers planning security whilst continually improving LED performance. The firm believes the dimensions, luminous flux and light distribution are the equivalent to the Edison socket in the analogue world of light.

The new Prevaled products are equipped with "Chip-on-Board technology". In other words, individual LEDs are no longer mounted on the printed circuit board, but are placed to create a surface made of LED chips. This ensures homogenous light, as one no longer perceives the light of every single LED chip.

Osram says the Prevaled Core Eco Z2 can replace high pressure discharge lamps of up to 70W, energy saving lamps with up to 2 x 42W and halogen lamps, each with up to 100W power consumption, and therefore the traditional technologies in the majority of the spotlight and downlight applications.

What's more, it is up to 70 percent more efficient than the previous Prevaled generation. The prerequisite for this, however, is the large portfolio ranging between 800 lm and 5,000

lm. Owing to LED technology, the light does not contain any harmful UV or infrared light components, thus sensitive products such as cosmetics or foodstuffs can also be illuminated. The low heat is given off to the back of the module via standardised thermal interfaces.

The fast pace of the LED era poses new challenges for luminaire manufacturers; the great leaps in performance with regard to the light diodes and the technical changes associated with this, require an entirely new luminaire design with every LED generation.

Osram believes it has solved this problem with its Prevaled Light Engine system. The Prevaled module offers standardised performance data and at the same time profits from significant improvements in LED efficiency. To ensure that this standardisation is reliable for the future, a number of manufacturers have teamed up in the Zhaga consortium.

Standards for LED modules that are supported by numerous manufacturers are developed here. “Our developers cooperate closely with the representatives in the consortium. Thus the future standards can be implemented in our products in a timely manner. In the course hereof, luminaires automatically benefit from the development advances made with LED, without this resulting in cost-intensive changes having to be made to the basic construction,” says Wolfgang Andorfer, Senior Director Solid State Lighting at Osram.

Technical Data:

Diameter of module: 50 mm
Colour temperature: 2,700K, 3,000K, 3,500K, 4,000K
Colour rendering: Ra > 80
Luminous flux: 800 lm, 1,500 lm, 2,000 lm, 3,000 lm

[additional varieties in 4,000 lm and 5,000 lm available from spring 2012]

Service life: Up to 50,000 hours
Module efficiency: Up to 108 lm/W (at operating temperature)
System efficiency: (Module, cable and driver) Up to 94 lm/W (at operating temperature)

Cree licenses remote phosphor patents

The company is advancing LED lighting adoption to facilitate the development of LED lights combining remote phosphor optical elements with blue LEDs

Cree has granted five LED lighting manufacturers licenses to select Cree patents through its recently launched remote phosphor licensing program.

“Cree is committed to the development of innovative, energy-efficient LED lighting technology and this program provides access to important technology developed by Cree,” said George Brandes, Cree director of intellectual property licensing. “The remote phosphor licensing program is designed to provide rights under the relevant Cree patents that our LED customers need to develop and commercialise leading-edge LED luminaires and bulbs, accelerating the LED lighting revolution.”

Initial licensees to Cree’s remote phosphor patents include lighting innovators Aurora Energie Corp., Horner APG, Ledzworld Technology, Vexica Technology, and Wyndsor Lighting, LLC.

Cree is currently in discussions with other companies to license the remote phosphor patents and aims to sign additional licensing agreements in the coming months. Details of the royalty-bearing licenses were not disclosed.

Luminus facility goes 100% green

The firm's Woburn, Massachusetts facility has purchased wind power RECs from Constellation Energy

Luminus Devices, the innovator of "Big Chip LEDs", has entered into a contract with Constellation Energy to purchase Renewable Energy Certificates (RECs) to match 100% of its electricity use at the Woburn, MA facility from October 2011 through October 2012.

The RECs supplied by Constellation Energy are Green-e Energy Certified and sourced from wind energy facilities located throughout the United States. Throughout the term of the contract, 100% of the electricity at Woburn will be matched with RECs.

Each REC represents the positive environmental attributes of 1 megawatt hour (MWh) of electricity generated by a renewable power plant, and is retired on behalf of customers wishing to promote their environmental commitment. Through the purchase of RECs, Luminus and Constellation Energy are supporting the operation and development of facilities that generate clean, renewable energy.

Jim Gallo, facility manager at the Luminus Woburn operation, commented, "Our LED products are highly energy efficient, and this purchase of Renewable Energy Certificates improves the sustainability of our manufacturing processes. We are pleased to take advantage of this opportunity with our energy supplier." Woburn annual electricity consumption for wafer fabrication is approximately 2,000,000 KWh; with the purchase of RECs Luminus helps avoid 946 metric tons of CO2 emissions.

First and only fully Integrated commercial solar system

The system incorporates triple-junction, III-V compound semiconductor cells and is claimed to reduce costs in all stages of the project lifecycle

GreenVolts has unveiled what it says is the industry's first complete and fully integrated solar system, including modules, trackers, inverters, and energy management software. Through control of the entire system design, GreenVolts says it has dramatically improved performance, simplified project engineering and installation, and reduced costs in all stageof the project lifecycle

GreenVolts› system which includes modules, trackers, inverters, DC wiring, combiner boxes, weather & solar monitoring station, networking, and energy management

"Our complete system approach changes the entire solar experience," said David Gudmundson, president and CEO, GreenVolts. "With GreenVolts, customers get simplicity, elegance, and precision in a utility-scale solar system that delivers higher performance and richer energy management than anything else in the world."

Traditional photovoltaic (PV) systems are composed of parts sourced from different suppliers, including solar panels, inverters, trackers, and monitoring. Because these parts are not designed to work specifically with one another, the overall system performance suffers. In contrast, GreenVolts provides a complete and fully integrated solar system, with

installations producing thirty to forty percent more energy than traditional PV.

“There is nothing like this in the industry today. By providing a complete system with a fully integrated design, GreenVolts is raising the bar,” said Jonathan W. Postal, SVP Business Development, Main Street Power. “We have had success with GreenVolts on our recent project in Yuma, Arizona, and are excited to work with them again on future projects.”

Additionally, the GreenVolts solution includes ISIS, an advanced energy management software in the industry. Because ISIS was designed with, and fully integrated into, the complete GreenVolts solar system, it offers deeper access and more sophisticated capabilities than are available in third-party software products.

ISIS includes: real-time monitoring of site conditions and energy production; extensive fault isolation and diagnostics at the site, system or component level; inventory and asset management; operation and maintenance logs; hundreds of alerts and alarms; extensive and programmable reporting capability; and remote access and control of the entire system. ISIS is Internet-based, secure, fast, and easy to access from a PC or mobile device.

The GreenVolts system is installed at numerous customer locations across the Southwest U.S. in Pacific Gas & Electric, Southern California Edison, Tucson Electric, Imperial Irrigation District, and Arizona Power Service territories. Existing projects include agricultural, utility, municipal, commercial and industrial applications.

“Having built numerous solar projects from various solar vendors, we appreciate the fast and efficient installation of the GreenVolts system, which minimises the possibility of mistakes, thus providing better cost estimates and on-time schedules,” said Brian Bothman, vice president, Robert A. Bothman Construction, Inc. “Their approach simplifies everything, from logistics and site engineering, training and installation, to final commissioning.”

Key features of the GreenVolts system include:

· Increased efficiency: Advanced CPV modules are 2-3 times more efficient than those of traditional PV or thin film modules

· Greater energy yield: High-precision, two-axis, intelligent tracking system accurately follows the sun, allowing solar modules to operate at peak efficiency throughout the day and resulting in greater energy yield than single-axis or fixed-tilt PV

· Integrated inverters and motion control: Bi-polar, transformerless inverters, working with the tracker motion control, continually seek the maximum power output for the system

· Intelligent Solar Information System (ISIS): This sophisticated energy management software provides monitoring, diagnostics, reporting, and system control

· Increased durability, decreased maintenance: Weather and solar monitoring stations at each site ensure that the system is stowed in a face-down position during harsh conditions, as well as at night to reduce soiling, dust, and condensation

· Sophisticated solar information network: All subsystems and components are interconnected for communications, including GPS and Wi-Fi for intrasite status, and Internet communication via secure VPN

· Comprehensive customer care: GreenVolts provides a single point of support over the life of the project, from sales, to planning and design, to installation, to operation and maintenance

First single-chip LED replacement for 300W and 175W bulbs

The next generation CBT-90 LED delivers a 25% increase in brightness for medical devices and entertainment lighting

Luminus Devices, the inventor of "Big Chip LEDs", has announced that its next generation CBT-90 white LED is breaking new ground by providing equivalent system-level light output within specialty lighting applications, including medical and entertainment lighting, that formerly used 300W Xenon and 175W metal halide lamps.

The CBT-90, consisting of a single 3mm x 3mm chip mounted on a metal core PCB, is now 25% brighter and capable of producing more than 2,200 lumens at its top end input current.

"The new CBT-90 performance has never been achieved before by an LED," said Chuck DeMilo, Global Director of Product Marketing for the Lighting Business Group at Luminus Devices. "The lumen density and brightness of the Luminus CBT-90 are unmatched in the marketplace, and are ideal for our customers working on exceptionally demanding specialty lighting applications. For example, our customers developing endoscopy light boxes, now for the first time, have an LED that produces system-level light intensity that rivals the gold standard for endoscopy -- the 300W Xenon lamp."

The story in entertainment lighting is similar as spot and wash fixtures are converting from specialty high intensity discharge lamps such as 175W metal halide to the CBT-90. "We expect the new generation CBT-90, featuring our industry leading Big Chip technology, will open new doors for the adoption of LEDs in some of the world's most challenging lighting applications that have been, until now, unable to reap the benefits of solid state lighting," DeMilo concluded.

Luminus is now accepting orders and shipping the new high performance CBT-90 from stock.

World's first on-site high-purity ammonia plant live in China

To support the booming LED market, Anhui Sanan Optoelectronics has had one of the largest NH3 facilities in the world installed. The plant has a supply capacity of 2,000 metrics tons per year

Air Products has brought a large-scale, on-site ammonia (NH_3) plant on-stream in China's Anhui Province.

The plant will supply ultra high-purity NH_3 to Anhui Sanan OptoElectronics, a subsidiary of Sanan OptoElectronics (Sanan). The plant, located at Sanan's new high brightness LED manufacturing facility in the Wuhu Economic and Technological Development Area, is claimed to be the largest on-site high-purity NH_3 facility in the world with a supply capacity of 2,000 metrics tons per year.

Sanan is the largest high quality LED manufacturer in China. To support Sanan's expansion plan, Air Products is also building a second high-purity NH_3 plant with the same capacity, which is expected to be on-stream in the middle of 2012. Large volumes of NH3 are needed to provide the nitrogen source for the GaN layers used in the manufacture of LEDs.

A grand opening ceremony was held on December 12 at Sanan's Wuhu facility to

celebrate the milestone. Attendees included Steve Jones, Air Products' China president and senior vice president and general manager of Global Tonnage Gases, Energy and Equipment; Joseph Stockunas, director of electronics materials for Air Products; and representatives from Sanan.

"Air Products has a long and proven record of building large-scale, on-site industrial gas plants around the world. We are pleased Sanan OptoElectronics chose Air Products for their high-purity ammonia supply to support its increased LED production. By working closely together, we successfully brought the world's first and largest on-site facility on-stream. It is a milestone for both Sanan and Air Products," said Steve Jones. "LED is an exciting market for Air Products. We will continue to leverage our leading technologies, excellent reliability and safety records to support the growing market needs."

"We are pleased to have partnered with Air Products as we rely on its leading technologies and global expertise to provide us ammonia with the purity necessary for high-quality LED production," said Wei Daman, general manager of Anhui Sanan OptoElectronics. "We hope the long-term partnership can reinforce our leadership in the LED market."

Air Products pioneered the on-site industrial gas supply mode in the 1940s. Since then, it has been building on-site facilities serving refining, chemicals, steel and glass-making industries around the world.

LEDs are used in applications such as automotive and traffic signage, and are displacing conventional lighting alternatives based on their ability to operate at reduced power, lower temperature and with extended lifetimes. LEDs are also increasingly finding use as backlighting for televisions and displays.

Nantong Tongfang enhances HB-LED capacity

The multiple Aixtron MOCVD G5 reactors will be used alongside the firm's two existing AIX 2800G4 systems

Aixtron SE has an MOCVD system order from existing customer Nantong Tongfang, China.

The contract is for multiple AIX G5 HT reactors in 56 x 2-inch and 14 x 4-inch configurations which will be dedicated to the growth of high brightness LEDs.

Nantong Tongfang placed the order in the first quarter of 2011. Delivery of the systems has been started in the second quarter of 2011 and will be completed in the fourth quarter of 2011. A local Aixtron support team will install and commission the new reactors in state-of-the-art clean-rooms at the company's factory in China.

Wang, Vice President of the Tsinghua Tongfang Group, comments, "With the new reactors we will be able to achieve the capacity increase needed for our high brightness LED products. They will augment our two existing AIX 2800G4 systems that continue to serve us well having very quickly provided high quality LED materials with excellent characteristics."

"Overall, we have a great deal of confidence in the total package from Aixtron. The systems are reliable and economic and their back up service is first rate. For the future we are convinced that the G5 systems will deliver the best throughput and performance to support our manufacturing plans."

Optogan LEDs to light up Turkey with Ledison Patan

Optogan opens sales hub in Koceali, Turkey for LED lamps and luminaires through a partnership agreement with Ledison Patan

More than 200 invited guests and members of the Turkish parliament attended the Grand Opening in Koceali, close to Izmit, where the new sales office is located.

Ledison Patan has a broad experience in interior and exterior LED lighting for hotels, hospitals, shipyards as well as for bridges and street lighting.

The market for Solid State Lighting (SSL) luminaries in Turkey has a tremendous potential in the coming years. “Especially for Turkey we estimate a hundreds of millions Euro market for SSL luminaries within the next two years. Turkey, as being the bridge between Europe and Asia is a key hub for Optogan. With its strong labour force, biggest GDP growth rate in Europe and a continuously growing population with currently over 73 Mio inhabitants we expect an especially strong growth in our retrofit lamps,” stated Ove Sörensen, Senior Director Sales & Business Development at Optogan.

Besides the retrofit business Optogan and Ledison will focus on market segments like street lighting, canopy, shop-lighting and lighting for hotels and restaurants.

“I strongly believe that LED lighting will become one of the most important technologies of the 21st century. Therefore we plan to invest about € 3.2 million for the year 2012 to create and develop the distribution network,” said Ahmet Patan, General Manager of Patan and Ledison Ltd. “We are very pleased about the partnership with Optogan, since Optogan´s LED-technology is ‘made in Germany’.”

Ledison Patan will distribute Optogan´s SSL LED-lamps and luminaires not only in Turkey but also in the Middle East and North Africa. Possible further steps will be investigated such as final assembly lines for LED lamps and luminaires situated in Turkey.

New services to accelerate LED product development

Cree is introducing a new thermal simulation service and advanced photometric testing

Extending the support services offered to LED lighting manufacturers that were launched this autumn, Cree, has added two new Cree TEMPO offerings to its design and evaluation services.

The new TEMPO (Thermal Electrical Mechanical Photometric Optical) Thermal Simulation and photometric testing options are designed to remove barriers for LED lighting manufacturers and accelerate broader market adoption of LED lighting.

“No other LED manufacturer has the same level of end-to-end development support for lighting OEMs,” said Mark McClear, Cree, director of global applications engineering. “This is further evidence of Cree’s commitment to the success of our customers and the solid state lighting industry. Cree Services can remove design, engineering and manufacturing barriers for manufacturers—extending Cree’s expertise and equipment to the developers of LED luminaires and lamps.”

Cree’s TEMPO Thermal Simulation is a cost-effective solution to model the thermal performance of prototype LED fixtures. Effective LED luminaire thermal design is essential to ensure reliability and optimum performance. TEMPO Thermal Simulation predicts the thermal behaviour of LED-based fixtures, including junction temperature, heat sink temperature, temperature profile and

airflow profile.

"Ready access to the TEMPO Thermal Simulation service has saved our team weeks in the product engineering process," said Jim Shapiro, FEIT ELECTRIC, director of product development. "And speed and quality are the name of the game in the LED marketplace."

Cree has also added an additional, quick turn-around photometric evaluation option to its TEMPO SPOT service to help prevent costly design mistakes at any step of the development process. TEMPO SPOT services are designed to give a rapid photometric view on a prototype's performance. This new service gives customers access to complex, costly equipment to measure the photometric performance of luminaires and replacement lamps. Customers can choose integrated measurements from a 2-meter sphere or 3-D measurements from a Type C Goniophotometer to visualize and predict the photometric performance of an installed luminaire.

"With the fast turnaround of Cree's new TEMPO SPOT service we were able to quickly validate our design assumptions," said Colin Piepgras, Digital Lumens, vice president of engineering. "Cree clearly understands the challenges of the LED fixture design cycle and its new service offerings hit the nail on the head, giving us precisely what we needed, in the time we needed it in."

Cree currently provides TEMPO Services out of its Cree Technology Centres, located in Research Triangle Park, N.C. and Santa Barbara, California. Future TEMPO Service locations in Shenzhen, Munich, Shanghai and Taiwan are targeted to open in 2012.

Commercialisation of large sapphire substrates

SMM aims to mass-produce 6-inch diameter sapphire substrates which are hoped to take over from 2-inch to 4-inch diameter wafers currently the most prevalent in the LED market

The president of Sumitomo Metal Mining (SMM), Nobumasa Kemori has announced a decision to establish a mass production line within its fully-owned subsidiary Okuchi Electronics based in Isa City, Kagoshima Prefecture, Japan.

Sapphire substrates are used in the fabrication of GaN for use in white and blue LEDs. Demand for white LEDs is growing for use in applications such as backlighting in large-screen LCD televisions and is also expanding rapidly in the general lighting market due to the use of LEDs saving energy and reducing environmental impacts. Accordingly, the sapphire substrate market is expected to see further growth.

Having planned entry into large sapphire substrates for some time, SMM has made the decision to install a new large fabrication furnace within Okuchi Electronics and mass-produce 6-inch-diameter sapphire substrates.

The planned value of the capital investment is about ¥1.2 billion (US $120 million) including investment already completed. Through the investment, SMM will construct a continuous production system extending from fabrication of large sapphire crystals to substrate processing.

At present, 2- to 4-inch-diameter sapphire substrates are prevalent in the market. However, due to demands for cost reductions from LED manufacturers, demand for larger-diameter substrates is forecast to expand. Production of 6-inch-diameter substrates requires the fabrication of large-size crystals, but according to SMM, production is technologically difficult and can be performed stably by only a small number of manufacturers worldwide.

Sumitomo Metal Mining has secured mass production capability based on its crystal

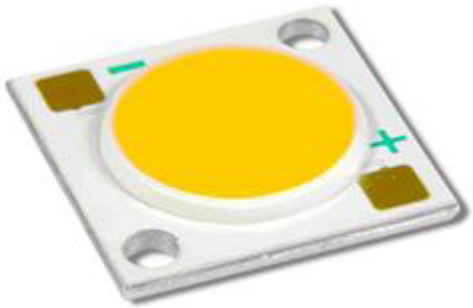
fabrication technology built over many years.

In the future, the company will enhance its development of materials in the environmental and energy sectors and will advance growth strategies in its materials business.

Seoul Semi launches chip-on-board DC LED

The new ZC series reduces thermal resistance to boost life expectancy and enhances design convenience and price competitiveness for manufacturers.

Korean LED packaging company, Seoul Semiconductor has launched its Chip-On-Board (COB) Type of Direct Current (DC) LED, named ZC (Z-Power COB).



The ZC series, based on Seoul Semi's Z-Power LEDs which are mainly used as a light source of high-brightness and high-power, decreases thermal resistance, resulting in an exponential improvement in LED lighting product life expectancy. What's more, it allows manufacturers to conveniently install and design price competitive products.

The ZC Series is designed as a COB type and removes the need for the LED to be surface-mounted on to a metal plate, allowing manufacturers to bypass the chip connection process before use. Companies can trim manufacturing and management costs and greatly improve end product price competitiveness.

Furthermore the use of highly reflective aluminium substrates in ZC also greatly improves the brightness and significantly prolongs LED bulb life spans. It is possible to use a single ZC from the ZC series to develop a LED light bulb which then allows light to be distributed more evenly than lights that connect several LED packages to a single module.

ZC will be offered in 6W, 10W and 16W, each of which will be appropriate replacements for 40W, 60W incandescent light bulbs and 100W down lights, respectively.

"The ZC will enable manufacturers to easily produce various LED light designs and providing longer-lasting LED lights," explained Sunghoon Bae, Vice President of Seoul Semiconductor. "As with the recent release of our AC LED, Acrich 2, the launch of our DC LED, ZC, is aligned with Seoul Semiconductor's commitment to providing a diverse and innovative product portfolio for consumers alongside continued investment in research and development"

The recently launched ZC Series will begin mass production in December and will subsequently be available to customers.

Indian LED lighting market to grow at CAGR of 45.5 % till 2015

Frost & Sullivan says LED lamps and luminaires exhibit the strongest growth trends among all lighting technologies

Energy-efficient lighting technologies and the need to develop alternate technologies is gaining importance in India due to issues of energy deficiency, electrification of remote rural regions, and energy sustainability. LED Lighting is considered the key emerging segment in

the Indian lighting market, driven by the move towards energy-efficient lighting solutions.

According to Frost & Sullivan Research, the LED lighting market in India was $73.3 million in 2010 and will continue growing at a CAGR 45.53 percent till 2015. This market is expected to grow considerably in the future and the growth is attributed to short-term drivers namely, street light applications and the railway sector. Over 60 percent of the total demand in 2012 will be attributed to these two applications.

Frost & Sullivan is confident that LED lighting is expected to grow significantly in the future, replacing traditional lighting technologies, but its penetration largely depends on standardisation, Government support, awareness, and affordability.

Keeping in perspective the challenges faced by the LED lighting suppliers and end users, Frost & Sullivan's Automation & Electronics Practice recently hosted its 2nd Annual Executive Congress on LED Lighting in association with Semiconductor Equipment and Materials International (SEMI).

According to Niju V, Deputy Director, Automation & Electronics Practice, Frost & Sullivan, South Asia & Middle East, "The excitement around LED Lighting applications is helping it to move towards newer user segments, thus expanding this market considerably.

The major challenges of absence of standards and lack of awareness are being mitigated by the efforts of the Bureau of Energy Efficiency (BEE) and the LED industry, thereby facilitating its usage in hitherto low-usage application areas. Phenomenal growth of the market is expected to make viable commercial volumes of local manufacturing that shall aid in driving down the prices of the products significantly.

As energy conservation initiatives gain more prominence, this industry is all set to acquire a star status in the next couple of years.

The LED lighting market also has its share of challenges. LED lighting installations require more complicated designs, spanning optical, thermal, and electronics domains. LED lamps continue to be quite expensive compared to conventional lamps; they rely on imports, as current economies of scale prevent indigenous manufacturing. Absence of uniform standards for different applications is also restraining LED adoption and is paving the way for sub-standard cheaper imports to flood the market.

The highly competitive factors affecting the Indian Lighting Market are price advantage and brand image. LEDs are garnering significant interest and playing a vital role in LEED certified buildings in India. The BEE is working with lighting associations to define standards, testing protocols, and certifying parameters for different lighting applications.

Star rating labels are being made mandatory for luminaires/lamps for indoor commercial and outdoor lighting applications. Government backing for green technologies and thereby its adoption in high-value applications like street lighting is helping LED Lighting make inroads in the Indian lighting industry. The increasing awareness of LED lighting benefits is also influencing its slow and steady penetration.

Frost & Sullivan's study provides an in-depth coverage of the LED lighting market in India by product and application segments. It discusses the key trends across applications and also analyses the market opportunities in India for LED lighting to provide strategic recommendations based on findings from the electronics manufacturing industry.

The Gold Partner supporting the Event was Sujana, Silver Partners were Moser Baer and UL, and the Associate Partner was Kwality Photonics. The Media Partners supporting the Event were Electronics Bazaar, Electronics For You, Electronics Maker, and LED Professional.

NGK reveals GaN substrates for use in HB-LEDs

The gallium nitride wafers, grown by a novel LPE technique, could be used in business projectors and vehicle headlights

Japanese firm, NGK Insulators, has developed new wafer products for electronic device applications, such as ultra high brightness (UHB) LEDs and smartphones.

The Company exhibited samples of these wafers for the first time at SEMICON Japan 2011, which was held between December 7 through 9 at Makuhari Messe in Chiba, Japan.

NGK targets wafer products as a major research and development theme in the electronics field. In the R&D line-up, there are bonded wafers that achieve new functions previously unavailable with a single material wafer, and GaN single crystal wafers that have low defect density and colourless transparency over the whole wafer surface. Ideal for use in UHB-LEDs, this innovative feature is realised by original liquid phase epitaxial growth technology.

NGK reckons its GaN wafer has an unprecedented high, efficient luminescence, which makes UHB-LEDs applicable for business projectors and headlights of automobiles. Application for power devices used in hybrid and electric vehicles is also anticipated.

The Company has also accelerated the development of wafer products including wafers for next-generation semiconductors which do not include rare metals.

Versatile Altatech system for LED inspection

The LEDMax tool, which can be used for four to eight inch wafers, performs fast, accurate defect detection in III-V compound semiconductor epiwafers, sapphire, silicon, SiC and other transparent surface substrates.

Altatech Semiconductor has entered the LED inspection market by introducing its new AltaSight LEDMax system, the company's first product designed specifically for detecting, classifying and characterising defects on wafers used in manufacturing LEDs.

AltaSight LEDMax improves production yields for LED devices by accurately detecting process-induced defects, including those that can result during MOCVD of epitaxial layers, subsequent patterning processes and final inspection. Using Altatech's patented sensor technology that filters out all background noise, the non-contact system generates images of surface imperfections with resolution down to 1 micron and a unique depth-of-focus capability approaching 500 microns.

An integrated review station performs real-time analysis of the gathered inspection data. It can stitch together images from different perspectives, generate 3D renderings and measure defect sizes. All defect-detection results are stored within the system, and can be output to an operator in standard file formats.

"With its multi-class defect reporting and high accuracy, our newest inspection system meets the unique needs of LED manufacturers," said Jean-Luc Delcarri, president of Altatech Semiconductor. "Altatech is entering this market by providing a defect-detection solution that traditional semiconductor-inspection tools cannot match in terms of reliability and cost-efficiency."

The highly flexible design enables AltaSight LEDMax to combine up to three inspection

modules, allowing it to be used in volume manufacturing, process development or R&D applications.

In addition to handling the full range of compound semiconductor wafers on which LEDs are produced today, AltaSight LEDMax has the versatility to meet other III-V inspection requirements. It can accommodate sapphire, silicon, SiC and other transparent surface substrates. The system's high flexibility and reliability extends to its ability to inspect thin and thick wafers as well as significantly bowed substrates. AltaSight LEDMax can handle four- to eight-inch wafers without any hardware changes, and a field-upgradeable option for handling two-inch substrates will be available in the coming months.

Altatech has begun taking orders for AltaSight LEDMax from LED manufacturers around the world. Production units will be shipped to customers in the first quarter of 2012.

Philips Lumileds receives "Best Technology Innovation Award"

The awards recognise LUXEON's development and stimulation of the LED industry in China.

Philips Lumileds received three l awards for its technology and market work in China over the last year at OFweek's 8th LED Forward-Looking Technology and Market Seminar and the 2011 LED Industry Outstanding Enterprises & Products Annual Award Ceremony. The company's awards included:

• Technical Innovation Award for LUXEON A, LUXEON S, and Freedom From Binning

• Best LED Application for the Guangzhou TV Tower, lit with LUXEON

• Most International Influence Award

LUXEON LED

In granting the awards, OFweek said, "It is clear that Philips Lumileds has invested a lot of work into providing the best technical innovations. They have also greatly stimulated the LED illumination industry in China, thus receiving the recognition of industry experts and the online audience."

Philips Lumileds was selected for these awards from more than 100 companies by more than 20,000 voters.

Philips Lumileds receives the Technical Innovation Award for LUXEON. One of three awards given to the company.

Philips Lumileds global partner, Future Lighting Solutions was also recognised with two awards for its work in China:

• Best LED application for the Pearl River installation

• Best LED service provider

“Philips Lumileds’ commitment to our customers in China and the Chinese lighting industry has never been stronger,” said Steve Barlow, Senior VP of Sales and Marketing. “Our Illumination Grade LUXEON innovation delivers unmatched quality of light and reliability and simplifies design-in with breakthroughs like Freedom From Binning.”

The company has continued to invest in its China operations adding technical experts, investing in educational seminars for lighting companies making the move to LED technology, and opening new China headquarters in Shanghai earlier this year.

OFweek is a web portal for the optoelectronic industry in China. It draws upon a rich pool of news, market-watch information, webinars, online exhibitions, tutorials, seminars and more to keep our customers up to date with the latest in the industry.

LUXEON LEDs are available worldwide from Future Lighting Solutions.

Lumidigm selects Osram LEDs for fingerprints

Osram’s Pointled LED provides uniform, efficient illumination in a compact package for the Mercury, Mariner fingerprint sensor.

Lumidigm has selected the Pointled from Osram Opto Semiconductors as the illumination source in its M-Series.

One of Lumidigm’s Mercury, Mariner(M-Series) fingerprint sensors

Lumidigm has a long history in the fingerprint sensor market with its proprietary multispectral imaging technology. The recent adoption of the compact, bright and efficient Osram Pointled has enabled Lumidigm to reduce the size and cost of its sensors and expand the reach of fingerprint authentication into new applications.

Lumidigm has chosen the Osram Pointled to provide a compact, uniform and efficient lighting platform in the company’s M-Series fingerprint sensors.

An innovator in fingerprint biometrics, Lumidigm provides state-of-the-art fingerprint scanning with special emphasis on high performance in real world conditions. The company’s patented multispectral fingerprint technology closes a 20% performance gap often seen with conventional technologies because it illuminates both surface and subsurface fingerprint features, ultimately collecting more biometric information from the finger than conventional sensors can.

“We chose the Pointled product from Osram Opto Semiconductors for our Mercury and Mariner product lines because of the unique combination of small package size, symmetric radiation pattern, long lifetime and the ability to operate in high ambient temperatures,” said Steve Corcoran, Lumidigm’s Chief Engineer.

“These attributes made it possible for us to design a compact illumination system that

produces a highly uniform and efficient lighting profile at the fingerprint reader platen. Thanks to the excellent output of the Osram Pointled, Lumidigm is able to leverage our multispectral technology in a compact fingerprint sensor series."

The Osram Pointled is a combination of advanced package and chip technologies and Osram claims it is the smallest LED with an integrated reflector and is suitable for both surface mount technology and zero-height mounting.

The 2 mm diameter x 0.775 mm high module allows the light source to be sunk completely in the printed circuit board, making it ideal for applications such as the Lumidigm M-Series fingerprint sensors where space is at a premium. The typical brightness of the white mini LED is currently 800 mcd at a beam angle of 120°, perfectly suitable for this unique imaging application.

Lumidigm's fingerprint scanners are available worldwide.

Dr. Philippe Roussel to present at CS Europe Conference 2012

Defining the next steps for the Compound Semiconductor Industry,Dr. Philippe Roussel of Yole Développement will present the talk "Wide Bandgap device market update".

Following the success of CS Europe 2011, next year's conference is expanding to 2 days and offers a fantastic mix/quality of speakers making it the must attend industry event for 2012.

Register at www.cseurope.net & book your delegate place now as numbers will be limited. The conference takes place on 12th/13th March 2012 at Hilton Hotel, Frankfurt, Germany.

A networking dinner will also be held on the night of 12th March.

Conference Chair

Dr Andrew W Nelson, President & CEO, IQE

Conference Schedule:

Markets and III-V CMOS - Morning 12th March

A mix of insightful market research presentations & cutting-edge research destined to shape tomorrow's compound semiconductor industry with talks including:

Compound Semiconductor Markets: Current Status and Future Prospects - Asif Anwar, Director – Strategic Technologies Practice, Strategy Analytics

The Market for LEDs in Lighting- Mr. Philip Smallwood, Lighting Market Analyst, IMS Research

Wide Bandgap device marketupdate - Dr. Philippe ROUSSEL, Senior Project Manager, Yole Développement

European efforts to develop III-Vs on 200 and 300 mm silicon- Dr. Matty Caymax, Chief Scientist, Imec

An Overview of the DARPA Diverse Accessible Heterogeneous Integration (DAHI) Program- Sanjay Raman, Program Manager, Defense Advanced Research Projects Agency/Microsystems Technology Office

The Integration of silicon CMOS with III-Vs- Professor Iain Thayne, University of Glasgow

III-Vs on 200 mm Si for VLSI– Dr Richard Hill, Project Manager, Sematech

III-V 3D Transistors- Peide Ye, Professor of

Electrical and Computer Engineering, Purdue University

LEDs, lasers, PV and electronics - Afternoon of 12th March & full day of 13th March

KEYNOTE SPEAKER*: III-V on Silicon: Challenges and Opportunities*- Robert S. Chau, Intel Senior Fellow, Intel

SiC and GaN Electronics- Dr. John Palmour, Cree co-founder and chief technology officer Power & RF, Cree

Ammono's ammonothermal method to make GaN substrates– Dr. Robert Dwiliński, President, CEO, Ammonno S.A.

Tomorrow's RF chips for mobile devices- Todd Gillenwater, VP of Technology and Advanced Development, RFMD

Building a Successful III-V Pure Play Foundry- Dr. John Atherton, Associate Vice President, WIN Semiconductors

Scalable "on-silicon" solutions (GaN-on-Si and Ge-on-Si) using rare oxide buffer layers– Dr. Michael Lebby, General Manager & Chief Technology Officer, Translucent Inc.

III-Nitride Lasers Based on Nonpolar/ Semipolar Substrates- Dr James W. Raring, VP Laser Engineering, Soraa Inc.

Markets and Applications for SiC Transistors - Dieter Liesabeths, Vice President Sales & Marketing, SemiSouth Laboratories, Inc.

Perspective of an LED Manufacturer- Professor Iain Black, VP WW Manufacturing Engineering, Technology & Innovation, Philips Lumileds Lighting Company

The CPV Market following the acquisition of Quantasol technology - Jan-Gustav Werthen, JDSU, Senior Director

Commercialisation of GaN on SI based Power Devices at International Rectifier- Dr. Michael A. Briere, International Rectifier

GaN the enabler for true SDR- Professor Rik Jos, RF Technology Fellow & Innovation Manager, NXP Semiconductors

Holistic Approach to MOCVD vacuum & Abatement- Dr Mike Czerniak, Product Marketing Manager, EdwardsVacuum Ltd

Advances in Wide Bandgap Semiconductors for Power Electronics- Dr. Markus Behet, Global market manager, Power Electronics, Dow Corning

Large diameter GaN-on-Si epiwafers for power electronics- Dr Mariane Germain, Co-Founder & CEO, EpiGaN

Achieveing Gan & GaAs RF Design Success through Product & Foundry Innovation– Mr Bryan Bothwell, Strategy and Business Development Manager – Foundry Services, TriQuint Semiconductor

Damage - free Deposition on LED devices- Dr Silvia Schwyn Thöny, Senior Process Engineer, Evatec Ltd

Temporary Bonding: An enabling technology for RF and power compound semiconductor devices - Dr Thomas Uhrmann, Business Development Manager, EV Group (EVG)

Bridgelux markets latest generation LED arrays

The new products allow customers to easily incorporate all performance enhancements with a simple upgrade path, minimising design efforts.

Bridgelux has announced the commercial availability of its latest generation of industry-

leading LS, ES, and award-winning RS product families.

They deliver an increase in efficacy of up to 30% and a reduction of up to 30% in cost per lumen compared to previous product generations.

Featuring a large portfolio of LED arrays in the lighting industry, Bridgelux offers products for lighting applications ranging from the light output equivalent of a 20 W decorative lamp to that of a 300 W high intensity discharge (HID) city streetlight.

Bridgelux's latest generation of LED arrays offer optical and mechanical compatibility with previous product generations, allowing customers to easily incorporate all performance enhancements with a simple upgrade path, minimising design efforts.

What's more, these new arrays offer greater system design flexibility to achieve Energy Star, Title 24, Part L and other global energy efficiency standards. All Bridgelux arrays are configured to align with industry standard drive currents to simplify the electronic driver selection process for new lamp and luminaire product development, enabling accelerated time to market.

"Bridgelux's commitment to rapid technology innovation while maintaining the product design characteristics of their LED arrays dramatically reduces our development risk, and ensures an easy design-in process," said Jeff Spencer, director of product management - commercial for Juno Lighting Group by Schneider Electric.

"We are very excited to be using their latest generation of arrays in the new Indy Performance Series LED downlights that we are launching later this month. As LED technology continues to rapidly evolve, Bridgelux has been a terrific strategic partner because they understand that by providing platform stability with the LED array products we can easily adopt the latest technology improvements and rapidly pass these innovations on to our customers without significant product redesigns."

Bridgelux arrays are available in a broad range of colour temperatures ranging from 2700K to 5600K with 3 SDCM colour control options to enable clean and consistent lighting installations. Multiple colour rendering index (CRI) options are available, providing increased design flexibility for lamp and luminaire manufacturers.

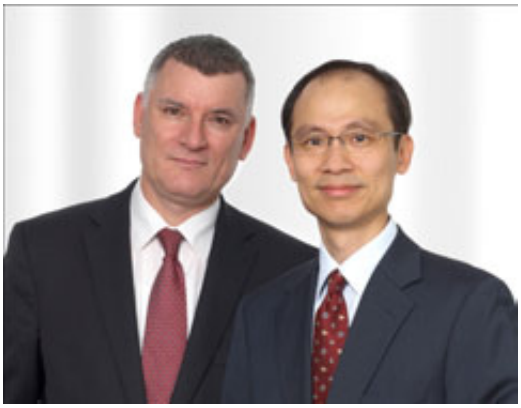
New CEO for Osram Opto in Asia

Louis Lam has more than 25 years of expertise in marketing and sales, and also experience in business development in the opto-semiconductor industry.

Louis Lam took over the company's Asian business at the beginning of December. He is also Vice President for worldwide sales of Osram Opto Semiconductors. His predecessor, Alfred Felder will in future be responsible for global sales of the business unit General Lighting at the parent company Osram AG.

Louis Lam can look back on more than 25 years of experience in marketing and sales, as well as business development in the opto-semiconductors industry. He was responsible, among other things, for the successful expansion of regional business in Asia in the fields of mobile devices, Solid State Lighting, automotive lighting and various other sectors of industry.

"With his know-how and many years of experience in market development and in building up customer loyalty, Louis Lam is an outstanding choice particularly with a view to the important Asian market. At the same time, our thanks are due to Alfred Felder for his excellent work in this position," says Aldo Kamper, CEO of Osram Opto Semiconductors.



Alfred Felder (left) has moved to Osram AG - Louis Lam (right) took over as Vice President Sales and new CEO of Osram Opto Semiconductors Asia Ltd. in December

Forepi selects Aixtron´s brand new CRIUS II-XL reactor

The Taiwanese firm will use the tool to manufacture indium gallium nitride epiwafers for HB-LEDs.

Forepi is installing an Aixtron CRIUS II-XL reactor in a 19x4-inch configuration.

The order came in the third quarter of 2011, initially for the CRIUS II-L version, and was immediately converted into Aixtron´s brand new XL-configuration right after its launch. Delivery of the new reactor will take place in the fourth quarter of 2011.

The CRIUS II-XL reactor has been acquired for the volume production of InGaN-based high-brightness (HB) blue LED epiwafer materials. One of Aixtron´s local support teams will install and commission the new reactor in the company's state-of-the-art production complex in Taiwan.

Forepi President Fen-Ren Chien, comments, "The acquisition of this four-inch wafer capable Showerhead system reflects a milestone for Forepi. Initially, we had been considering the CRIUS II-L to be a candidate tool for the next stage in our expansion plans. When the XL version was introduced recently, we were impressed by the performance of the 19x4-inch configuration. Thanks to our excellent long-term relationship, Forepi's technical team trusts both the technology and the service so we will be soon working closely with Aixtron to ensure the system is successful on all counts."

Bernd Schulte, COO at Aixtron, adds, "The CRIUS II-XL system offers the world's highest throughput and productivity and is the latest addition to Aixtron´s renowned CRIUS series. Any existing process on CRIUS II can be smoothly transferred to CRIUS II-XL. Changing from one wafer size to another only requires a simple carrier plate exchange without further hardware or process adjustment. All these aspects greatly assist wafer manufacturers seeking to keep InGaN LED manufacturing costs under tight control."

Forepi was incorporated in November 1999 as a dedicated pure-play manufacturer of high brightness InGaN LED wafers and chips. Currently, the company has the capability of offering a product range that covers the full spectrum of LEDs including high brightness InGaN blue, green and near-UV LEDs for markets in Taiwan as well as South Korea, Hong Kong, the US and China.

Rubicon celebrates first anniversary of Batavia sapphire growth facility

The next generation facility provides high quality, large diameter sapphire wafer for markets including LED manufacturers.

Rubicon Technology, provider of sapphire substrates and products to the LED, RFIC, Semiconductor, and Optical industries, is marking the first anniversary of the company's

next-generation sapphire crystal growth facility, located in Batavia, IL.

The 135,000 sq. ft. facility is used for the production of sapphire crystals which are further processed into sapphire ingots and large diameter sapphire wafers used in products such as LED-based lighting, HDTVs, laptops, netbooks, smart phones and tablets, and automotive lighting.

As a vertically integrated supplier, Rubicon grows large sapphire crystals at the Batavia facility from raw materials in custom-built, proprietary furnaces replicating the organic sapphire creation process found in nature. The company completes the process to make large diameter wafers in their Penang, Malaysia cutting and polishing facility.

“Rubicon’s proprietary crystal growth technology, as exemplified by our Batavia plant, has been refined over the past 11 years to provide consistently high yield and the highest quality sapphire for our customers,” said Raja Parvez, Rubicon President and CEO.

“Rubicon’s Batavia plant is the cornerstone of our market leadership in providing large-diameter sapphire wafers to the LED industry. Rubicon offers LED manufacturers the most reliable supply of high quality, high yield, large diameter sapphire wafers which is important to supporting the adoption of LED-based general lighting worldwide.”

To date, Rubicon has shipped more than 200,000 six-inch sapphire wafers to the LED manufacturing and RFIC industries. The transition to larger diameter wafers in LED production has started at the LED manufacturing level. Several key LED chip manufacturers have announced plans to migrate to and/or test large diameter wafers in 2011/2012. The process and cost efficiencies brought by large diameter sapphire wafers are instrumental to driving prices down in the LED industry.

Bringing down the overall price of LEDs is a key element in supporting the worldwide commercial adoption of solid state lighting based on LEDs as a light source. According to market research firm DisplaySearch, the total average LED penetration in lighting was 1.4% in 2010 and is forecast to reach 9.3% in 2014. Government entities around the world including China, European Union, Australia, Canada and the United States have introduced legislation to require energy efficient lighting.

China’s LED lamp prices tumble in November

IMS Research›s «Global Monthly LED Lamp Retail Price Tracker» says that the biggest decline in LED lamp prices was seen in the Chinese market, where the average price fell 62% from $30 to $11.

According to the latest analysis from IMS Research, the global average retail price for LED lamps has steadily decreased on a monthly basis from $30 in September to $28 in November.

IMS Research has highlighted regional differences regarding the global retail LED lamp market :

China - The biggest decline in LED lamp prices was seen in the Chinese market, where the average price fell 62% from $30 to $11. The price of 60W replacement A19 lamps fell 38%, while the price of 20W MR 16 replacement lamps fell 52%. It appears that Chinese manufacturers have also been pushing to increase the efficiency of their lamps, with Lumens/Watt increasing 24% from September to November.

United States- November is the first month that Samsung lamps have been sold in Lowe’s home improvement stores. The company has seven new Parabolic Aluminised Reflector and Multifaceted Reflector replacement

lamps available and one 50W incandescent replacement. It appears that Samsung is delaying the introduction of its other incandescent replacement lamps available in other countries.

Japan– November was the first month that a 40W incandescent replacement lamp has been priced under 1000 Yen ($13). The average price of 40W replacement lamps in Japan is still over $30.

South Korea– Of the 31 incandescent replacement lamps tracked in South Korea, 26 were mislabelled with regards to their wattage replacement. The average luminous output of LED lamps labelled as 60W replacements was 505 lumens, almost 200 lumens below the threshold used by IMS Research for a 60W replacement.

World– Of the over 480 LED lamps tracked by IMS Research in 12 countries, only 32 (7%) were for 60 and 75W replacements, with no 100W replacement lamps (using IMS Research metrics) on the market.

Phillip Smallwood, Lighting Market Analyst at IMS Research will give a presentation on "*The Market for LEDs in Lighting*" at CS Europe 2012.

Register at www.cseurope.net & book your delegate place now as numbers will be limited. The conference takes place on 12th/13th March 2012 at Hilton Hotel, Frankfurt, Germany

Telecoms

Skyworks ramps up GPS/ GNSS manufacturing for Samsung

The new device launched by the company has an LNA which uses proprietary gallium arsenide pHEMT technology. It enables high performance navigation functionality in smart phones and tablets

Skyworks' SKY65702-11 is a Front-End Module (FEM) with an integrated Low Noise Amplifier (LNA) and pre-filter designed for Global Positioning System/Global Navigation Satellite System (GPS/GNSS) receiver applications.

The Company's newest devices, which integrate an LNA with filtering specifically designed for GPS/GNSS receiver applications, are claimed to deliver industry-leading performance and be one of the smallest solutions in the market requiring no external components, allowing manufacturers an easy "plug and play" option.

"This is an exciting new product area for Skyworks, particularly as navigation is becoming one of the fastest growing consumer features for smart phones and tablets," said Liam K. Griffin, executive vice president and general manager of high performance analogue at Skyworks. "By leveraging core capabilities, Skyworks is delivering innovative solutions that help drive better performance and reduce complexity for our customers, while at the same time capturing additional RF content in high-growth markets."

Global adoption of smart phones continues to be robust, and is quickly being followed by a growing tablet adoption cycle. According to Oppenheimer & Co. Inc. worldwide shipments of smart phones are predicted to reach one billion by 2015, up from approximately 400 million units by the end of 2011. In addition, global tablets are expected to surpass 125 million units by 2015, up from roughly 50 million for the end of December 2011. Embedded GPS/GNSS functionality is expected to be an integral part of these devices.

The SKY65702-11 is a receive only front-end solution with an integrated low-noise amplifier and filtering designed for GPS and global navigation satellite system receiver

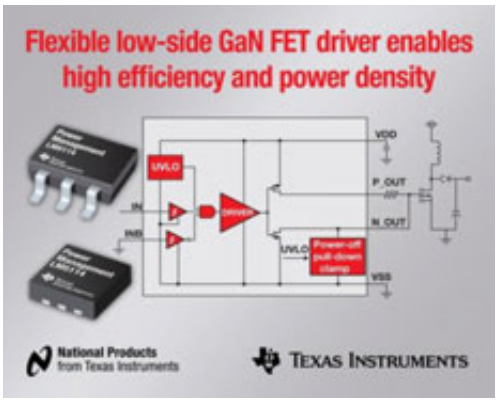
applications. The device provides high linearity, excellent gain, a high 1 dB input compression point and a superior noise figure. The integrated GPS and GNSS filter provides low in-band insertion loss and excellent out-of-band rejection performance for the cellular\LTE, personal communication service and wireless local area network frequency bands. The SKY65702-11 comes in an ultra-small 2.5 x 2.0 millimetre low cost package.

Texas Instruments expands its family of GaN FET driver ICs

The flexible low-side gate gallium nitride driver is suited for use with MOSFETs and GaN power field-effect transistors (FETs) in high-density power converters

The new LM5114 drives GaN FETs and MOSFETs in low-side applications, such as synchronous rectifiers and power factor converters.

Together with the LM5113, one of the industry's first 100-V half-bridge GaN FET drivers, the family provides a complete isolated DC/DC conversion driver solution for high-power GaN FETs and MOSFETs used in high-performance telecom, networking and data centres applications.



The LM5114 drives both standard MOSFETs and GaN FETs by using independent sink and source outputs from a 5-V supply voltage. It features a high 7.6-A peak turn-off current capability needed in high-power applications where larger or paralleled FETs are used. The increased pull-down strength also enables it to drive GaN FETs properly. The independent source and sink outputs eliminate the need for a diode in the driver path and allows tight control of the rise and fall times.

TI is showcasing its FET driver family - the LM5114, the LM5113 in a new micro SMD package, the pin compatible 4-A/8-A UCC27511 low-side gate driver scheduled for release in March, and other products that help unlock the full benefits of GaN FET technology - in booth #401 at the Applied Power Electronics Conference and Expo (APEC) in Orlando, Florida, Feb. 6-8.

APEC is one of the industry's leading conferences for practicing power electronics professionals.

The LM5114 is available in volume now from TI and its authorised distributors. Offered in a 6-pin SOT-23 package and 6-pin LLP package with exposed pad, the suggested retail price is $0.58 in 1,000-unit quantities.

Samples and an evaluation module of the new GaN FET can be ordered at www.ti.com/lm5114-pr

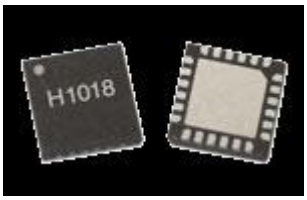
New wideband control GaAs products spanning 100 MHz to 50 GHz

The recently released gallium arsenide based devices are ideal for automotive, microwave radio, test equipment, military and space applications up to 50 GHz

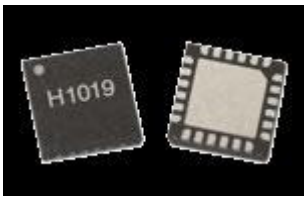
Hittite Microwave Corporation has introduced a new Single Pole Double Throw (SPDT) Switch and two new Serial Controlled 5-Bit Digital

Attenuator GaAs MMICs.

The HMC1018LP4E and HMC1019LP4E are serial controlled GaAs MMIC 5-Bit Digital Attenuators which are rated from 0.1 to 30 GHz. The HMC1018LP4E can be programmed to provide up to 31 dB attenuation in 1.0 dB steps, while the HMC1019LP4E provides up to 15.5 dB attenuation in 0.5 dB steps.

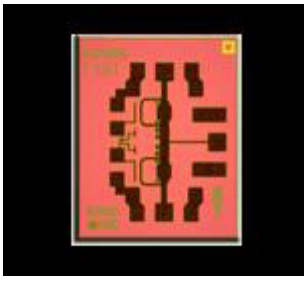


HMC1018LP4E



HMC1019LP4E

These new products exhibit insertion loss as low as 4 dB, excellent attenuation accuracy of ± 0.3 dB, and input IP3 up to +45 dBm. Both are housed in 4 x 4 mm QFN packages, and offer a versatile control interface accepting positive control voltages from 0/+2V to 0/+5V. These 5-Bit Digital Attenuators are also available with parallel control as the HMC939LP4E and HMC941LP4E, and in bare die form as the HMC939 and HMC941.



HMC986

Also released is the HMC986 wideband GaAs pHEMT MMIC SPDT switch die. This miniature switch is controlled with two complementary inputs of 0/-3V to 0/-5V, and can be switched as fast as 10 ns. With an input frequency of 40 GHz, the HMC986 exhibits 20 dB return loss, 31 dB isolation, and only 1.9 dB insertion loss. The combination of wideband performance and fast switching speed make this switch ideal for a wide range of test equipment, switching matrix and electronic warfare applications.

These new products complement Hittite's extensive line of control components, including one of the widest selections of MMIC digital attenuators and switches available from any OEM.

Samples and evaluation PC boards for all SMT packaged products are available from stock and can be ordered via the company's e-commerce site or via direct purchase order.

Inphi and NeoPhotonics InP 100G systems to move into the next dimension

The firms will attempt to accelerate the mass transition of indium phosphide optical modules into 100GbE products for cloud, data centre and 100G transport applications

Inphi will offer its portfolio of 100G TIA and 100GbE iPHY solutions, which include PHY and Clock Data Recovery (CDR) chipsets along with its transimpedance amplifiers (TIAs) to NeoPhotonics to use in its 100G optical product developments.

The mixed signal semiconductor devices offered by Inphi are designed to provide NeoPhotonics higher performance and lower power consumption for next generation optical modules and subsystems for high-speed transport and client-side applications.

Based on its patented iPHY architecture,

Inphi recently announced the availability of its industry leading low power CMOS PHY and CDR solutions for 100GbE alongside the availability of its industry leading high-performance 100GbE TIA (see press announcements here). Inphi's CMOS PHYs and CDRs offer a substantial savings in power -- 3x less than currently available offerings -- in a 2x reduced area footprint, while improving reliability without sacrificing performance.

NeoPhotonics is a designer and manufacturer of photonic integrated circuit (PIC) based modules and subsystems for bandwidth-intensive, high-speed communications networks.

"We continue to demonstrate our commitment to the ultra-high speed segment of the optical market by working with industry leaders like Inphi to offer high-speed products for transport, cloud and data center applications," said Tim Jenks, Chairman and CEO of NeoPhotonics. "Our next-generation 100G optical solutions can benefit from Inphi's technology leadership position in the 100G market and help us deliver high levels of performance and low power consumption for our PIC-based product portfolio."

"We are excited to cooperate with NeoPhotonics to accelerate the deployment of power and area efficient, cost optimised 100G products for cloud and enterprise data centres as well as for transport applications," said Young K. Sohn, President and CEO of Inphi. "Inphi remains uniquely positioned to deliver a platform level 100GbE solution with its portfolio of CMOS PHY ICs and high-performance PMD products, which will allow for faster deployment of next-generation 100GbE optical solutions in enterprise, data centre and service provider networks."

Cost-effective, energy-efficient 100GbE links will soon become essential tools for data centre and service provider networks, which are struggling to satisfy the global economy's relentless hunger for more bandwidth. With service providers and data centres demanding technology with low power consumption, Inphi's iPHY CMOS PHY solutions and NeoPhotonics PIC-based modules and sub-systems are designed to provide easy upgrades to 100GbE networks while retaining a lower carbon footprint.

Next Generation Jammer arrays use GaN transmitter technology

The technology is developed for mid band and high band PAs which employ gallium nitride semiconductors

Along with Boeing, ITT Exelis has successfully completed testing of critical components of the GaN array transmitter technology envisioned for the U.S. Navy Next Generation Jammer (NGJ) program.

The Boeing EA-18G Growler will be the initial host platform for the Next Generation Jammer

The testing, observed by U.S. Navy representatives, successfully demonstrated multiple critical technology elements, including digital beam-forming, mid band and high band Power Amplifiers (PAs). These demonstrations were accomplished in accordance with program objectives to achieve a high-technology readiness level deemed critical to reducing future technical risk to the Navy's Next Generation Jammer program.

The digital beam-forming technology demonstrated recent advancements made in broad band electronically steerable antenna arrays. The technology developed for the mid band and high band PAs displayed high technical maturity and performance of state-of-the-art gallium nitride semiconductors, as well as the packaging and cooling required for a future NGJ array transmitter.

"Our receiver exciter expertise, coupled with these recent successes, enables a low-risk transition to an integrated operational system," said Bob Ferrante, vice president and general manager of the Exelis Electronic Systems' airborne electronic attack business. "Our technology efforts are highly focused to ensure we address the evolving NGJ requirements."

The NGJ will help ensure that U.S. forces have complete dominance of the electronic spectrum, providing a comprehensive capability to disrupt and disable enemy communications and radars. Exelis, teamed with Boeing, leads one of four industry teams in competition to develop the final NGJ system.

The NGJ program, valued at more than $2 billion, will replace the current inventory of aging ALQ-99 jamming pods on the Navy's newest airborne electronic attack aircraft, the Boeing EA-18G Growler. The Next Generation Jammer pod will also be a stepping stone to electronic attack capability on other advanced platforms.

RFaxis granted four patents for mobile connectivity

The firm's RFeIC architecture can be implemented in gallium arsenide-based HBT, indium phosphide-based HEMT and silicon germanium-based BiCMOS technologies

RFaxis has been awarded four patents for its revolutionary single-chip, single-die RF Front-end Integrated Circuit (RFeIC) architecture.

These are the fundamental patents among the company's substantial intellectual property (IP) portfolio which consists of more than 30 patents that have been filed to-date.

The patents are "Radio Frequency Transceiver Front End Circuit with Matching Circuit Voltage Divider," "Multi Mode Radio Frequency Transceiver Front End Circuit," "Multi Mode Radio Frequency Transceiver Front End Circuit with Inter-Stage Matching Circuit," and "Multi Mode Radio Frequency Transceiver Front End Circuit with Inter-Stage Power Divider."

"Our single-chip, single-die RFeIC architecture is process and materials agnostic, and can be implemented in all semiconductor technologies such as Gallium Arsenide-based HBT, Indium Phosphide-based HEMT, Silicon Germanium-based BiCMOS or pure bulk CMOS," commented Oleksandr Gorbachov, CTO of RFaxis.

"We developed and productised our first-generation RFeICs including the RFX2401 for ZigBee and RFX2402 for WLAN using BiCOS process in 2009. We have since successfully migrated these products to standard bulk CMOS process and are now shipping our second-generation, backwards-compatible products including RFX2401C and RFX2402C. We are in the process of launching several new pure CMOS-based RFeICs that serve major wireless protocols including WLAN 802.11a/b/g/n/ac, Bluetooth, ZigBee/ISM, and markets such as Smart Meters, Wireless Audio/Video and Home Automation, among others."

"These four fundamental patents provide full protection for our main architecture," said Mike Neshat, chairman and CEO of RFaxis. "Our disruptive RFeIC technology is now fully patented. We expect to have more patents granted in the coming weeks and months. Combining these patented architectures along with our in-house design methodologies and trade secrets, RFaxis is truly leading the way of 'Bridging the RF Gap' for the exponentially-growing wireless industry, as initially envisioned

when we started the company four years ago."

Optelian acquires GaAs innovator Versawave

The designer and manufacturer of optical transport systems intends to drive growth and strengthen its leadership in high speed optical technology

Optelian has acquired Versawave Technologies, of Vancouver, British Columbia.

Versawave is a developer in the field of ultra-high bandwidth gallium arsenide based optical modulators with patented polarisation modulation technology.

This strategic move further positions Optelian to broaden its markets, extend technical leadership and strengthen its client services through innovative product development in the field of optical communications, worldwide.

«Our acquisition of Versawave is very much a part of our core strategy of continuing to manufacture in North America and being as vertically integrated as possible to provide our customers with very cost effective solutions and short lead times,» said Optelian›s CEO, David Weymouth.

A recent study from market research firm, Infonetics Research, has found that operators have a strong preference for deploying 100 Gigabit-per-second (Gbps) technology as they upgrade their networks. «Versawave brings exceptional technology for 100Gbps and will accelerate Optelian›s growth into the next generation of highly integrated photonic systems,» continued Weymouth.

Versawave, led by Hiroshi Kato, will continue to operate at its current Vancouver facility as a division of Optelian. Kato stressed that the «synergy with Optelian will enable Versawave to expand manufacturing, accelerate the making of new products and enhance customer support.»

3S Photonics transforms into 3SPGroup

Following the successful synergies between 3S Photonics, Avensys and Manlight, the Group is uniting these three companies as a single entity

The name change to 3SP aims to simplify the Group's image and to pursue its internal and external growth strategy.

The year 2011 was marked by significant events for the Group. It announced a growth in turnover of 64% and the change of ownership with the arrival of Eurazeo a listed investment company in Europe, who became the majority shareholder of the Group in October 2011. More recently, was the acquisition of Manlight, a globally recognised player for optical fibre amplifiers and lasers.

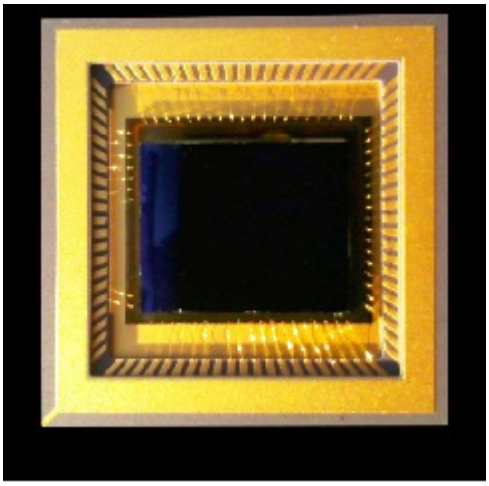
In 2012, 3SPGroup will continue its acquisition strategy in order to strengthen its position in its historical markets, and to pursue vertical and market growth. To this end, the Group has decided to reorganise itself and simplify its image and name under one single brand.

"Beyond this marketing strategy, with the industrial and trade integration of our different structures, we wanted to offer a diversified and easily accessible range of products and solutions," says Alexandre Krivine, President and CEO of 3SPGroup. "Our customers will continue to benefit from the increase of our production capacities and technical expertise."

Xenics unleashes SWIR quiet multitasking detector

The firm›s latest detectors are based on indium gallium arsenide, MCT and broadband indium antimonide arrays suited to SWIR cameras for medical, scientific and industrial markets

Xenics› new XFPA-1.7-640-LN2 detector, is geared to very demanding low-signal-level measurements in semiconductor inspection and fault localisation.



XFPA-1.7-640-LN2: LN2 cooled high resolution SWIR detector

The company is also introducing the Bobcat-320-Gated, a camera for scientific R&D applications, which is claimed to deliver extremely short integration times of 80 nanoseconds.

The Lynx high speed SWIR line-scan series offers highest resolution of up to 1 x 2048 for non-intrusive medical imaging and general SWIR applications, whereas Gobi-640-GigE addresses the lower-cost LWIR thermal imaging segment.

Xenics is exhibiting its high-speed SWIR and advanced thermal imaging for non-intrusive medical applications at the BiOS 2012 presentation. Targets are bio-medical technology providers of optical coherence tomography, molecular imaging, and spectroscopy solutions product range in Booth # 8216

Among Xenics' new camera releases for the medical market is the Lynx, with the new model offering a unique achievement in resolution of up to 1 x 2048 pixels. This is an outstanding value in the SWIR line-scan camera market. It enables the user to increase resolution by a factor of two compared to others offering 1024 pixels. Lynx-1.7-2048 offers low noise at a high line rate of 10 kHz; Lynx-1.7-1024 and Lynx-1.7-512 even offers up to 40 kHz line rate, which enables the capture of fast moving samples. Lynx is equipped with the smallest available sensor having a pixel pitch of 12.5 µm to support inspection tasks that demand ever higher accuracy in the SWIR range. A special benefit for medical imaging applications in the SWIR realm, such as OCT, is that the light source radiates at a wavelength of 1.3 µm, which increases the penetration depth in human tissue. Lynx is compatible with the C-Mount standard.

Another new product release, Gobi-640-GigE, addresses lower-cost, high-sensitivity medical imaging in a small form factor with 640 x 480 pixels. The camera includes a compact GigE interface, on-board image processing and Power over Ethernet (PoE). The new model offers unparalleled ease of integration via GigE Vision, as well as utmost flexibility through PoE.

The Xenics Gobi series is also well suited for life tissue imaging and breast cancer examination.

Xenics' new-product presentation builds on highly advanced SWIR cameras and detectors for demanding low-light-level applications and gated imaging. Photonics West 2012 will see the introduction of a high-resolution liquid-nitrogen- (LN2) cooled SWIR detector, the XFPA-1.7-640-LN2. It was specifically developed for R&D spectroscopy and photon emission in the semiconductor failure analysis industry, high-resolution spectroscopy and low-

light-level SWIR and VisNIR imaging.

The new detector XFPA-1.7-640-LN2, based on source-follower detector (SFD) read-out technology, offers high sensitivity at a resolution of 640 x 512 pixels with a pixel pitch of 20 µm and reaches extreme long integration times. LN2-cooling at 77K allows for lowest noise (< 20 e-) ever seen for SWIR detectors and low dark current (< 5 e-/sec per pixel).

Optionally, the measurement realm can be extended into the visible spectrum. Easy focusing on the microscope stage is supported by the increased frame rate in windowing mode.

Based on this new XFPA detector, Xenics will introduce a complete camera system, the "Cougar", in the second half of 2012.

Another highlight at the Xenics booth is Bobcat-320-Gated, an SWIR camera operating in the 0.85 to 1.6 µm spectral band. It provides extremely short integration times down to 80 nsec. Bobcat-320-Gated makes use of a highly sensitive uncooled InGaAs detector, which is available in a 20µm pixel-pitch. The compact camera contains real-time on-board image processing and image correction – all at a very favourable price point.

A special feature of Bobcat-320-Gated is the programmable trigger-out delay between the internally generated trigger-out pulse and the start of integration. It is configurable from 80 nsec up to 2 msec in steps of 80 nsec. Bobcat-320-Gated

captures frames at a frame rate tuneable around 28 fps. With all these features, Bobcat-320-Gated is ideally suited for the inspection of hot and fast moving objects or measurement systems requiring synchronisation of the camera with a pulsed laser.

"Our main message," says Xenics founder and CEO Bob Grietens, "is that Xenics covers the entire wavelength span from SWIR over MWIR to LWIR with advanced thermography systems. For medical applications such as OCT, our new high-speed SWIR cameras are the perfect fit. In the scientific markets, our new Bobcat-320-Gated takes the lead by providing very short integration times."

Microsemi on a roll with ZTE's '2011 Best Delivery Support' award

The firm has been commended for its exceptional delivery of semiconductor products for applications supporting a wide range of communications products and networks

Microsemi Corporation was named the recipient of ZTE Corporation's "2011 Best Delivery Support" award at ZTE's Supplier Day event in Shenzhen, China.

Microsemi received the award in recognition of its ability to consistently meet delivery schedule commitments and for providing superior service and support. ZTE Corporation is a global provider of telecommunications equipment and network solutions, and one of China's largest listed telecoms equipment companies.

"We strive to provide our customers with consistently high-quality products, on-time deliveries, and best-in-class technical and customer service support," said Rick Goerner, senior vice president of Worldwide Sales for Microsemi. "We are honoured to receive this important award from ZTE in recognition of achieving these goals."

"We chose Microsemi as the winner of this award because of the company's demonstrated ability to reliably adhere to product delivery schedules and adapt to changing requirements," said Peter Zeng, VP of procurement for ZTE. "These attributes are essential to ensuring our ability to meet our customers' needs, and a key factor in our long-

term success."

Microsemi provides voice and timing products to ZTE supporting a wide range of communications products and networks including multi- and single-dwelling units , multi-service access nodes , digital subscriber line access multiplexers, public telecommunications and optical transport networks.

ZTE recognises Anadigics for high-performance 3G and 4G PAs

The global provider of telecommunications equipment and network solutions awards Anadigics for outperforming over 1,000 suppliers

Anadigics, a provider of RF products, has received the "2011 Best Comprehensive Performance" Award from ZTE Corporation.

Anadigics received this award at ZTE's 2012 Supplier Day in Shenzhen, China, for its commitment to technological leadership, quality excellence, and superior service.

"Anadigics is extremely proud to be recognised by ZTE, a global leader of wireless devices," said Michael Canonico, senior vice president of worldwide sales at Anadigics. "Through a combination of industry-leading products, outstanding applications support, and impeccable quality, we were able to surpass the performance of more than 1,000 suppliers to receive the award. Anadigics views this event as another milestone in our successful relationship and we look forward to continue working closely with the talented team at ZTE."

Frontier Communications chooses Infinera for Pennsylvania OTN

Infinera's indium phosphide PICs will simplify optical transport for triple play, mobile backhaul, high-speed Internet and business broadband services

Infinera has announced that Frontier Communications Corporation, one of the nation's largest providers of communications services focused on rural America, has deployed Infinera's ATN for its metro network.

Infinera's ATN extends the benefits of Frontier's backbone network, which is based on Infinera's DTN platform. The new Infinera ATN metro platform adds scale and simplicity to Frontier's network, and the combined platforms enable Frontier to serve customers in 14 counties, spanning more than 640 fibre route miles in eastern Pennsylvania.

Frontier offers consumers, businesses and service providers a full range of communications services in Pennsylvania and 26 other states. Its Infinera network in Pennsylvania provides voice, business and wholesale bandwidth services to consumers and businesses and wholesale mobile backhaul for Tier 1 mobile operators.

"We are very pleased with the simplicity and efficiency of Infinera's DTN and ATN solutions," said Michael Golob, Senior Vice President, Engineering & Technology at Frontier. "The operational simplicity of these advanced platforms enabled us to turn up a new network across 14 locations in just three days. The efficiency of Infinera's solution has reduced certain off-net lease costs in our network by as much as 75 percent."

"Frontier is an important customer and we are delighted that the Infinera ATN is adding value to its existing DTN network," said Tom Fallon,

Infinera CEO. “At Infinera, we are committed to providing regional and metro solutions that help service providers like Frontier simplify network operations while efficiently scaling the network for broadband services.”

Frontier’s deployment of Infinera’s DTN and ATN platforms provides customers with a state-of-the-art network. The Infinera DTN platform, powered by photonic integrated circuits (PICs), is designed to scale up to 6.4 Tb/s of transmission capacity per fiber. The Infinera ATN, a scalable WDM transport platform with multi-service aggregation and small form-factor, brings the intelligence of the Infinera Digital Optical Network to the metro edge. Infinera’s DTN and ATN platforms are elements of the Infinera product portfolio that includes Infinera’s DTN-X with 500 Gb/s FlexCoherent super-channels.

Discovering the 10 Gb/s InGaAs APD

A new versatile indium gallium arsenide device aims to maximise test time by simplifying measurement in analogue RF links and ultrafast digital communications

Discovery Semiconductors is introducing a 10 Gb/s InGaAs APD + TIA + CDR Lab Buddy instrument for SONET, Ethernet, PON, and Fibre Channel applications.

Discovery is also offering both its 10GHz linear PIN + TIA and 10 Gb/s High-Sensitivity Limiting PIN + TIA with a CDR Lab Buddy option. The O/E section provides the receive and regenerate functions, and the CDR provides the clock and data recovery function from the input signal.

Discovery’s APD + CDR Lab Buddy includes a limiting amplifier with LOS power detector, and PLL data re-timer with a LOL indicator. The Lab Buddy supports multi-rate operation from 9.5 Gb/s up to 11.1 Gb/s. The CDR function has a 7mVp-p Input Sensitivity and 0.6UIp-p total high-frequency jitter tolerance. The clock and data outputs are compatible with BER test stations.

What’s more, the APD + CDR Lab Buddy has a programmable bias voltage source and a built-in temperature controller for improved gain stabilization and increased reliability. The bias and temperature can be set either from the front panel or via a remote computer interface. The APD + CDR Lab Buddy monitors the bias, temperature, and average DC photocurrent of the APD in real-time.

Roy Howard, Applications Specialist at Discovery Semiconductors added, “The new APD + CDR Lab Buddy aims to maximise your test time by simplifying your measurement. This is accomplished through the combination of the O/E & CDR functions by providing both clock and data electrical outputs conveniently to your scope or BERT.”

Discovery Semiconductors is a manufacturer of ultrafast, high optical power handling InGaAs photodiodes, radio frequency over fibre optical receivers, balanced optical receivers and several other custom products for applications ranging from analogue RF links to ultrafast digital communications. Discovery’s subsystems include Kitty Hawk, an ultra-fast Optical Coherent System.

Teledyne and Zephyr Photonics unite to advance optical interconnect technology

The partnership is aimed at developing and marketing high bandwidth, harsh environment optoelectronic solutions for the military, aerospace, commercial aviation, and oil and gas industries

The venture combines Zephyr Photonics’

VCSEL technology and Teledyne Microelectronics Technologies' five decades of experience in producing multichip modules and ruggedised fibre optic assemblies.

This is the first major commercial partnership for Zephyr Photonics, which recently transitioned to a commercial enterprise after more than 25 years as a research and development company.

The agreement with Teledyne Microelectronic Technologies includes joint product development to address future market opportunities. It also provides a collaborative sales channel to reach more customers faster while opening new markets via Teledyne's multiple divisions, and establishes a trusted partnership for government funding proposals for new technology development.

"This is a significant step for Zephyr Photonics as we work to establish our foothold as a trusted resource and partner for optoelectronic technology across a variety of markets and industries," said Tom Steding, CEO of Zephyr Photonics. "Working with Teledyne Microelectronic Technologies provides credibility to our customers via a trusted manufacturing facility and further demonstrates our commitment to the defence OEMs, and ultimately, the warfighter."

This collaboration will provide customers with advanced optical interconnect fibre optic products that can overcome harsh environment data communications obstacles and enable optical interconnect solutions that meet the requirements of national security and commercial applications.

"Together, we will deliver unparalleled and reliable solutions to system designers and improved SWaP for applications and environments where data communications is not just important, it is mission critical and potentially life-saving," said Terry Thomas, Executive Vice President of Business Development for Zephyr Photonics. "Zephyr Photonics' proprietary high temperature VCSELs can withstand temperatures over 155°C and are well suited for unmanned airborne vehicles, in addition to extreme heat conditions in down hole oil drilling applications."

"Teledyne Microelectronic Technologies relationship with Zephyr Photonics expands our range of optoelectronic packaging solutions well beyond the competition's," said Albert Andry, Vice President and General Manager of Teledyne Microelectronic Technologies. "By partnering with Zephyr Photonics, we can take our superior fibre optic packaging capabilities to the Oil & Gas sector, where extreme temperature requirements are driving technology to limits not seen before."

Skyworks diversifies to go sky high in GaAs market

Strategy Analytics says TriQuint, RFMD and Avago were the other main players in the gallium arsenide device market in 2011

Propelled by rapidly increasing rates of data consumption and sophisticated handsets with more GaAs content, the GaAs device market reached $5.45 billion of revenue in 2010.

The recently published Strategy Analytics report, "GaAs Device Vendor Market Share 2010: North America," estimates that the GaAs device market grew by 35 percent since 2009.

The report addresses GaAs vendors in North America and concludes that Skyworks Solutions remains the largest GaAs device manufacturer. Skyworks increased its lead over second-place RFMD through a combination of product diversification and design wins at major handset manufacturers.

TriQuint Semiconductor is still in third place and is now less than half of a percentage point behind RFMD. Avago Technologies rounds out the top four. These companies account for

nearly 60 percent of total GaAs device revenue.

"The GaAs device market had a banner year in 2010, reaching record revenue levels," noted Eric Higham, Director of the Strategy Analytics GaAs and Compound Semiconductor Technologies Service. "The growth was driven by increasing GaAs content in handsets in response to more multi-mode and multi-band capabilities. We expect these drivers will continue, but growth is likely to be more in-line with historical averages of five to seven percent."

Asif Anwar, Director in the Strategy Analytics Strategic Technologies Practice, added, "The 35 percent growth rate in the GaAs device market was the largest the industry experienced since the "telecom bubble" of the early 2000s. This time, growth is so broadly based that Strategy Analytics does not anticipate a repeat of the collapse in GaAs revenue, as seen after the telecom bubble burst."

GaAs device market grows 35% from 2009 to nearly $5.5 billion

WIN Semiconductors rose to become the largest merchant GaAs foundry in 2010

The GaAs device market recovered sharply in 2010, driven by increasing GaAs content in mobile handsets and growing data consumption.

The recently published Strategy Analytics GaAs and Compound Semiconductor Technologies Service report, "GaAs Device Vendor Market Share 2010: Asia-Pacific and Europe," estimates that the GaAs device market grew by 35 percent from 2009 to reach nearly $5.5 billion of revenue.

Addressing GaAs vendors in Asia Pacific and Europe, this report concludes that the trend toward foundry outsourcing and the very rapid market recovery drove revenue growth at WIN Semiconductors in excess of the overall GaAs device market. This established WIN as the largest merchant GaAs foundry in the world and the largest GaAs device supplier in the Asia Pacific and Europe region. Of the top ten largest GaAs suppliers, Taiwan's WIN Semiconductors is fifth and Japan's Sumitomo Electric is eighth on the list.

"Pent-up demand from 2009 helped fuel the extraordinary growth of the GaAs industry in 2010, increasing GaAs content in mobile phones," noted Eric Higham, Director of the Strategy Analytics GaAs and Compound Semiconductor Technologies Service. "Demand picked up much faster than captive foundries could increase capacity. This, coupled with the increasing trend toward outsourcing propelled pure-play foundries in Asia Pacific, is the key to strong growth."

Asif Anwar, Director in the Strategy Analytics Strategic Technologies Practice added, "Consolidation at large Japanese electronics companies like Renesas Electronics and Sumitomo Electric continued in 2010. Strategy Analytics expects renewed growth in this region."

This report provides strategic comments, representative products and selected news items for a comprehensive set of GaAs vendors in Asia Pacific and Europe. It also identifies the top ten global vendors in terms of GaAs device market share. Strategy Analytics estimates that only two of the top ten GaAs vendors are located in Asia Pacific and Europe.

Thailand floods to slash Opnext quarterly finances

The loss of production capacity at Fabrinet will have significant impact on the Company's operations and its ability to meet customer demand for its products for the remainder of its fiscal year ending March 31, 2012

Following the severe flooding in Thailand in October 2011, Opnext, a designer and manufacturer of optical modules and components, has issued an update regarding the status of its operations which halted operations at the Chokchai campus of Fabrinet, Opnext's primary contract manufacturer.

Production at the factory remains suspended and Fabrinet has stated that it is unlikely that production at Chokchai will resume. As a result, Opnext has relocated limited production capacity to its manufacturing facilities in Totsuka, Japan and Fremont, California. In addition, the Company is diverting a portion of the 10Gbps module production capacity previously at Fabrinet's Chokchai facility to Fabrinet's Pinehurst facility, located approximately seven miles north of Chokchai.

Fabrinet has allocated surface mount technology (SMT) lines at Pinehurst to Opnext and new test systems are being constructed to replace systems lost in the flooding. The Company anticipates that Fabrinet will start production in February 2012 and ramp production as new test systems come online. Opnext is also in the process of engaging an additional contract manufacturer with the goal of dual sourcing the manufacturing of certain high volume products.

Opnext expects to have restored approximately 20 percent of the lost 10Gbps module production capacity by the end of December, and anticipates continuing to increase production capacity during the quarter ending March 31, 2012, with a return to full production capacity expected sometime early in the quarter ending June 30, 2012.

Opnext expects that the loss of production capacity at Fabrinet will have significant impact on the Company's operations and its ability to meet customer demand for its products for the remainder of its fiscal year ending March 31, 2012. The Company expects that the loss of revenue in each of the third fiscal quarter ending December 31, 2011 and the fourth fiscal quarter ending March 31, 2012 will be material.

Multiple factors will affect the extent of revenue loss, including, but not limited to, Opnext's ability to move production to other locations, existing inventory from which to meet customers' needs, the Company's ability to source parts from suppliers that have been impacted by the flooding or from alternative suppliers in instances where the Company has had to locate alternatives, the level of demand from customers, and Opnext's ability to incrementally increase production at its other facilities.

In addition to the loss of revenue, Opnext has experienced some loss of equipment and inventory in connection with the flooding at Fabrinet's facility, the full extent of which is still not known. At the time of the flooding, the Company had production equipment at the Chokchai facility, primarily consisting of 10Gbps module test sets, with an original cost of approximately $31.3 million.

While it has been determined that some of the more sophisticated measurement equipment escaped damage from the flood waters, the Company is still in the process of determining the extent of equipment lost as a result of the flooding. The Company also had approximately $15.7 million of inventory with Fabrinet in Thailand, consisting of approximately $7.6 million of raw materials and $8.1 million of finished goods.

Although approximately one half of the finished goods have already been determined to be in good condition, Opnext is still in the process

of determining the status of the remainder of the finished goods as well as the status of the Company's raw materials.

While Fabrinet maintains insurance for the equipment and inventory located at the facility (and Opnext maintains independent insurance for a portion of the inventory) and there are additional contractual protections in favour of Opnext that Fabrinet has stated it will honour, it is not clear that the insurance will be adequate to fully cover Opnext's losses or that Opnext will otherwise be made whole.

Infinera top dog in North America

In Q3 2011, the indium phosphide PIC provider achieved number three position worldwide in the terrestrial long haul WDM transport and ROADM market

Infinera, provider of InP based digital optical networking solutions, has announced that Infonetics Research ranks Infinera the number-one supplier in the North America terrestrial long-haul WDM transport and ROADM market. This ranking demonstrates the company›s continual growth and market reach.

«In the third quarter of 2011, Infinera posted a revenue increase that moves them into first position in North America and third position worldwide for combined terrestrial long-haul WDM transport and ROADM equipment,» noted Andrew Schmitt, directing analyst for optical at Infonetics Research.

Infinera›s market share results in the third quarter for North America were driven largely by leading cable companies, wholesale carriers, Tier 1 customers and Internet Content Providers. European wholesale carriers and opportunities in the submarine space contributed to the company›s third quarter growth worldwide.

«Global network operators benefit from the scale, simplicity and efficiency of Infinera›s optical network solution,» said Tom Fallon, Infinera CEO. «Infinera›s solution for network operators helps them be more responsive to their customers› needs while confidently planning for future network growth. We are pleased by Infonetics› ranking as this reflects the support and faith our customers continue to put in us.»

Infinera›s product portfolio includes Infinera›s DTN platform, powered by photonic integrated circuits (PICs), Infinera ATN, a scalable metro WDM transport platform and the recently announced DTN-X platform with 500 Gb/s FlexCoherent super-channels.

InAs/InGaAs QDs for ultra-high speed communication

Using a sandwiched sub-nano separator growth technique, indium arsenide / indium gallium arsenide quantum dots have been used to create a broad new band the 1.31-μm region

The National Institute of Information and Communications Technology (NICT) says it has developed the world's first optical source for generating light spanning a large number of wavelengths with high precision.

The researchers used nanoscale InAs/InGaAs quantum dots grown on GaAs, in a band consisting of wavelengths in the 1.3-μm region that are not currently used for optical communication.

What's more, the researchers say they have developed an optical transmission experiment using this light source and a photonic crystal fibre, demonstrating the possibility of using a new wavelength band for optical communication.

This "quantum dot light source technology" makes it possible to secure an optical

frequency resource (about 70 THz) whose band covers about 10 times the width of the currently used 1.55-μm optical communication wavelength band.

Moreover, as quantum dots and a photonic crystal fibre have nanoscale structures, the application of nanotechnology is expected to be revolutionary for optical information communication.

Background

Current optical fibre communication systems use a 1.55-μm wavelength band of about 10 THz, where the attenuation of the optical signal and distortion of data are quite low (see Fig. 1). Although research and development for efficient use of the optical signal in this wavelength band has been in progress, these measures alone are not sufficient for bringing the ultra-high-speed and the large-capacity optical communication in the future into reality, due to lack of frequency resources.

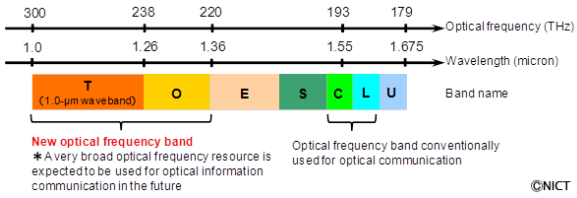


Fig. 1: The relationship between band name and optical frequency (wavelength)

For this reason, NICT has engaged in photonics-based research in order to develop efficient optical frequency resources in the broad T and O bands which cover the 1.0–1.3 μm wavelength region.

By employing InAs/InGaAs quantum dots as an optical amplifying material acting in the 1.0–1.3 μm wavelength band, NICT has developed a quantum dot light source which is stable and has a high optical frequency.

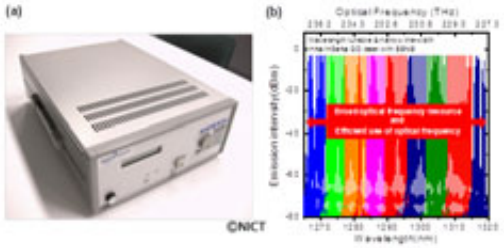


Fig. 2 : The newly developed quantum dot light source

(a) An optical source using high-quality InAs/InGaAs quantum dots as light-amplifying material

(b) An example of the wavelength tunability of the quantum dot light source

NICT says the world's longest wavelength for optical communication (1.3 μm), has been achieved in the form of low-cost quantum dots with a large surface area on a GaAs base. By obtaining a stable high optical frequency, the scientists say they can effectively wave-tune in the T and O bands.

In order to develop the quantum dot material, which is the key to the light source, NICT has used a self-developed "subnanometer interlayer separation technique" (see Fig. 3) which controls the crystal structure on an atomic scale.

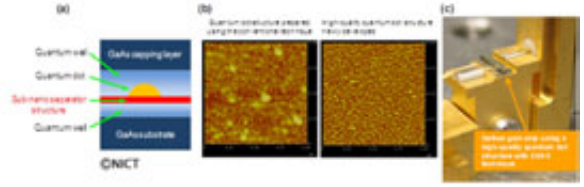


Fig. 3 : The subnanometer interlayer separation technique

(a) A sectional diagram of the subnanometer interlayer separation technique

(b) Left: A quantum dot structure developed

using the conventional technique

Right: A high-quality newly developed quantum dot structure

(c) Newly developed quantum dot wavelength-tunable optical gain device

The interlayer separation technique originally developed by NICT has a structure where a crystal of atomic size (with a subnanometer length) is sandwiched between a quantum dot and a quantum well as shown in Fig. 3(a).

In this technique, the structure of the quantum dots does not involve large aggregates leading to deterioration of the crystal properties or light amplification characteristics, in contrast to the conventional technique (Fig. 3(b), left). NICT says it has succeeded in creating a semiconductor (Fig.3(b), right) of the world's highest quality and density, which is more than twice higher than that achieved by conventional methods.

What's more, NICT says it has succeeded in building a high-speed data transmission system (see Fig. 4) with error-free data transmission that combines this light source and the photonic crystal fibre with ultra-broadband optical propagation characteristics.

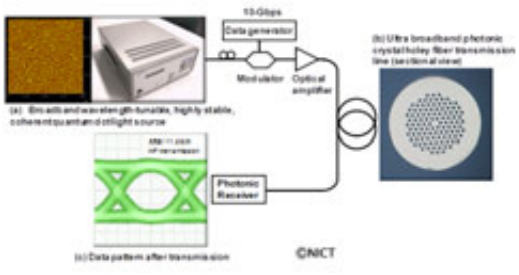


Fig. 4 : A high-speed optical propagation subsystem

The optical transmission subsystem was built using the combination of the two components in Figs. 4(a) and (b). By applying nanotechnology, the possibility of using a new optical frequency band in an optical information transmission network has been demonstrated (Fig. 4(c)).

NICT reckons its basic quantum dot and photonic crystal fibre technology could revolutionise optical communication technology. What's more, as the 1.0–1.3 μm band exhibits excellent permeation through human skin and moisture, applications in bioimaging or medical sensing are expected.

A prototype of the "quantum dot light source", developed by NICT, has been designed by Koshin Kogaku Co. Ltd. and Sevensix, Inc. The technology transfer and development for commercialisation of the product is currently under way.

More details of this research are described in the paper " Narrow-line-width 1.31-μm wavelength tunable quantum dot laser using sandwiched sub-nano separator growth technique," by Yamamoto et al, "Optics Express, Vol. 19, Issue 26, pp. B636-B644 (2011), http://dx.doi.org/10.1364/OE.19.00B636

Drew Perkins to step down as CTO at Infinera

The co-founder of the indium phosphide based telecoms company will continue to support Infinera as a technical advisor

Drew Perkins will step down as Infinera's chief technology officer to pursue other opportunities. Perkins is one of Infinera's co-founders and has been at the company since 2001.

"I want to acknowledge and thank Drew for the contributions he has made to the company," said Tom Fallon, Infinera CEO. "Drew played a significant role in starting and shaping the company over the last decade and I wish him the best in his future endeavours."

Perkins will commence his position as an advisor in January 2012. The office of the CTO will be assumed by Dave Welch, Executive Vice President and Chief Strategy Officer. A co-founder and current member of the Board of Directors, Welch was co-CTO for the four years after the company was founded.

"Helping to build Infinera, our world-class team, our revolutionary technologies and products, and much of the optical network underlying the Internet over the past eleven years has been one of the greatest experiences of my life," said Perkins. "Infinera is well positioned for the next stage of their growth with continued investment in the DTN and the upcoming release of the DTN-X platform."

Infinera specialises in Digital Optical Networking systems that are designed to continually improve the economics of optical networking by combining the speed of optics with the simplicity of digital. Infinera is unique in its use of breakthrough semiconductor technology: Large Scale Photonic Integrated Circuit (PIC).

Infinera's systems leverage PIC technology to provide customers with a service-ready architecture that enables faster time-to-revenue and greater profitability through network efficiency and the ability to rapidly deliver differentiated services without reengineering their optical infrastructure.

Avantes opens new office in United Kingdom

Avantes, an innovator in the field of fibre optic spectroscopy, announces the start of Avantes (UK)Ltd

This new United Kingdom subsidiary is based in Leatherhead, Surrey. Operations commence in January 2012 and will be headed by Keith James, Managing Director.

The Avantes Group has recently moved to their new World Headquarters in Apeldoorn, the Netherlands. The group is a key manufacturer of Photonics and Optical instrumentation, providing 'Solutions in spectroscopy'. Avantes has established subsidiaries in the USA and China and is supported worldwide by a network of qualified distributors.

Avantes develops and manufactures products in the field of spectroscopy, such as spectrometers, light sources, software, fibre optic cables and probes, accessories and fibre optic sensor systems. With over 15 years of experience in solutions is spectroscopy, Avantes continues to produce innovative applications in diverse fields including industrial, chemical, petrochemical, gemology, biomedical, semiconductor, and food processing technology.

Unison to advance steep ultra-shallow junction technology

The Dainippon Screen and Sematech partnership combines individual strengths to develop sub 14 nm semiconductor manufacturing using high mobility materials

Dainippon Screen Manufacturing has entered into a partnership to accelerate development and commercialisation of advanced semiconductor doping technology with Sematech, a global consortium of the world's leading chip manufacturers.

Screen and Sematech will collaborate on techniques for monolayer doping and activation methods that are compatible with ultra-shallow junctions for planar and non-planar device technologies (e.g., FinFETs, nanowires, memories) in silicon and non-silicon high mobility materials.

To achieve faster transistor speeds and

lower power dissipation, device fabrication will require innovative solutions to minimise leakage resulting from process damage and electrostatic control. Ultra-shallow, abrupt, damage-free junctions with high active dopant concentrations are essential for better off-state leakage control in modern highly scaled nano-electronics.

With the advent of non-planar device architectures and high mobility compound semiconductors, doping conformality and minimal lattice damage are increasingly important, and cooperative research efforts are needed to meet ITRS roadmap requirements. A promising defect-free and conformal doping alternative, monolayer doping, will be investigated, and developed for commercial use.

“This partnership with Screen is a key component of our overall strategy to develop critical infrastructure needed for major industry transitions. Innovative process technologies like monolayer doping are essential to enable transitions to non-planar and to non-silicon high mobility channels, while minimising processing induced damage, cost and complexity,” said Dan Armbrust, president and CEO of Sematech. “We are excited to combine our materials and process technology strengths with Screen’s leading tool engineering strengths to bring innovative solutions for next generation device manufacturers.”

“We are very pleased to collaborate with Sematech and its leading-edge industry partners on advanced doping techniques for next generation devices,” said Tadahiro Suhara, President of the Semiconductor Equipment Company at Screen. “We believe that this alliance could be a key driver for improving annealing processes and address associated defect issues for manufacturers to continue scaling of CMOS devices.”

Ken Koffman elected to QuEST forum executive board

JDSU says the election expands its leadership in establishing and implementing telecom industry quality standards

Ken Koffman, vice president of global business quality for JDSU’s Communications Test and Measurement business segment, has been named to the Executive Board of QuEST Forum.

QuEST Forum is a global association of communications equipment manufacturers and service providers dedicated to industry-wide network performance excellence. JDSU is the first communications test company elected to its board.

As a member of QuEST Forum’s Executive Board, Koffman helps drive the continuous development and implementation of the TL 9000 quality management system, a set of global standards designed to safeguard the quality of communications services and products worldwide. JDSU is using TL 9000 as the basis for its Communications Test business quality system.

“Our collaboration with customers and partners is the cornerstone of our success,” said David Heard, president of JDSU’s Communications Test and Measurement business segment. “Ken’s election to QuEST Forum’s Executive Board provides even more opportunity to work with the world’s leading network operators and equipment manufacturers to improve quality across our industry. Our customers face unprecedented bandwidth demand, and we are committed to innovating new technologies that support their drive to achieve the highest levels of quality and reliability.”

TL 9000 requires registrants to submit performance measurement results into a

data repository for each of their products and services. Outputs from this repository provide benchmarking information for over 130 unique product categories. Companies utilise these industry metrics to calibrate their competitiveness and drive improvement within their organisation.

Koffman joined JDSU's Communications Test senior management team earlier this year. He oversees the creation and optimisation of all business processes and the measurement systems that drive continuous improvement and customer satisfaction.

"Given Ken's expertise with TL 9000, he is ideally suited to help us meet our goals of advancing the reliability and performance of telecommunications products and services around the world," said Don Pickens, chief operating officer, QuEST Forum.

New executive vice president for Samsung Electronics

David Eun is to enhance Samsung's global media and content efforts

Samsung Electronics, an innovator in consumer electronics and telecommunications, has appointed David Eun as Executive Vice President.

Eun joins Samsung after an accomplished career in media and content. He was most recently President of AOL Media and Studios, where he oversaw AOL›s efforts to become a leading provider of premium content, spanning over 100 different websites and production studios in New York and Los Angeles.

Before that, he formed a global Content Partnerships group at Google with oversight for media strategy, partnerships and strategic alliances spanning over 30 different Google products including Google Books, Maps and YouTube. He also has a deep knowledge of traditional media businesses from working at Time Warner and NBC.

He will play a key role in developing a global media strategy and driving new business opportunities to take advantage of Samsung's growing number of digital televisions and displays, mobile phones, tablets and other connected devices.

"Samsung Electronics has an unparalleled footprint across multiple devices and platforms that provides a unique experience to consumers around the world. The competition for prominence in the living room has already begun, and Samsung Electronics is ideally situated to extend beyond that to connect the entire home and the lives of consumers," stated Eun. "I'm looking forward to joining the impressive leadership already in place and to building a new presence in media for Samsung Electronics."

Eun received a J.D. from Harvard Law School, where he was a Teaching Fellow for the Harvard Negotiation Project, and an A.B., magna cum laude in Government, from Harvard College. He was selected "Digital Power Player of the Year" by the Hollywood Reporter in 2010, is an Advisory Board Member for the Harvard School of Engineering and Applied Sciences, and sits on the Board of the Television Academy of the Arts and Sciences Foundation.

Avago added to NASDAQ-100 index

The provider of a broad range of analogue semiconductor solutions with a focus on III-V compound semiconductor based products has been upgraded

The addition of Avago Technologies Limited to the NASDAQ-100 Index by the Nasdaq Stock Market, will become effective with the market open on Monday, December 19, 2011.

The NASDAQ-100 Index is composed of the 100 largest non-financial stocks listed on the Nasdaq Stock Market based on market capitalisation.

“We are honoured to be added to the NASDAQ-100 alongside some of the world’s leading technology companies,” said Doug Bettinger, Avago’s SVP Finance and CFO. “Avago’s inclusion is another milestone in our evolution as a public company.”

The NASDAQ-100 Index reflects companies across major industry groups including computer hardware and software, telecommunications, retail/wholesale trade and biotechnology.

The company focuses on wireless communications, wired infrastructure, industrial and automotive electronics, and consumer and computing peripherals.

GSA awards Avago for outstanding financial management

The award was based on financial metrics, such as growth rates, margins, cash flow, profitability ratios, efficiency ratios and return on capital

Avago Technologies, a supplier of analogue interface components for communications, industrial and consumer applications, has been named the “Best Financially Managed Semiconductor Company” for 2011 by the Global Semiconductor Alliance (GSA).

Avago was presented with the award on December 8 at the GSA Awards Dinner Celebration, which recognises semiconductor companies that have demonstrated excellence through their success, vision, strategy and future opportunities in the industry.

Determining the top company, the GSA and selected financial analysts reviewed the overall performance and financial health of the industry›s semiconductor companies. Avago was named the best financially managed semiconductor company among its peers based on a number of financial metrics, such as growth rates, margins, cash flow, profitability ratios, efficiency ratios and return on capital.

“Being recognised by the GSA as the industry›s best financially managed company is outstanding validation of our business model and our execution,» said Doug Bettinger, Avago›s SVP of Finance and CFO. “This award serves as a tribute to Avago’s exceptional technologies and to the tremendous work ethic of our employees.”

The GSA mission is to accelerate the growth and increase the return on invested capital of the global semiconductor industry by fostering a more effective fabless ecosystem through collaboration, integration and innovation. It addresses the challenges within the supply chain including IP, EDA/design, wafer manufacturing, test and packaging to enable industry-wide solutions.

Dow develops tin CVD precursor for new electronic devices

The viability of Dow’s material has been confirmed in a new CVD process developed by the Belgium-based nanoelectronics research centre imec

Dow Electronic Materials, a business unit of Dow Advanced Materials, has introduced what it says is a stannic chloride precursor which is the first industrially viable, electronic-grade tin precursor for the generation of germanium tin (GeSn) films for electronics.

Until now, production of GeSn by chemical

vapour deposition (CVD) has been limited to R&D-scale use because only specialised and cost-prohibitive precursors have been available. Tin-containing materials are currently in demand as the electronics industry looks for ways to increase the speed of transistors.

In response, Dow Electronic Materials has introduced an electronic grade of a tin CVD precursor, stannic chloride, which has been successfully used by imec for the growth of germanium tin for use in stressors, high-mobility channels and other features of future semiconductor devices.

"We are very pleased that we found a tin precursor that enables the industrial production of GeSn for future generation electronic devices" says Egbert Woelk, Technology and Applications Manager at Dow Electronic Materials. "Together with our VAPORSTATION Central Delivery System, we have a turn-key solution to deliver our new tin precursor to any CVD tool on the market. This removes all barriers to using the new GeSn CVD process on a large scale in the latest generation CVD tools."

In the past GeSn CVD was limited to using deuterated stannane, SnD_4, which is costly to make and not available on a commercial basis. Silicon germanium (SiGe) is a desirable material for electronics and optoelectronics manufacturers, and the addition of tin increases the speed of transistors made from this material.

There is a growing interest in thin germanium or germanium-silicon materials containing tin to enhance semiconductor structures, such as the high-mobility channel that conducts current in transistors, and photonic devices, such as LEDs.

The viability of Dow's material has been confirmed in a new CVD process developed by the Belgium-based nanoelectronics research centre imec. Using stannic chloride supplied by Dow Electronic Materials, imec has demonstrated the material's viability in an industrial CVD process, overcoming the barrier of tin's propensity to etch deposited material. Imec has produced high-content germanium tin epitaxial films (>8% tin content) with outstanding electronic and structural quality. This work has been described in the paper "Undoped and in-situ B doped GeSn epitaxial growth on Ge by atmospheric pressure-chemical vapor deposition", by B. Vincent *et al,* Appl. Phys. Lett. 99, 152103 (2011).

According to imec, the CVD grown GeSn layer can also be used as a high-mobility channel material on germanium. A strained GeSn channel on germanium is also a possible candidate to be used in the device channel of future Ge-based metal-oxide semiconductor field-effect transistor (MOSFET) devices.

"The CVD growth of GeSn with commercially-available precursors will boost the research on high-mobility MOSFETs," says Roger Loo, R&D Manager at imec. "Besides, it opens new routes for group-IV semiconductors research in other fields, such as photonics (having indirect-to-direct-bandgap transition expected for about 10% Sn incorporated in monocrystalline GeSn alloys) and photovoltaics (ternary SiGeSn alloys). The good results that we achieved with stannic chloride precursor convince us to continue our successful collaboration with Dow Electronic Materials," adds Loo.

Imec recently presented the results of their development work at The 2nd GeSn Workshop: GeSn Developments for Future Applications, which was held in conjunction with the 7th International Conference on Si Epitaxy and Heterostructures 2011 in Leuven, Belgium.

Intel and IQE present papers at IEDM

The three joint papers demonstrating the benefits of III-V compound semiconductors were presented at the conference in Washington DC on 7 December 2011.

Intel Corporation and IQE plc presented a series of joint papers on recent key developments in compound semiconductor device technologies at the International Electron Devices Meeting (IEDM) in Washington, DC.

The first paper was entitled «*Electrostatics Improvement in 3-D Tri-gate Over Ultra-Thin Body Planar InGaAs Quantum Well Field Effect Transistors with High-K Gate Dielectric and Scaled Gate-to-Drain/Gate-to-Source Separation*". Presented by M. Radosavljevic from Intel, the research demonstrated, what is claimed, for the first time 3-D Tri-gate InGaAs devices with significantly improved electrostatic parameters compared with equivalent ultra-thin planar devices. The research presented shows that the 3-D Tri-gate architecture is an effective way to improve the scalability of III-V FETs for future low power logic applications.

The second paper, "*Fabrication, Characterization, and Physics of III-V Heterojunction Tunnelling Field Effect Transistors (H-TFET) for Steep Sub-Threshold Swing*" presented by Gilbert Dewey from Intel, demonstrated one of the steepest subthreshold swing (SS < 60 mV/decade) ever reported in a III-V Tunnelling Field Effect Transistor (TFET) by using thin gate oxide, heterojunction engineering and high source doping. The overall TFET device performance is improved compared with homojunction TFETs due to the decreased source-to-channel tunnel barrier height.

The third paper; "*MOVPE III-V Material Growth on Silicon Substrates and its Comparison to MBE for Future High Performance and Low Power Logic Applications*" presented by Niloy Mukherjee from Intel, demonstrated that the material quality of MOVPE III-V QWFET structures on silicon can be matched to that of the best MBE III-V QWFET structures on silicon, using 75mm diameter silicon substrates. The research presented suggests that MOVPE can be a promising technique for III-V material growth on silicon substrates for future logic device applications.

Established in 1955, the IEDM is the world's premier forum for reporting breakthroughs in technology, design, manufacturing, physics and the modelling of semiconductors and other electronic devices. Proceedings of the conference are published by the IEEE.

Dr. Philippe Roussel to present at CS Europe Conference 2012

Defining the next steps for the Compound Semiconductor Industry,Dr. Philippe Roussel of Yole Développement will present the talk "Wide Bandgap device market update".

Following the success of CS Europe 2011, next year's conference is expanding to 2 days and offers a fantastic mix/quality of speakers making it the must attend industry event for 2012.

Register at www.cseurope.net & book your delegate place now as numbers will be limited. The conference takes place on 12th/13th March 2012 at Hilton Hotel, Frankfurt, Germany.

A networking dinner will also be held on the night of 12th March.

Conference Chair

Dr Andrew W Nelson, President & CEO, IQE

Conference Schedule:

Markets and III-V CMOS - Morning 12th March

A mix of insightful market research presentations & cutting-edge research destined to shape tomorrow's compound semiconductor industry with talks including:

Compound Semiconductor Markets: Current Status and Future Prospects - Asif Anwar, Director – Strategic Technologies Practice, Strategy Analytics

The Market for LEDs in Lighting- Mr. Philip Smallwood, Lighting Market Analyst, IMS Research

Wide Bandgap device marketupdate - Dr. Philippe ROUSSEL, Senior Project Manager, Yole Développement

European efforts to develop III-Vs on 200 and 300 mm silicon- Dr. Matty Caymax, Chief Scientist, Imec

An Overview of the DARPA Diverse Accessible Heterogeneous Integration (DAHI) Program- Sanjay Raman, Program Manager, Defense Advanced Research Projects Agency/Microsystems Technology Office

The Integration of silicon CMOS with III-Vs- Professor Iain Thayne, University of Glasgow

III-Vs on 200 mm Si for VLSI– Dr Richard Hill, Project Manager, Sematech

III-V 3D Transistors- Peide Ye, Professor of Electrical and Computer Engineering, Purdue University

LEDs, lasers, PV and electronics - Afternoon of 12th March & full day of 13th March

KEYNOTE SPEAKER*: III-V on Silicon: Challenges and Opportunities*- Robert S. Chau, Intel Senior Fellow, Intel

SiC and GaN Electronics- Dr. John Palmour, Cree co-founder and chief technology officer Power & RF, Cree

Ammono's ammonothermal method to make GaN substrates– Dr. Robert Dwiliński, President, CEO, Ammonno S.A.

Tomorrow's RF chips for mobile devices- Todd Gillenwater, VP of Technology and Advanced Development, RFMD

Building a Successful III-V Pure Play Foundry- Dr. John Atherton, Associate Vice President, WIN Semiconductors

Scalable "on-silicon" solutions (GaN-on-Si and Ge-on-Si) using rare oxide buffer layers– Dr. Michael Lebby, General Manager & Chief Technology Officer, Translucent Inc.

III-Nitride Lasers Based on Nonpolar/ Semipolar Substrates- Dr James W. Raring, VP Laser Engineering, Soraa Inc.

Markets and Applications for SiC Transistors - Dieter Liesabeths, Vice President Sales & Marketing, SemiSouth Laboratories, Inc.

Perspective of an LED Manufacturer- Professor Iain Black, VP WW Manufacturing Engineering, Technology & Innovation, Philips Lumileds Lighting Company

The CPV Market following the acquisition of Quantasol technology - Jan-Gustav Werthen, JDSU, Senior Director

Commercialisation of GaN on SI based Power Devices at International Rectifier- Dr. Michael A. Briere, International Rectifier

GaN the enabler for true SDR- Professor Rik Jos, RF Technology Fellow & Innovation Manager, NXP Semiconductors

Holistic Approach to MOCVD vacuum & Abatement- Dr Mike Czerniak, Product

Marketing Manager, EdwardsVacuum Ltd

Advances in Wide Bandgap Semiconductors for Power Electronics- Dr. Markus Behet, Global market manager, Power Electronics, Dow Corning

Large diameter GaN-on-Si epiwafers for power electronics- Dr Mariane Germain, Co-Founder & CEO, EpiGaN

Achieveing Gan & GaAs RF Design Success through Product & Foundry Innovation– Mr Bryan Bothwell, Strategy and Business Development Manager – Foundry Services, TriQuint Semiconductor

Damage - free Deposition on LED devices- Dr Silvia Schwyn Thöny, Senior Process Engineer, Evatec Ltd

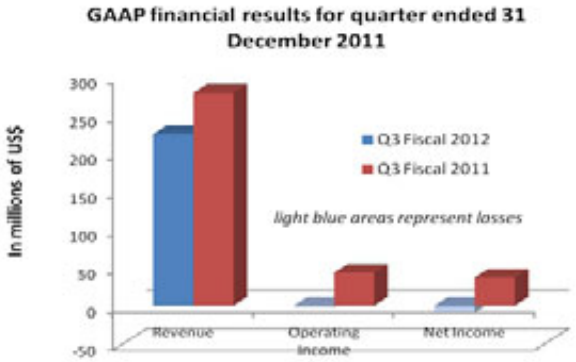
Temporary Bonding: An enabling technology for RF and power compound semiconductor devices - Dr Thomas Uhrmann, Business Development Manager, EV Group (EVG)

RF Electronics

RFMD not on track with 19.5% loss in revenues

Sales to Nokia in FY Q3 2012 declined and are likely to continue to drop in the next quarter. Business with Samsung is however expected to grow fiscal year with fiscal year

RF Micro Devices has reported financial results for its fiscal 2012 third quarter ended December 31, 2011.



The firm's third quarter revenue was $225.4 million, a decrease of approximately 8% sequentially versus $243.8 million in the September 2011 quarter and a 19.5% decline over the same quarter the previous year. On a GAAP basis, gross margin was 28.2%, quarterly operating loss totalled $2.2 million, and quarterly net loss was $9.4 million, or $0.0) per diluted share.

During the December quarter, RFMD generated approximately $46.2 million in cash flow from operations and $37.5 million in free cash flow. The company repurchased approximately 2.3 million shares of common stock during the quarter and purchased and retired $6.0 million principal amount of convertible debt.

Quarterly shipments of switch and signal conditioning products exceeded $25 million. However, in a conference call held discussing the results, Dean Priddy, CFO and vice president of administration of RFMD remained tight lipped and said, "I believe for competitive reasons, we're going to discontinue breaking out the preciseness of where the growth is coming from".

Bob Bruggeworth, president and chief executive officer of RFMDdid however comment, "Over time, we clearly expect 3G to become a significantly larger portion of our portfolio in China. As I said in my opening comments, we grew about 50%. It's just we had expected to grow a lot more."

Financial Outlook and Business Commentay

For the March quarter, RFMD anticipates share gains in smartphones and projects 3G/4G products will represent approximately two-thirds of total cellular revenue. The Company currently forecasts a greater-than-seasonal decline in sales to cellular handset manufacturers in China, primarily as a result of the impact of lunar new year on order visibility and the projected impact of channel inventory.

For the March 2012 quarter, RFMD expects March quarter revenue of approximately $185 million and gross margin to improve 200-300 basis points. The firm also anticipates that it will reduce inventory levels and generate positive free cash flow.

Bob Bruggeworth commented, “Although RFMD’s December quarter clearly did not live up to our expectations, RFMD’s growth drivers are very much intact, led by industry-leading new products and the release of exciting new product categories, like RFMD’s antenna control solutions. In the March 2012 quarter, we anticipate sales of 3G/4G components will continue to increase as a percentage of CPG revenue, and we expect MPG will outperform its underlying markets. We have begun to see signs of stabilisation in customer order activity, and we believe RFMD will return to growth in the June 2012 quarter.”

Dean Pridd added, “During the December quarter, RFMD’s market share gains in smartphones were offset by less than forecasted demand from manufacturers of handsets in China. Despite this, RFMD was able to generate cash flow from operations of approximately $46 million and free cash flow of approximately $38 million. In the March 2012 quarter, we currently expect sequential improvement in gross margin, and we anticipate RFMD’s gross margin will return to historical levels as revenue growth resumes.”

A webcast of the conference call discussing the results can be accessed by any interested party athttp://www.rfmd.com (under “Investors”).

A telephone playback of the conference may be accessed by dialling 303-590-3030 and entering pass code 4500529.

China rates TriQuint for its RF power

The firm has received several industry awards and recognition from key customers in China during 2011

Todd DeBonis, vice president of global sales and strategic development at TriQuint said, “The honours we have received in China are the direct result of our strong relationships with partners and customers,” said. “We begin 2012 by reaffirming our commitment to our customers and delivering market-leading innovation for connected devices and the networks that power them.”

Besides its 3G/4G solutions, TriQuint has been recognised for delivering innovative power amplifiers for 2G, WiFi and base stations.

TriQuint Power Amplifiers Selected for ZTE Smartphone Models

ZTE chose TriQuint’s TQM7M5012H and TQM7M5022 power amplifier modules (PAMs) for the 3G ZTE Blade and the new ZTE Skate, two standout offerings in ZTE’s global line of smartphones. TriQuint’s highly integrated PAMs offer superior RF performance, compact packaging and longer battery life.

TriQuint Named a Top 10 Most Popular Semiconductor Brand

For the second consecutive year, TriQuint was designated a top 10 “Most Popular Semiconductor Brand in China” in recognition of its sales revenue, localisation efforts, product performance and service. The China Electronic News (CEN) award nominees are compiled by the editors of the magazine and voted on by readers.

Yulong Telecommunication Honoured TriQuint with "Excellent Supplier Award"

Yulong Telecommunication recognised TriQuint's performance in the areas of service, strategic support and technology development by giving the company an "Excellent Supplier Award." Yulong Telecommunication provides integrated solutions for smartphone sets, mobile data platform systems and value-added business operations in China. The company's flagship product is the Coolpad handset.

TriQuint Dual Band Wi-Fi Power Amplifier Earned AET "Best Product" Award

Application of Electronic Techniques (AET) in China selected TriQuint's TQP6M9002 dual-band WiFi power amplifier as the 2011 Best Product in the networks and telecommunications category. Industry teardown reports found TriQuint's WiFi power amplifiers in smartphones and tablets such as the Amazon Kindle Fire* and the RIM BlackBerry Playbook*.

TriQuint QUANTUM TX Won EDN China Innovation Award

EDN China named TriQuint's QUANTUM Tx "Best Product" in the communications and networks front-end category of the 2011 EDN China Innovation Awards. The 2G broadband transmit module TQM6M4068 stood-out for its full GaAs HBT performance and size benefits offered at similar prices as lower-performing CMOS solutions.

TriQuint Awarded "Best Power Amplifier" by EEPW Magazine

TriQuint's TQP7M9101, a high linearity amplifier, won the Editor's Choice "Best Power Amplifier" Award from Electronic Engineering & Product World (EEPW) magazine in China. The product is ideal for wireless infrastructure where high linearity, medium power and high efficiency are required, such as transceiver line cards in current and next generation multi-carrier 3G / 4G base stations. The annual EEPW Editor's Choice Award recognises electronics design products with cutting-edge performance and innovative technology.

Skyworks soars above expectations

The firm has reported its first fiscal quarter 2012 results with revenues up by 17 percent Year-Over-Year to $ 393.7 million

The revenue for the latest quarter exceeded the Company's guidance of $390.0 million.

"Specifically, we expect revenue of $360 million, including a partial quarter contribution from AATI, with $0.40 of non-GAAP diluted earnings per share. While we are forecasting AATI to be neutral to second fiscal quarter earnings, we expect the acquisition to be accretive for fiscal year 2012."

On a GAAP basis, operating income for the first fiscal quarter of 2012 was $75.0 million and diluted earnings per share was $0.30, including AATI acquisition-related charges.

"Skyworks' solid performance against the current economic backdrop is being driven by our expanding positions in adjacent analogue semiconductor markets, global demand for mobile internet applications and strong operational execution," said David J. Aldrich, president and chief executive officer of Skyworks. "More specifically, we are capitalizing on new opportunities in medical, automotive, smart energy and home automation markets while capturing additional content and share within LTE smart phones, e-readers, tablets and LED TVs. As a result, Skyworks' ongoing diversification and scale are positioning us to deliver above market growth and, ultimately, create greater competitive advantages."

Second Fiscal Quarter 2012 Outlook

"Based on our diverse customer and market base as well as share gains, we are planning to outperform our addressable markets in the seasonally low March quarter," said Donald W. Palette, vice president and chief financial officer of Skyworks. "Specifically, we expect revenue of $360 million, including a partial quarter contribution from AATI, with $0.40 of non-GAAP diluted earnings per share. While we are forecasting AATI to be neutral to second fiscal quarter earnings, we expect the acquisition to be accretive for fiscal year 2012."

Skyworks hosted a conference call with analysts to discuss its first fiscal quarter 2012 results and business outlook.

A replay of the conference call will be available on Skyworks' Web site or by calling

888-203-1112 (from the U.S.) or 719-457-0820 (from outside the U.S.) using pass code: 4056697

A new way to check out Mitsubishi's GaAs and GaN RF devices

Agilent's newest ADS model library includes Mitsubishi's high-power gallium nitride HEMT and low-noise HEMT devices commonly used in base station and direct-broadcast satellite receivers

Agilent Technologies' latest model library for Mitsubishi Electric's nonlinear gallium arsenide and gallium nitride RF devices is now available for use with Agilent's Advanced Design System (ADS).

The upgraded library works seamlessly with ADS 2009 Update 1, as well as prior ADS releases. ADS2011 and future versions will also be supported. The model can be obtained by contacting Mitsubishi Electric.

The library helps designers better explore design alternatives in order to meet demanding performance specifications with a cost-effective solution.

The library includes an ADS symbol for schematic capture, a simulation model that includes parasitic effects. It also covers a broad variety of body sizes and part values that enable sweeps and optimisations.

"Collaborating with a recognised world leader in design software allows Mitsubishi Electric to support and leverage its high-power and low-noise HEMT device offering," said Takao Ishida, manager of the wireless communication device application engineering section at Mitsubishi Electric's High Frequency and Optical Device Works.

"We are very pleased to offer our design kit to help support ADS users and allow them to bring superior products to the marketplace ahead of the competition."

"The combination of ADS and the Mitsubishi Electric library gives our mutual customers a powerful, integrated design solution for a fast and efficient RF design flow," said Juergen Hartung, foundry program manager of Agilent's EEsof EDA organisation. "Our customers are now able to enjoy the industry's most comprehensive multi-technology design platform with the breadth of simulation capability in ADS, including yield optimisation, DFM tools and the Momentum 3-D planar EM simulator."

Customers can also generate X-parameter models of their circuit-level designs directly from ADS. X-parameters provide fast and accurate behavioural modelling. These capabilities are vital to designing high-performance RF modules and RF system-in-package components.

ZTE recognises Anadigics for high-performance 3G and 4G PAs

The global provider of telecommunications equipment and network solutions awards Anadigics for outperforming over 1,000 suppliers

Anadigics, a provider of RF products, has received the "2011 Best Comprehensive Performance" Award from ZTE Corporation.

Anadigics received this award at ZTE's 2012 Supplier Day in Shenzhen, China, for its commitment to technological leadership, quality excellence, and superior service.

"Anadigics is extremely proud to be recognised by ZTE, a global leader of wireless devices," said Michael Canonico, senior vice president of worldwide sales at Anadigics. "Through a combination of industry-leading products, outstanding applications support, and impeccable quality, we were able to surpass the performance of more than 1,000 suppliers to receive the award. Anadigics views this event as another milestone in our successful relationship and we look forward to continue working closely with the talented team at ZTE."

Microsemi's SiGe 5th generation RF platform

The new silicon germanium platform supports 4G product developments

Microsemi's new platform integrates multiple filters, switches, LNAs and power amplifiers onto a single monolithic SiGe die, and supports multiple input/multiple output (MIMO) functionality.

The high level of integration allows substantial reductions in cost and printed circuit board footprint, which are key considerations when designing devices such as smartphones and tablets.

"Microsemi has developed what we believe to be the world's first silicon germanium-based, single-chip RF front-end module platform capable of meeting the stringent requirements of 4G applications while still offering space and cost-savings," said Darcy Poulin, director of product engineering for Microsemi. "Moving forward, we will continue to innovate solutions that facilitate the growth of new industry standards such as IEEE 802.11ac."

According to ABI Research, IEEE 802.11ac shipments will increase significantly in 2013 with IEEE 802.11ac emerging as the dominant Wi-Fi protocol by 2014. Industry research firm In-Stat estimates that nearly 350 million routers, client devices and attached modems with 802.11ac will ship annually by 2015, up from about 1 million units in 2012.

"The performance achieved with this platform is truly impressive and quite an accomplishment in the industry," said Paul Pickle, senior vice president of Microsemi. "The first-of-its-kind digital tuning capability we have designed will reduce future development times and customisation efforts as we engage our baseband partners. In addition, the performance achieved will enable Microsemi to drive innovation into the latest wireless LAN standard, IEEE 802.11ac, as well as the next-generation 4G mobile standard."

Microsemi's RF front-end-module includes two fully functional 2.5GHz IEEE 802.16 power amplifiers, two transmit/receive switches, two LNAs, two baluns, harmonic and noise shaping filters, and a digital interface for control and tuning. Its performance meets the strict 802.16 mask and EVM requirements at an output power of 24dBm in a 5x5.6mm package.

Microsemi's next-generation wireless LAN dual-band FEM will be able to integrate highly linear 802.11ac compliant 2.4GHz and 5GHz PAs, 2.4

and 5GHz bypassable LNAs, switches, filters, a diplexer and an I2C digital interface into a tiny 3x4mm QFN package.

Microsemi is an established manufacturer in the wireless communications market. The firm has shipped more than 200 million RF integrated circuits to customer globally, predominantly for the wireless LAN market.

RFMD veteran joins Delta Apparel Board of Directors

Suzanne B. Rudy has unanimously been voted onto the company's board

Rudy brings more than 20 years of proven financial, corporate governance and investor relations expertise to the Delta Apparel Board of Directors.

Delta Apparel, along with its operating subsidiaries, is an international design, marketing, manufacturing, and sourcing company that features a diverse portfolio of lifestyle branded activewear apparel and headwear, and high quality private label programs.

Rudy is Vice President, Corporate Treasurer, Compliance Officer and Assistant Secretary of RF Micro Devices, a leading supplier of semiconductor products for the wireless communications market. In addition to her Treasury and Compliance duties, Suzanne Rudy is a director for all twelve subsidiaries of RFMD and is a member of the Investor Relations Team presenting to analysts worldwide.

Prior to joining RFMD in 1999, she was the Controller for Precision Fabrics Group, a textile spin-off of the Fortune 500 Company Burlington Industries. Additionally, she spent six years as a CPA and Manager for BDO Seidman, LLP, an international CPA firm. From 2007 through 2010, Rudy served as a director and chaired the Audit Committee of First National Bank United Corporation and currently serves on the Board of Visitors for Guilford College. She is a Certified Public Accountant holding a BS from the University of California, Santa Barbara and a Master's of Accounting from the University of North Carolina.

"Suzanne brings a wealth of experience to our Company," commented Robert W. Humphreys, Chairman and CEO of Delta Apparel. "Her membership on our Board of Directors ensures our Company will continue to benefit from a diversity of experience, expertise and opinions. We are pleased to welcome Suzanne, and are confident she will make a significant contribution to our Board of Directors."

RFMD's 2.4GHz FEMs for ZigBee/HAN applications

The RFFM6201 FEM is specifically optimised for Smart Energy applications and HAN devices. The module is also suitable for industrial, wireless sensing, and control applications requiring low power, high performance and assured reliability

RF Micro Devices has released the RFFM6201, a 2.4GHz band single-chip Zigbee front-end module (FEM) featuring an integrated power amplifier, low noise amplifier, and diversity switch.

RFMD says this device delivers industry-leading current consumption (170mA at rated power) and high-power performance (+23dBm) for Home Area Networking (HAN)/Smart Energy applications. The energy efficient RFFM6201 is pin-for-pin compatible with RFMD's RF6555 and offers 5dB higher output power, enabling customers to increase power output and range without requiring changes in product layout.

Rohan Houlden, general manager of RFMD's Wireless Connectivity business unit, said, "RFMD's expanding FEM portfolio supports our customers' rapid ZigBee product launches while reducing component count, size, cost, and power consumption. RFMD's RFFM6201 ZigBee FEM is specifically optimised for Smart Energy applications, including smart meters, energy usage control, or 'demand response,' and HAN devices. Beyond Smart Energy, the RFFM6201 is also suited for industrial, wireless sensing, and control applications requiring low power, high performance and assured reliability."

ZigBee Smart Energy is one of the world's leading standard for home area networks (HAN) used by smart grid programs to boost energy management and efficiency in homes around the world.

Skyworks buys outstanding shares of Advanced Analogic Technologies

The AATI shares were bought for $5.80 per share, paid to the seller in cash, without interest and subject to any required withholdings of taxes

Skyworks' wholly-owned subsidiary, PowerCo Acquisition Corporation ("Offeror") has successfully completed the tender offer for all outstanding shares of common stock of Advanced Analogic Technologies Incorporated (AATI).

The offering period expired at 12:00 midnight, Eastern Standard Time, on Monday, January 9, 2012.

BNY Mellon Shareowner Services, the depositary for the tender offer, has indicated that since the offering period ended, a total of 42,861,222 shares of AATI's common stock had been validly tendered and not withdrawn pursuant to the tender offer during the offering period (including 5,096,232 shares delivered pursuant to the guaranteed delivery procedures).

Assuming all shares tendered pursuant to guaranteed delivery procedures are delivered, approximately 96.7% of all outstanding shares have been tendered (the percentage is 85.2% if guaranteed delivery shares are not taken into account).

To complete the acquisition of 100% of the common stock of AATI, Skyworks will effect, without prior notice to, or any action by any other AATI stockholder, a short-form merger in which Offeror will merge with and into AATI, with AATI surviving the merger and continuing as a wholly owned subsidiary of Skyworks.

To that end, Offeror has notified AATI of its intent to exercise its option under the merger

agreement to purchase sufficient newly issued AATI shares to ensure ownership of at least 90% of the outstanding AATI shares to complete the short-form merger.

In the merger, each of the remaining untendered shares of AATI common stock (other than shares as to which appraisal rights are properly demanded and perfected under Delaware law, if any) will be converted into the right to receive the same $5.80 per share, paid in cash, without interest and subject to any required withholdings of taxes, as was paid to AATI stockholders pursuant to the tender offer.

Following the merger, instructions will be mailed to those AATI stockholders who did not tender their shares in the tender offer outlining the steps to be taken to obtain the merger consideration. AATI's common stock will cease to be traded on the NASDAQ Stock Market after the merger.

Samsung selects Anadigics dual-band PA for the Galaxy Nexus

Anadigics' HELP3E PAs use the Company's exclusive indium gallium phosphide - Plus technology. They achieve optimal efficiency across low-range and mid-range output power levels and provide low quiescent currents

Anadigics is shipping production volumes of its AWC6323 dual-band High-Efficiency-at-Lower-Power (HELP3E) power amplifiers (PAs) to Samsung Electronics for the new Galaxy Nexus.

Samsung's Galaxy Nexus features a slim, curved case that contains a 4.65 inch high definition display, 5 megapixel camera, and 1.2 GHz dual-core processor. The Galaxy Nexus is available through Verizon Wireless, and is claimed to be the first smartphone to use the new Android 4.0 Ice Cream Sandwich operating system.

"The selection of Anadigics' dual-band power amplifier for the flagship Galaxy Nexus from Samsung demonstrates the strength of the relationship forged between Anadigics and Samsung," said Ron Michels, president and CEO of Anadigics.

"Samsung Electronics remains at the forefront of the mobile digital lifestyle by continually innovating and evolving the smartphone to provide an unparalleled user experience. Our goal is to support Samsung through each successive generation of mobile connectivity."

Anadigics' HELP3E PAs use the Company's exclusive InGaP-Plus technology to achieve optimal efficiency across low-range and mid-range output power levels and provide low quiescent currents. The compact 3 mm by 5 mm HELP3E dual-band PAs feature an integrated voltage regulator and an integrated RF coupler. The company says this level of integration reduces printed circuit board (PCB) space by 25% compared with current generation dual-band solutions.

Anadigics HELP3E PAs have three mode states to achieve high power-added efficiencies at low-range and mid-range output power levels. With a quiescent current of 4 mA, Anadigics says its PAs offer best-in-class linearity at maximum output power. The two independent PAs come in a single package.

RFMD revenues pounded due to weakness in entry level handset market

The firm's revenue for the December 2011 quarter was approximately $225 million, 10% less than was forecast by the company

RF Micro Devices, a designer and manufacturer of high-performance radio frequency components and compound semiconductor technologies, has provided a quarterly financial update for its third fiscal quarter, ended December 31, 2011.

In RFMD's Cellular Products Group (CPG), revenue was approximately $179 million, as sales of 2G components to China-based customers for entry-level handsets were below expectations. In RFMD's Multi-Market Products Group (MPG), revenue was approximately $46 million, reflecting broad weakness in MPG's end markets.

The Company noted customer demand softened during the December quarter, with end-of-quarter 2G demand significantly below customer forecasts. RFMD expects gross margin for the December 2011 quarter will decline approximately 9 points sequentially, due to the lower revenue, lower factory utilisation, and inventory reserves.

Sales of RFMD's components for 3G/4G smartphones increased sequentially approximately 16% during the December 2011 quarter.

Bob Bruggeworth, president and CEO of RFMD, said, "RFMD is navigating broadly lower demand in 2G handsets and softness across MPG's markets. Despite this challenging macro environment, RFMD is winning new business with industry-leading products and technologies, and we fully expect to grow in fiscal 2013, supported by market share gains, new product launches, and expanding relationships with both channel partners and customers."

In the March 2012 quarter, RFMD anticipates normal seasonality in the handset industry and in MPG's end markets. The Company will provide additional guidance in its quarterly earnings announcement and corresponding conference call on January 24, 2012.

Skyworks diversifies to go sky high in GaAs market

Strategy Analytics says TriQuint, RFMD and Avago were the other main players in the gallium arsenide device market in 2011

Propelled by rapidly increasing rates of data consumption and sophisticated handsets with more GaAs content, the GaAs device market reached $5.45 billion of revenue in 2010.

The recently published Strategy Analytics report, "GaAs Device Vendor Market Share 2010: North America," estimates that the GaAs device market grew by 35 percent since 2009.

The report addresses GaAs vendors in North America and concludes that Skyworks Solutions remains the largest GaAs device manufacturer. Skyworks increased its lead over second-place RFMD through a combination of product diversification and design wins at major handset manufacturers.

TriQuint Semiconductor is still in third place and is now less than half of a percentage point behind RFMD. Avago Technologies rounds

out the top four. These companies account for nearly 60 percent of total GaAs device revenue.

"The GaAs device market had a banner year in 2010, reaching record revenue levels," noted Eric Higham, Director of the Strategy Analytics GaAs and Compound Semiconductor Technologies Service. "The growth was driven by increasing GaAs content in handsets in response to more multi-mode and multi-band capabilities. We expect these drivers will continue, but growth is likely to be more in-line with historical averages of five to seven percent."

Asif Anwar, Director in the Strategy Analytics Strategic Technologies Practice, added, "The 35 percent growth rate in the GaAs device market was the largest the industry experienced since the "telecom bubble" of the early 2000s. This time, growth is so broadly based that Strategy Analytics does not anticipate a repeat of the collapse in GaAs revenue, as seen after the telecom bubble burst."

Raytheon shines a light on TriQuint

TriQuint has been recognised by Raytheon for exceptional performance in supporting its Space and Airborne Systems (SAS) business during 2011

TriQuint Semiconductor was honoured by Raytheon for the fourth consecutive year at the company's 2011 SAS Supplier Excellence Award (SEA) recognition event.

Winning suppliers represent less than one percent of the SAS supply base. Only 39 companies that supply Raytheon SAS received awards in 2011. Winning companies were chosen by Raytheon for meeting demanding standards in the areas of quality and delivery performance, customer satisfaction, total business and financial health. Evaluations from Raytheon buyers and material program managers who interact with TriQuint every day were also part of the selection process.

"We're extremely proud of continuing recognition from Raytheon SAS. TriQuint's Defence team is focused on service, quality and highly-reliable solutions for phased array radar chipsets and other critical programs. Our ISO/AS9100 foundry continually strives to offer the best technology in the industry in order to enable customers' leading-edge applications—systems that are vitally important to service personnel across the globe," remarked James L. Klein, TriQuint Vice President and General Manager for Defence Products and Foundry Services.

TriQuint's expertise in GaN, GaAs surface acoustic and bulk acoustic wave (SAW / BAW) technologies has made it a leading supplier of RF system components and foundry services to Raytheon and other major defence / aerospace contractors. TriQuint currently supports multiple GaN process and manufacturing development programs funded by DARPA as well as US Air Force, Army and Naval laboratories.

WiFi propels RF power markets to over $1 billion

ABI Research says gallium nitride has the promise of increased market share in 2012 and is forecast to be a significant force by 2017

Spending on RF power semiconductors for the wireless infrastructure market has experienced significant growth in 2011.

Other markets – notably the military – are seeing some moderation in growth as the global economic picture and political factors come into play. Also, GaN, long seen as the promising new "material of choice" for RF power semiconductors – is continuing its march to capture share.

"GaN has the promise of increased market share in 2012 and is forecast to be a significant force by 2017," notes Lance Wilson, research director, mobile networks. "It bridges the gap between two older technologies, exhibiting the high-frequency performance of gallium arsenide combined with the power-handling capabilities of Silicon LDMOS. It is now a mainstream technology that has achieved measurable market share and in the future will capture a significant part of the market."

The vertical market showing the strongest uptick in the RF power semiconductor adoption business, outside of wireless infrastructure, is commercial avionics and air traffic control, which Wilson describes as now being "a significant market." While the producers of these chips' devices are located in the major industrialized countries, this sub-segment market is now so global that end equipment buyers can be from anywhere.

ABI Research's new study, "RF Power Semiconductors," examines RF power semiconductor devices that have power outputs of greater than four watts and operate at frequencies of up to 3.8 GHz, which represent the bulk of applications in use today. This study is part of the firm's RF Power Devices Research Service.

With the current release, analysis of the six main vertical segments (wireless infrastructure; military; industrial, scientific, and medical (ISM); broadcast; commercial avionics and air traffic control; and non-cellular communications) which were previously subdivided into 24 sub-segments, are expanded to 29 sub-segments.

Skyworks honoured by ZTE for Global Partnership Award

The RF electronics supplier has been recognised for its performance and cooperation and is the only RF company honoured with this achievement

Skyworks Solutions has received the 2011 Global Partnership Award from ZTE for excellence in performance and worldwide cooperation. Skyworks was the only RF company honoured with this achievement.

ZTE, a global provider of telecommunications equipment and network solutions, leverages multiple Skyworks' products including EDGE and WCDMA/LTE front-end solutions for data cards and USB modems, TD-SCDMA and CDMA solutions for handsets, as well as antenna switch modules for several smart phone platforms. ZTE also utilises several custom high performance analogue solutions from Skyworks for infrastructure and WLAN applications.

"Congratulations to Skyworks on achieving this notable distinction," said the management at ZTE. "Skyworks' commitment to customer satisfaction and working closely together as a partner has helped ZTE achieve our growth goals and deliver best-in-class solutions to customers in 140 countries around the globe."

"Skyworks is extremely honoured to receive this recognition from ZTE," said Bradley C. Byk, senior vice president of worldwide sales at Skyworks. "We are committed to continuous improvement and providing our customers with unparalleled service and support."

RFMD wins 2011 best supplier award

The firm has been recognised for its transmit modules, 3G switches and wide range of power amplifiers

RF Micro Devices has been honoured with 2011 Best Supplier Award by Lenovo Mobile Internet and Digital Home Business Group (MIDH).

Lenovo MIDH is the subsidiary of Lenovo responsible for creating mobile Internet-focused

devices, including tablets and smart-phones, as well as devices for new categories like cloud computing, smart TV and the digital home.

Bob Bruggeworth, president and CEO of RFMD, said, "RFMD is greatly honoured to receive this award from Lenovo in recognition of RFMD's local product development and customer support, our record for reliable on-time delivery, and our commitment to product and technology leadership. RFMD is especially proud to support Lenovo broadly across our entire cellular product portfolio, and we look forward to expanding our relationship with Lenovo in calendar 2012 as new 2G feature phones and 3G/4G smart phones are introduced."

RFMD currently has greater than ten products in volume production in support of Lenovo MIDH, and the Company anticipates significant expansion in calendar 2012, with approximately 20 RFMD products expected in production by the March 2012 quarter.

RFMD's product portfolio for Lenovo includes 2G transmit modules, WEDGE and WGPRS power amplifiers and transmit modules, TD-SCDMA power amplifiers, TD/EDGE multimode power amplifiers, 3G switches, and 3G power amplifiers, including RFMD's family of ultra-high efficiency 3G/4G power amplifiers. In the September 2011 quarter, RFMD commenced shipments of multiple ultra-high efficiency 3G/4G power amplifiers in support of the highly popular Lenovo A60 dual-SIM 3G smart-phone.

'Best-in-Class'GaN switches made by TriQuint

The company's gallium nitride RF switches include die-level devices for 6, 12 and 18 GHz

TriQuint claims its innovative new family of 40V RF GaN switches deliver unequalled power handling, low loss and superior isolation for defence, aerospace and commercial applications.

The GaN switch family was featured in a recent Microwave Journal article and includes die-level devices for 6, 12 and 18 GHz, plus the TGS2351-SM, a convenient surface mount GaN switch for rapid 'COTS' design-in.

"TriQuint is a leader in high-performance GaN innovation," remarked TriQuint Defence Products & Foundry Services VP and GM, James L. Klein. "Our latest gallium nitride products have established a new, unequalled level of solid-state RF switch performance."

RFMD reveals high power GaAs/InGaP FEMs

Based on the firm's gallium arsenide pHEMT and indium gallium phosphide HBT technologies, the modules are designed for many applications including WiFi

The RF5605 and RFFM420x family of parts (RFFM4200, RFFM4201, RFFM4202, and RFFM4203) from RFMD are 6 x 6mm high power, front end modules (FEMs) specifically designed for IEEE 802.11b/g/n WiFi 2.4 -2.5GHz customer premises equipment (CPE) applications.

They each have an integrated three-stage linear power amplifier, Tx harmonic filtering, and SPDT switch. These modules also have a fully matched input and output for a 50Ω system and incorporate matching networks optimised for linear output power and efficiency.

With mirrored pinout options, these modules align with any chipset or configuration and can also be used in WiFi-enabled set-top boxes. They can also be applied in access points or gateways, data cards and terminals and spread-spectrum and MMDS systems.

Features

POUT = 27.5dBm < 2.5% EVM
Single 5.0V Supply
35dB Typical Gain Across Frequency Band
2.4GHz to 2.5GHz Frequency Range
1X1 MIMO architecture
Integrated 3-stage PA, filtering and T/R switch

The products are currently available in product quantities. Pricing begins at $4.67 each for 100 pieces.

Cree cooperates with RFHIC on Doherty amplifier patents

The agreement is designed to accelerate telecommunications and infrastructure innovations based on Cree's high-power gallium nitride HEMT technology

Cree has announced a nonexclusive worldwide license agreement with RFHIC Corporation, an innovator of cutting-edge RF power amplifiers. The license provides access to Cree's pioneering Doherty amplifier-related patents.

One of Cree›s GaN HEMT Doherty power amplifiers, the CGH21240F

Cree's RF innovation and novel Doherty architecture can serve as the foundation for advanced 4G base stations that are substantially more efficient than conventional designs. 4G mobile data networks are being deployed around the world to address the burgeoning demand for mobile broadband services.

"Cree is a leader in the development of GaN HEMT technology for RF and microwave applications," said Jim Milligan, Cree, director of RF. "From our early work in maximising the efficiency of silicon LDMOS amplifiers to our current initiatives using GaN-based devices, Cree has successfully developed innovative circuits that enhance the performance of the classic Doherty architecture."

With Cree's advanced circuits, amplifier efficiency can be increased by as much as five percentage points when conventional

silicon LDMOS or GaAs transistors are used. This improved performance can help meet the stringent efficiency and linearity requirements of upcoming 4G LTE base stations, and related wireless systems, that use high peak-to-average ratio signal modulation.

When these circuit innovations are implemented using Cree's high-frequency, high-power GaN HEMTs and the latest generation digital pre-distortion systems, the resulting efficiency improvements can be up to a staggering 15 percentage points greater than that achieved by a conventional Doherty amplifier implemented with silicon LDMOS.

The Doherty amplifier is a fundamental RF amplifier architecture invented by William Doherty in 1936 using vacuum tubes. Modern implementations of the Doherty amplifier use power transistors. The fundamental Doherty architecture uses two parallel, equal power split transistors, a carrier amplifier transistor for low level signals and a peaking amplifier transistor for high level signals.

The fundamental, equal power split Doherty architecture offers up to a 40 percent improvement in efficiency over traditional non-Doherty Class A/B approaches. Interest in Doherty amplifiers has grown with increased demand for higher-efficiency systems employing digital modulation formats, such as those used for 3G W-CDMA networks. Online applications including video chat and streaming video are driving a need for still higher-efficiency amplifiers to support 4G LTE systems.

"Cree innovations in Doherty amplifier technology can set the standard for the newest generation of 4G network deployments requiring high-efficiency macro and pico cell base stations. Cree's advancements on the fundamental two-transistor, parallel Doherty architecture can yield significant efficiency improvements," Milligan added.

The nonexclusive license agreement between RFHIC, headquartered in Suwon, South Korea, and Cree underscores each company's commitment to developing products that enhance the telecommunications infrastructure, while respecting the value and importance of intellectual property.

Skyworks showcases new design centre in Korea

The site will support integrated circuit and multi-chip-module designs and layouts, RF-laboratory work, and customer support through early manufacturing.

The new design centre in Korea will support the Company's increasing demand for 3G and 4G front-end solutions.

In fiscal 2011, Skyworks grew its 3G front-end module shipments by more than 150 percent year-over-year.

"Skyworks is delighted to be placing more of our highly-skilled engineering teams closer to our customers," said Gregory L. Waters, executive vice president and general manager, front-end solutions at Skyworks. "We realise that our customers' success depends upon the performance and reliability of our products, and the strength of our service. We are committed to meeting the market's need for the smallest and highest performance device architectures, as well as strengthening our local support for leading smart phone providers and handset manufacturers."

Global adoption of 3G and 4G devices, including smart phones, tablets and a seemingly unending array of new applications, continues to be robust. The proliferation of embedded wireless functionality is driving a tremendous increase in RF content and the number of connected devices. In fact, the GSMA recently released research which suggests that the number of mobile connected

devices is expected to reach 12 billion units by 2020, twice the number in service today.

TriQuint earns "Excellent Supplier" award

Yulong honoured the company for its significant contributions to mobile handset designs in China

Yulong's Senior Vice President of Supply Chain, Xiaohui Xu said, "TriQuint is now an important RF front-end supplier of Yulong; this award represents our recognition and appreciation to TriQuint. We hope our co-operation with TriQuint can be extended to becoming strategic partners, and we look forward to having a better co-development with TriQuint."

According to David Kerr, Vice President at Strategy Analytics, Yulong and two other Asian microvendors outperformed major international handset brands in China and India in Q1 2011.

He said, "Yulong Coolpad is on track to becoming a known player in the China 3G market, supplying affordable, mid-tier 3G smartphones to suburban and urban users. Yulong Coolpad is growing relationships with all three Chinese mobile carriers, tapping the growing 3G boom in this important handset market."

Coolpad handsets are the main products of Yulong, and TriQuint has supplied Yulong with cellular power amplifier (PA) modules and WLAN PAs for its broad smartphone portfolio.

"Yulong is one of the leaders in the field of 3G technology, so earning this "Excellent Supplier" award from Yulong Coolpad highlights TriQuint's significant contributions to mobile handset designs in China," said Glen Riley, TriQuint Vice President. "As a global supplier, TriQuint will continue to grow its portfolio of wireless broadband solutions for mobile devices, helping phone manufacturers improve the performance and lower their cost."

TriQuint unveils InGaP/GaAs broadband gain block series

The Darlington-pair amplifiers use the firm's high reliability indium gallium phosphide / gallium arsenide HBT process technology.

TriQuint has released a new family of high-efficiency Darlington-pair cascadable gain block amplifiers that delivers cost-effective, broadband solutions in base station transceiver, repeater, CATV, SATV and defense / aerospace applications.

The new 50 Wgain blocks are internally matched to help cut BOMs while reducing current consumption to just 45 A. The new devices provide two gain levels (15 and 20dB) as well as 29dBm OIP3 across DC-6 GHz. They are offered in RoHS-compliant, industry-standard SOT-363 or SOT-89 packages. The new gain blocks also provide very robust Class 1C HBM ESD performance.

RFMD 3G/4G products power the latest smartphones

RFMD says its PowerSmart power platform and RF724x modules deliver unmatched performance in next-generation smartphones.

RF Micro Devices has commenced volume production of multiple 3G/4G power amplifiers

(PAs) in support of two leading smartphone families.

The two most recent smartphones are supported by RFMD's PowerSmart power platform and the firm's RF724x family of ultra-high efficiency PAs.

The first smartphone, featuring RFMD's PowerSmart, is a stylish, all-touch handset featuring a brilliant 3.2" high resolution display, a 5MP camera with flash and video recording, and preinstalled social networking apps for a smoothly integrated mobile experience.

The second smartphone, featuring RFMD's RF7241, RF7242, RF7244, RF7245, and RF7258, is a powerful, full-featured smartphone with a high resolution touch display, a highly tactile keyboard, and a precise optical trackpad. The smartphone will be available in multiple triple-band 3G versions featuring RFMD's 3G/4G PAs exclusively. Both smartphones are manufactured by a leading North America-based smartphone manufacturer.

Eric Creviston, president of RFMD's Cellular Products Group (CPG), said, "RFMD's industry-leading 3G/4G products continue to gain design momentum with the world's leading smartphone manufacturers. Similar to calendar 2011, we believe RFMD will be a clear share gainer during calendar 2012, not only in UMTS/HSPA+, but also in 4G LTE."

RFMD claims its RF724x UMTS/HSPA+ PAs are ultra-high efficiency, single-mode 3G/4G components that reset the bar for performance in smartphones, tablets, and other high-performance data-centric connected devices.

The RF724x PAs deliver peak efficiencies of 48% - 51%. RFMD says this is significantly above current competitive offerings. The product family currently covers WCDMA bands 1, 2, 4, 5 and 8, addressing the most common UMTS/HSPA+ frequency bands and band combinations.

RFMD's PowerSmart power platform is a new product category reshaping the future of multimode, multi-band cellular RF architectures. PowerSmart features a revolutionary new RF Configurable Power Core that delivers multiband, multi-mode coverage of all cellular communications modulation schemes, including GSM/GPRS, EDGE, EDGE Evolution, CDMA, 3G (TD-SCDMA or WCDMA) and 4G (HSPA+, LTE or WiMAX). The RF Configurable Power Core in PowerSmart is compliant with all current and known future 4G data standards (HSPA+, LTE QPSK, LTE 16QAM, and LTE 64QAM).

In addition to the RF Configurable Power Core, which performs all power amplification and power management functionality the PowerSmart power platform includes all necessary switching and signal conditioning functionality in a compact reference design, providing smartphone manufacturers a single scalable source for the entire cellular front end.

RFMD offers a broad portfolio of 3G/4G solutions in single-mode and multimode converged and hybrid architectures to ensure compatibility with leading chipset providers and enable global platform manufacturing. RFMD's 3G/4G product portfolio reduces the thermal impact of data usage in smartphones while

enabling increased battery life during data-based applications, such as web surfing, video calls and internet radio services.

Dr. Philippe Roussel to present at CS Europe Conference 2012

Defining the next steps for the Compound Semiconductor Industry,Dr. Philippe Roussel of Yole Développement will present the talk “Wide Bandgap device market update”.

Following the success of CS Europe 2011, next year’s conference is expanding to 2 days and offers a fantastic mix/quality of speakers making it the must attend industry event for 2012.

Register at www.cseurope.net & book your delegate place now as numbers will be limited. The conference takes place on 12th/13th March 2012 at Hilton Hotel, Frankfurt, Germany.

A networking dinner will also be held on the night of 12th March.

Conference Chair

Dr Andrew W Nelson, President & CEO, IQE

Conference Schedule:

Markets and III-V CMOS - Morning 12th March

A mix of insightful market research presentations & cutting-edge research destined to shape tomorrow’s compound semiconductor industry with talks including:

Compound Semiconductor Markets: Current Status and Future Prospects - Asif Anwar, Director – Strategic Technologies Practice, Strategy Analytics

The Market for LEDs in Lighting- Mr. Philip Smallwood, Lighting Market Analyst, IMS Research

Wide Bandgap device marketupdate - Dr. Philippe ROUSSEL, Senior Project Manager, Yole Développement

European efforts to develop III-Vs on 200 and 300 mm silicon- Dr. Matty Caymax, Chief Scientist, Imec

An Overview of the DARPA Diverse Accessible Heterogeneous Integration (DAHI) Program- Sanjay Raman, Program Manager, Defense Advanced Research Projects Agency/Microsystems Technology Office

The Integration of silicon CMOS with III-Vs- Professor Iain Thayne, University of Glasgow

III-Vs on 200 mm Si for VLSI– Dr Richard Hill, Project Manager, Sematech

III-V 3D Transistors- Peide Ye, Professor of Electrical and Computer Engineering, Purdue University

LEDs, lasers, PV and electronics - Afternoon of 12th March & full day of 13th March

KEYNOTE SPEAKER*: III-V on Silicon: Challenges and Opportunities*- Robert S. Chau, Intel Senior Fellow, Intel

SiC and GaN Electronics- Dr. John Palmour, Cree co-founder and chief technology officer Power & RF, Cree

Ammono’s ammonothermal method to make GaN substrates– Dr. Robert Dwiliński, President, CEO, Ammonno S.A.

Tomorrow’s RF chips for mobile devices- Todd Gillenwater, VP of Technology and Advanced Development, RFMD

Building a Successful III-V Pure Play

Foundry- Dr. John Atherton, Associate Vice President, WIN Semiconductors

Scalable "on-silicon" solutions (GaN-on-Si and Ge-on-Si) using rare oxide buffer layers– Dr. Michael Lebby, General Manager & Chief Technology Officer, Translucent Inc.

III-Nitride Lasers Based on Nonpolar/ Semipolar Substrates- Dr James W. Raring, VP Laser Engineering, Soraa Inc.

Markets and Applications for SiC Transistors - Dieter Liesabeths, Vice President Sales & Marketing, SemiSouth Laboratories, Inc.

Perspective of an LED Manufacturer- Professor Iain Black, VP WW Manufacturing Engineering, Technology & Innovation, Philips Lumileds Lighting Company

The CPV Market following the acquisition of Quantasol technology - Jan-Gustav Werthen, JDSU, Senior Director

Commercialisation of GaN on SI based Power Devices at International Rectifier- Dr. Michael A. Briere, International Rectifier

GaN the enabler for true SDR- Professor Rik Jos, RF Technology Fellow & Innovation Manager, NXP Semiconductors

Holistic Approach to MOCVD vacuum & Abatement- Dr Mike Czerniak, Product Marketing Manager, EdwardsVacuum Ltd

Advances in Wide Bandgap Semiconductors for Power Electronics- Dr. Markus Behet, Global market manager, Power Electronics, Dow Corning

Large diameter GaN-on-Si epiwafers for power electronics- Dr Mariane Germain, Co-Founder & CEO, EpiGaN

Achieveing Gan & GaAs RF Design Success through Product & Foundry Innovation– Mr Bryan Bothwell, Strategy and Business Development Manager – Foundry Services, TriQuint Semiconductor

Damage - free Deposition on LED devices- Dr Silvia Schwyn Thöny, Senior Process Engineer, Evatec Ltd

Temporary Bonding: An enabling technology for RF and power compound semiconductor devices - Dr Thomas Uhrmann, Business Development Manager, EV Group (EVG)

Lasers

Fluorescence sensitivity that will make you GaAsP

A new gallium arsenide phosphide non-descanned photodetector for highly sensitive photon detection and fluorescence imaging

Olympus has released the new FV10MP-BXD-GAP photodetector for enhanced sensitivity when performing multi-photon fluorescence imaging.

The Olympus FV10MP-BXD-GAP photodetector

The new non-descanned detector unit is ideal for capturing very faint fluorescence signals and for minimising the laser power required to

generate a detectable signal, making it the best choice for advanced life science research.

Exceptional sensitivity is achieved by coating the photoelectric surface of the detector with GaAsP, which offers superior quantum efficiency compared to conventional PMTs. In addition, noise is kept to an absolute minimum via the use of Peltier cooling, boosting signal-to-noise ratio. The detector unit also includes standard PMTs, allowing these to be used for identifying regions of interest (ROI) which can then be scanned using the GaAsP PMTs, maximising their lifetime.

When used in combination with a member of the Olympus range of FluoView FV1000MPE multiphoton microscope systems, researchers can produce insightful images, even when using advanced irradiation techniques, low laser power or very faint fluorophores.

The new FV10MP-BXD-GAP non-descanned photodetector from Olympus has been designed to make the best use of every photon emitted by a sample. Efficient photon detection means that a wide range of biological processes can be investigated using fluorescently-tagged molecules expressed at physiologically relevant concentrations, even at levels that were previously too low to be detected using traditional multi-alkali PMTs.

In addition, as a lower intensity of laser light is required to accurately detect each fluorophore, the power of the laser can be reduced. This minimises the effects of photobleaching and phototoxicity, thereby increasing the accuracy and biological relevance of results, especially for experiments performed over long time periods or requiring frequent laser light exposure.

The FV10MP-BXD-GAP is equipped with 2 conventional multi-alkali PMTs for the routine browsing of samples, and 2 GaAsP PMTs for the highly sensitive analysis of a specific ROI. Switching between the two types of detector is easy and fast, providing a hassle-free workflow.

To further lengthen the lifetime of the GaAsP PMT, the system prevents any unnecessary exposure to ambient light such as room lighting or excessive fluorescence. The FV10MP-BXD-GAP can be purchased as part of a new FluoView system, or can be used to upgrade an existing setup, where it will provide the sensitivity required to produce high quality images, facilitate accurate photon detection and allow even deeper imaging via multiphoton microscopy.

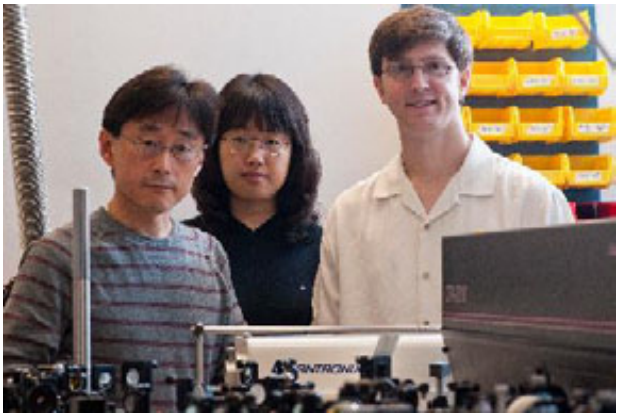
Many bodies make one coherent burst of light

Rice University researchers first to see superfluorescence from solid-state material, incorporating indium, gallium and arsenide quantum wells separated by gallium arsenide barriers

In a flash, the world changed for Tim Noe – and for physicists who study what they call many-body problems.

The Rice University graduate student reckons he was the first to see, in the summer of 2010, proof of a theory that solid-state materials are capable of producing an effect known as superfluorescence.

That can only happen when “many bodies” – in this case, electron-hole pairs created in a semiconductor – decide to cooperate.



Rice University researchers have confirmed

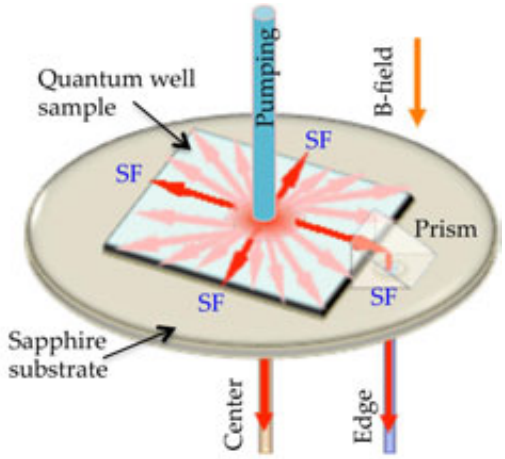
a long-held theory that solid-state materials are capable of producing an effect known as superfluorescence. From left: Junichiro Kono, Ji-Hee Kim and Tim Noe. (Credit: Jeff Fitlow/Rice University)

Noe, a student of Rice physicist Junichiro Kono, and their research team used high-intensity laser pulses, a strong magnetic field and very cold temperatures to create the conditions for superfluorescence in a stack of 15 undoped quantum wells. The wells were made of InGaAs and were separated by barriers of GaAs.

Noe spent weeks at one of the only facilities with the right combination of tools to carry out such an experiment, the National High Magnetic Field Laboratory at Florida State University. There, he placed the device in an ultracold (as low as 5 K) chamber, pumped up the magnetic field (which effectively makes the "many body" particles – the electron-hole pairs – more sensitive and controllable) and fired a strong laser pulse at the array.

"When you shine light on a semiconductor with a photon energy larger than the band gap, you can create electrons in the conduction band and holes in the valence band. They become conducting," said Kono, a Rice professor of electrical and computer engineering and in physics and astronomy. "The electrons and holes recombine – which means they disappear – and emit light. One electron-hole pair disappears and one photon comes out. This process is called photoluminescence."

The Rice experiment acted just that way, but pumping strong laser light into the layers created a cascade among the quantum wells. "What Tim discovered is that in these extreme conditions, with an intense pulse of light on the order of 100 femtoseconds (quadrillionths of a second), you create many, many electron-hole pairs. Then you wait for hundreds of picoseconds (mere trillionths of a second) and a very strong pulse comes out," Kono said.



Pumping laser pulses into a stack of quantum wells created an effect physicists had long sought but not seen until now: superfluorescence in a solid-state material. The Rice University lab of physicist Junichiro Kono reported the results in Nature Physics. (Credit: Tim Noe/Rice University)

In the quantum world, that's a long gap. Noe attributes that "interminable" wait of trillionths of a second to the process going on inside the quantum wells. There, the 8 nm thick layers soaked up energy from the laser as it bored in and created what the researchers called a magneto-plasma, a state consisting of a large number of electron-hole pairs. These initially incoherent pairs suddenly line up with each other.

"We're pumping (light) to where absorption's only occurring in the GaAs layers," Noe said. "Then these electrons and holes fall into the well, and the light hits another GaAs layer and another well, and so on. The stack just increases the amount of light that's absorbed." The electrons and holes undergo many scattering processes that leave them in the wells with no coherence, he said. But as a result of the exchange of photons from spontaneous emission, a large, macroscopic coherence develops.

Like a capacitor in an electrical circuit, the wells become saturated and, as the researchers

wrote, “decay abruptly” and release the stored charge as a giant pulse of coherent radiation.

“What’s unique about this is the delay time between when we create the population of electron-hole pairs and when the burst happens. Macroscopic coherence builds up spontaneously during this delay,” Noe said.

Kono said the basic phenomenon of superfluorescence has been seen for years in molecular and atomic gases but wasn’t sought in a solid-state material until recently. The researchers now feel such superfluorescence can be fine-tuned. “Eventually we want to observe the same phenomenon at room temperature, and at much lower magnetic fields, maybe even without a magnetic field,” he said.

Even better, Kono said, it may be possible to create superfluorescent pulses with any desired wavelength in solid-state materials, powered by electrical rather than light energy.

The researchers said they expect the paper to draw serious interest from their peers in a variety of disciplines, including condensed matter physics; quantum optics; atomic, molecular and optical physics; semiconductor optoelectronics; quantum information science; and materials science and engineering.

There’s much work to be done, Kono said. “There are several puzzles that we don’t understand,” he said. “One thing is a spectral shift over time: The wavelength of the burst is actually changing as a function of time when it comes out. It’s very weird, and that has never been seen.”

Noe also observed superfluorescent emission with several distinct peaks in the time domain, another mystery to be investigated.

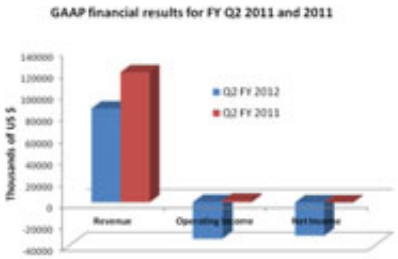
Support for the research came from the National Science Foundation, with support for work at the National High Magnetic Field Laboratory from the state of Florida.

Further details of the researchers’ results can be seen in the paper, “ Giant superfluorescent bursts from a semiconductor magneto-plasma,” byG. Timothy Noe II*et al*, *Nature Physics,* Published online on 29 January 2012. DOI: 10.1038/nphys2207

Thailand floods cause Oclaro revenues to slide 28%

The optical communications and laser innovator had revenues of $86.5 million for the second quarter of fiscal 2012, compared to revenues of $120.3 million for Q2 FY 2011

Oclaro has announced its financial results for its second quarter of fiscal year 2012, which ended December 31, 2011.



Revenues were $86.5 million for the second quarter of fiscal 2012, compared to revenues of $105.8 million in the first quarter of fiscal 2012.

“In the second quarter of fiscal 2012, Oclaro achieved revenue at the high end of our previous guidance range, primarily due to our recovery efforts from the recent Thailand flooding,” said Alain Couder, chairman and CEO of Oclaro.

“We are pleased with our recovery progress thus far. We expect full commercial production by the end of March for three of our five affected product lines and within the June quarter for the remaining two. In spite of the flood, we remain focused on enabling Oclaro to emerge from this period better positioned

than before, in terms of our market position on certain existing products, recent introductions and our pipeline of new products and new technologies."

When asked if orders from customersconcerned about supply chain continuity and part availability have improved as a result of the Thailand floods, Couder commented, "No, I think we have been seeing something pretty stable. We also have some good customer relationships where even if our customers have been asking for more from some of our competitors on a temporary basis, we have some assurance from them that they will get back to us. On the other end, we benefited from the same thing on a few product lines where our competition couldn't supply and we did supply, but overall, it's balanced, I would say."

GAAP results

Gross margin was 13% for the second quarter of fiscal 2012, compared to a gross margin of 23% in the first quarter of fiscal 2012. Operating loss was $33.6 million for the second quarter of fiscal 2012, which included $9.1 million flood-related write-offs and expenses due to the flooding in Thailand, compared to an operating loss of $10.2 million in the first quarter of fiscal 2012.

Adjusted EBITDA was negative $14.3 million for the second quarter of fiscal 2012, compared to negative $4.5 million in the first quarter of fiscal 2012.

Net loss for the second quarter of fiscal 2012 was $31.1 million, which included $9.1 million flood-related write-offs and expenses due to the flooding in Thailand, compared to a net loss of $10.2 million in the first quarter of fiscal 2012.

Cash, cash equivalents and restricted cash were $54.2 million as of December 31, 2011 compared to $51.7 million at the end of September. No additional amounts were drawn under the Company's $45 million credit facility in the quarter.

Third Quarter Fiscal 2012 Outlook

For the third quarter of fiscal 2012, which ends March 31, 2012, Oclaro expects revenues in the range of $90 million to $97 million. Adjusted EBITDA is anticipated to be in the range of negative $13.5 million to negative $9 million.

When asked if orders have improved as a result of the flooding from customers Alain Couder,President and Chief Executive Officer of Oclaro commented "No, I think we have been seeing something pretty stable. We also have some good customer relationships where even if our customers have been asking for more from some of our competitors on a temporary basis, we have some assurance from them that they will get back to us. On the other end, we benefited from the same thing on a few product lines where our competition couldn't supply and we did supply, but overall, it's balanced, I would say."

Introducing Intense's 808 nm and 793 nm laser pump modules

The gallium arsenide QWI based devices are designed for defence, medical, and industrial applications and thulium holmium pumping applications

Intense, a developer of next generation semiconductor lasers, systems and solutions, introduced two new products at Photonics West 2012 this week.

Both products are from the company's Series 8000 and use GaAs/AlGaAs technology.

The entire Series 8000 family of laser pump products is based on Intense's next generation of single and multi-emitter chips

that incorporate narrow beam divergence and Intense's patented Quantum Well Intermixing (QWI) technology to maximise power, brightness, and reliability.

The first product is a 10 W version of the Series 8000 793nm High Brightness Laser Pump Modules.

8000-793 Series

This compact module is designed specifically for use as a pump source for Thulium and Holmium pulsed laser systems which are seeing increased use in defence and medical applications.

Currently, the high power chip technology of the Series 8000 793nm is available in fibre coupled single emitters at 4.5W, as well as compact, multi emitter, high brightness, fibre coupled 10W and 20W modules.

"Intense continues to lead the 793 nm pump market, a market we established over 5 years ago with the production version of our 4.5 W high brightness, single emitter pumps," stated Kevin Laughlin, CEO, Intense. "When we introduced the 20 W version last year, medical OEMs approached us with requests for a lower power, high efficiency, high brightness pump in a more compact package. Today's introduction of the 10 W 793 nm completes development of what has become a formidable and wide ranging 793 nm pump product portfolio."

The new 808 nm multi-emitter pump module laser is designed to meet growing demand for fibre or solid state pumping applications and delivers 30 W. Its compact size and combination of efficiency and high brightness make it a high performance pumping alternative for fibre and solid-state laser systems used in defence, medical, and industrial applications.

The new 808 nm Fibre Coupled Packages provide robust, cost effective, and compact solutions for applications with power requirements up to 30W. The high power chip technology of the Series 8000 808 nm is now available for a range of power levels, from fibre coupled single emitters at 6 W, to multi-emitter, high power, high brightness, fibre coupled modules at 30 W.

"The new compact 30 W module was introduced to serve a growing number of defence and industrial customers who were using our 793 and 808 nm mini fibre packages," stated Kevin Laughlin, CEO, Intense. "The 30 W 808 nm was introduced as a compact, high efficiency and high brightness pumping alternative for fibre and solid state laser systems. Intense's family of Series 8000 QWI-enabled pumping modules has continued to evolve. It now includes 808nm and 793nm offerings. In 2012, these will serve as the cornerstone for a much expanded product line."

The Series 8000 793 nm Fibre Coupled Packages come standard with 105 µm x 0.22 NA fibres while the 808 nm come standard with 200 µm x 0.22 NA fibres. 0.15 NA fibre options are also available on request for both modules.

The chip technology is offered for both devices in a variety of free space configurations with

FAC options.

Availability

The Series 8000 793nm single and multi emitter pump modules, 4.5W, 10W, and 20W, are available in custom packaging to match OEM system requirements.

The Series 8000 808nm 30W multi-emitter pump modules are also available in custom packaging to match OEM system requirements.

OEM discounts are available and based on the quantities ordered for both modules.

Oclaro brings you laser diodes for 15kW operation

The 910nm to 1070nm phosphide based diodes deliver the highest power levels

Oclaro has announced that its laser diodes have been designed into the industry's first 15 kilowatt (kW) direct diode fibre coupled laser systems.

Featuring some of the highest power levels, broadest wavelength range and leading brightness, the Oclaro laser diodes scale from 910nm to 1070nm at high power levels and leading brightness to uniquely meet the demanding performance requirements of these next generation 15kW systems.

The company is showcasing its complete line of laser diodes, which are currently shipping in volume to the industrial, semiconductor, automotive and materials processing markets, at this week's Photonics West Conference in the Oclaro booth #1101.

15kW and other multi-kilowatt systems are ideal for applications such as metal welding, cladding and cutting that continually require higher power to improve the performance of the laser system and process efficiency. Due to their output power, brightness and "colours", the Oclaro laser diodes have become a key technology that is driving the development of these next generation laser systems.

Because the power of these systems scales linearly with the number of wavelengths available for multiplexing, Oclaro's ability to provide lasers with wavelengths from 910nm up to 1070nm with high power levels and excellent brightness is the technology that is allowing customers to design commercial fibre coupled multi-kilowatt direct diode laser systems that can meet and exceed 15kW.

Bernd Meyer, VP Product Management High Power Laser Business for Oclaro said the announcement highlights Oclaro's continued ability to advance the performance and features of its industry-leading laser diode platform. "Our customers are always looking for ways to expand their business into new markets and applications that require more power and brightness, and the 15kW laser systems being enabled by our laser diodes are key to their success," he continued.

One of the first Oclaro customers designing next generation 15kW laser systems is Laserline, the leading manufacturer of high power diode laser systems. Laserline chose the Oclaro direct diode solutions because they deliver the power, brightness and reliability needed to bring 15kW direct diode systems to market. In addition, Oclaro was able to provide Laserline with its in-house design and manufacturing expertise along with the capability to scale to volume quickly and cost effectively.

Oclaro has its own design capabilities in house, which it says, enable significant improvements in overall efficiency and design. Epitaxial engineering is one of Oclaro's key competencies.

Telecom grade AuSn (gold tin) hard solder make the Oclaro laser diodes suitable for demanding applications in CW and hard-pulse

operation mode.

Like all Oclaro high power laser products, the front facet of these laser diodes is protected against Catastrophic Optical Damage (COD) by the Oclaro E2 mirror passivation process. This enables higher power densities on each laser diode, which allows power scaling of diodes.

By owning the laser diode development from initial design and wafer form to final product, Oclaro can deliver designs that reach the power, brightness and reliability required at leading cost structures.

Oclaro's portfolio of laser diodes include low-fill-factor bars from 50W to 80W and high-fill-factor conduction cooled bars at 120W and active cooled bars up to 200W. These products, all of which feature the a wavelength range from 910nm to 1070nm, allow for wavelength multiplexing with 5 to 6 colours (assuming 30nm spacing).

3S Photonics transforms into 3SPGroup

Following the successful synergies between 3S Photonics, Avensys and Manlight, the Group is uniting these three companies as a single entity

The name change to 3SP aims to simplify the Group's image and to pursue its internal and external growth strategy.

The year 2011 was marked by significant events for the Group. It announced a growth in turnover of 64% and the change of ownership with the arrival of Eurazeo a listed investment company in Europe, who became the majority shareholder of the Group in October 2011. More recently, was the acquisition of Manlight, a globally recognised player for optical fibre amplifiers and lasers.

In 2012, 3SPGroup will continue its acquisition strategy in order to strengthen its position in its historical markets, and to pursue vertical and market growth. To this end, the Group has decided to reorganise itself and simplify its image and name under one single brand.

"Beyond this marketing strategy, with the industrial and trade integration of our different structures, we wanted to offer a diversified and easily accessible range of products and solutions," says Alexandre Krivine, President and CEO of 3SPGroup. "Our customers will continue to benefit from the increase of our production capacities and technical expertise."

Cooling semiconductors with laser light

When laser light impacts a gallium arsenide nanomembrane, some of the light is reflected and the light is reflected back again via a mirror. The light flies back and forth in this space and forms an optical resonator.

Researchers at the Niels Bohr Institute have combined two worlds – quantum physics and nano physics, and this has led to the discovery of a new method for laser cooling semiconductor membranes.

The efficient cooling of semiconductor components is important for future quantum computers and ultrasensitive sensors. The new cooling method works quite paradoxically by heating the material! Using lasers, researchers cooled membrane fluctuations to minus 269 degrees C.

"In experiments, we have succeeded in achieving a new and efficient cooling of a solid material by using lasers. We have produced a semiconductor membrane with a thickness of 160 nanometres and an unprecedented surface area of 1 by 1 millimetre. In the experiments, we let the membrane interact with the laser light in such a way that its mechanical movements affected the light that hit it. We carefully examined the physics and discovered

that a certain oscillation mode of the membrane cooled from room temperature down to minus 269 degrees C, which was a result of the complex and fascinating interplay between the movement of the membrane, the properties of the semiconductor and the optical resonances," explains Koji Usami, at the Niels Bohr Institute.

From gas to solid

Laser cooling of atoms has been practiced for several years in experiments in the quantum optical laboratories of the Quantop research group at the Niels Bohr Institute. Here researchers have cooled gas clouds of caesium atoms down to near absolute zero, minus 273 degrees C, using focused lasers and have created entanglement between two atomic systems. The atomic spin becomes entangled and the two gas clouds have a kind of link, which is due to quantum mechanics. Using quantum optical techniques, they have measured the quantum fluctuations of the atomic spin.

The experiments are carried out in the Quantop laboratories at the Niels Bohr Institute. The laser light that hits the semiconducting GaAs nanomembrane is controlled with a forest of mirrors. (Photo: Ola J. Joensen)

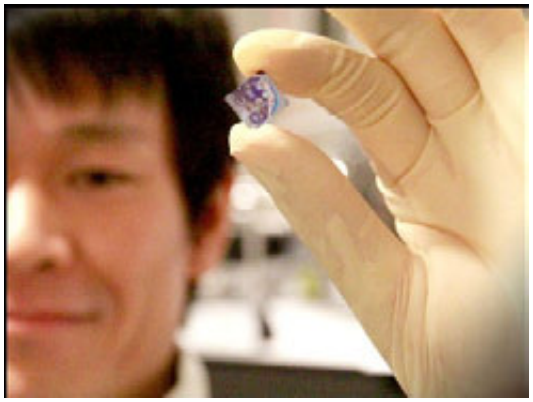
"For some time we have wanted to examine how far you can extend the limits of quantum mechanics – does it also apply to macroscopic materials? It would mean entirely new possibilities for what is called optomechanics, which is the interaction between optical radiation, i.e. light, and a mechanical motion," explains Eugene Polzik, head of the Centre of Excellence Quantop at the Niels Bohr Institute at the University of Copenhagen.

But they had to find the right material to work with.

Lucky coincidence

In 2009, Peter Lodahl (now head of the Quantum Photonic research group at the Niels Bohr Institute) gave a lecture at the Niels Bohr Institute, where he showed a special photonic crystal membrane that was made of GaAs.

Eugene Polzik immediately thought that this nanomembrane had many advantageous electronic and optical properties and he suggested to Peter Lodahl's group that they use this kind of membrane for experiments with optomechanics. But this required quite specific dimensions and after a year of trying they managed to make a suitable one.



Koji Usami shows the holder with the semiconductor nanomembrane. The holder

measures about one by cm, while the nanomembrane itself has a surface area of 1 by 1 millimetere and a thickness of 160 nanometres. Photo: Ola J. Joensen

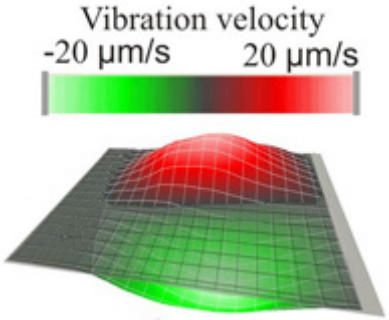
“We managed to produce a nanomembrane that is only 160 nanometres thick and with an area of more than 1 square millimetre. The size is enormous, which no one thought it was possible to produce,” explains Søren Stobbe, who also works at the Niels Bohr Institute.

Basis for new research

Now a foundation had been created for being able to reconcile quantum mechanics with macroscopic materials to explore the optomechanical effects.

Koji Usami explains that in the experiment they shine the laser light onto the nanomembrane in a vacuum chamber. When the laser light hits the semiconductor membrane, some of the light is reflected and the light is reflected back again via a mirror in the experiment so that the light flies back and forth in this space and forms an optical resonator.

Some of the light is absorbed by the membrane and releases free electrons. The electrons decay and thereby heat the membrane and this gives a thermal expansion. In this way the distance between the membrane and the mirror is constantly changed in the form of a fluctuation.



Seen here are fluctuations of the membrane. With the optical resonance frequency you can control the fluctuations of the membrane and the researchers succeeded in cooling a certain oscillation to minus 269 degrees C.

“Changing the distance between the membrane and the mirror leads to a complex and fascinating interplay between the movement of the membrane, the properties of the semiconductor and the optical resonances and you can control the system so as to cool the temperature of the membrane fluctuations. This is a new optomechanical mechanism, which is central to the new discovery. The paradox is that even though the membrane as a whole is getting a little bit warmer, the membrane is cooled at a certain oscillation and the cooling can be controlled with laser light. So it is cooling by warming! We managed to cool the membrane fluctuations to minus 269 degrees C”, Koji Usami explains.

“The potential of optomechanics could, for example, pave the way for cooling components in quantum computers. Efficient cooling of mechanical fluctuations of semiconducting nanomembranes by means of light could also lead to the development of new sensors for electric current and mechanical forces. Such cooling in some cases could replace expensive cryogenic cooling, which is used today and could result in extremely sensitive sensors that are only limited by quantum fluctuations,” says Eugene Polzik.

Further details of this research are published in the paper, “Optical cavity cooling of mechanical modes of a semiconductor nanomembrane”, by K. Usami et al, Nature Physics, published online on 22 Jan 2012, DOI:10.1038/nphys2196.

Oclaro samples 20G VCSEL and extends its position

Higher data rates using III-V compound semiconductor VCSELs will enable faster data transfer in high volume consumer devices such as notebook computers and optical cables

Oclaro, a provider and innovator of optical communications and laser solutions, is sampling a 20G VCSEL (Vertical-Cavity Surface-Emitting Laser).

Having shipped well over 100 million VCSELs, including more than 500 thousand 10G VCSELs in the last year alone, Oclaro is currently one of the world's largest suppliers of VCSELs and its products have been designed into high-volume consumer electronics products such as notebook computers, optical cables, optical mice and smart phones.

By continuing to offer new VCSEL solutions that deliver higher data rates, Oclaro can enable customers to develop faster performing products at better price/performance points.

The firm will be showcasing its leading family of VCSELs at this week's Photonics West Show in the Oclaro booth #1101.

VCSELs are semiconductor laser diodes that take advantage of optical technology to connect electronic devices such as peripherals, workstations, displays, disk drives and docking stations. For example, a VCSEL in a notebook computer allows data transfer with another computer or enables the user to transfer video content such as movies from their computer onto a high-definition (HD) television.

Because VCSELs are extremely reliable and can meet the stringent requirements of consumer devices, they are rapidly becoming adopted in all areas of consumer electronics. Oclaro has secured one of the volume leadership positions in this market by leveraging its proven expertise in optical laser technology and reliability and its ability to quickly achieve the high-volume production capacities needed for consumer products.

"Just as we are continually addressing the increased bandwidth requirements of the core optical network, we are also committed to meeting the demands of the consumer industry by enabling customers to increase the data transfer rates between various devices such as computers, disk drives or HD TVs," said Karlheinz Gulden, Senior Director Product Management at Oclaro. "With the introduction of reliable 20G VCSELs, Oclaro is helping its customers to double the bandwidth over existing solutions and be first to market with higher performing next generation consumer devices."

The new 20G VCSELs are available for sampling to customers today and are also ideally suited to address the growing 16G Fibre channel transceiver market, which is starting to ramp this year.

High-power 532 nm compact green laser module developed

Promise seen for applications in life sciences, precise measurements for industry and ultra-compact projectors

QD Laser, the Institute for Nano Quantum Information Electronics, the University of Tokyo, and Fujitsu Laboratories have successfully developed a high-power 532 nm-wavelength compact green laser module with high efficiency and high-speed modulation capability.

Combining the near-infrared high-power single-mode laser based on proprietary semiconductor DFB (Distributed feedback) laser technology with wavelength conversion technology realises a compact laser module of about 0.5 cc that can provide high output power.

Figure 1: Prototype module appearance (a dime is also shown for size reference)

An evaluation of the prototype module confirmed green light output of greater than 100 mW under CW (Continuous wave) conditions and high-speed modulation of more than 100 MHz. This module shows promise for a wide range of applications such as with florescence microscopes or spectral analysis in life science or biomedical applications, and precise measurements as well as nondestructive inspections in industry.

What's more, it is also expected to apply to future ultra-compact projectors in consumer electronics. QD Laser is planning to start sample shipments of the new product, QLD0593-P50, with > 50 mW output power from the 2nd quarter of 2012 and to start mass-production from the 4th quarter.

Recently, high-power green lasers have been garnering much attention in many fields, including life sciences and with biomedical and industrial applications. Different from near-infrared lasers for optical communications and red and blue lasers for optical storage, semiconductor lasers provide limited output characteristics in the case of green lasers.

Therefore, diode pumped solid state (DPSS) lasers are usually used in applications which require high output power at wavelengths around 530 nm. In these applications, it is imperative to have improved wavelength stability and high-speed modulation capability as well as low power consumption and compact size.

QD Laser developed 1064 nm high-power single-mode lasers optimized for wavelength conversion in collaboration with Fujitsu Laboratories and the University of Tokyo. This development was based on the collective core proprietary technologies of semiconductor crystal growth, precise grating fabrication, and device design technology.

What's more, the newly developed module assembling technology enables precise integration of the laser chip and wavelength conversion crystal. As a result, a high output power of more than 100 mW at a wavelength of 532 nm from an ultra-compact package of just 0.5 cc was achieved.

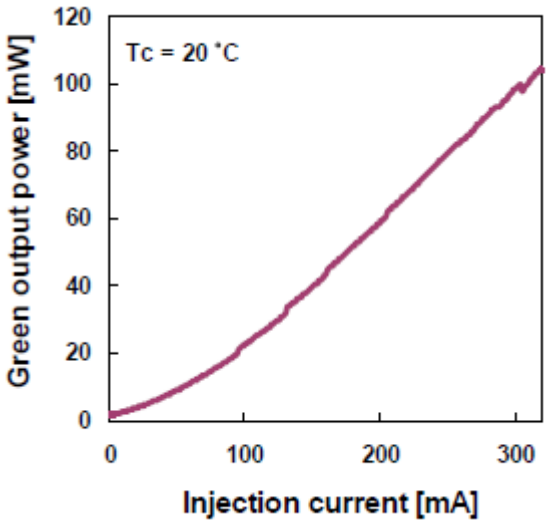


Figure 2: Light output characteristics (DFB current = 100 mA)

According to the test results of the prototype module, 100 mW output power was obtained with power dissipation of about 900 mW, which means high wall-plug efficiency of more than 10%. For the optical spectral characteristics, narrow line-width of less than 0.01 nm with a high side-mode suppression ratio was obtained, which is particularly suitable for precise measurements using an optical interference or high resolution spectroscopy.

In addition, confirmation was made of a high-

speed optical modulation capability of more than 100 MHz and short pulse of less than 1 nsec operation. This was done with a simple direct current modulation scheme, which showed that it could be effective for time resolved spectroscopy and other fields. These unique characteristics of high-power, high-efficiency, and high-speed modulation with compact package are also expected to apply to future display applications like heads-up displays or ultra-compact mobile projectors, which are attracting much attention and growing in the market.

QD Laser has already started shipping samples of QLD0593-P05, a module with 5 mW output power. In addition, it plans to start shipping high power samples of QLD0593-P50, a module with > 50 mW output power, in April, 2012 with mass production commencing from the 4th quarter of 2012.

QD Laser markets 1064 nm band DFB laser modules, mainly for industrial applications including as a seed source for fibre lasers, and has already shipped them to more than 30 companies worldwide. QD Laser's in-house epitaxial growth and grating technology provides the flexibility to handle a wide range of wavelength bands and is now extending the wavelength line-up of DFB laser modules from 1030 to 1300 nm.

The firm says it also has the potential to extend wavelength line-up by combining with a wavelength conversion technology in visible wavelength regions like 515 nm and 555 nm for special green laser or 560 nm and 590 nm for yellow to orange colours. QD Laser will continue these unique technical developments to meet market requirements.

B&W Tek to demonstrate tiny fibre-optic Raman probe

The micro lensed tool will be exhibited at SPIE's BiOS & Photonics West conferences

B&W Tek, an advanced instrumentation company producing optical spectroscopy and laser systems, has revealed the BAC200 Raman probe.

The firm says this is the first fibre optic Raman probe capable of delivering the performance of a larger probe; it has a diameter of less than 4mm with enhanced optical collection power.

The BAC200's design enables both immersion and direct contact measurements, allowing for measurements and applications previously not possible with standard Raman probes. The fused silica tip is housed in a stainless steel needle tube, allowing for a scratch resistant, easy to clean probe. Unlike other commercially available lensed fibre optic probes, the optical elements in the BAC200 are permanently fixed in alignment, with no possibility of movement due to impact or vibrations.

"The small size, flexibility, and durability of the BAC200 micro Raman probe make it ideal for analysis in small sample size biological and biomedical applications," says Travis Thompson, Raman Product Specialist at B&W Tek. "This marks a leap forward for scientists performing molecular level spectroscopic analysis by allowing them to perform in vivo analyses of specimens without creating

apertures any larger than 4mm."

B&W Tek will be performing a live demonstration of the new BAC200 micro Raman probe at the BiOS and Photonics West exhibits in San Francisco at booth numbers 8401 and 401 respectively.

Oclaro beats financial target with $86 million in revenue

The company is still flourishing despite the Thailand floods and currently expects four of the five flood affected product lines to have restarted commercial output at Fabrinet's Pinehurst facility by the end of January

Oclaro, a provider of innovative optical communications and laser solutions, has provided further details about the progress of the company's recovery efforts from the flooding in Thailand.

The Company also announced preliminary revenues of approximately $86 million for the quarter ended December 31, 2011 compared to a guidance range of $75 million to $85 million which was provided by the Company on November 9, 2011.

"Our top priority has been to restart production in Thailand following the intensive floods, and minimise any impact to our customers," said Alain Couder, chairman and CEO, Oclaro. "As a result of the efforts of our teams in Thailand and around the world, we have made substantial progress in restarting production for our affected product lines. These efforts have also contributed to our achieving preliminary revenues for the December quarter above the top end of our guidance range."

Oclaro currently expects four of the five flood affected product lines to have restarted commercial output at Fabrinet's Pinehurst facility by the end of January.

Commercial shipments of high-powered lasers resumed in November and production capacity is currently at pre-flood levels. Commercial shipments of amplifiers resumed in the last week of December and production capacity is expected to increase to pre-flood levels by the end of the March quarter. Commercial shipments of tunable dispersion compensators are expected to begin by the end of January and production capacity is expected to increase to pre-flood levels by the end of the March quarter.

Commercial shipments of lithium niobate external modulators are expected to begin by the end of January and production capacity is expected to return to pre-flood levels early in the June quarter. Commercial shipments of WSS products are expected to begin at the end of the March quarter and production capacity is expected to return to pre-flood levels in the June quarter. In the meantime limited commercial output of lithium niobate external modulators and WSS products is being delivered from some of its existing Western sites.

Oclaro currently expects capital expenditures of approximately $6 million in each of the second (December) and third (March) fiscal quarters. These amounts include the necessary capital currently expected to recover product lines lost during the flood. Oclaro believes it has adequate property and business interruption insurance to cover its flood related losses.

Oclaro also has certain insurance recovery rights under its supply agreement with Fabrinet. While the total amount of insurance claims, and related recoveries, if any, cannot be estimated at this time, Oclaro currently believes that an advance payment from its insurance carrier in excess of $10 million is likely to be received in the March fiscal quarter.

Intel veteran Wilfred Martis joins Soraa to boost laser products

Martis will concentrate on laser products for the display and lighting markets

Soraa , a developer of LED and laser diode products, has enlisted Wilfred Martis as Vice President and General Manager of Laser Products.

“Wilfred brings a wealth of experience in managing semiconductor businesses for the consumer electronics and embedded markets,” said Eric Kim, Chief Executive Officer. “We are very excited that he has chosen to join our world-class team and help us fulfil the potential of our laser products for the display and lighting markets.”

Prior to joining Soraa, Martis was the General Manager of Retail Consumer Electronics in the Digital Home Group at Intel Corporation, where he was responsible for the Digital TV, Blu-ray and OTT business. His team established the Smart TV category through the launch of several Google TV products from Sony and Logitech, and Boxee products from DLink and Iomega. He spent 13 years at Intel, in several engineering, business & management roles, primarily focused on the consumer electronics and embedded markets.

Martis holds a BSEE from Bangalore University, India, an MSEE from the South Dakota School of Mines & Technology, and an MBA from the Wharton School of the University of Pennsylvania.

BinOptics attracts $13.3 million in funding

The Ithaca-based manufacturer of lasers and monolithically integrated optoelectronic components is accelerating laser growth

BinOptics Corporation has closed $13.3 million in new funding.

The firm will use the funding to continue expansion of its product lines and to accelerate development of new products.

Five new investors participated in this round: Advantage Capital Partners, Enhanced Capital Partners, Gefinor Ventures, Onondaga Venture Capital Fund, and Rand Capital. Existing investors ArrowPath Venture Partners, Cayuga Venture Fund, Draper Fisher Jurvetson, and FA Technology Ventures also participated.

“This funding enhances our ability to meet strong demand for our current 2.5 Gbps and 10 Gbps Distributed Feedback (DFB) laser products,” said BinOptics Chairman and CEO Alex Behfar. “We look forward to continuing to provide the most innovative and highest value products in the industry to our customers around the world.”

“Advantage Capital Partners is pleased to support BinOptics and its impressive array of unique products,” said Reid Hutchins, Advantage Capital senior vice president, who joins the board. Rand Capital’s President, Allen “Pete” Grum added, “BinOptics has great potential to create new jobs here in upstate New York, another welcome outcome of this funding.” The business currently employs over 50 people, with plans to hire additional engineers and technicians in 2012.

BinOptics, founded in 2000, uses proprietary processes for manufacturing lasers and integrated photonic devices at low cost. In recent years, the company has established a strong global market presence by shipping

more than 25 million Fabry-Perot (FP) and DFB lasers in high-growth markets such as EPON (Ethernet Passive Optical Network) and GPON (Gigabit Passive Optical Network).

"The current funding will enable BinOptics to leverage its patented laser structures and manufacturing processes to move into new materials and markets," said Gefinor Ventures' Chris Davis.

BinOptics, a supplier of compound semiconductor lasers current products include a wide range of FP and DFB lasers as well as lasers with integrated monitoring photodiodes. With modulation speeds up to 10 Gbps, these products provide transceiver and other photonic equipment manufacturers with unprecedented price-performance advantages.

BinOptics also provides custom integrated components for optical systems and subsystems. These solutions deliver exceptional value through cost, size, and power reductions by replacing several discrete components with a monolithic chip.

InP fibre-coupled diode laser for minimally invasive therapy

Laser Operations' 200W 1470nm indium phosphide laser has double the output power of the original laser of this kind launched in 2009

Recent developments in performance of InP semiconductor materials and beam combination optics pioneered by Laser Operations LLC have enabled a new milestone for "eyesafe" fibre-coupled laser module performance.

The Ultra-500 QPC Lasers fibre-coupled module now produces 200W CW from a standard detachable 550µm core fibre at a wavelength of 1470nm. This achievement represents a doubling of output power since the launch of the first laser of this kind in 2009), in the same Ultra-500 conduction-cooled rugged package.

The increased power will enhance ablation rate and efficient blood coagulation for applications such as Benign Prostate Hyperplesia and ENT surgery where "eyesafe" wavelengths have already demonstrated superior clinical results.

The small laptop-size and low power consumption of the conduction-cooled Ultra-500 diode laser module (>25% conversion efficiency) enables a 3X to 5X reduction in size and cost of ownership versus incumbent laser technologies which are based on power hungry, high maintenance and bulky DPSS or flashlamp-based laser platforms.

The OEM module is equipped with redundant fibre sensors and monitor photodiodes, visible aiming beam, field-replaceable blast shield, integrated cooling plate and thermistor for "plug and play" system integration.

Jenoptik's Berlin plant for high-power semiconductor lasers

The investment for the expansion is in total approximately € 10 million. This will more than double the production capacities of gallium arsenide based lasers from 2013.

Jenoptik laid the foundation stone for the expansion of the semiconductor production in a

ceremony attended by around 80 invited guests on 12 Dec 2011. They included representatives from business, the world of politics and industry as well as the Jenoptik workforce at the Berlin-Adlershof site.

“Germany is and remains a location for high-tech manufacturing even though we in the Jenoptik Group are currently pushing forward the process of internationalization in Asia and North America,” said Jenoptik Chairman Michael Mertin at the ceremony to celebrate the laying of the foundation stone. He emphasised the need for investment primarily in the technology-intensive field. “Our local industry knows how to position itself as a supplier of high-tech to the world,” continued Mertin.

The existing production facility in Berlin has reached the limits of its capacity and is being expanded as a result of the high level of customer satisfaction and rapidly increasing demand, particularly from Asia, for future projects as well as for the advancing process of internationalisation by the Lasers & Material Processing division.

The new building will more than double the production capacities. The expansion will increase the gross floor area by around 1,400 sq m to around 3,400 sq m. The production area, including clean room area, will increase from a total of 540 sq m to 930 sq m and is expected to be available to production from 2013.

The manufacturing facility will be automated and equipped with state-of-the-art production technology. GaAs will be structured and processed to create high-power laser bars in a typical semiconductor manufacturing process.

The various work areas will be fitted out with clean room facilities in the categories of between 100 and 1,000 particles per cubic metre – depending upon the requirements of the process step. The complete process line from epitaxy, wafer processing and facet coating through to the manufacture of GaAs components will be installed in the clean rooms.

A total of around € 10 million will be invested in the extension. The financing of the building will be provided by the Hoesch Dortmund pension fund, the internal fittings, including clean rooms as well as the production equipment will come from Jenoptik. Including the existing production facility, the total amount of the investment at the Jenoptik Berlin-Adlershof site will then come to approximately € 24 million.

The laser bars from the production facility at Berlin-Adlershof will be sent to customers all over the world and will be processed to create high-power diode lasers at Jenoptik in Jena. This is a field in which Jenoptik is considered one of the leading suppliers and an acknowledged world leader in quality. The group has the entire technology chain at its disposal – from the manufacture of high-power diode lasers, the most energy-efficient of all types of lasers, through to laser processing systems for material processing.

Jenoptik has had its own production facility in Berlin-Adlershof since 2006. The optoelectronic base material and its efficient manufacture are developed by Jenoptik in close cooperation with the locally based Ferdinand-Braun-Institut, Leibniz-Institut for Ultra High Frequency Technology (FBH).

Dr. Philippe Roussel to present at CS Europe Conference 2012

Defining the next steps for the Compound Semiconductor Industry,Dr. Philippe Roussel of Yole Développement will present the talk “Wide Bandgap device market update”.

Following the success of CS Europe 2011, next year’s conference is expanding to 2 days and offers a fantastic mix/quality of speakers making it the must attend industry event for 2012.

Register at www.cseurope.net & book your delegate place now as numbers will be limited. The conference takes place on 12th/13th March 2012 at Hilton Hotel, Frankfurt, Germany.

A networking dinner will also be held on the night of 12th March.

Conference Chair

Dr Andrew W Nelson, President & CEO, IQE

Conference Schedule:

Markets and III-V CMOS - Morning 12th March

A mix of insightful market research presentations & cutting-edge research destined to shape tomorrow’s compound semiconductor industry with talks including:

Compound Semiconductor Markets: Current Status and Future Prospects - Asif Anwar, Director – Strategic Technologies Practice, Strategy Analytics

The Market for LEDs in Lighting- Mr. Philip Smallwood, Lighting Market Analyst, IMS Research

Wide Bandgap device marketupdate - Dr. Philippe ROUSSEL, Senior Project Manager, Yole Développement

European efforts to develop III-Vs on 200 and 300 mm silicon- Dr. Matty Caymax, Chief Scientist, Imec

An Overview of the DARPA Diverse Accessible Heterogeneous Integration (DAHI) Program- Sanjay Raman, Program Manager, Defense Advanced Research Projects Agency/Microsystems Technology Office

The Integration of silicon CMOS with III-Vs- Professor Iain Thayne, University of Glasgow

III-Vs on 200 mm Si for VLSI– Dr Richard Hill, Project Manager, Sematech

III-V 3D Transistors- Peide Ye, Professor of Electrical and Computer Engineering, Purdue University

LEDs, lasers, PV and electronics - Afternoon of 12th March & full day of 13th March

KEYNOTE SPEAKER*: III-V on Silicon: Challenges and Opportunities*- Robert S. Chau, Intel Senior Fellow, Intel

SiC and GaN Electronics- Dr. John Palmour, Cree co-founder and chief technology officer Power & RF, Cree

Ammono’s ammonothermal method to make GaN substrates– Dr. Robert Dwiliński, President, CEO, Ammonno S.A.

Tomorrow’s RF chips for mobile devices- Todd Gillenwater, VP of Technology and Advanced Development, RFMD

Building a Successful III-V Pure Play Foundry- Dr. John Atherton, Associate Vice President, WIN Semiconductors

Scalable “on-silicon” solutions (GaN-on-Si and Ge-on-Si) using rare oxide buffer

layers– Dr. Michael Lebby, General Manager & Chief Technology Officer, Translucent Inc.

III-Nitride Lasers Based on Nonpolar/ Semipolar Substrates- Dr James W. Raring, VP Laser Engineering, Soraa Inc.

Markets and Applications for SiC Transistors - Dieter Liesabeths, Vice President Sales & Marketing, SemiSouth Laboratories, Inc.

Perspective of an LED Manufacturer- Professor Iain Black, VP WW Manufacturing Engineering, Technology & Innovation, Philips Lumileds Lighting Company

The CPV Market following the acquisition of Quantasol technology - Jan-Gustav Werthen, JDSU, Senior Director

Commercialisation of GaN on SI based Power Devices at International Rectifier- Dr. Michael A. Briere, International Rectifier

GaN the enabler for true SDR- Professor Rik Jos, RF Technology Fellow & Innovation Manager, NXP Semiconductors

Holistic Approach to MOCVD vacuum & Abatement- Dr Mike Czerniak, Product Marketing Manager, EdwardsVacuum Ltd

Advances in Wide Bandgap Semiconductors for Power Electronics- Dr. Markus Behet, Global market manager, Power Electronics, Dow Corning

Large diameter GaN-on-Si epiwafers for power electronics- Dr Mariane Germain, Co-Founder & CEO, EpiGaN

Achieveing Gan & GaAs RF Design Success through Product & Foundry Innovation– Mr Bryan Bothwell, Strategy and Business Development Manager – Foundry Services, TriQuint Semiconductor

Damage - free Deposition on LED devices- Dr Silvia Schwyn Thöny, Senior Process Engineer, Evatec Ltd

Temporary Bonding: An enabling technology for RF and power compound semiconductor devices - Dr Thomas Uhrmann, Business Development Manager, EV Group (EVG)

Solar

MiaSolé CIGS efficiency beats targets for panel production

Advancement in R&D and manufacturing efficacy is accelerating the advancement of CIGS thin film technology

MiaSolé has achieved a 17.3 percent champion device result, while the manufacturing process for 14 percent efficiency is now in production at its facility in Silicon Valley, California.

These latest achievements occur ahead of schedule, and represent an increase of more than 30 percent in efficiency from this time last year.

“The progress in efficiency gains we’ve repeatedly demonstrated are further proof that we’re aggressively moving toward a cost structure that is competitive with top-tier global solar manufacturers,” said John Carrington, CEO of MiaSolé.

With increased manufacturing efficiency and investment in research and development, MiaSolé has been able to unlock the vast potential for CIGS thin-film in the solar industry. To date, the firm has shipped over 55MW with

its panels being used for a wide range of global projects in North America, Europe and Asia.

The panels have been selected for a range of segments from utility scale fields to rooftops, and unique applications like electric vehicle recharging stations.

“Our ability to deliver 14 percent in production with the capability to achieve efficiency up to 17 percent further emphasises the progress we are continuously making against our roadmap,” said Carrington. “Our ultimate goal is to continue scaling innovation and deliver the lowest levelised cost of electricity to our customers.”

Manz gives an updates on its CIGSfab

The efficiency of CIGS modules from the Manz CIGSfab is nearing the lab values attained by ZSW. The CIGS “innovation line” acquired from Würth Solar is also accelerating technological development

Manz presented the latest advances to its integrated production line for the manufacture of CIGS thin-film solar modules, the Manz CIGSfab, at the fourth Thin-Film Conference held by the solar industry magazine PHOTON.

This includes achieving the previously attained increases to module efficiency under mass production conditions, cutting the capital expenditures required for the Manz CIGSfab by nearly one fifth, and reducing the cost of manufacturing modules by 25 percent since 2010.

“Efficiency, capital expenditures for the equipment, and ongoing production costs – all three criteria help module manufacturers significantly cut their costs per watt. And in the current market phase, cutting costs is one of the main keys to a company’s success”, says Dieter Manz, founder and CEO of Manz.

Under the CIGSfab brand name the company has offered complete turnkey production lines, which are scalable from an output of 43 MW to over 350 MW, since 2010.

Market analysts are forecasting that the market for CIGS modules will double in the coming three years. CIGS technology has one of the highest potentials to cut costs and increase efficiency of all the thin-film technologies. As such, Manz’s strategic partner ZSW, the Centre for Solar Energy and Hydrogen Research Baden-Württemberg, located in Stuttgart, Germany, has already achieved efficiencies of over 20 percent in a laboratory setting.

Manz manufactured the solar panel, that it says, currently holds the world record for the highest level of efficiency ever achieved in a mass-produced panel, with an efficiency of 14 percent (15.1% aperture), on the CIGS innovation line that the company acquired in its entirety from Würth Solar at the beginning of this year.

In addition to the complete rights to the technology, Manz also acquired 118 specialists with the CIGS innovation line. “This level of expertise gives us an absolutely unparalleled position in the PV industry and can accelerate technological advancements in the field of CIGS,” explains Dieter Manz.

The next upgrade to Manz’s CIGS innovation line installed in Schwäbisch Hall will be a completely new system for co-deposition developed by Manz Coating. This system allows throughput to be increased by 50 percent. When it comes to advancements to its CIGSfab turnkey lines, Manz is also concentrating on cutting materials costs.

Since these costs amount to about 50 percent of the costs of manufacturing solar modules, Manz also sees significant potential to help solar power achieve grid parity in this area. In its technology road map, Manz offers module manufacturers a detailed schedule as the industry travels along the path to this goal.

Soitec completes acquisition of Altatech

The acquisition will provide Soitec access to specific equipment necessary to deliver its LED strategy. It will also support manufacturing ramp up of its new Plug&Sun stand-alone mini solar tracker system

Soitec, a manufacturer of revolutionary semiconductor materials for electronic and energy industries, has successfully completed its acquisition of all of the outstanding shares composing the capital of Altatech Semiconductor S.A.

Altatech Semiconductor was a privately held French company located in Montbonnot-Saint-Martin near Grenoble, France. Altatech, created in 2004 by a group of semiconductor professionals, currently develops highly efficient, cost-effective technologies and equipments for new applications in emerging markets.

The final purchase price was set to € 15 million. The acquisition was financed partly in cash and partly using Soitec stock, purchased by BNP Paribas Exane on the market. This was completed under the share buy-back program approved by the shareholders during the combined ordinary and extraordinary meetings held on June 24, 2011. Selling shareholders are bound by certain holding requirements for the portion of the purchase price to be paid in Soitec stock.

Soitec's products include substrates for microelectronics (most notably SOI : Silicon-on-Insulator) and concentrating photovoltaic systems (CPV). The company's core technologies are Smart Cut, Smart Stacking and Concentrix, which is based on III-V multi-junction cell technology. Applications include consumer and mobile electronics, microelectronics-driven IT, telecommunications, automotive electronics, lighting products and solar power plants for large-scale utilities.

MidAmerican Renewables acquires Topaz Solar Farm from First Solar

The cadmium telluride photovoltaic power plant in California will generate enough electricity for 160,000 homes

MidAmerican Renewables, LLC, a subsidiary of MidAmerican Energy Holdings Company, has completed its acquisition of the Topaz Solar Farm from First Solar.

The 550-mW photovoltaic power plant being built in San Luis Obispo County, California, will have the capacity to generate enough renewable energy to power approximately 160,000 average California homes.

"There is a growing desire to utilise renewable energy," said Bill Fehrman, president of MidAmerican Renewables. "Solar plays a crucial role in meeting renewable energy targets and portfolios. The closing of the Topaz project acquisition makes it the second solar project in our renewables business, and we look forward to evaluating and acquiring additional opportunities."

The Topaz project will be built, operated and maintained by First Solar. Construction began in December 2011 and is expected to be complete by early 2015. The project will create approximately 400 construction jobs and 15 ongoing operations and maintenance jobs.

"We are pleased to be moving forward with MidAmerican Renewables on the Topaz project — one of the two largest PV projects in the world, which are both being built by First Solar," said Frank De Rosa, First Solar senior vice president for business development — the Americas. "First Solar is the leading developer of utility-scale PV projects, and MidAmerican Renewables' investment in these renewable resources is a significant endorsement."

Pacific Gas and Electric Company will purchase the electricity from the Topaz project under a 25-year power purchase agreement, helping California meet its mandate to generate 33 percent of its power from renewable sources by 2020.

Developed by First Solar, the Topaz project will incorporate the company's advanced thin-film CdTe PV modules, which generate electricity with no emissions, waste or water use and have the smallest carbon footprint of any PV technology. Electricity generated from the Topaz project will displace approximately 377,000 metric tons of CO2 per year — the equivalent of taking approximately 73,000 cars off the road.

CIGS solar panels market to shine through rest of decade

NanoMarkets forecasts revenues from CIGS panels will reach $4.4 billion by 2017

While the recent announcement of a 150 MW solar farm supports the notion that CIGS technology is finally ready for prime time, NanoMarkets says that CIGS manufacturers will have to adopt new strategies to protect themselves from falling solar panel prices.

"CIGS Photovoltaics Markets – 2012" is the latest in NanoMarkets' ongoing series of industry reports on CIGS markets. Applications sectors covered include rigid panels (conventional and BIPV), flexible PV, portable PV and BIPV glass. The report also includes in-depth analysis of the latest trends in CIGS manufacturing and their market impact. The eight-year forecasts in this report are broken out by application sector and by type of deposition/manufacturing. Both revenue and volume (MW) forecasts are included and the report also discusses the strategies of important suppliers of both CIGS panels and materials.

To meet the challenge of very low-cost crystalline silicon (c-Si) solar panels, CIGS will need to continue to improve on its cost per watt. NanoMarkets expects CIGS to succeed in this regard through volume production and manufacturing efficiencies such as thinner absorber layers and aggressive recycling of absorber materials. CIGS can also compete with c-Si based on superior aesthetics and good performance in indirect light.

NanoMarkets believes that reducing the cost of encapsulation is the key to success for flexible CIGS panels, which will generate more than $635 million by 2017. Current use of complex dyadic film encapsulation is proving very expensive and the new report suggests that there may be some potential for lowering costs by using overcoats of SiN, SiO2 and/or silicon oxynitride (SiOxNy)before final module encapsulation. The report also says that the CIGS industry will embrace low-cost advanced plastic substrates going forward as a replacement for polyimide.

NanoMarkets also believes that CIGS manufacturing will take new directions resulting in higher efficiencies and lower costs. Laser annealing of the absorber layer will become more common and will enable more thermally sensitive substrates to be used.

However, the cost of laser annealing equipment will need to be reduced before this can happen. Solution-based deposition is expected to play a growing role in the creation of CIGS panels based on new types of solvents. In the past, this type of approach has suffered as the result of high levels of impurities in the materials. However, hydrazine is now proposed as a solvent system for solution-based deposition, and has shown promising results in the lab. This new approach seems likely to considerable improve CIGS efficiency.

GaAs based module cell efficiency reaches a new high at 33.9%

Confirmed by the Instituto de Energía Solar of the Universidad Politécnica de Madrid, Semprius' gallium arsenide based multi-junction cells have been independently verified

Semprius, an innovator in high concentration photovoltaic (HCPV) solar modules, says it has set a new world record for photovoltaic module efficiency, reaching 33.9 percent (active area).

The module was tested indoors at Standard Test Conditions (850 W/m2, 25°C cell temperature, and a spectrum matched to AM1.5D) by the Instituto de Energía Solar at the Universidad Politécnica de Madrid (IES-UPM). This efficiency result, certified by the IES-UPM and corroborated by outdoor measurements made at the Institute of Concentration Photovoltaic Systems (ISFOC) in Puertollano, Spain, significantly exceeds the previous claim of 32.0 percent.

"This is a significant milestone for Semprius and the entire PV industry," said Scott Burroughs, vice president of Technology at Semprius. "For the first time, we have been able to convert more than one-third of the sun's energy into usable electricity. This demonstrates how concentrated PV can leverage rapidly increasing efficiencies to continue driving down the cost of solar generated electricity."

Semprius delivers a unique GaAs based multi-junction HCPV module design that begins with its proprietary micro-transfer printing process. This process enables the company to fabricate one of the world's smallest solar cells - approximately the size of a pencil point – to create solar modules with excellent efficiency and performance.

"This is the culmination of our emphasis on bringing smart design to solar," said Joe Carr, chief executive officer of Semprius. "We looked carefully at each component of our module – cell, optics, enclosure and the manufacturing process – to develop a competitive solution that embodies high efficiency, performance and reliability. Important to our customers is the fact that the module chosen for this third-party evaluation is part of the normal production distribution that will be commercially available later this year."

After developing its module with the support of the U.S. Department of Energy's National Renewable Energy Laboratory, Semprius is now ramping up global deployment of demonstration systems while completing construction of a pilot plant in Henderson, North Carolina. Commercial production at the plant will begin during the second half of 2012.

"Semprius as a leader in HCPV modules shows us that we have bet on the right technology," said Martin Pfund, CEO of the Siemens Energy Photovoltaic Business Unit. "The world record is a breakthrough in module efficiency. Combined with our expertise in turnkey solutions business, it has the potential to become a game changer for the solar markets in regions with high irradiation. With Semprius as a partner, we will further broaden our portfolio in the photovoltaics market. We're very pleased to be working together with Semprius to commercialise this technology globally."

Emcore announces reverse one for four stock split

The provider of compound semiconductor-based components and subsystems for the fibre optic and solar power markets expects the common stock will begin trading on a split adjusted basis on February 16, 2012

The Reverse Stock Split was approved by Emcore's shareholders at its June 14, 2011 annual meeting. The Reverse Stock Split will

become effective following the filing of an amendment to Emcore's corporate charter.

Emcore has set February 15, 2012, as the record date for the Reverse Stock Split and anticipates that Emcore common stock will begin trading on the NASDAQ Global Market ("Nasdaq") on a split adjusted basis at the opening of trading on February 16, 2012.

Nasdaq may append a "D" to the end of Emcore's current trading symbol to indicate the Reverse Stock Split, but the trading symbol would revert to "EMKR" after approximately twenty trading days. In addition, Emcore common stock will trade under a new CUSIP number following the effectiveness of the Reverse Stock Split.

When the Reverse Stock Split becomes effective, every four shares of issued and outstanding Emcore common stock will be automatically combined into one issued and outstanding share of common stock without any change in the no par value per share or rights and preferences of our common stock. This will reduce the number of issued and outstanding shares of Emcore common stock from approximately 94.0 million to approximately 23.5 million.

No fractional shares will be issued in connection with the Reverse Stock Split, as any fractional shares which result from the Reverse Stock Split will be rounded up to the next whole share. Furthermore, proportional adjustments will be made to Emcore options, warrants and other securities, entitling their holders to purchase shares of Emcore common stock. The number of authorised shares of our common stock will also be proportionally reduced from 200 million to 50 million.

Additional information regarding the Reverse Stock Split may be found in Emcore's definitive proxy statement filed with the Securities and Exchange Commission on May 5, 2011.

Amonix recognised for its quality operations

The designer and manufacturer of utility-scale concentrated photovoltaic (CPV) multi-junction III-V solar power systems has received ISO 9001:2008 and IEC 62108 certifications

Both certifications represent key milestones in Amonix' quality management system and field operation durability.

To become ISO 9001:2008 compliant, Amonix worked with a leading ISO accreditation agency that leveraged their vast aerospace and defence program knowledge to conduct a thorough assessment to be eligible for submission to the International Organization for Standardisation. This certification of compliance recognises that the policies, practices and procedures ensure consistency and the highest quality standards in the products provided to customers.

Receiving IEC 62108 compliancy is an important milestone and verifies that Amonix CPV solar power systems are capable of withstanding the extreme climate conditions.

"Achieving ISO 9001:2008 and attaining IEC certification further solidifies our leadership in utility-scale solar." Amonix' Interim CEO, Jan Van Dokkum stated. "Such effort demonstrates our commitment to providing superior quality and reliability in our CPV solar power systems."

"Implementing an ISO-inspired, robust quality management processes adds immense value to our development and manufacturing plans," Azmat Siddiqi, VP of Quality and Reliability at Amonix added. "ISO achievement was accomplished in record time based on an existing solid foundation. This along with the IEC Certification proves that we are committed to excellence every day in all we do."

Sputtering targets affect cost and efficiency of CIGS

Changing the sputtering system from planar to rotary targets increases the target utilisation from about 30 to 75%

The sputtering process is one of the most important techniques for material deposition in CIGS manufacturing.

With innovative sputtering targets, CIGS producers can significantly reduce their production costs.

According to Plansee, a manufacturer of sputtering targets, most of the players in the market have two approaches to reduce CIGS module manufacturing costs. The first is to improve the target utilisation and the second is to use an alloy with increased conversion efficiency.

To address these problems, Plansee have introduced new monolithic and dogbone rotary target designs. With MoNa the company offers a new material alloy that increases conversion efficiencies.

Monolithic rotary target

Plansee says that changing the sputtering system from planar to rotary targets increases the target utilisation from about 30 to 75%, which saves expensive raw material. Depositing the molybdenum back contact by monolithic molybdenum rotary targets - which are completely made of molybdenum - gives additional benefits: The expensive bonding of molybdenum on a stainless steel backing tube is not required. What's more, a higher sputtering power of up to 30 kW/m can be applied.

This creates a very high heat load which cannot be accommodated by bonded-type targets: Indium is used as bonding material which melts at only 156 °C . This eliminates the risk of de-bonding with monolithic targets. A higher sputtering power results in a higher deposition rate and improved thin film properties, e.g. higher electrical conductivity.

In contrast to the high lateral homogeneity of thin films deposited by sputtering, a sputtered target normally has an erosion profile which is not homogeneous – a result of different plasma densities. As a consequence, the targets have to be replaced even if there is sufficient material on most of the target area. To overcome this limitation, targets with varying outer diameter (named "dogbone" for rotary targets) or thickness is a solution to extend the target lifetime and increase the target exchange interval.

Two elements have a big impact on the CIGS cell efficiency: iron (Fe) and sodium (Na). Iron degrades the cell performance by introducing defects in the CIGS structure. Sodium has the opposite effect ; It concentrates defects at grain boundaries, which is needed for achieving high efficiencies.

Low iron levels are only achieved by a high purity of the primary materials as well as a high quality manufacturing process. Especially for molybdenum targets the iron content can vary significantly. The traditional way to introduce sodium into the CIGS absorber is by means of a soda-lime-glass substrate.

During the manufacturing process sodium diffuses from the glass through the molybdenum back contact into the absorber layer, resulting in a sodium concentration in the order of 0.1 at%. However, reproducibility and lateral homogeneity of this process is low, and flexible substrates do not act as sodium source.

Solar cell producers now have an easy alternative at hand. By sputtering a layer of sodium doped molybdenum, the amount of sodium in the absorber layer can precisely be controlled and reproduced.

Plansee offers MoNa sputtering targets with high purity and a uniform and fine grained microstructure. Tests in cooperation with the Swiss EMPA institute have already proven their benefits in practice. With sodium doped molybdenum layers the efficiency of CIGS solar cells could be significantly improved.

GreenVolts and ISD to provide solar solutions in California

The two firms will install complete and fully integrated III-V multi-junction solar cell systems for agricultural applications

GreenVolts has formed a strategic partnership with Independent Solar Developers (ISD), a turnkey solar system developer, owner, and operator.

ISD specialises in providing solar energy solutions for Southern California agricultural applications.

Solar Panels at Belk Farms, California

Using solar energy for agriculture is a large and untapped opportunity. In California alone, agricultural businesses require over 2,000 MW and use more than 10 TWh annually. These businesses have plenty of land and sun, ideal for solar energy, and are very interested in lowering their cost of electricity, which can exceed 20 percent of production costs.

GreenVolts and ISD have worked closely together to develop a solution that provides long term, economical electricity supply along with a unique set of land use, project planning, installation, and operational benefits tailored to this market. ISD can also provide financing, thereby overcoming the primary barrier for most projects. With its first project installed and operating successfully, and others in progress, GreenVolts is delivering tailored solutions for irrigation, cattle, food processing, and other agricultural applications.

“I cannot overemphasise the advantage that a complete system from one supplier with a single, overall, 20-year warranty presents to an owner who is considering solar energy,” said Peter Molloy, Principal, Independent Solar Developers. “GreenVolts is high performance, rugged, and an overall excellent fit for agricultural applications.”

GreenVolts’ CPV systems are based on III-V compound semiconductor multi-junction cell technology. This is the most efficient solar technology available for hot, sunny environments such as the Southwest U.S. agricultural areas. The modular design can be configured for distributed loads, such as irrigation pumps located on different parcels of land, or scaled up to meet higher demand, such as refrigeration in the processing of vegetables. ISIS, the energy management software included with the system, allows remote monitoring and management of all the systems from anywhere on the Internet.

“ISD has established themselves as a total solution partner to their customers, going beyond just solar. They offer energy analysis, system audits that include usage and load patterns, financing, and operations

and maintenance, and will do everything possible to reduce the cost of energy," said David Gudmundson, president and CEO of GreenVolts. "Our installation for irrigation in Coachella Valley went well, and we already have projects for several different applications underway."

Eugenia Corrales to brighten up Nanosolar as new CEO

The CIGS cell manufacturer has also received significant amounts of funding from the California Energy Commission as well as the National Science Foundation

By appointing industry veteran Eugenia Corrales, the thin film solar manufacturer has completed the transformation of its senior management team.

Current CEO Geoff Tate will retire after two years at the company.

Eugenia Corrales , CEO of Nanosolar

Tate recruited Corrales in May 2010 to serve as the executive vice president of engineering and operations. In this role, she has led the company's transition to a commercial production phase while achieving both efficiency and production capacity benchmarks for Nanosolar.

For the past 18 months Corrales has managed all Operations, as well as Engineering, Purchasing and Planning for both the San Jose, California and Luckenwalde, Germany sites. Under Corrales, cumulative shipments have gone from zero to 10MW; and median panel efficiencies are now 11.5%.

Corrales held a number of executive positions including several years as a Vice President at Cisco where she ran all of Product Operations for Cisco-branded products. She was previously responsible for Manufacturing Operations of $7B in router, switching and optical product revenue. Prior to Cisco, Corrales spent 11 years in engineering and R&D management at HP.

Prior to joining Nanosolar, she was founder and VP engineering of two cleantech startups. She holds a bachelor's degree in physics from Grinnell College and a master's in mechanical engineering from Stanford University.

Tate, who joined Nanosolar in early 2010, was recruited as an interim CEO with the charter to build an executive team capable of scaling into high volume manufacturing at high efficiencies and low cost.

Today's transition is the culmination of that effort. Tate had retired from Rambus in 2006 and is returning to retirement.

"I would like to congratulate Geoff on the tremendous progress made during his tenure at Nanosolar," said Erik Straser, Nanosolar board member and general partner, Mohr Davidow Ventures. "Eugenia's track record at Nanosolar and prior speaks for itself, and this planned transition will allow the company to maintain its momentum and trajectory. We are confident that under her stewardship we can grow the market for Nanosolar Utility panels and expand our global footprint."

"I am proud of the work we've done positioning the company for its next stage of growth," said Tate. "With Eugenia at the helm, the team and the technology are poised to make giant

strides."

"I am thrilled to lead such a talented team as we leverage this innovative printing technology to fulfil our mission to become the world's lowest cost cell and panel manufacturer, independent of subsidies," said Corrales. "We will continue to deliver on our stated production goals and efficiency roadmap for 2012."

CIGS innovator NuvoSun endorses Vistrian's software

In conjunction with VistrianMES, the FactoryLOOK manufacturing intelligence solution provides visibility, traceability & accountability to NuvoSun's manufacturing operations

FactoryLOOK is a Manufacturing Intelligence System used by a number of companies including manufacturers of Solar, Semiconductor, Advanced lighting, Data Storage, Networking, and Electronic assembly.

FactoryLOOK allows for the gathering, analysing and archiving significant amounts of information from throughout the factory including tooling, utilities, testing, metrology, recipe tracking and legacy data systems/ databases.

FactoryLOOK allows for the immediate alerting and identifying of process anomalies and the ability to quickly identify factors affecting the development process or manufacturing process and their associated variables thus reducing costs, and reducing the development time of a product.

Vistrian FactoryLOOK interface

Along with FactoryLOOK, Vistrian is also providing its integrated VistrianMES software that integrates seamlessly with FactoryLOOK utilising its unique "Quick Launch" feature. This feature brings a uniquely high degree of usability by all users with all functions accessible with just a few clicks of the mouse. VistrianMES allows for managing the factories materials, workflow, WIP and long-term field correlation.

Vistrian configures all elements of FactoryLOOK and VistrianMES without the need for a 3rd party integrator or internal IT department resources thus significantly reducing implementation cost.

Ronald Allen, Vistrian's co-founder and CEO states, "we are very excited to have been selected by NuvoSun. Vistrian is a company founded and operated by manufacturing executives who have integrated their knowledge and experience into a software system allowing for a true benefit to the user based on our true experience. Our products allow for us to accommodate unique customer needs with our installation base growing Worldwide. The integration of FactoryLOOK and VistrianMES along with our unique "Quick Launch" system will allow our product to be adopted by all users in the organization providing full adoption and visibility to NuvoSun."

Dave Pearce, president and CEO of NuvoSun said that "the team at Vistrian has worked closely with us to implement their system to meet our specific needs and work with us every step of the way. Vistrian's short implementation time has allowed us to bring up our process in record time while being scalable to our future needs. We are confident with Vistrian's software we can run a consistent process at any factory location throughout the world."

FactoryLOOK is used as a tool to integrate all processes and equipment data and to provide access to all users using a web browser. This includes the Facility, Environmental, Tooling, Test Equipment, Flat Files, Legacy systems (MES, ERP) and Operator interfaces. FactoryLOOK's tool set features provide analysis, alerts, dashboards and reports using the integral rules engine in real-time, thus providing the user with timely information to optimize operations and processes. Vistrian says its customers have reported significant improvements in utilisation and yields. FactoryLOOK has also found a common application for the monitoring of offshore manufacturing sites and vendors.

Vistrian claims the FactoryLOOK has proven invaluable with its user base both in high volume and pilot production environment. It has helped to increase yields, reduce process and development time and increase process uptime through significantly increased visibility to the process and the variables that affect it.

Magnolia Solar explores new limits on solar cell performance

The firm's aim is to increase both the current and voltage output of single-junction compound semiconductor cells

Roger E. Welser, Chief Technology Officer of Magnolia Solar, Inc., presented an invited paper at a SPIE Photonic West Conference on the Physics, Simulations and Photonic Engineering for Photovoltaic Devices.

The presentation, entitled "Exploring the Radiative Limits of Dark Current Operation in InGaAs Quantum Well Solar Cells," was made on January 23, 2012 in San Francisco, as part of a special session on Quantum Well and Superlattice Solar Cells.

Welser stated, "Magnolia Solar has developed a novel device structure that suppresses undesirable recombination events, enabling photovoltaic devices to reach new levels of performance. To better design and realise ultra high efficiency solar cells, we continue to explore the underlying physical mechanisms controlling the power output. The aim of our ongoing work summarised at the SPIE conference in San Francisco is to increase both the current and voltage output of single-junction cells by employing a quantum-structured active region and advanced light-trapping strategies. With this patent-pending approach, we expect to demonstrate high solar electric conversion efficiency over a wider range of operating conditions."

Ashok K. Sood, President and CEO of Magnolia Solar Corporation, stated, "Photovoltaic devices can provide a mobile source of electrical power for a variety of commercial and defense applications in both space and terrestrial environments. Many of these applications can directly benefit from enhancements in the efficiency of the photovoltaic devices. Magnolia Solar is developing and commercializing revolutionary new thin-film solar cell technologies employing nanostructured materials. In collaboration with our partners, we intend to update our shareholders as we continue the development effort for next generation high performance solar cells."

CIGS solar market to nearly double to $2.35 billion and 2.3 GW in 2015

A standout performance in 2011 has raised expectations but only a few manufacturers like Solar Frontier, Avancis and Solibro are likely to succeed

Manufacturers took advantage of falling production costs, improving module conversion efficiencies and increasing adoption in commercial rooftops in 2011, according to Lux Research.

The firm's report titled, "Sorting through the Maze of CIGS Technologies: Who Will Cash in on the Breakout Year?" says CIGS technology will benefit from a surge in demand to nearly 2.3 GW in 2015, nearly double the current 1.2 GW level.

However, it will still face numerous challenges including a sharp fall in venture capital money. In the emerging environment, few manufacturers - among them, Solar Frontier, Avancis, and Solibro - will succeed, mainly through strategic partnerships and investments that are critical to ramp capacities and improve production processes.

"Manufacturers have begun ramping meaningful capacities and there have been tremendous improvements in module efficiency," said Pallavi Madakasira, Lux Research Analyst and lead author of the report. "Now, strategic partnerships between start-ups and industrial conglomerates are likely to determine this technology's overall viability and competitiveness."

Lux researchers positioned CIGS developers based on their Technical Value and Business Execution, with companies that are strong on both axes reaching the "Dominant" quadrant -- and also assessed each company's maturity, providing an overall "Lux Take."

The report says Solar Frontier is a clear winner, with a solid position in the "Dominant" quadrant -- and was the only firm to earn a "Strong Positive" take. With inroads into new and emerging markets such as India, where it is selling over 30 MW of panels, Solar Frontier excels in overall execution.

Global Solar, Avancis and Solibro are likely to consolidate. The three companies are likely to emerge as bankable players. Global Solar has demonstrated slow but steady progress and is currently selling its PowerFLEX Technology, a shingle product, to Dow. Still, to succeed it needs to adopt a less conservative approach. Avancis has a joint venture with Hyundai Heavy Industries for CIGS module production in Asia. As for Solibro it will need to quickly and independently strengthen its financial position to succeed.

Stion, Miasole and Nuvosun can emerge as champions. All three are "Dominant" with the potential to emerge as early champions in this technology. However, their success will depend on capacity utilization and ramp-up, customer relationships, strategic partnerships and consistent execution in terms of their module costs, yield and module efficiency.

ISET, Flisom and AQT can be acquisition targets. All three are "High Potential" companies -- firms with strong technical value but weaker business execution scores -- and have assets that make them prized acquisition targets.

AQT gets ready to commercialise CZTS solar cells

The firm says earth abundant materials hold the promise to reduce the cost of thin-film solar cells including CIGS technology

AQT Solar reckons it has achieved near world record efficiencies using a low cost and production friendly sputter deposited CZTS (copper-zinc-tin-sulphide) thin-film solar cell.

AQT has established that the same manufacturing-ready processes and platforms used to make its CIGS 2.0 solar cells are ideally suited for CZTS. The firm has adopted the term CIGS 3.0 to refer to its future CZTS product to reflect the broad production compatibility and similarities of the two systems.

Like their CIGS counterparts, AQT CZTS cells are manufactured as drop-in replacements for crystalline silicon cells making their adoption seamless with existing crystalline silicon module manufacturing equipment and infrastructure.

The "earth abundant" raw materials comprising CZTS are claimed to be substantially cheaper than those in CIGS, making it much cheaper to produce. An added benefit of these constituents is that they are mined and available worldwide, mitigating any geopolitical influence on raw material sourcing.

The firm says this will eliminate concerns such as the Indium availability and price volatility that have impacted the display and thin-film photovoltaics (TFPV) industries in the past.

A great deal of research and development has been conducted on CZTS since the mid-1990s, and CZTS thin-film solar cells made by IBM employing a complex organometallic spin coating process have recently achieved efficiencies as high as 10.4 percent. In contrast, AQT has rapidly achieved close to 10 percent efficiencies for sputtered CZTS by leveraging the manufacturing process and platform foundation established for its CIGS product.

AQT plans to have CZTS modules "under sun" later this year and actively begin the product commercialization process. By employing the same capitally-efficient platform for its CZTS product as it does for its CIGS product, AQT is further validating the flexibility and long shelf life of its equipment and manufacturing strategy.

"The founders of AQT, all of whom have previously worked in capitally intensive commodity industries, have experienced firsthand the huge disruption to business that occurs when re-capitalisation is required due to technology migration and we have done everything possible to avoid this from affecting our business," said Michael Bartholomeusz, CEO of AQT Solar. "Early on we recognised the critical necessity to adopt a future-proofed manufacturing platform and strategy and it remains a cornerstone of our business, enabling us to easily adapt solar cell production to new, advantageous materials such as CZTS."

CIS modules to power largest commercial California plants

The completed project between Solar Frontier and enXco is set to become the world's largest solar installations

Solar Frontier and enXco have signed a module supply agreement for up to 150 megawatts peak (MWp) of Solar Frontier's CIS solar modules.

A firm order for 26 MWp was completed and delivered in the last quarter of 2011 for the Catalina Solar Project located in Kern County, California.

The second plant in California will be built in two phases – the first phase of approximately 60 MWp is targeted to go online by the end of 2012 and the remainder of the project by June 2013. The plant will generate enough clean energy to power the equivalent of about 35,000 homes annually and will offset about 74,000 metric tons of greenhouse gas emissions every year.

"This is a landmark moment not only for Solar Frontier but the CI(G)S industry as a whole," said Gregory W. Ashley, chief operating officer of Solar Frontier Americas. "We have demonstrated successfully that the unique characteristics of CIS technology are compelling to major customers by delivering more KWh over the lifetime of a project for a lower cost. We see this project as a launch pad for ever greater CIS achievement in the United States and across the world. We are pleased to work with enXco, which has shown its commitment to the industry by continuing to develop and build utility-scale solar projects."

"We are excited to deploy Solar Frontier's thin film technology," said Kristina Peterson, Vice President, Solar Business Unit for enXco. "With its gigawatt-scale production capacity, and favourable energy production profile, Solar Frontier and its parent company Showa Shell Sekiyu, have positioned themselves through a long and proven development process to be able to meet the supply expectations required for such large utility-scale projects."

Abound Solar and Solarsis commission CdTe plant in India

The 1MW project will be the first in the Andhra Pradesh region to use Abound Solar's cadmium telluride modules

Abound Solar and Solar Integration Systems (Solarsis), a solar system integration company in India, have installed a 1MW solar photovoltaic plant in Kadiri, Andhra Pradesh, India.

The commissioning officially took place on January 14, 2012 and comes less than a year after the two companies announced a partnership targeting the fast-growing Indian solar market.

This project was commissioned under the Rooftop and Other Small Solar Power Generation Plant (RPSSGP) Scheme administered by IREDA under the Jawaharlal Nehru National Solar Mission (JNNSM).

It is the first project in the state of Andhra Pradesh to use Abound Solar CdTe thin-film modules. The combination of Abound Solar's low-cost modules and Solarsis' homegrown racking and mounting solution cuts down on the overall balance-of-system (BoS) cost of the project.

"This plant will generate operational data on different technology performance in Indian weather," said Venkat Rajaraman, CEO of Solarsis.

"India is a key market for Abound Solar due to our U.S.-made CdTe panel's excellent performance in India's climate, our commercial focus over the past two years and our successful use of U.S. Export-Import Bank financing. We have a significant installed base in India and see this growing in 2012," said Craig Witsoe, President and CEO of Abound Solar. "Solarsis is a good partner for us, offering project and local industry expertise."

ThomasLloyd appoints a new head of Solar Energy

The firm strengthens its Merchant Banking business by appointing Matthias Altieri as Managing Director, head of Solar Energy

Prior to joining ThomasLloyd, Altieri spent five years as Vice President with Q-Cells, a leading CIGS solar manufacturer, where he was responsible for Business Development.

In that role he drove Q-Cells' worldwide expansion of its solar energy businesses. He has been with ThomasLloyd in London since early December 2011.

In his new capacity, Altieri will be responsible for sourcing new business both in the provision of technology and in the sourcing of new development opportunities. He will head the solar advisory team, seeking to build on the track record already established by ThomasLloyd based on among others the successful financial close of the 70 MW solar installation in Sault Ste. Marie which is one of the biggest ground mounting systems in North America.

Tony Coveney, Executive Director and Head of Merchant Banking, says, “Matthias is a hugely popular and well-connected character in the solar sector, with deep sector experience and a wealth of great contacts. We are very excited that he has chosen to work with us.”

While he worked with Q-Cells over the past five years, Matthias Altieri was jointly responsible for the expansion of the company’s solar business in Europe, North- and Latin America as well as Asia. Part of his function was to launch new photovoltaic technologies such as thin-film modules (CIS, CIGS, CdTe).

In his role as Vice President Origination, he expanded Q-Cells’ system business. This included the evaluation, set-up, management and sale amounting to a scale of more than 350 megawatt (MW) on three continents. He also managed more than 70 project companies and was the CEO of Q-Cells Italia.

T.U. Michael Sieg, Chairman & CEO ThomasLloyd Group, says, “Matthias can draw on a large and valuable international network in politics and economy. He is an active member of several professional associations like the German Solar Industry Association, as well as being a board member of the Italian equivalent Assosolare and the European umbrella association EPIA.”

Brian Robertson of Amonix passes away

The CEO and Board Director of the multi-junction III-V solar cell manufacturer will be sorely missed

Brian Robertson tragically passed away in a plane crash in York County, Pennsylvania on December 22, 2011.He was Chief Executive Officer and a Director of the Board at Amonix, whose CPV products are particularly suited for use in utility-scale solar power in sunny and dry climates.

Brian Robertson

Brian Robertson joined Amonix in late 2009, bringing deep expertise in solar start-ups and developing early stage organisations and significant solar power plant development and solar financing experience. He worked in many corporations including solar power manufacturing plant development company Sunworks Solar LLC, where he was co-founder and CEO (2008-2009). Prior to that, he co-founded Sun Edison LLC.

Brian Robertson has built several companies from early stage development. In 1996, he co-founded PlanetAll, where he served as Chief Technical Officer until Amazon.com acquired the web-based services start-up in 1998.

He was instrumental in building out community and personalisation technologies as a group

program manager at Amazon.com, where he also launched the company's toy business.

In 1999, Robertson also co-founded Visible Markets, an electronic trading platform for mortgage- and asset-backed securities, where he was CEO until the platform was acquired by Thomson Financial in 2001.

Robertson is a graduate of Massachusetts Institute of Technology with a degree in Computer Science and holds an MBA from Harvard Business School, where he led students' efforts to install solar panels on the Shad Hall athletic facility.

Married with three children, he was an avid pilot with instrument and commercial rating licenses.

All at Compound Semiconductor offer our deepest condolences to all friends and family of Brian Robertson.

TFG Radiant elevates ownership in Ascent Solar to 41%

The Thornton, Colorado, CIGS based solar panel manufacturer believes it will enable TFG Radiant to lead in rooftop and portable power applications in East Asia

Ascent Solar has announced that TFG Radiant Investment Group, is poised to increase its ownership interest in the company.

TFG Radiant acquired approximately 20 percent of the outstanding shares of Ascent in August 2011. The increase will put TFG Radiant's ownership at approximately 41 percent.

TFG Radiant will purchase the stake in the Company presently owned by Norsk Hydro Produksjon AS for $4 million, or approximately $0.50 per share. The transaction is expected to close within the next 90 days.

Victor Lee, managing director of TFG Radiant and an Ascent board member, said, "We continue to be very excited about the market potential for Ascent's transformational solar power technology. No other manufacturer can match the combination of power density and flexibility, which we believe will enable TFG Radiant to lead in rooftop and portable power applications in East Asia."

"We are pleased to see that our most recent strategic partner, and licensee for our technology in East Asia, is increasing its commitment to Ascent," commented Ron Eller, Ascent president and CEO. "

We have the same vision for our unique, high performing flexible technology to bring solar power to everyday lives in a seamless and compelling manner."

Soitec to acquire Altatech for € 15 million

The integration will entitle Soitec to accelerate its development roadmap in the electroluminescent diodes area, as well as in CPV systems

Soitec, an innovator of III-V semiconductor materials for the electronics and energy industries has announced a letter of intent for the acquisition of all of the outstanding shares composing the capital of Altatech Semiconductor.

Altatech is a French company that specialises in the development of highly efficient technologies and equipment. Located in Montbonnot Saint Martin near Grenoble, the acquisition is to be completed before the end of January 2012.

Altatech's integration within Soitec shall entitle the latter to accelerate its development

roadmap in the electroluminescent diodes area, as well as in the concentrating photovoltaic systems, especially the Plug&Sun mini-trackers systems (launch announced last December 13).

For the purposes of this transaction, Altatech's base value was set to € 15 million, in line with the independent appraisal carried out at Soitec's request by Oddo Corporate Finance.

The acquisition of all of the shares composing the capital of Altatech shall be financed partly in cash and partly using Soitec stock. Selling shareholders shall be bound by certain holding requirements for the portion of the purchase price to be paid in Soitec stock.

BNP Paribas Exane was mandated by Soitec to implement its share buy-back program as approved by the shareholders during the combined ordinary and extraordinary meetings held on June 24, 2011 and purchase on the market the Soitec stock to be allotted to the Altatech selling shareholders as consideration for their shares.

As a result of the personal interest held by André-Jacques Auberton-Hervé in the capital of Altatech, whose supervisory board he chairs, the transaction was carried out by Soitec's finance department and the Audit Committee of the Board of Directors. The transaction was approved by a decision of the Board of Directors of Soitec dated November 15, 2011. André-Jacques Auberton-Hervé neither deliberated not voted on this transaction.

The acquisition documentation must be finalised and the final purchase price must be determined before January 25, 2012.

New head of European Sales Operations at First Solar

Stephan Hansen will leave the CdTe solar cell manufacturer on May 1 2012

First Solar has announced that Christopher Burghardt will lead Sales Operations for First Solar in Europe in addition to his current responsibilities leading Government Affairs in the region.

In his new role Burghardt will report to Jim Brown, President of Global Business Development, and will continue to report to Maja Wessels, Executive Vice President of Public Affairs, with respect to his Government Affairs responsibilities. Stephan Hansen, who has led First Solar's European sales organisation for the past seven years, will leave First Solar effective May 1 2012.

Both moves are part of a realignment of First Solar's European sales team amid a broader consolidation of the Company's worldwide sales and business development activities. As previously announced, First Solar has combined its Utility Systems Business Group and Components Business Group under a unified global structure led by Jim Brown, who has been appointed to the new role of President, Global Business Development.

"Christopher has a deep understanding of European markets that will be invaluable as we position our sales effort to develop sustainable, utility-scale energy opportunities," said Brown. "Stephan's contribution to First Solar cannot be understated. He helped found our European business and led it, with deep customer relationships, to more than $1 billion in annual sales and 4 GW of cumulative sales. Stephan will work with us to ensure a smooth transition."

"I am proud to have helped First Solar become the industry leader that it is today and I am confident that Christopher will build on this success," said Hansen. "With a highly talented

and motivated team and superior technology First Solar is best positioned to lead Europe into a subsidy-free PV market."

Burghardt joined First Solar in Sept. 2009 as Vice President of Government Affairs for EMEA. Prior to joining the company he was most recently Vice President for Corporate Affairs of Anheuser-Busch InBev for Western Europe and a Vice President for Business Development and Marketing EMEA at Hill & Knowlton in the EMEA region. He is a dual German-Belgian national and earned an MBA from the Wharton School of Business at the University of Pennsylvania, a master's degree from the College of Europe and a bachelor's from the University of Sussex and the Institut d'Etudes Politiques of Aix-en-Provence.

Stephan Hansen joined First Solar as Managing Director for the EMEA region in 2004. At the same time he was Vice President for Sales, Market Strategy and Customer Service. Before joining First Solar he spent 5 years in the U.S., first as general manager of a research & development venture, then starting his career in the photovoltaic industry as Chief Operating Officer of Schott Applied Power, a distribution and engineering, procurement and construction provider and Vice President of Sales and Marketing for RWE Schott Solar. He earned his master's degree in mechanical engineering from the University of Stuttgart.

CdTe solar innovator First Solar awards its top suppliers

The cadmium telluride solar cell manufacturer presented NOVA awards to STR Holdings, Grenzebach and Master Pack

First Solar recently honoured its premier suppliers at the company's first Supplier Recognition Day, held on December 8 in Phoenix, Arizona.

Approximately 60 of First Solar's top-spend suppliers attended the event, three of which were honoured with the company's NOVA award for outstanding performance in 2011.

First Solar created the NOVA award to recognise suppliers who significantly support the company's mission.

"Our suppliers play an essential role in achieving our mission to create enduring value by enabling a world powered by clean, affordable solar electricity," said Doug Duval, Vice President, Global Supply Chain. "We appreciate the exceptional efforts of these NOVA award recipients and value they provide through the highest standards of quality, cost and performance."

The companies honoured with the NOVA award include STR Holdings, an innovator in solar panel encapsulation; Grenzebach, a material handling solutions company; and Master Pack, a specialty packing and shipping company.

Collaboration with STR Holdings, significantly contributed to First Solar's cost-per-watt roadmap, quality performance and supply risk reduction. Grenzebach's flexible partnering approach enabled on-time execution of key technical initiatives, and Master Pack's support significantly contributed to First Solar's cost-per-watt roadmap in Malaysia.

Emcore quarterly gross profit plummets by 22%

On the positive side, consolidated revenue for fiscal 2011 increased by 5% from fiscal 2010, to $200.9 million

Emcore Corporation has announced its financial results for its fourth quarter and fiscal year ended September 30, 2011.

Consolidated revenue for the fourth quarter ended September 30, 2011 was $52.1 million, which represents a 4% decrease compared to the prior year. Revenue for the Fibre Optics segment was $30.9 million, a 10% decrease compared to the same quarter last year. Revenue for the Photovoltaics segment was $21.2 million, representing an 8% increase compared to the prior year.

Consolidated gross profit was $10.0 million, a 22% decrease compared to the prior year. Consolidated gross margin was 19.2%, which represents a decrease from the 23.6% gross margin reported in the same quarter last year.

On a segment basis, Fibre Optics gross margin was 18.0%, a decrease from the 20.4% gross margin reported in the prior year. Photovoltaics gross margin was 21.0%, a decrease from the 29.3% gross margin reported in the same quarter, 2010.

The consolidated operating loss was $14.4 million, which represents a $12.6 million increase in operating loss when compared to the prior year. Emcore says the quarter-over-quarter variance was primarily due to the $8.0 impairment charge recorded on the long-lived assets of its Fibre Optics segment offset slightly by the change in litigation settlements totalling $1.5 million and a decrease in non-cash stock-based compensation expense of $1.1 million.

The consolidated net loss was $14.3 million, which represents a $13.4 million increase in net loss when compared to the prior year. The consolidated net loss per share was $0.15, which represents a $0.14 increase in net loss per share when compared to the same quarter last year. During the fourth quarter ended September 30, 2011, the firm recorded $1.0 million of non-operating expense related to its Suncore joint venture.

Annual Financial Results

Consolidated revenue for fiscal 2011 was $200.9 million, which represents a 5% increase compared to the prior year. On a segment basis, revenue for the Fibre Optics segment was $125.6 million, which represents a 3% increase compared to the prior year. Revenue for the Photovoltaics segment was $75.3 million, which represents an 8% increase compared to the same quarter last year.

Consolidated gross profit was $42.8 million, a 16% decrease compared to the prior year. Consolidated gross margin was 21.3%, which represents a decrease from the 26.5% gross margin reported in the prior year.

On a segment basis, Fibre Optics gross margin was 18.5%, which represents a decrease from the 23.1% gross margin reported in the corresponding quarter last year. Photovoltaics gross margin was 26.0%, a decrease from the 32.3% gross margin reported in the prior year.

The consolidated operating loss was $32.5 million, which represents an $11.1 million increase in operating loss when compared to the prior year. The year-over-year variance was primarily due to the decrease in gross profit and the $8.0 impairment charge recorded on the long-lived assets of the firm's Fibre Optics segment, offset slightly by lower stock-based compensation expense of $2.4 million and the net gain related to litigation settlements totalling $1.1 million.

The consolidated net loss was $34.2 million, which represents a $10.5 million increase in net loss when compared to the prior year. The consolidated net loss per share was $0.38,

which represents a $0.10 increase in net loss per share when compared to the prior year. During fiscal 2011, Emcore recorded $1.8 million of non-operating expense related to its Suncore joint venture.

As of September 30, 2011, cash, cash equivalents, and restricted cash totalled approximately $16.1 million. With respect to measures taken to improve liquidity, in December 2011, Emcore amended the Wells Fargo credit facility, which included adding new classes of assets into the borrowing base calculation and reducing the excess availability covenant requirements. As a result of this amendment, the firm can increase its potential borrowings by up to $14 million.

In addition, the company entered into an equity line of credit arrangement with Commerce Court Small Cap Value Fund, Ltd. in August 2011, pursuant to which, it may sell up to $50 million in shares of its common stock over the 24-month term.

Business Outlook and Commentary

As disclosed on October 24, 2011, flood waters infiltrated the offices and manufacturing floorspace of Emcore's primary contract manufacturer in Thailand. The areas used to manufacture its fibre optic products and our process and test equipment were submerged in several feet of flood water for more than a month. As a result, the manufacturing infrastructure that supports approximately 50% of Emcore's Fibre Optics segment revenue was damaged.

This has had a significant impact on operations and the firm's ability to meet customer demand for fibre optics products. Production capabilities for three major product lines were impacted: these include Telecom products, such as tunable lasers and our high-volume tunable XFP line (our low-volume TXFP production line is in the Bay Area and producing products), Cable television (CATV) laser components and transmitters, and other legacy products.

Over the past two months, Emcore has been developing and implementing alternative manufacturing plans in its facilities in China and the U.S. to meet short-term customer demand. Concurrently, Emcore has been focusing on rebuilding the high-volume production infrastructure for impacted product lines in other locations owned by its primary contract manufacturer in Thailand, as well its China facility.

The focus during the rebuild is on a quick recovery and strategies to better configure the equipment for efficiency, reduce costs and provide manufacturing diversification in order to turn this crisis into an opportunity.

Purchase orders have been issued to replace the damaged process and test equipment and new equipment is now being received. Between its own facilities and its contract manufacturer, Emcore expects to rebuild its production capacity for its CATV business by the end of March 2012, and rebuild the production capacity of its Telecom production lines before the end of May 2012. The company is working closely with customers on its recovery manufacturing plan to align with their needs.

As for the inventory materials, Emcore were able to move a significant portion of its finished goods inventory to the second story of the facility right before the flood waters reached the manufacturing floor. This has allowed Emcore to serve the near-term demands of some key customers. The major focus is to work with customers to meet their near-term needs and to ascertain that the demand will still be there for Emcore's products when it is back to full capacity. Emcore says many of its key customers for Telecom products have stepped up and committed their demand through non-cancellable purchase orders and pre-payments. As a result, the production capacity for tunable lasers in calendar 2012, when it is fully recovered, is almost fully booked with the existing commitments from customers.

Emcore has entered into agreements with its

key contract manufacturing partner and Wells Fargo Business Credit. These agreements significantly improved the Company's liquidity position while it processes and receives proceeds from insurance claims. The firm believes it has a solid plan in place to rebuild impacted business.

Emcore says its manufacturing infrastructure in the Photovoltaics segment was not impacted by the flooding.

The Company expects the revenues for its first quarter of fiscal year 2012 ending December 2011 to be in a range of $36 to $38 million with the sequential revenue decline primarily attributable to the flood impact to its Fibre Optics business.

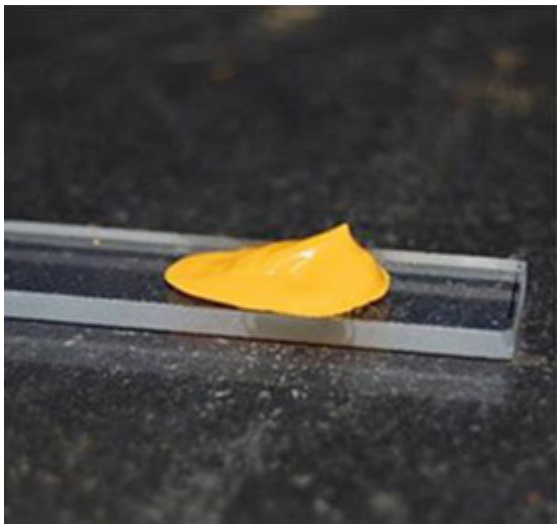
Emcore discussed its financial results on 27 December 2011. The call has been archived for one year and can be accessed from the firm's website.

Sun-Believable paint-on solar cells

Scientists say they have developed a solar paint which can be made cheaply and in large quantities. If the efficiency can be improved, they may be able to make a real difference in meeting energy needs in the future

Imagine if the next coat of paint you put on the outside of your home generates electricity from light- electricity that can be used to power the appliances and equipment on the inside.

A team of researchers at the University of Notre Dame has made a major advance toward this vision by creating an inexpensive "solar paint" that uses semiconducting nanoparticles to produce energy.



This paste of cadmium sulphide-coated titanium dioxide nanoparticles could turn large surfaces into solar cells. (Photo Credit: ACS Nano)

"We want to do something transformative, to move beyond current silicon-based solar technology," says Prashant Kamat, John A. Zahm Professor of Science in Chemistry and Biochemistry and an investigator in Notre Dame's Centre for Nano Science and Technology (NDnano), who leads the research.

"By incorporating power-producing nanoparticles, called quantum dots, into a spreadable compound, we've made a one-coat solar paint that can be applied to any conductive surface without special equipment."

The team's search for the new material, described in the journal ACS Nano, centred on nano-sized particles of titanium dioxide, which were coated with either cadmium sulphide or cadmium selenide. The particles were then suspended in a water-alcohol mixture to create a paste.

When the paste was brushed onto a transparent conducting material and exposed to light, it created electricity.

Prashant Kamat

“The best light-to-energy conversion efficiency we’ve reached so far is 1 percent, which is well behind the usual 10 to 15 percent efficiency of commercial silicon solar cells,” explains Kamat.

“But this paint can be made cheaply and in large quantities. If we can improve the efficiency somewhat, we may be able to make a real difference in meeting energy needs in the future.”

“That’s why we’ve christened the new paint, Sun-Believable,” he adds.

Kamat and his team also plan to study ways to improve the stability of the new material.

NDnano is one of the leading nanotechnology centres in the world. Its mission is to study and manipulate the properties of materials and devices, as well as their interfaces with living systems, at the nano-scale.

This research was funded by the Department of Energy’s Office of Basic Energy Sciences.

Stion secures $130 million funding led by Korea

The CIGS solar cell manufacturer is continuing its expansion in Mississippi and is launching operations in Korea

Stion has announced a $130 million equity investment led by Avaco and Korean private equity funds.

Existing investors Khosla Ventures, Taiwan Semiconductor (through VentureTech Alliance), Lightspeed Venture Partners, Braemar Energy Ventures, and General Catalyst Partners all participated in the round.

Stion is continuing the planned expansion of its US manufacturing facility in Hattiesburg, MS. Stion will establish a subsidiary in Korea (“Stion Korea”) to build a thin-film module factory to help serve the Asian and European markets. Stion will make a $35 million initial investment into Stion Korea.

“This investment and partnership represents an exceptional opportunity for Stion,” said Chet Farris, Stion’s President & CEO. “Solar has always been a global business and this investment enables Stion to address market demand in Asia and beyond. We have added world-class investors as well as a strategic partner with deep technical expertise.”

“I congratulate Stion officials on this latest round of investment,” said Governor Haley Barbour of Mississippi. “Stion opened its first commercial-scale manufacturing plant in Hattiesburg this fall, and I am proud that the innovative company’s high-efficiency, thin-film solar panels are now being produced in Mississippi and selling like hotcakes. I wish Stion continued success as it ramps up to full production in Hattiesburg and continues to sell all it can produce.”

The transaction includes a strategic partnership with Avaco, a leading provider of thin-film

processing equipment. The two parties will collaborate to develop next generation thin-film production equipment, focusing on lowering costs, improving tool productivity and increasing module efficiency.

"We are very excited to combine our advanced equipment technology with Stion's innovative thin-film PV module manufacturing expertise," said Jae-Gon Wee, the Chairman of Avaco. "The strategic partnership between Avaco and Stion will accelerate each company's technology roadmap, thus enabling much faster growth for both parties."

Stion is producing high-efficiency, thin-film solar modules using a simple, low-cost monolithically integrated circuit design. Stion's module has a convenient form factor (65 cm x 165 cm) and is specifically designed for use in all major market segments. Stion recently produced one of the world's most efficient monolithic thin-film circuits at production scale, which was verified at 14.1% efficiency by the National Renewable Energy Lab.

Soitec reveals San Diego North American solar headquarters

The III-V compound semiconductor solar cell factory will be capable of supplying more than 300-MW in solar projects to provide electricity to SDG&E

Soitec inaugurated its new North American solar headquarters and manufacturing plant in San Diego at a ceremony held on Friday, December 16.

Governor Edmund G. Brown Jr., spoke at the event. Also participating in the factory dedication were San Diego Mayor Jerry Sanders, Jessie J. Knight, chairman and CEO of San Diego Gas & Electric Company (SDG&E) and California Public Utilities Commissioner (CPUC), Timothy Simon. They were joined by governmental officials and over 300 community and business leaders that attended the dedication event.

The San Diego based factory is to supply more than 300-MW in solar projects to provide electricity to SDG&E. All Power Purchase Agreements (PPAs) have been approved by the CPUC.

The new factory will enable a manufacturing capacity of 200-MW of Soitec's fifth generation of Concentrix III-V multi-junction CPV modules, with the opportunity for future expansion to double the capacity to 400-MW per year.

Soitec's highly efficient, durable CPV systems have enabled the company to plan for more than 300-MW in utility-scale solar power plant projects throughout the Southwest U.S., including 155- MW in PPAs with San Diego Gas & Electric, approved by the CPUC last month.

In addition, a power purchase agreement for up to 150-MW for the Imperial Solar Energy Centre West project, another project that currently proposes to use Soitec's CPV technology, was approved by the CPUC on December 15. Tenaska Solar Ventures, LLC, an affiliate of independent energy company Tenaska, is developing that project. Jerry Crouse, CEO of Tenaska also attended the dedication event on Friday.

"SDG&E has signed more contracts using CPV technology than any other utility in the world - a distinction we're proud of," said Jessie J. Knight, Jr., chairman and CEO of SDG&E. "At the time we began our talks with Soitec, we realised we had a unique opportunity to negotiate not only a good contract for solar energy at prices that competed head-to-head with other technologies, but also to solidify an agreement that would bear fruit for years to come in new local jobs and overall economic benefits. From a reliability and grid stability perspective, this technology is far superior to other typical ground-mounted arrays."

With installations on four continents around the world, Soitec's CPV technology has proven to be one of the most efficient and most environmentally friendly solar power technologies. It demonstrates unique cost competitiveness compared to other solar technologies, largely due to its higher production yields at peak times and lower construction and maintenance costs. In addition, CPV technology's abilities to operate without cooling water, to withstand hot ambient temperatures and to accommodate the dual use of land with minimal environmental impact make it perfectly suited for use throughout the desert southwest.

Soitec employs a distributed manufacturing model which locates CPV module factories close to its customers to provide the most efficient and environmentally beneficial green power. The distribution model also calls for a large percentage of local content and local job generation.

"Soitec's new facility will create hundreds of well-paying jobs and build on San Diego's growing reputation as one of the world's leading clean-technology clusters," commented San Diego Mayor Jerry Sanders. "We are so honoured and proud to welcome Soitec to the San Diego community, and I know that San Diego's collaborative business community will continue to work with Soitec to ensure the company's success and prosperity."

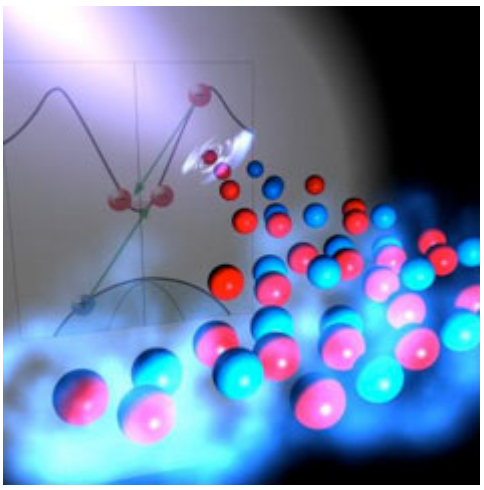
CPUC Commissioner Timothy Simon also commented during Soitec's dedication event. "I encourage Soitec to continue to work with the other utilities in our state and in our nation so we can ensure that this very important technology is doing its best to help us reduce greenhouse emissions," said CPUC Commissioner Simon. "I look forward to working with President Peevey and my fellow commissioners to ensure that all needed essentials to make this project successful continue to have the support of the CPUC."

Governor Brown noted, "I'm glad to be here for the dedication of Soitec's manufacturing plant. The expansion of clean energy businesses is a direct result of legislation mandating that one-third of California's electricity come from renewable sources by 2020. That's a goal and we're going to meet it. In fact, we are going to do better."

Terahertz pulse increases electron density in GaAs by a thousand

These findings may lead to the development of ultra-high-speed transistors and high-efficiency photovoltaic cells using gallium arsenide

Researchers at Kyoto University have made a breakthrough with broad implications for semiconductor-based devices.



A picosecond terahertz pulse causes an avalanche of excitons to burst forth from GaAs (Credit:Courtesy Tanaka Lab, Kyoto University iCeMS)

Working with GaAs, the team observed that exposing the sample to a terahertz (1,000 gigahertz) range electric field pulse caused an avalanche of electron-hole pairs (excitons) to burst forth. This single-cycle pulse, lasting merely a picosecond (10-12 s), resulted in a 1,000-fold increase in exciton density compared

with the initial state of the sample.

“The terahertz pulse exposes the sample to an intense 1 MV/cm2 electric field,” explains Hideki Hirori, team leader and Assistant Professor at Kyoto University’s Institute for Integrated Cell-Material Sciences (iCeMS). “The resulting exciton avalanche can be confirmed by a bright, near-infrared luminescence, demonstrating a three-order of magnitude increase in the number of carriers.”

Research in Kyoto using terahertz waves is led by Koichiro Tanaka, whose lab at the iCeMS pursues numerous applications including the development of new biological imaging technologies.

“Since terahertz waves are sensitive to water, our goal is to create a microscope that will allow us to look inside living cells in real time,” says Tanaka. “These just-released results using semiconductors are an entirely different field of science, but they demonstrate the rich potential that lies in the study of terahertz waves.”

This work was supported by Grant-in-Aid for Young Scientists (B) (Grant No. 21760038) of the Japan Society for the Promotion of Science, and also Grant-in-Aid for Scientific Research on Innovative Area “Optical science of dynamically correlated electrons (DYCE)” (Grant No. 20104007) and Grant-in-Aid for Creative Scientific Research (Grant No. 18GS0208) of the Ministry of Education, Culture, Sports, Science and Technology, Japan.

This research is further detailed in the paper “Extraordinary carrier multiplication gated by a picosecond electric field pulse” by H. Hirori *et al* in the online December 20, 2011 issue of *Nature Communications*.

Isofoton leads photovoltaic research in the EU

The Spanish company is showing a lot of activity in European R&D photovoltaic technology projects

To commemorate its 30th anniversary, Malaga based firm photovoltaic manufacturer Isofoton takes a look back into its history of R&D&i activities in the European region.

The European Union has several instruments aimed at supporting photovoltaic technology research and development, the most relevant of which is the Seventh Framework Programme for Research and Technology Development.

Known as FP7, the NMP activities support nanotechnology and nanoscience projects, in addition to projects associated with new production and material development processes.

Between 2007 to 2013, the EU backed 39 R&D&i projects in the field of photovoltaic technology. These projects are grouped into 7 theme categories or clusters under the name ANNEX. The total sum contributed by the EU to these projects equals € 142.8 million, 90% of which come from FP7.

All this information has been collected from the report “Photovoltaics and nanotechnology: from innovation to industry” published by the European Commission.

Isofoton participates in 4 R&D projects of the 4 technology clusters that deal with the manufacture of existing photovoltaic devices, meaning the directly participates in over 10% of on-going photovoltaic technology projects at the European scale, ranking the firm as Europe’s first in terms of number of projects.

Isofoton is currently developing R&D activities along the four lines of work the EU considers have the greatest potential in the medium

term. Isofoton is listed among the firms that are leading the research effort together with renowned research centres such as the Fraunhofer ISE Institute (Germany), ECN (The Netherlands), imec (Belgium) and the Lausanne Federal Polytechnic School (Switzerland). Spain's second entity, Madrid Polytechnic University, ranks at 18. No other European company is listed among the first twenty entities.

ANNEX: DETAILED OVERVIEW OF RESEARCH CLUSTERS IN THE EU

The 7 clusters through which the European Union groups aid to photovoltaic technology include:

Cluster 1:Photovoltaic cells based on silicon wafers. These are first-generation photovoltaic devices.

Cluster 2:Thin film photovoltaic technology. This second-generation technology with a 12% market share covers diverse thin film technologies including CIGS and CdTe. Eight R&D projects are being financed under this cluster, where Isofoton participates in the so-called THINSI project (www.sintef.no/Projectweb/thinsi).

Cluster 3:Third-generation photovoltaic technology. This technology uses advanced concepts including nanomaterials (quantum dots, nanoparticles, nanowires, etc.) or new concepts for developing new photovoltaic devices such as organic cells. This heterogeneous cluster comprises 15 projects that are subdivided into three groups (quantum dot or nanowire based photovoltaics, organic cells and innovative nanostructures).

Cluster 4:Concentration photovoltaic technology. There are three projects that are financed by the EU under this group, where Isofoton participates in the NACIR project.

Cluster 5:This cluster focuses on innovations surrounding grid connections and photovoltaic installations (one project is currently being financed under this category).

Cluster 6:This cluster deals with the development of new manufacturing equipment (three projects are currently being financed under this category).

Cluster 7:This cluster deals with industry support on general and crosscutting aspects such as infrastructure, market, legal, quality and training. There are 6 projects that are currently being financed under this category. Although Isofoton does not participate directly, it does so indirectly through the European Photovoltaic Industry Association (EPIA), which participates in 4 of these initiatives.

MidAmerican Energy invests in Arizona NRG solar plant

The 290-MW Agua Caliente solar project is being constructed by cadmium telluride manufacturer First Solar

MidAmerican Energy Holdings is to acquire a 49% interest in the Agua Caliente solar project from NRG Energy.

The 290-MW solar photovoltaic (PV) project in Yuma County, Arizona, will generate enough electricity to offset about 5.5 million metric tons of carbon dioxide over 25 years.

The $1.8 billion project, is being constructed by CdTe manufacturer, First Solar and is expected to be complete by 2014. It is supported by a $967 million loan guarantee from the U.S. Department of Energy and a long-term power purchase agreement with Pacific Gas and Electric for all of the project's generation.

"We are aggressively pursuing opportunities to expand our presence in the renewable energy sector, and the Agua Caliente project is another important step toward that goal," said Greg Abel, Chairman, President and CEO of

MidAmerican Energy Holdings Company. “We look forward to partnering with NRG Energy on this exciting project.”

NRG first announced in May the company’s intention to bring quality partners into its large-scale solar projects, noting the strength and creditworthiness that credible partners can bring to these projects.

“Partnering with an industry leader like MidAmerican on Agua Caliente, one of the largest PV

projects in the world, enhances the strength and credibility of what was already one of the world’s leading solar projects,” said David Crane, NRG President and CEO. “NRG and MidAmerican complement each other in the capabilities and experiences they bring to this project and to solar power more generally.”

The deal is subject to certain customary closing conditions, including the U.S. Department of Energy approval.

This is the second solar project announced by MidAmerican this month. On December 7, MidAmerican announced it had purchased the 550-MW Topaz project, being built in San Luis Obispo County, California, from First Solar. The Topaz project is one of the world’s largest solar projects.

The MidAmerican group is one of the largest owners of wind-powered energy among rate regulated utilities and, at year-end 2011, 28% of its total generation capacity will be from renewable and non-carbon sources.

Avancis increases CIS production capacity six-fold

The firm’s second plant in Torgau is now operational and commercial market introduction of new products is planned for Q1 2012

Avancis has began production at its second plant at the company headquarters in Torgau, Germany.

The new production facility for state-of-the-art CIS solar modules has an overall capacity of 100 megawatt peak (MWp) per year. More than 200 new jobs have been created.

Successful start of production of Fab 2: The new plant of AVANCIS in Torgau, Germany, was build to produce modern CIS solar modules and has an annual capacity of 100 MWp

The new plant allows Avancis to expand its annual production capacity from the current 20 MWp to a total of 120 MWp. Construction began in June 2010 and was completed on schedule within just 18 months. At peak production on an area of 25,000 m², the company will now annually produce over 800,000 high-performance CIS solar modules – enough power to provide a town of 15,000 inhabitants with clean electricity for a year. The

number of employees at Avancis will double from the current 250 to almost 500.

“We are proud to be able today to begin operations at our second factory at the Torgau location on schedule and therefore ultimately be able to join the commercial mass production of CIS solar modules,” said Avancis CEO Hartmut Fischer. “Our new factory is currently the most state-of-the-art production facility in the CIS sector: developed and built by our own factory planning team and equipped with the most modern equipment by established German mechanical engineers, here we will produce the next generation of CIS solar modules,” Fischer added.

The multiplication of production capacity also means an expansion of the module portfolio. As a part of this Avancis is bringing together its existing and new product lines under the PowerMax umbrella brand. The already established product line that has until now used this name will be renamed PowerMax STRONG as of 1 January 2012; the module design and functions of this product line will remain unchanged. The new product line that will be produced in the new factory will be released onto the market under the PowerMax SMART brand in spring 2012.

“We are expecting our new product line including all necessary quality certificates to be commercially available by the end of the 1st quarter of next year. By then we will also have concluded the start-up phase of the new facility as well as the certification of the new product line,” explained Hartmut Fischer.

To mark the occasion of the commercial market introduction of PowerMax SMART, Avancis is planning a major celebratory event in spring 2012 in Torgau with attendance from investors, politicians, customers and members of the press. Until then the new product line, currently in the certification phase, will only be available upon request.

Avancis develops and produces photovoltaic modules based on CIS (copper indium selenide) technology. The innovative manufacturing process relies on the next generation CIS technology developed by the Avancis Research & Development department in Munich. The first two plants at the company’s headquarters in Torgau have an overall production capacity of 120 megawatt peak per year (MWp p.a.). The company is currently building a third factory of 100 MWp p.a. in South Korea as part of the ‘Hyundai-AVANCIS’ production joint venture.

Siemens, Shell and Saint-Gobain are some of the big names that helped cultivate the technology now available from Avancis while it was still in its infancy. The successes achieved in the field of photovoltaics are largely due to their efforts. As a wholly-owned subsidiary of Saint-Gobain since autumn 2009, Avancis benefits from Saint-Gobain’s many years of expertise in glass coating and heat treatment, both core competencies of this leading global construction and automotive glass supplier.

GreenVolts secures $35 million ABB investment

The stake in the US-based III-V compound semiconductor solar cell developer GreenVolts strengthens ABB’s focus on renewables

ABB, a global power and automation technology group, has agreed to invest approximately $20 million as part of a $35 million financial round, for a substantial minority stake in California-based GreenVolts, a leading provider of turnkey concentrating photovoltaic (CPV) systems.

Through the investment ABB gains access to GreenVolts’ proprietary technology and can now offer turnkey solutions for concentrating photovoltaic power plants in addition to its current capabilities in solar thermal and conventional photovoltaic power plants.

GreenVolts' CPV system is more efficient than traditional photovoltaic and thin-film modules. By optimising and integrating field-proven, high-performance components such as proprietary optics and tracking technology into a complete system, GreenVolts delivers energy yields that can be 30 to 40 percent higher than traditional panel-based systems.

"The technology combines simplicity and precision with unmatched performance, fast installation, easy operation and low cost of production," said Peter Leupp, head of ABB's Power Systems division. "Our extensive footprint, which covers all key solar markets in the world, will help us to make this technology globally accessible."

"Our complete and fully integrated photovoltaic system is an industry game-changer," said David Gudmundson, president and CEO of GreenVolts. "Every component was carefully designed to work together in a turnkey solution that dramatically reduces the cost and complexity of solar projects. With ABB's global presence and expertise, these benefits will now be available to customers worldwide."

First Solar selling 550-MW Topaz CdTe solar plant

MidAmerican Energy is planning to buy the cadmium telluride PV power plant which will generate enough electricity for 160,000 homes in California

MidAmerican Energy Holdings Company has entered into definitive agreements to acquire the Topaz Solar Farm from First Solar.

The 550-MW photovoltaic power plant being built in San Luis Obispo County, California, will have the capacity to generate enough renewable energy to power approximately 160,000 average California homes. The more than $2 billion Topaz project is one of the two largest PV projects in the world, both being built by First Solar.

"MidAmerican is the No. 1 owner of wind-powered energy generation among U.S. rate-regulated utilities. Adding solar energy to our generation portfolio is a strategic move to invest in yet another renewable energy source," said Greg Abel, chairman, president and CEO of MidAmerican Energy Holdings Company. "Our investment in wind resources benefits both our customers and the environment, and our entry into the solar energy industry expands our renewable energy footprint and will help meet current and future energy needs in a manner that reflects our ongoing commitment to environmental respect and cost-effective generation."

"As energy needs continue to increase, the Topaz project will allow MidAmerican to produce renewable energy for thousands of Californians. This project also demonstrates that solar energy is a commercially viable technology without the support of governmental loan guarantees and reflects the type of solar and other renewable generation that MidAmerican will continue to seek to add to its unregulated portfolio."

First Solar has agreed to construct, operate and maintain the Topaz project for MidAmerican. Construction began in November 2011 and is expected to be complete by early 2015. The project will create approximately 400 construction jobs and 15 ongoing operations and maintenance jobs. According to an economic benefits study by The Brattle Group and California Polytechnic State University, the project is estimated to infuse $417 million into the local economy, the majority of which will be generated during construction, with the remainder over the project's minimum 25-year operating period.

"First Solar is very pleased to bring together one of the world's most significant solar projects with MidAmerican, one of the leading investors in renewable energy," said Frank De Rosa, First Solar senior vice president of project and business development for North America. "This demonstrates solar is an important part of a renewable generation portfolio."

The closing of MidAmerican's acquisition of Topaz is contingent on the satisfaction of certain closing conditions specified in the acquisition agreement, including certain required actions with respect to the project's permits and electrical interconnection arrangements. The project sale is not contingent on MidAmerican obtaining debt financing.

Pacific Gas and Electric Company will purchase the electricity from Topaz under a 25-year power purchase agreement, helping California to meet its mandate to generate 33 percent of its power from renewable sources by 2020.

Developed by First Solar, the Topaz project will incorporate the company's advanced thin-film CdTe PV modules, which generate electricity with no emissions, waste or water use and have the smallest carbon footprint of any PV technology. Electricity generated from the Topaz project will displace approximately 377,000 metric tons of CO2 per year – the equivalent of taking approximately 73,000 cars off the road.

Concentrix solar panels the centre of attention in San Diego

Soitec will create 450 on-site jobs at its new manufacturing plant which is to manufacture gallium indium phosphide, gallium indium arsenide and germanium based CPV solar modules for the U.S. renewable energy market

Soitec has purchased a manufacturing facility in Rancho Bernardo, California, within San Diego City limits.

The French company will soon begin fitting the factory to produce its concentrator photovoltaic (CPV) modules for the U.S. renewable-energy market. The site, acquired from Sony Electronics, will enable a manufacturing capacity of 200 MW of Soitec's fifth generation Concentrix CPV modules and with future expansion to double the capacity to 400 MW per year.

This major project for Soitec represents an investment of more than $150-million and will create 450 on-site jobs ─ including employees for the joint venture ─ in the City of San Diego and more than 1,000 indirect jobs at full capacity (200 MW).

Soitec's investment includes the acquisition of a 176,000-square-foot manufacturing centre on 14.8 acres of land located within the campus of Sony Electronics' U.S. headquarters. Soitec will begin extensive upgrade of the facilities in early 2012 and plans to have its first phase (100 MW) production line operational by the fourth quarter of 2012.

M+W U.S., Inc, a subsidiary of the M+W Group, a global engineering and construction partner for technology-based clients and renowned in constructing solar cell manufacturing facilities, has been selected as general contractor for the facility construction work.

Situated inside the San Diego factory will be the joint venture Reflexite Soitec Optical Technology LLC, announced last month. This new company will operate its own 100-person manufacturing operation within the facility developing and manufacturing leading-edge silicone-on-glass (SOG) Fresnel lens plates used in Soitec's CPV modules.

"Bringing Soitec's solar manufacturing business here has been an example of successful collaboration between the city, the nonprofit

CleanTECH San Diego, the San Diego Regional Economic Development Corporation, SDG&E and the University of California, San Diego," said San Diego Mayor Jerry Sanders. "Soitec's new facility will create hundreds of well-paying jobs and build on San Diego's growing reputation as one of the world's leading clean-technology clusters."

"Soitec's local presence is indeed a welcome boost for our regional economy and will support our company's commitment to help to ensure a sustainable solar future for our customers," said Jessie J. Knight, Jr., SDG&E's chairman and CEO. "This year we have signed a half-dozen renewable energy contracts with solar developers that will use Soitec's highly efficient technology. We will continue to make great strides in securing contracts for utility-scale renewable projects to leverage the ideal solar, geothermal and wind resources in the San Diego County, Imperial County and Baja California region."

"Having already announced our solar projects contracted with San Diego Gas & Electric, it makes perfect sense for us to launch our U.S. manufacturing operations here," said André Jacques Auberton-Hervé, chairman and CEO of Soitec. "With strong support from the mayor and the City of San Diego, we look forward to taking part in the local economy amid the area's large pool of trained and educated high-tech employees, the vibrant business community and the strong cluster of renewable-energy companies. We want to help California meet its Renewable Portfolio Standard, which calls for a third of the state's utility-scale energy production to be generated by renewable sources by 2020."

Soitec's highly efficient, durable CPV systems have enabled the company to plan for more than 300 MW in solar power plant projects throughout the Southwest U.S. including 155 MW in power purchase agreements with San Diego Gas & Electric, approved by the California Public Utilities Commission (CPUC) last month. Additionally, a power purchase agreement for up to 150 MW for the Imperial Solar Energy Centre West project, another project that currently proposes to use Soitec's CPV technology, was also approved by the CPUC on December 15. Tenaska Solar Ventures, LLC, an affiliate of independent energy company Tenaska, is developing that project.

Soitec's CPV modules to be manufactured in San Diego have performance characteristics which are specifically designed to benefit large-scale utility power plants to deliver higher efficiency and lower cost of electricity.

First and only fully Integrated commercial solar system

The system incorporates triple-junction, III-V compound semiconductor cells and is claimed to reduce costs in all stages of the project lifecycle

GreenVolts has unveiled what it says is the industry's first complete and fully integrated solar system, including modules, trackers, inverters, and energy management software. Through control of the entire system design, GreenVolts says it has dramatically improved performance, simplified project engineering and installation, and reduced costs in all stages of the project lifecycle.

GreenVolts› system which includes modules, trackers, inverters, DC wiring, combiner boxes, weather &solar monitoring station, networking, and energy management

"Our complete system approach changes

the entire solar experience," said David Gudmundson, president and CEO, GreenVolts. "With GreenVolts, customers get simplicity, elegance, and precision in a utility-scale solar system that delivers higher performance and richer energy management than anything else in the world."

Traditional photovoltaic (PV) systems are composed of parts sourced from different suppliers, including solar panels, inverters, trackers, and monitoring. Because these parts are not designed to work specifically with one another, the overall system performance suffers. In contrast, GreenVolts provides a complete and fully integrated solar system, with installations producing thirty to forty percent more energy than traditional PV.

"There is nothing like this in the industry today. By providing a complete system with a fully integrated design, GreenVolts is raising the bar," said Jonathan W. Postal, SVP Business Development, Main Street Power. "We have had success with GreenVolts on our recent project in Yuma, Arizona, and are excited to work with them again on future projects."

Additionally, the GreenVolts solution includes ISIS, an advanced energy management software in the industry. Because ISIS was designed with, and fully integrated into, the complete GreenVolts solar system, it offers deeper access and more sophisticated capabilities than are available in third-party software products.

ISIS includes: real-time monitoring of site conditions and energy production; extensive fault isolation and diagnostics at the site, system or component level; inventory and asset management; operation and maintenance logs; hundreds of alerts and alarms; extensive and programmable reporting capability; and remote access and control of the entire system. ISIS is Internet-based, secure, fast, and easy to access from a PC or mobile device.

The GreenVolts system is installed at numerous customer locations across the Southwest U.S. in Pacific Gas & Electric, Southern California Edison, Tucson Electric, Imperial Irrigation District, and Arizona Power Service territories. Existing projects include agricultural, utility, municipal, commercial and industrial applications.

«Having built numerous solar projects from various solar vendors, we appreciate the fast and efficient installation of the GreenVolts system, which minimises the possibility of mistakes, thus providing better cost estimates and on-time schedules,» said Brian Bothman, vice president, Robert A. Bothman Construction, Inc. «Their approach simplifies everything, from logistics and site engineering, training and installation, to final commissioning.»

Key features of the GreenVolts system include:

· Increased efficiency: Advanced CPV modules are 2-3 times more efficient than those of traditional PV or thin film modules

· Greater energy yield: High-precision, two-axis, intelligent tracking system accurately follows the sun, allowing solar modules to operate at peak efficiency throughout the day and resulting in greater energy yield than single-axis or fixed-tilt PV

· Integrated inverters and motion control: Bi-polar, transformerless inverters, working with the tracker motion control, continually seek the maximum power output for the system

· Intelligent Solar Information System (ISIS): This sophisticated energy management software provides monitoring, diagnostics, reporting, and system control

· Increased durability, decreased maintenance: Weather and solar monitoring stations at each site ensure that the system is stowed in a face-down position during harsh conditions, as well as at night to reduce soiling, dust, and condensation

· Sophisticated solar information network: All subsystems and components are interconnected for communications, including GPS and Wi-Fi for intrasite status, and Internet communication via secure VPN

· Comprehensive customer care: GreenVolts provides a single point of support over the life of the project, from sales, to planning and design, to installation, to operation and maintenance

Photocurrent electrons overpower solar photons

Researchers from NREL have developed a solar cell using PbSe quantum dots which exhibits multiple exciton generation

The U.S. Department of Energy's National Renewable Energy Laboratory (NREL) says they have developed the first solar cell that produces a photocurrent that has an external quantum efficiency (EQE) greater than 100 percent when photo-excited with photons from the high energy region of the solar spectrum.

The EQE for photocurrent, usually expressed as a percentage, is the number of electrons flowing per second in the external circuit of a solar cell divided by the number of photons per second of a specific energy (or wavelength) that enter the solar cell. The scientists believe none of the solar cells to date exhibit photocurrent EQEs above 100 percent at any wavelength in the solar spectrum.

The EQE developed by NREL reached a peak value of 114 percent.

The newly reported work marks a promising step toward developing next generation solar cells for both solar electricity and solar fuels that will be competitive with, or perhaps less costly than, energy from fossil or nuclear fuels.

Multiple Exciton Generation (MEG) is key to making this possible. In this process, a single absorbed photon of appropriately high energy can produce more than one electron-hole pair per absorbed photon.

NREL scientist Arthur J. Nozik first predicted in a 2001 publication that MEG would be more efficient in semiconductor quantum dots than in bulk semiconductors. Quantum dots are tiny crystals of semiconductor, with sizes in the range of 1-20 nm.

On this scale, semiconductors exhibit quantum effects ; the bandgap rapidly increases with decreasing quantum dot size and correlated electron-hole pairs (excitons) are created at room temperature. What›s more, they exhibit enhanced coupling of electronic particles (electrons and positive holes) through Coulombic forces and improve enhancement of the MEG process.

Quantum dots, by confining charge carriers within their tiny volumes, can harvest excess energy that otherwise would be lost as heat – and therefore greatly increase the efficiency of converting photons into usable free energy.

The researchers achieved the 114 percent external quantum efficiency with a layered cell consisting of antireflection-coated glass with a thin layer of a transparent conductor, a nanostructured zinc oxide layer, a quantum dot layer of PbSe treated with ethanedithol and hydrazine, and a thin layer of gold for the top electrode.

In a 2006 publication, NREL scientists Mark Hanna and Arthur J. Nozik showed that ideal MEG in solar cells based on quantum dots could increase the theoretical thermodynamic power conversion efficiency of solar cells by about 35 percent relative to today's conventional solar cells.

Furthermore, the fabrication of Quantum Dot Solar Cells is also amenable to inexpensive, high-throughput roll-to-roll manufacturing.

Such potentially highly efficient cells, coupled with their low cost per unit area, are called «Third (or Next) Generation Solar Cells». Present day commercial photovoltaic solar cells are based on bulk semiconductors, such as silicon, CdTe, or CIGS, or on III-V multi-junction tandem cells. All of these cells are referred to as» First- or Second-Generation Solar Cells».

MEG, also referred to as Carrier Multiplication (CM), was first demonstrated experimentally in colloidal solutions of quantum dots in 2004 by Richard Schaller and Victor Klimov of the DOE's Los Alamos National Laboratory.

Since then, many researchers around the world, including teams at NREL, have confirmed MEG in many different semiconductor quantum dots. However, nearly all of these positive MEG results, with a few exceptions, were based on ultrafast time-resolved spectroscopic measurements of isolated quantum dots dispersed as particles in liquid colloidal solutions.

The new results published in Science by the NREL research team is the first report of MEG manifested as an external photocurrent quantum yield greater than 100 percent measured in operating quantum dot solar cells at low light intensity; these cells showed significant power conversion efficiencies (defined as the total power generated divided by the input power) as high as 4.5 percent with simulated sunlight.

While these solar cells are un-optimised and exhibit relatively low power conversion efficiency (which is a product of the photocurrent and photovoltage), the demonstration of MEG in the photocurrent of a solar cell has important implications because it opens new and unexplored approaches to improve solar cell efficiencies.

Another important aspect of the new results is that they agree with the previous time-resolved spectroscopic measurements of MEG and hence validate these earlier MEG results.

Excellent agreement follows when the EQE is corrected for the number of photons that are actually absorbed in the photoactive regions of the cell. In this case, the determined quantum yield is called the internal quantum efficiency (IQE).

The IQE is greater than the EQE because a significant fraction of the incident photons are lost through reflection and absorption in non-photocurrent producing regions of the cell. A peak internal quantum yield of 130% was found taking these reflection and absorption losses into account.

This research was supported by the Centre for Advanced Solar Photophysics, an Energy Frontier Research Centre funded by the DOE Office of Science, Office of Basic Energy Sciences. Scientists affiliated with the University of Colorado at Boulder also contributed to the study.

Further details of this work are published in the online publication, "Peak External Photocurrent Quantum Efficiency Exceeding 100 percent via MEG in a Quantum Dot Solar Cell ", *Science*, published online on 16 December 2011, Vol. 334 no. 6062 pp. 1530-1533.

DOI: 10.1126/science.1209845

First Solar slashes 2011 financial guidance

The cadmium telluride solar panel manufacturer has said the primary reason for the revised 2011 guidance is continued delays of certain projects in First Solar's systems business due to weather and other factors

First Solar has updated the Company's 2011 financial guidance and announced 2012 guidance.

First Solar now forecasts 2011 net sales in the range of $2.8 to $2.9 billion, down from

the Company's prior guidance range for net sales of $3.0 to $3.3 billion. The Company expects diluted earnings per share (EPS) for 2011 to be in the range of $5.75 to $6.00, with consolidated operating income of $575 to $600 million.

Not included in the revised guidance are expected charges related to a series of initiatives to accelerate operating cost reductions and improve overall operating efficiency, the majority of which the Company expects to incur in the current quarter. These charges include up to $0.75 per fully diluted share of impairment and associated charges primarily related to certain equipment, and a severance charge of up to $0.10 per fully diluted share related to a workforce reduction of approximately 100 associates, less than 1.5 percent of First Solar's workforce.

For 2012, First Solar forecasts net sales in the range of $3.7 to $4.0 billion, including approximately $1.7 billion from the systems business. Diluted EPS is expected to be in the range of $3.75 to $4.25, and consolidated operating income is expected to be $425 to $450 million. The Company expects to generate $0.9 to $1.1 billion of operating cash flow and plans for approximately $375-$425 million in capital investment in 2012.

"Our diverse business model and robust project pipeline will help First Solar generate a significant amount of cash in 2012 while improving operational efficiencies, but we are recalibrating our business to focus on building and serving sustainable markets rather than pursuing subsidized markets," said Mike Ahearn, Chairman and Interim CEO of First Solar.

"By channelling our core strength in utility-scale PV systems to markets with immediate need for mass-scale renewable energy our goal is to earn substantially all of our new revenues from sustainable markets by the end of 2014."

First Solar will discuss the Company's revised 2011 guidance and outlook for 2012 in a conference call scheduled on 14 Dec 2011 at 8:00 a.m. EST. Investors may access a live audio webcast of this call and presentation in the Investors section of the Company's website at www.firstsolar.com.

Company restructuring to boost First Solar efficiency

As a result of the reorganisation, TK Kallenbach, President of the Components Business Group and James Zhu, Chief Accounting Officer, will leave the cadmium telluride solar cell manufacturer in 2012

CdTe solar panel manufacturer First Solar will consolidate its worldwide sales and project development activities under Jim Brown, who has been appointed to the new role of President, Global Business Development.

The move combines First Solar's Utility Systems Business Group and Components Business Group under a unified global structure encompassing sales, project development, product management and the customer service and technical services groups. TK Kallenbach, President of the Components Business Group (CBG), will leave First Solar effective January 1, 2012.

In addition, First Solar has reorganised the structure and roles in its finance and accounting groups to optimise efficiency. As a result, James Zhu, Chief Accounting Officer, has elected to leave the company to pursue other opportunities. Mark Widmar, Chief Financial Officer (CFO), will add the role of Chief Accounting Officer to his responsibilities effective February 1, 2012, and Zhu will remain with First Solar through May 1, 2012 to ensure a smooth transition.

"We thank TK and James for their dedication and for their commitment to helping us build sustainable global markets for solar electricity,"

said Mike Ahearn, Chairman and interim CEO of First Solar. “These changes support our broader effort to reposition First Solar to lead the industry through the current market turbulence, and to better serve our customers around the world with comprehensive solar energy solutions.”

“First Solar is uniquely positioned in the PV (photovoltaic) industry to have a deep and meaningful impact on the future of electricity generation, and it has been rewarding to be a part of that success,” said Kallenbach.

Brown joined First Solar in 2008 as Vice President, Project Finance, and was appointed President of the Utility Systems business in Aug. 2011. Prior to joining First Solar, Brown worked in banking for approximately 20 years covering project and structured finance for the energy and industrial sectors.

Widmar joined First Solar as CFO in April 2011 from Graftech International, where he was CFO. Prior to joining Graftech in 2006, he held senior positions in finance and controlling at NCR, Dell, and Lucent Technologies. Widmar is a Certified Public Accountant (CPA).

Kallenbach joined First Solar in December 2009 as Executive Vice President of Marketing and Product Management and was appointed President of the Components Business Group in February 2011. Before joining First Solar, Kallenbach worked for Honeywell Aerospace for 30 years in variety of senior business, technical and strategy leadership positions.

Zhu joined First Solar in 2007 as Vice President and Corporate Controller and has been Chief Accounting Officer since 2009. Prior to joining, First Solar Zhu was Vice President and Corporate Controller at Salesforce.com.

Isofoton completes its first III-V HCPV plant in China

Chinese energy producer GD Solar has chosen Isofoton’s compound semiconductor solar cells for its Golmud plant. Over 200,000 residents in the area will benefit from the energy produced by the facility

Spanish firm, Isofoton has completed the installation of an electricity generation plant in China that is based on high concentration photovoltaic (HCPV) technology.

The 100kWp facility is located in the outskirts of the town of Golmud, in the Qinghai province in the northeast part of the country. The facility construction site sits at an elevation of 2,900 metres and is located in a geographical area that features one of the best solar resources on the planet, with over 7KWh/m2 and day of direct solar radiation in an area with very little annual precipitation.

Golmud HCPV plant

This plant will be the first of its kind developed by a company of non-Chinese origin. During implementation, Isofoton has worked with a local provider. China’s energy company GD Solar chose the Malaga based company for its experience and quality in HCPV technology, a field where Isofoton has been conducting steady research for over 10 years and one which continues to make the company a global

pioneer.

High concentration is a new yet already successfully proven technology by Isofoton that is capable of generating up to 50% more energy than conventional photovoltaic systems. To achieve this, HCPV systems must be installed under specific site conditions such as those existing in Golmud. Some nations like China, United States and Italy are betting strongly on this new promising technology which is capable of generating more energy at less cost, as well as creating jobs and wealth in areas of the globe where it is not possible to do so by other means.

The plant will be capable of producing over 220MWh/year that will be managed by GD Solar to satisfy part of the needs of the 200,000 residents of this area.

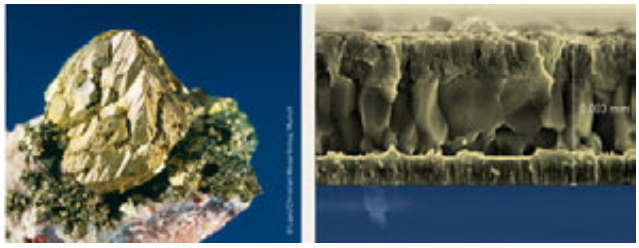
With this facility, Isofoton has achieved its ambitious objective of commercialising its HCPV technology in the Chinese market, one of the most demanding and complex, which also presents ideal locations for this type of technology.

Soltecture sets up new brand design

The CIS solar module manufacturer is expanding its range of services to customers and the entire range of its products has been renamed to reflect a more client-friendly process of planning and installation

Soltecture is taking another step in its growth from a manufacturer of photovoltaic solar modules towards becoming a source of intelligent solutions for solar construction.

With the introduction of a new brand design, Soltecture has restructured the array of services that it provides in the field of residential and commercial solar energy, improving client accessibility for the future.



CIS in nature and in a solar module: Chalcopyrite mineral and electron-microscopic image of a thin film.

"The focus of our new brand design is our client; they will get a focused overview of our services and portfolio," explains Soltecture's CSO Henrik Kruepper. "Through the integration of our system solutions with our range of services, and by renaming our products in less technical terms, we are delighted to give our brand a more focused and clear identity."

Soltecture offers complete system solutions for solar construction for large commercial sites and residences. The firm's products meet the demands of commercial and industrial BAPV (Building Applied Photovoltaics) projects; it offers Tectum, a flat-roof system, and Sertum for sloped roofs. Both the facade system Corium and the roof-integrated system Pallium meet the demands in integrated photovoltaics (BIPV).

Soltecture's array of services span from its online planning tool, SOLdesign, which allows quick and efficient planning and ordering of a solar energy system, to SOLtraining, a specialised training service for Soltecture's partners. These systems have been developed and tailored to various system solutions, offering custom-fitted consulting services for developers and installers.

The entire range of Soltecture's products have been renamed to reflect a more client-friendly process of planning and installation. Soltecture's thin-film CIS solar module is now called Linion, reflecting its pinstriped appearance.

Anthracite laminated and framed modules, Linion L and Linion F, are two of the most elegant modules on the market and can be used as building materials on building facades as well as roofing.

Components from the Inteo product family have been developed by Soltecure to custom-fit its products and guarantee easy and exact installation as well as optimum performance of the PV-systems. Completing Soltecture's product pallet is the Omnio product line, offering technical components for the various system solutions.

Presidential inauguration of COP17 solar flagship legacy project

Soitec's gallium indium phosphide, gallium indium arsenide and germanium based CPV solar cell plant is South Africa's first commercial solar power plant.

South Africa's first 500kW concentrator photovoltaic (CPV) power plant representing the COP17 flagship project was officially inaugurated by President Jacob G. Zuma on Sunday, December 4. Soitec is a developer and manufacturer of III-V semiconductor materials for the electronics and energy industries.

As the solar flagship legacy project for the 17th annual Conference of the Parties (COP17) to the United Nations Framework Convention on Climate Change (UNFCCC), the inauguration ceremony was attended by close to 200 distinguished guests including amongst others, President of COP17 and Minister of International Relations & Cooperation, Minister of Environmental Affairs, Minister of Energy, Minister of Economic Development as well as French, German and British governmental officials and their receptive ambassadors.

The solar plant located in Hazelmere, next to Durban, installed by Soitec and developed in partnership with the Department of Environmental Affairs (DEA) and Thekwini Municipality, was constructed in just one month. It showcases the country's commitment to lowering its carbon footprint through the deployment of renewable energy during COP17. Group Five, an integrated construction services, materials and infrastructure investment group operating in Africa, was the construction partner for the project.

In his keynote address, President Jacob G. Zuma said, "This is South Africa's first large scale offering within the Clean Energy Arena, but it is not the last. We congratulate all partners in this project. We are ready to forge and support those partnerships that will enable us to embark on the journey to a low carbon economy, while stimulating economic development and creating jobs," added President Zuma.

In her speech, Minister of Energy Dipuo Peters said, "It is encouraging that this project has already started contributing towards the Integrated Resource Plan 2010 which outlines 42% of renewable energy by 2030 and leaves a legacy for COP 17. This is an exciting development for South Africa and will be the forerunner of a range of renewable energy projects currently being developed in the country."

"This CPV is connected to the electricity distribution supply grid of the city to augment the power supply to the ICCC where the UNFCCC COP 17 is being hosted to reduce the carbon footprint of the event. This clearly demonstrates the state of readiness in the municipal's energy planning and installation

of this 500kw as a first phase. It is even more encouraging to see that the Municipality is a buyer of this clean electricity," she continued.

"Soitec is proud to continue supporting the country's young but growing renewable energy sector. We are committed to South Africa. No other company has taken a similar approach and we are ready to take the next step," commented president and CEO of Soitec André-Jacques Auberton-Hervé. "It is a tangible commitment from South African government to 'work together to save tomorrow today'."

The 500 kW solar plant consists of 32 two-axis tracking systems to ensure that concentrated sunlight remains focused on the solar cells with a high degree of precision throughout the day, delivering constant power output feeding into the area's power-supply grid. The Fresnel lens used in the modules focuses sunlight concentrated by a factor of 500 on the high-performance solar cells beneath for a world-leading module efficiency of close to 30 percent.

Reusable substrates for III-V multi-junction solar cells

Fraunhofer has been awarded for its work with CEA-LETI on developing reusable substrates for solar applications.

On December 5, 2011, Fraunhofer scientists were presented with the Franco German Business Award for their work with the Carnot-Institut Laboratoire d'électronique des technologies de l'information (CEA-LETI).

The photovoltaics industry is booming – more and more solar modules are appearing on rooftops, and even large-scale solar power plants are increasingly feeding power into the grid. Multi-junction solar cells are particularly efficient in this regard; they can achieve efficiencies of up to 43 percent - twice the level of conventional solar cells made of crystalline silicon.

The difference is that they consist of several semiconductor layers that combine to transform the entire spectrum of sunlight into electrical energy. This technology is used in concentrator photovoltaics. There, lenses focus the light of the sun 500 times onto tiny solar cells. These concentrator systems produce solar electricity on a large scale, particularly in solar power plants located in areas rich in sunlight. Among the producers of these plants is Soitec Solar based in Freiburg, Germany which is a former spinoff of the Fraunhofer Institute or Solar Energy Systems ISE.

The multi-junction solar cells themselves consist of some 30 semiconductor layers built up, layer for layer, on ultra-pure crystals of germanium or GaAs. These materials are very costly, however. In a joint Franco-German project, researchers at ISE in Freiburg and their colleagues from CEA-LETI in Grenoble, France, are working to develop new substrates for multi-junction solar cells. The new technology replaces the expensive materials with reusable substrates.

Until now, Fraunhofer says solar cells had to remain on top of the the germanium or GaAs crystals. Now solar cells are removable from the new substrate which can be recycled several times. This way, the cost of producing solar cells can be reduced by up to 20 percent.

"In the Solar-Bond project, two high-tech institutes have combined their skills," according to Frank Dimroth, Head of Department III-V - Epitaxy and Solar Cells at Fraunhofer ISE. "CEA-LETI is a leader in the microelectronics field and Fraunhofer ISE in photovoltaics."

CEA-LETI grows the substrates and adapts the properties to the requirements involved in growing multi-junction solar cells. The Fraunhofer scientists then apply the solar cells to these substrates and process them to create ready-to-use devices. The researchers are also working closely with Soitec; in the future, the

new solar cells will be used in their concentrator modules.

The scientists were honoured for their international research on December 5, 2011, in Paris with the Franco-German Business Award 2011, presented by the Franco-German Chamber of Commerce and Industry AHK.

The business award is presented in recognition of best practices over the past two years. Patrons of the award are the French Minister of Economy, Finance and Industry, François Baroin; and the German Federal Minister for Economics and Technology, Philipp Rösler.

Dr. Philippe Roussel to present at CS Europe Conference 2012

Defining the next steps for the Compound Semiconductor Industry,Dr. Philippe Roussel of Yole Développement will present the talk “Wide Bandgap device market update”.

Following the success of CS Europe 2011, next year’s conference is expanding to 2 days and offers a fantastic mix/quality of speakers making it the must attend industry event for 2012.

Register at www.cseurope.net & book your delegate place now as numbers will be limited. The conference takes place on 12th/13th March 2012 at Hilton Hotel, Frankfurt, Germany.

A networking dinner will also be held on the night of 12th March.

Conference Chair

Dr Andrew W Nelson, President & CEO, IQE

Conference Schedule:

Markets and III-V CMOS - Morning 12th March

A mix of insightful market research presentations & cutting-edge research destined to shape tomorrow’s compound semiconductor industry with talks including:

Compound Semiconductor Markets: Current Status and Future Prospects - Asif Anwar, Director – Strategic Technologies Practice, Strategy Analytics

The Market for LEDs in Lighting- Mr. Philip Smallwood, Lighting Market Analyst, IMS Research

Wide Bandgap device marketupdate - Dr. Philippe ROUSSEL, Senior Project Manager, Yole Développement

European efforts to develop III-Vs on 200 and 300 mm silicon- Dr. Matty Caymax, Chief Scientist, Imec

An Overview of the DARPA Diverse Accessible Heterogeneous Integration (DAHI) Program- Sanjay Raman, Program Manager, Defense Advanced Research Projects Agency/Microsystems Technology Office

The Integration of silicon CMOS with III-Vs- Professor Iain Thayne, University of Glasgow

III-Vs on 200 mm Si for VLSI– Dr Richard Hill, Project Manager, Sematech

III-V 3D Transistors- Peide Ye, Professor of Electrical and Computer Engineering, Purdue University

LEDs, lasers, PV and electronics - Afternoon of 12th March & full day of 13th March

KEYNOTE SPEAKER*: III-V on Silicon: Challenges and Opportunities*- Robert S. Chau, Intel Senior Fellow, Intel

SiC and GaN Electronics- Dr. John Palmour,

Cree co-founder and chief technology officer Power & RF, Cree

Ammono's ammonothermal method to make GaN substrates– Dr. Robert Dwiliński, President, CEO, Ammonno S.A.

Tomorrow's RF chips for mobile devices- Todd Gillenwater, VP of Technology and Advanced Development, RFMD

Building a Successful III-V Pure Play Foundry- Dr. John Atherton, Associate Vice President, WIN Semiconductors

Scalable "on-silicon" solutions (GaN-on-Si and Ge-on-Si) using rare oxide buffer layers– Dr. Michael Lebby, General Manager & Chief Technology Officer, Translucent Inc.

III-Nitride Lasers Based on Nonpolar/ Semipolar Substrates- Dr James W. Raring, VP Laser Engineering, Soraa Inc.

Markets and Applications for SiC Transistors - Dieter Liesabeths, Vice President Sales & Marketing, SemiSouth Laboratories, Inc.

Perspective of an LED Manufacturer- Professor Iain Black, VP WW Manufacturing Engineering, Technology & Innovation, Philips Lumileds Lighting Company

The CPV Market following the acquisition of Quantasol technology - Jan-Gustav Werthen, JDSU, Senior Director

Commercialisation of GaN on SI based Power Devices at International Rectifier- Dr. Michael A. Briere, International Rectifier

GaN the enabler for true SDR- Professor Rik Jos, RF Technology Fellow & Innovation Manager, NXP Semiconductors

Holistic Approach to MOCVD vacuum & Abatement- Dr Mike Czerniak, Product Marketing Manager, EdwardsVacuum Ltd

Advances in Wide Bandgap Semiconductors for Power Electronics- Dr. Markus Behet, Global market manager, Power Electronics, Dow Corning

Large diameter GaN-on-Si epiwafers for power electronics- Dr Mariane Germain, Co-Founder & CEO, EpiGaN

Achieveing Gan & GaAs RF Design Success through Product & Foundry Innovation– Mr Bryan Bothwell, Strategy and Business Development Manager – Foundry Services, TriQuint Semiconductor

Damage - free Deposition on LED devices- Dr Silvia Schwyn Thöny, Senior Process Engineer, Evatec Ltd

Temporary Bonding: An enabling technology for RF and power compound semiconductor devices - Dr Thomas Uhrmann, Business Development Manager, EV Group (EVG)

Emcore solar cells to power CRS space missions

The firm's III-V compound semiconductor multi-junction cells will be used to power the Cygnus cargo spacecraft to the International Space Station (ISS).

Emcore Corporation has been awarded a solar panel manufacturing contract to utilise its 3rd Generation Triple-Junction (ZTJ) InGaP / InGaAs / Ge Solar Cells solar cells in the new lightweight and highly-efficient ATK Ultraflex solar arrays.

The solar panels will be used to power cargo delivery spacecraft for Orbital Sciences Corporation's Commercial Resupply Services (CRS) missions to the ISS.

Under contract with NASA, Orbital will provide

cargo logistics support services to the ISS, beginning in 2012. Emcore's solar panels will be assembled into deployable solar arrays by ATK's Solar Arrays and Deployables business based in Goleta, California. The arrays will then be delivered to Orbital Sciences Corporation for integration into their Cygnus space vehicles.

"Coupling Emcore's heritage of providing highly-efficient and reliable photovoltaics with ATK's lightweight Ultraflex solar array design will result in a winning solution to produce the most advanced and reliable power to ensure Orbital's Cygnus spacecraft is the long-term solution for the automated transport of goods to the International Space Station for many years to come," said Dave Messner, General Manager of ATK's Solar Arrays and Deployables business.

"Emcore values our long-standing business relationship with ATK and we are extremely honoured to receive this award," said Christopher Larocca, Chief Operating Officer for Emcore. "Our proven manufacturing capability, technology leadership and high-reliability solar panels make Emcore the supplier of choice for demanding spacecraft power systems. We look forward to working with ATK to support Orbital and NASA for these important missions."

Emcore is the world's leading manufacturer of highly-efficient radiation-hard solar cells for space power applications. With a beginning-of-life conversion efficiency nearing 30% and the option for a patented, onboard monolithic bypass diode, Emcore's industry leading multi-junction solar cells provide the highest available power to interplanetary spacecraft and earth orbiting satellites.

Power Electronics

How to make more efficient GaN transistors

Industry experts from EPC have published a new textbook which will enlighten power system design engineers on the theory and applications for gallium nitride transistors

The textbook, "GaN Transistors for Efficient Power Conversion" is being released by Efficient Power Conversion Corporation (EPC).

It is designed to provide power system design engineers basic technical and application-focused information on how to design more efficient power conversion systems using gallium nitride-based transistors.

"This book will help designers to understand the exceptional benefits of GaN technology and the intricacies of working with GaN transistors in power conversion systems. It will set the stage for a new era in power electronics applications that surpass everything that came before it," commented Sam Davis, Editor-in-Chief, Power Electronics Technology magazine.

This practical guide provides guidance on the use of GaN transistors in widely used power electronics applications, ranging from buck converters to Power over Ethernet. Also included are discussions on fundamental power engineering subjects such as; performance characteristics of GaN transistors, layout considerations for GaN circuits, paralleling GaN transistors and driver IC requirements for GaN transistors. The final chapters address GaN device reliability, their exceptional radiation-resistant characteristics as well as their future in power electronics.

According to Alex Lidow, Efficient Power Conversion CEO and co-author of this book, "Gallium nitride transistors provide a long-awaited displacement technology for MOSFETs, and much has been learned over the past several years about how to apply this new technology. In addition to increasing the efficiency of today's power conversion systems, GaN transistors open up new applications such as RF envelope tracking and wireless power transmission that are much needed to keep pace with the ever-expanding communications industry and battery operated products. These new applications are enabled by the high frequency switching capability combined with the high voltage and high power capabilities of gallium nitride FETs."

"GaN Transistors for Efficient Power Conversion" is available for $39.95 and can be purchased from the EPC website (www.epc-co.com), Digi-Key (www.digikey.com) or Amazon (www.amazon.com).

The four authors, Alex Lidow, Michael DeRooij, Johan Strydom and Yanping Ma are working for EPC, the first company to introduce enhancement mode GaN transistors. Collectively the authors have over ninety years experience working in power transistor design and application. All four authors have doctorates in scientific disciplines and are widely recognised published authors. They are pioneers in the emerging GaN transistor technology with Lidow concentrating on transistor process design, DeRooij and Strydom focusing on power transistor applications and Ma providing expertise on quality assurance and reliability.

1700V SiC Schottky diodes improve efficiency

The new devices extend the benefits of silicon carbide and enables the replacement of silicon diodes across a wide range of power levels

Cree has introduced a series of packaged diodes that deliver what it claims is the industry's highest blocking voltage available in SiC Schottky technology.

Cree's 1700V Z-Rec Schottky diodes virtually eliminate the reverse recovery losses suffered in silicon PiN diode alternatives, enabling ultra-efficient, smaller and lighter systems—all with improved reliability. These newly released packaged products extend the performance improvements and system cost savings enabled by Z-Rec technology at 1700V to lower-power applications designed with discrete components.

"Cree's 1700V silicon carbide Schottky diodes are ideal for high-efficiency power electronics systems," explained Cengiz Balkas, Cree vice president and general manager, Power and RF. "They provide all the proven benefits of Cree's Z-Rec SiC Schottky diodes—zero reverse recovery losses, temperature-independent switching and higher frequency operation."

While the 1700V bare die have been available for customers who design their own custom power modules, the new TO-247-2 packages allow customers to take advantage of SiC for lower-power 1700V designs, enable more design flexibility in choosing current levels, and support a faster time to market.

"The availability of 1700V SiC Schottky diodes provides a number of advantages for design engineers in high-voltage power applications," added Balkas. "Silicon carbide diodes enable maximum power efficiency and better EMI performance.»

The switching loss improvement allows for increased system frequencies that can reduce the size of magnetic and capacitive components. Significant reductions in system size, weight and cost can be achieved. Moreover, the availability of 1700V SiC diodes can eliminate the need for stacking multiple lower voltage silicon diodes, thereby cutting component count, improving thermal

performance and increasing reliability.

Designated the C3Dxx170H Series, the new Cree SiC Schottky diodes are rated for 10A/1700V and 25A/1700V and are available in an industry standard TO-247-2 package. Operating junction temperature is rated for -55°C to +175°C.

Next Generation Jammer arrays use GaN transmitter technology

The technology is developed for mid band and high band PAs which employ gallium nitride semiconductors

Along with Boeing, ITT Exelis has successfully completed testing of critical components of the GaN array transmitter technology envisioned for the U.S. Navy Next Generation Jammer (NGJ) program.

The Boeing EA-18G Growler will be the initial host platform for the Next Generation Jammer

The testing, observed by U.S. Navy representatives, successfully demonstrated multiple critical technology elements, including digital beam-forming, mid band and high band Power Amplifiers (PAs). These demonstrations were accomplished in accordance with program objectives to achieve a high-technology readiness level deemed critical to reducing future technical risk to the Navy's Next Generation Jammer program.

The digital beam-forming technology demonstrated recent advancements made in broad band electronically steerable antenna arrays. The technology developed for the mid band and high band PAs displayed high technical maturity and performance of state-of-the-art gallium nitride semiconductors, as well as the packaging and cooling required for a future NGJ array transmitter.

"Our receiver exciter expertise, coupled with these recent successes, enables a low-risk transition to an integrated operational system," said Bob Ferrante, vice president and general manager of the Exelis Electronic Systems' airborne electronic attack business. "Our technology efforts are highly focused to ensure we address the evolving NGJ requirements."

The NGJ will help ensure that U.S. forces have complete dominance of the electronic spectrum, providing a comprehensive capability to disrupt and disable enemy communications and radars. Exelis, teamed with Boeing, leads one of four industry teams in competition to develop the final NGJ system.

The NGJ program, valued at more than $2 billion, will replace the current inventory of aging ALQ-99 jamming pods on the Navy's newest airborne electronic attack aircraft, the Boeing EA-18G Growler. The Next Generation Jammer pod will also be a stepping stone to electronic attack capability on other advanced platforms.

Raytheon board elects James E. Cartwright as a director

The specialist in defence and homeland security products which employ gallium arsenide and gallium nitride technology now has 10 directors

Cartwright, 62, joins the Board following more than 40 years of distinguished military service, culminating in his service from 2007 to 2011

as the eighth vice chairman of the Joint Chiefs of Staff, the nation's second-highest military officer. He retired from the United States Marine Corps in August 2011 and currently is the Harold Brown Chair in Defence Policy Studies at the Center for Strategic and International Studies

"General Cartwright's deep understanding of defense and broad experience in military operations and matters of national security will be of great value to our Board," said Raytheon Chairman and CEO William H. Swanson.

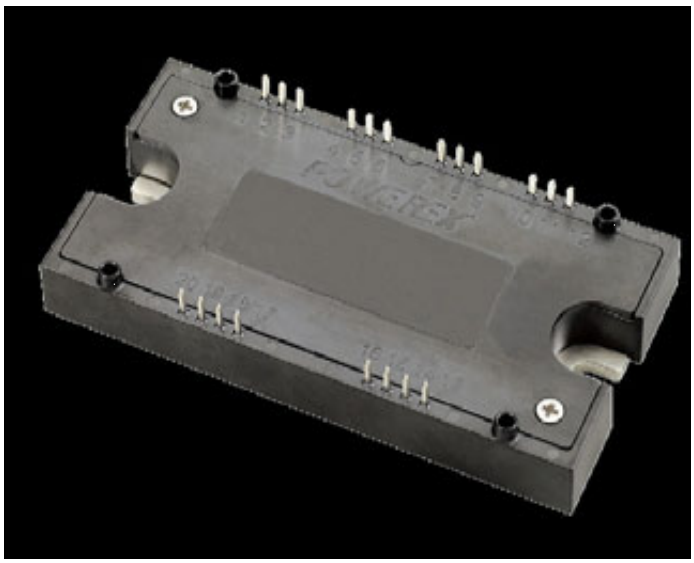
Prior to serving as vice chair of the Joint Chiefs, Cartwright was commander, U.S. Strategic Command, from 2004 to 2007. He served as director for Force Structure, Resources and Assessment, J-8, Joint Staff (2002-2004); as Commanding General, 1st Marine Aircraft Wing (2000-2002); and in a number of other positions including operational assignments as a naval flight officer and naval aviator who flew the F-4 Phantom, OA-4 Skyhawk and F/A-18 Hornet.

Cartwright attended the University of Iowa and was commissioned a second lieutenant in the U.S. Marines in 1971. He graduated with distinction from the Air Command and Staff College, received an M.A. in national security and strategic studies from the Naval War College, completed a fellowship with the Massachusetts Institute of Technology, and was honoured with a Naval War College Distinguished Leadership Award.

Low-profile SiC MOSFET modules with multiple circuit topologies

Powerex is introducing two new split dual silicon carbide devices which are designed for use in high frequency applications power systems. They are ideal for use in fans, pumps ,UPS, high speed motor drives as well as electric vehicle and aviation systems

Each QJD1210010 and QJD1210011 module consists of two MOSFET SiC transistors, with each transistor having a reverse-connected Cree Zero Recovery free-wheel SiC Schottky diode. All components and interconnects are isolated from the heat sinking baseplate, offering simplified system assembly and thermal management.



Rated at 100A/1200V, the SiC modules have a junction temperature of - 175°C and low internal inductance. Featuring high speed switching and a high power density, Powerex says they have industry leading RDS(on).

With 2 individual switches per module, the devices also demonstrate low switching losses, low capacitance and require a low drive. They also have a low profile and multiple circuit topologies, including independent; dual; in parallel; common collector; and common emitter.

The QJD1210010 has an isolated copper baseplate . For extended thermal cycle life, the QJD1210011 has an isolated AlSiC baseplate.

These MOSFET modules can be used in various high frequency applications, including energy saving power systems, such as fans, pumps and consumer appliances. They are also suited to high frequency type power systems, such as UPS, high speed motor

drives, induction heating, welding and robotics.

The power systems can withstand high temperatures and as such, can be used in electric vehicle and aviation systems.

Renesas releases more low loss SiC power devices

The modules incorporate multiple silicon carbide diodes and multiple power transistors in a single package to compose a power converter circuit or switching circuit

Renesas Electronics has announced the availability of three new SiC compound power devices, the RJQ6020DPM, the RJQ6021DPM and the RJQ6022DPM.

These are the second series of power semiconductor products from Renesas to employ SiC, a new material effective in reducing loss, and they are intended for use in home appliances such as air conditioners, PC servers, and power electronics products such as solar power generation systems.

Recently, efforts to reduce the power consumption of electric devices have progressed to address considerations such as environmental protection, and demand has increased for higher efficiency in a variety of electrical products.

In particular, a strong trend can be seen toward boosting power conversion efficiency and operating efficiency to reduce power consumption in power switching circuits for products such as air conditioners, communication base stations, PC servers, and solar power generation systems, and in inverter circuits for applications such as motors and industrial equipment.

This has spurred demand for power devices with improved efficiency and lower loss characteristics. Renesas responded by introducing SiC Schottky barrier diode (SiC-SBD) products employing SiC to achieve reduced loss. This is now followed by a series of SiC compound power devices that implement a circuit (switching, power conversion, etc.) in a single package by combining an SiC-SBD and high-power MOSFETs or IGBTs.

The new products have a voltage tolerance of 600 V and use an SiC diode based on low-leakage SiC-SBD technology developed jointly by Hitachi, Ltd., and Renesas. They combine low loss and compactness and are available in a fully molded TO-3P package with a 5-pin configuration and pin assignments optimized for specific applications, making it easy to configure a circuit unit incorporating them.

The RJQ6020DPM device for critical-conduction mode PFC applications The RJQ6020DPM device combines in a single package an SiC-SBD and two high-voltage power MOSFETs required in switching circuits for critical-conduction mode PFC in the power supplies of products such as air conditioners or flat-panel TVs. The reverse recovery time (trr) of the SiC-SBD is only 15 nanoseconds (ns), and the high-voltage power MOSFETs are highly efficient super-junction (SJ-MOS) transistors employing a deep-trench configuration to achieve a low on-resistance of 100 m

Soitec and Sumitomo Electric jointly develop engineered GaN substrates

The 4- and 6-inch gallium nitride substrates are suited for manufacturing advanced high-brightness LEDs and power-efficient controllers for the electric vehicles and energy markets

Soitec and Sumitomo Electric Industries have reached a major milestone in their strategic joint development program started in December 2010.

They have demonstrated four- and six-inch engineered GaN substrates and are launching pilot production lines in Itami, Japan, and Bernin, France to enable wider market adoption. The pilot lines will initially fabricate four-inch wafers with six-inch wafer production to quickly follow to support customer demand.

These substrates are produced by transferring ultra-thin high quality GaN layers from a single GaN wafer to produce multiple engineered GaN substrates.

Leveraging Sumitomo Electric's manufacturing technology for GaN wafers and Soitec's proven Smart Cut layer-transfer technology, this strategic alliance project had originally produced two-inch wafers.

Sumitomo Electric will manufacture bulk free-standing GaN substrates in Japan for shipment to France, where Soitec will apply its Smart Cut layer-transfer process to generate the final engineered wafers with the same thermal expansion as GaN wafers. The resulting wafers have low defect density, enabling the manufacturing of advanced semiconductor devices at lower costs than bulk GaN wafers.

"Our partnership's successful demonstration of four- and six-inch engineered GaN substrates' scalability is a critical milestone, accomplished by applying very strong innovative capabilities from both sides," said Frédéric Dupont, vice president of Soitec's Specialty Electronics Business Unit. "The advanced substrates we are developing will allow the introduction of a new materials platform with novel and advanced functionalities."

Yoshiki Miura, general manager of the Compound Semiconductor Materials Division at Sumitomo Electric, said, "With layer-transfer technology's production readiness now proven for larger wafers, the substrates can be made even more cost effectively for large-volume production. We look forward to continuing our successful collaboration with Soitec to fulfil the requirements of the LED and energy markets, which represent amazing business opportunities."

Brian Bennett awarded as a fellow of the American Physical Society

His important contributions in materials physics over the last two decades include electro-optical effects in III-V compound semiconductors and as well as self-assembled quantum dots

Brian Bennett, a scientist at the Naval Research Laboratory is recognised by APS "for pioneering contributions to the epitaxial growth, characterisation, and design of narrow band-gap semiconductor heterostructures."

Brian Bennett transfers samples into an MBE system prior to the growth of InAs quantum wells for high-speed transistors with ultra-low power consumption. (Photo: Jamie Hartman, U.S. Naval Research Laboratory)

His primary focus over the last several years has been in the design, growth, and characterisation of antimonide-based semiconductor heterostructures for application to high-frequency, low-power electronics. Bennett's research (in collaboration with J. Brad Boos and colleagues) has established the Naval Research Laboratory as one of the world leaders in this field. His efforts on the design and epitaxial growth of high-electron

mobility transistors based upon InAs quantum wells and antimonide barriers helped to develop a technology which was transferred to industry, leading to the production of low-noise amplifiers operating at ultra-low-power for DoD applications.

Bennett received his bachelor's degree (1984), master's degree (1985), and doctorate (1992) all from the Massachusetts Institute of Technology. He served as a military officer in the U.S. Air Force's Solid-State Sciences Division from 1984 to 1988.

He has been at NRL since 1992 and currently serves in the Electronics Science and Technology Division as head of the Nanotechnology Section, which includes 12 PhD scientists working on topics including graphene, carbon nanotubes, quantum wires, atomic layer deposition, and plasmonics.

Results of his research have been reported in over 160 archival journal publications and cited over 5,000 times. He also holds ten U.S. patents. Bennett has served as an organiser and/or committee member of Electronic Materials Conference since 2000.

Bennett has been recognised with an NRL Technology Transfer Award in 2001; an NRL Group Achievement Award in 2004 for successful transition of antimony based HEMT technology developed at NRL to Northrop-Grumman Space Technology; an NRL Edison Patent Award in 1998 and 2009; an NRL Berman Publication Award in 1998, 2000, and 2008; and a Navy Top Scientist/Engineer of the Year Award (one of 18 out of 35,000 eligible) in 2009.

Skyworks soars above expectations

The firm has reported its first fiscal quarter 2012 results with revenues up by 17 percent Year-Over-Year to $ 393.7 million

The revenue for the latest quarter exceeded the Company's guidance of $390.0 million.

"Specifically, we expect revenue of $360 million, including a partial quarter contribution from AATI, with $0.40 of non-GAAP diluted earnings per share. While we are forecasting AATI to be neutral to second fiscal quarter earnings, we expect the acquisition to be accretive for fiscal year 2012."

On a GAAP basis, operating income for the first fiscal quarter of 2012 was $75.0 million and diluted earnings per share was $0.30, including AATI acquisition-related charges.

"Skyworks' solid performance against the current economic backdrop is being driven by our expanding positions in adjacent analogue semiconductor markets, global demand for mobile internet applications and strong operational execution," said David J. Aldrich, president and chief executive officer of Skyworks. "More specifically, we are capitalizing on new opportunities in medical, automotive, smart energy and home automation markets while capturing additional content and share within LTE smart phones, e-readers, tablets and LED TVs. As a result, Skyworks' ongoing diversification and scale are positioning us to deliver above market growth and, ultimately, create greater competitive advantages."

Second Fiscal Quarter 2012 Outlook

"Based on our diverse customer and market base as well as share gains, we are planning to outperform our addressable markets in the seasonally low March quarter," said Donald W. Palette, vice president and chief financial officer of Skyworks. "Specifically, we expect revenue of $360 million, including a partial quarter contribution from AATI, with $0.40 of non-GAAP diluted earnings per share. While we are forecasting AATI to be neutral to second fiscal quarter earnings, we expect the acquisition to be accretive for fiscal year 2012."
Skyworks hosted a conference call with

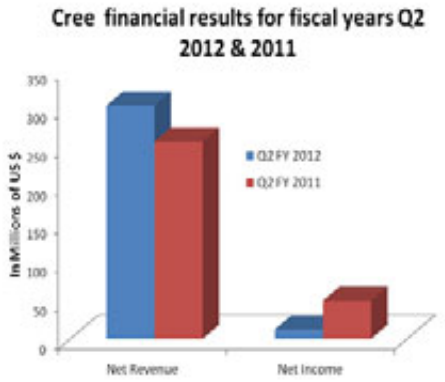
analysts to discuss its first fiscal quarter 2012 results and business outlook.

A replay of the conference call will be available on Skyworks' Web site or by calling 888-203-1112 (from the U.S.) or 719-457-0820 (from outside the U.S.) using pass code: 4056697

Cree net income slashed 76%

On the plus side, quarterly revenues rise significantly through Ruud Lighting acquisition

Cree has announced revenue of $304.1 million for its second quarter of fiscal 2012, ended December 25, 2011.



This represents an 18% increase compared to revenue of $257.0 million reported for the second quarter of fiscal 2011. GAAP net income for the second quarter of $12.1 million, or $0.10 per diluted share, decreased 76% year-over-year compared to GAAP net income of $49.8 million, or $0.45 per diluted share, for the second quarter of fiscal 2011.

Financial results for the second fiscal quarter reflect the inclusion of Ruud Lighting for the entire period. Ruud Lighting was acquired in the first quarter of fiscal 2012 approximately one month before quarter-end.

"Our second quarter results demonstrated the strength in our expanded lighting product line with strong growth in sales of both indoor and outdoor products," stated Chuck Swoboda, Cree Chairman and CEO. "While the business environment remains challenging, our results demonstrate that our strategy is working. Our future business outlook remains very optimistic based on our belief that innovation drives payback, payback drives LED lighting adoption and adoption expands the market for both Cree and our customers."

Business Outlook:

For its third quarter of fiscal 2012 ending March 25, 2012, Cree targets revenue in a range of $290 million to $310 million with GAAP gross margin targeted to be 34% to 35%. The GAAP gross margin targets include stock based compensation expense of approximately $2.2 million.

Operating expenses are targeted to increase by approximately $3 million to $4 million on a GAAP basis. The tax rate is targeted at 13.0% for fiscal Q3. GAAP net income is targeted at $4 million to $12 million, or $0.04 to $0.10 per diluted share. The latter target is based on an estimated 116.4 million diluted weighted average shares.

SiC and silicon combined produce ultra-high performance MOSFETs

The UniSiC 1200V device is formed by stacking a specially designed low voltage silicon MOSFET above a normally-on silicon carbide JFET

Alpha and Omega Semiconductor (AOS) and SemiSouth Labs have jointly demonstrated UniSiC, a 1200V, 90 mΩ MOSFET in a TO262 package.

The device is designed to meet the growing need for energy efficient switching devices for high performance power conversion

applications in the alternative energy, industrial and consumer markets. The firms say the dramatic reduction in form factor and figures-of-merit put this 1200V MOSFET device in a class of its own.

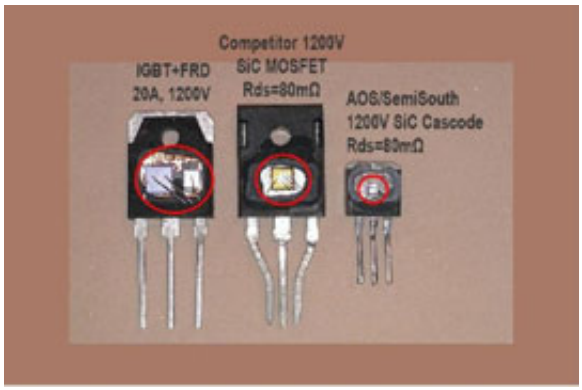


Figure 1: Comparison of Die Sizes

Figure 1 shows the die sizes of a 1200V IGBT with co-packaged diode, a 1200V competitor SiC MOSFET and the AOS UniSiC stack-cascode device. The small die size shows the tremendous potential this device creates for future miniaturisation of power circuits given how much it cuts conduction and switching losses.

The UniSiC MOSFET provides very low Rdson and gate charge Qg, an excellent body diode with virtually no stored charge and a low diode forward voltage drop. The device can be used in applications used by conventional MOSFETs or IGBTs with standard gate drives. It can be switched over a wide speed range – as fast as a superjunction MOSFET, or as slow as an IGBT.

Alpha and Omega says the device has far superior characteristics compared to existing IGBTs, silicon power MOSFETs and the best competitive SiC 1200V MOSFET as shown in the table below.

Parameters	Test Conditions	CMF20120 (Cree)	Cascode (AOS + Semisouth)	1200V Silicon Superjunction FET
Size		4.4 x 4.4 mm	2 x 2.25 mm	7 x 11 mm
BVdss	Id = 100 µA	1200 V	1200 V	1200 V
Vth	Id = 1 mA	2.5V	3.6V	3.0 V
Rdson	Vgs = 20 V	80 mΩ	80 mΩ	100 mΩ
Rdson	Vgs = 10 V	> 200 Ω	80 mΩ	100 mΩ
Qgs	Vds = 400 V, Id = 20 A	25 nC	4.4 nC	70 nC
Qgd	Vds = 400V, Id = 20A	29 nC	3.6 nC	125 nC
Qg(19V)	Vds = 400V, Id = 20A	80 nC	22.6 nC	350 nC
Rds(20V)*Qg(19V)		6.4 Ω*nC	1.8 Ω*nC	35mΩ*nC
VFSD	IF = 10 A	3.5 V	1.5 V	0.9 V
Qrr	Vds = 400V, Id = 20 A, di/dt = 500A/µs, Vgs = 0V	168 nC	151 nC	15000 Nc

Table 1 : Comparison of Cree SiC MOSFET, the UniSiC Stack-Cascode MOSFET and a projected 1200V silicon superjunction device

The UniSiC device is formed by stacking a specially designed low voltage silicon MOSFET over a normally-on SiC JFET. The SiC JFET is provided by SemiSouth, one of the leading suppliers of SiC JFET technology.

The low voltage MOSFET is specially engineered to allow optimal operation of the composite device with clean switching, low Rdson, gate charge and superb diode characteristics. It is intended to provide great ease of use, working with standard drive circuitry, and drastically improving circuit efficiencies over the whole range of load current.

“Using the superb characteristics of SiC JFETs for high voltage applications, and solving the switching problems that have plagued cascode devices in the past, AOS is in a position to offer the power electronics community a dream switch,” said Anup Bhalla, Vice President of High-Voltage Discretes at AOS. “The devices can be used like conventional discrete IGBTs and FETs using the same gate drives, allowing the user to realise huge efficiency gains without too much re-engineering.”

“We are very pleased with the introduction of this new high voltage technology, which, in partnership with SemiSouth laboratories, allows AOS to bring a truly revolutionary device to the

world of power conversion," commented Mike Chang, President and CEO of AOS. "Products like these will set AOS apart as the high voltage supplier of choice, facilitating our twin goals of product diversification and rapid growth."

"SemiSouth is excited to see the performance achieved by AOS using our SiC power JFET die. First released in 2008, we have seen our JFET products gain rapid adoption in the market, and this first-ever stack-cascode demonstration from AOS really takes the performance and ease of use to the next level. We are pleased to have this relationship with AOS as a valued customer," said Jeff Casady, President and CTO of SemiSouth Laboratories.

Microsemi accepts "Strategic Partner" award

The provider of semiconductor products for power and security has been honoured for its excellence in a number of departments

Microsemi Corporation has received FiberHome's "Strategic Partner" award in recognition of its outstanding product quality, customer service, technical support and for meeting product delivery schedules.

FiberHome Telecommunication is one of China's largest providers of fibre-optic and communications equipment. Microsemi received the award at FiberHome's 2011 supplier conference, which was held in December 2011 in Wuhan, China.

"Receiving this prestigious award illustrates our commitment to developing innovative solutions that provide our customers with a competitive edge, backed by superior service and support," said Rick Goerner, senior vice president of Worldwide Sales for Microsemi. "I want to commend the Microsemi team for their continued hard work and dedication, and enabling us to earn this prestigious award for the second consecutive year."

"Microsemi shares our devotion to continuously delivering high quality in all areas of operation, and it is an honour to once again present them with our Strategic Partner award," said He Jianming, vice president of FiberHome Telecommunication. "We look forward to further strengthening our relationship with Microsemi in the future."

Microsemi's communications portfolio includes: network and timing solutions; voice-over-IP, FTTX AND DSL products; wireless LAN and RF integrated circuits; and power management, conversion and delivery devices. The company also offers sense and control solutions, as well as Power over Ethernet (PoE) integrated circuits and midspans.

GaN gaining traction in commercial applications

With military applications leading the way, the overall gallium nitride device market is forecast to grow to nearly $178 million in 2015

Despite continuing dominance by military applications, GaN technology is also seeing widespread deployment in commercial applications.

The "GaN Microelectronics Market Update 2010-2015" report, recently released by Strategy Analytics to its GaAs and Compound Semiconductor Technologies Service (GaAs) and its Advanced Defence Systems Service (ADS) subscribers, forecasts that the overall GaN device market will grow at a CAAGR of nearly 29 percent, to reach $178 million in 2015. During this time, commercial applications, led by CATV and high power electronics will grow from less than one million dollars to reach nearly $58 million.

This report predicts that military applications will continue to dominate, but the percentage of the total GaN revenue derived from military applications will shrink from 98 percent in 2010

to 67 percent in 2015. In addition, Strategy Analytics forecasts that revenue growth rates for GaN devices in wireless infrastructure, high power electronics and CATV/VSAT (very small aperture terminals) will all exceed 100 percent.

"Driven by performance advantages like efficiency, power dissipation and operating temperature, GaN is finally starting to generate interest in commercial market applications," noted Eric Higham, Director of the Strategy Analytics GaAs and Compound Semiconductor Technologies Service.

"GaN developments by device manufacturers like RFMD and Nitronex (for CATV applications) and International Rectifier and EPC (for power converter applications) are displacing other technologies. Operators and equipment manufacturers are recognising the operating cost advantage that GaN can provide."

Asif Anwar, Director in the Strategy Analytics Strategic Technologies Practice, added, "Military applications and government funding for semiconductor companies like TriQuint and Cree will continue to drive GaN development. Additionally, the overall GaN market will expand with demand for commercial applications."

The Strategy Analytics report covers GaN technology trends, advantages, disadvantages and challenges to wider deployment in military and commercial applications. It also reviews some of the centrally funded programs from the US, Europe and Japan.

Cree silicon carbide chips energise power electronics

The company's SiC MOSFET chips can create new opportunities for energy efficiency in solar, telecom and industrial power applications.

Cree says it is continuing to advance the revolution in high-efficiency power electronics with the release of the industry's first fully qualified SiC MOSFET power devices in "bare die" or chip form for use in power electronics modules.

Cree's SiC Z-FET MOSFETs and diodes are used in advanced power electronics circuits to achieve significantly higher levels of energy efficiency than is possible with conventional silicon devices.

Cree's SiC devices

Power modules typically combine a number of discrete power switching devices – MOSFETs and diodes – in a single integrated package for high-voltage power electronics applications such as three-phase industrial power supplies, telecom power systems and power inverters for solar and wind energy systems.

In traditional MOSFET packaging technologies, the parasitic inductance of the long leads can limit the switching capability of SiC MOSFETs. By offering Cree customers bare die alternatives, circuit designers can now take full advantage of the switching performance of SiC technology by reducing the effects of the package-parasitic inductance.

"With the availability of fully qualified SiC MOSFETs as unpackaged chips, manufacturers of power modules can realise the performance advantages of SiC devices—better high temperature operation, higher switching frequencies and lower switching losses – without the limitations imposed by conventional plastic packaging of discrete devices," explains Cengiz Balkas, Cree vice president and general manager, power and RF.

"The design advantages of implementing SiC power devices in power electronic modules include the ability to achieve higher current and

voltage ratings with fewer components, which in turn can enable maximum power density and increased reliability."

"Power module manufacturers can new combine Cree's 1200V SiC power MOSFET and Schottky diodes in chip form to create an 'all-silicon carbide' module design for ultra-high-efficiency power electronics systems," continued Balkas. "These new modules provide the proven benefits of silicon carbide—zero reverse recovery losses, temperature-independent switching, higher frequency operation with low electromagnetic interference (EMI), and significantly higher avalanche capability – and deliver switching frequencies that are five to eight times higher compared to conventional silicon solutions. The higher switching frequencies enable smaller magnetic and capacitive elements, thereby shrinking overall system size, weight and cost."

The new Cree power MOSFET devices are initially available in two versions: the CPMF-1200-S080B measures 4.08mm x 4.08mm and is rated at 1200V/20A with a nominal on-resistance (RDS(on)) of 80mΩ; and the CPMF-1200-S160B measures 3.1mm x 3.1mm and is rated at 1200V/10A with a nominal on-resistance (RDS(on)) of 160mΩ. Operating junction temperature for both devices is rated at -55°C to +135°C.

The two versions of the 1200V MOSFET die are fully qualified and released for production use and available to Cree's customers, as well as through Cree's Power die distributor Semi Dice.

Cree has published specifications and detailed design guidelines, including recommendations on die attach and bonding, to assist power module manufacturers in the use of the new devices and optimising their designs. In addition, Cree is offering customers the availability of a SiC MOSFET Model created to help with early simulation and evaluation.

Dr. Philippe Roussel to present at CS Europe Conference 2012

Defining the next steps for the Compound Semiconductor Industry,Dr. Philippe Roussel of Yole Développement will present the talk "Wide Bandgap device market update".

Following the success of CS Europe 2011, next year's conference is expanding to 2 days and offers a fantastic mix/quality of speakers making it the must attend industry event for 2012.

Register at www.cseurope.net & book your delegate place now as numbers will be limited. The conference takes place on 12th/13th March 2012 at Hilton Hotel, Frankfurt, Germany.

A networking dinner will also be held on the night of 12th March.

Conference Chair

Dr Andrew W Nelson, President & CEO, IQE

Conference Schedule:

Markets and III-V CMOS - Morning 12th March

A mix of insightful market research presentations & cutting-edge research destined to shape tomorrow's compound semiconductor industry with talks including:

Compound Semiconductor Markets: Current Status and Future Prospects - Asif Anwar, Director – Strategic Technologies Practice, Strategy Analytics

The Market for LEDs in Lighting- Mr. Philip Smallwood, Lighting Market Analyst, IMS Research

Wide Bandgap device marketupdate - Dr.

Philippe ROUSSEL, Senior Project Manager, Yole Développement

European efforts to develop III-Vs on 200 and 300 mm silicon- Dr. Matty Caymax, Chief Scientist, Imec

An Overview of the DARPA Diverse Accessible Heterogeneous Integration (DAHI) Program- Sanjay Raman, Program Manager, Defense Advanced Research Projects Agency/Microsystems Technology Office

The Integration of silicon CMOS with III-Vs- Professor Iain Thayne, University of Glasgow

III-Vs on 200 mm Si for VLSI– Dr Richard Hill, Project Manager, Sematech

III-V 3D Transistors- Peide Ye, Professor of Electrical and Computer Engineering, Purdue University

LEDs, lasers, PV and electronics - Afternoon of 12th March & full day of 13th March

KEYNOTE SPEAKER*: III-V on Silicon: Challenges and Opportunities*- Robert S. Chau, Intel Senior Fellow, Intel

SiC and GaN Electronics- Dr. John Palmour, Cree co-founder and chief technology officer Power & RF, Cree

Ammono's ammonothermal method to make GaN substrates– Dr. Robert Dwiliński, President, CEO, Ammonno S.A.

Tomorrow's RF chips for mobile devices- Todd Gillenwater, VP of Technology and Advanced Development, RFMD

Building a Successful III-V Pure Play Foundry- Dr. John Atherton, Associate Vice President, WIN Semiconductors

Scalable "on-silicon" solutions (GaN-on-Si and Ge-on-Si) using rare oxide buffer layers– Dr. Michael Lebby, General Manager & Chief Technology Officer, Translucent Inc.

III-Nitride Lasers Based on Nonpolar/ Semipolar Substrates- Dr James W. Raring, VP Laser Engineering, Soraa Inc.

Markets and Applications for SiC Transistors - Dieter Liesabeths, Vice President Sales & Marketing, SemiSouth Laboratories, Inc.

Perspective of an LED Manufacturer- Professor Iain Black, VP WW Manufacturing Engineering, Technology & Innovation, Philips Lumileds Lighting Company

The CPV Market following the acquisition of Quantasol technology - Jan-Gustav Werthen, JDSU, Senior Director

Commercialisation of GaN on SI based Power Devices at International Rectifier- Dr. Michael A. Briere, International Rectifier

GaN the enabler for true SDR- Professor Rik Jos, RF Technology Fellow & Innovation Manager, NXP Semiconductors

Holistic Approach to MOCVD vacuum & Abatement- Dr Mike Czerniak, Product Marketing Manager, EdwardsVacuum Ltd

Advances in Wide Bandgap Semiconductors for Power Electronics- Dr. Markus Behet, Global market manager, Power Electronics, Dow Corning

Large diameter GaN-on-Si epiwafers for power electronics- Dr Mariane Germain, Co-Founder & CEO, EpiGaN

Achieveing Gan & GaAs RF Design Success through Product & Foundry Innovation– Mr Bryan Bothwell, Strategy and Business Development Manager – Foundry Services, TriQuint Semiconductor

Damage - free Deposition on LED devices-

Dr Silvia Schwyn Thöny, Senior Process Engineer, Evatec Ltd

Temporary Bonding: An enabling technology for RF and power compound semiconductor devices - Dr Thomas Uhrmann, Business Development Manager, EV Group (EVG)

Six-inch silicon carbide single crystal wafers

Japanese company Nippon Steel have developed a new method of producing 6» SiC wafers which can be used in large-area power devices for applications in automobiles and rapid-transit railways.

At the Advanced Technology Research Laboratories of its Technical Development Bureau, Nippon Steel Corporation has successfully grown a six-inch diameter SiC single-crystal wafer.

Six-inch SiC wafer

SiC is a key material for high performance next generation power semiconductor devices. Compared to silicon used in the manufacture of diodes, transistors and other semiconductor devices, SiC is capable of suppressing the power-conversion loss to less than half when used in various electronic devices. Its excellent high-voltage and heat resistance properties make SiC suitable for use in photovoltaic power generation, automotive (EV, HEV, etc.) and other power electronic applications.

Power semiconductors using SiC wafers also raise expectations of significant reductions in power loss and CO2 emission.

High-quality SiC wafers currently on the market predominantly have 3-inch and 4-inch diameters, and semiconductor-manufacturers' development and commercialisation of semiconductors are being made based upon the availability of such SiC wafers.

But, there is a very strong need for greater efficiency in device production and also for the development and commercialisation of SiC devices in the large-current & high-voltage segment requiring large-aperture SiC wafers.

Volume production of six-inch SiC wafers is expected to increase the efficiency of SiC device production and to decrease the cost of device manufacture.

Six-inch wafers will make it possible to manufacture large-area devices for controlling larger currents and higher voltages, extending applications to automobiles (EV/HEV, etc.), rapid-transit railways, and other areas.

Because of its potential, the 6-inch SiC wafer has also been the subject of research and development in the national project of the Ministry of Economy, Trade and Industry in Japan, as a next-generation material capable of enhancing industrial competitiveness based on energy-saving technology.

SiC single crystal wafers are usually manufactured by sublimation, a recrystallisation method; the reactor is heated to over 25000C

and the growth of the SiC single crystal is achieved by having vapour sublimated from the SiC material in powder form to recrystallise on top of seed crystals.

In 2007, using its own sublimation-recrystallisation method established through long years of R&D efforts, the firm developed and established a mass production technique for manufacturing high-quality 4-inch SiC wafers, which Nippon Steel Materials started selling in 2009.

In the sublimation-recrystallisation method, the growth of crystals of compounds at ultra-high temperatures makes process control difficult. The major problem is that with an increase in the size of crystal diameters, there is an increasing tendency for crystals to become susceptible to cracking induced by crystal defects and thermal stress.

By accelerating R&D efforts to resolve these problems, and based on numerical simulation technology, Nippon Steel developed a process using ultra-high-temperature equipment and operating conditions suitable for 6-inch diameter wafers. The process successfully restrained crystal defects and crystal cracks in the growth of large-diameter crystals, and the firm manufactured what it claims is Japan's first 6-inch SiC aperture wafer.

Part of this R&D program was subsidised under the "Novel Semiconductor Power Electronics Project Realising Low Carbon Emission Society" of the New Energy and Industrial Technology Development Organization (NEDO).

Nippon Steel says that in order to establish its 6-inch wafer manufacturing technology, it will continue efforts to achieve further product stability and productivity. The firm will also pursue the development of 6-inch SiC epitaxial film manufacturing.

EPC's eGaN FET is a leading product

The firm's enhancement mode gallium nitride (eGaN) transistor is being adopted by customers as higher performance replacements for silicon-based MOSFETs

Efficient Power Conversion Corporation (EPC) has been honoured with a "Leading Product Award" by EDN China Innovation Award 2011 in its Power Device and Module category.

In its seventh year, the EDN China Innovation Award 2011 is a benchmark event for recognising product innovation by China's electronics design engineers and managers.

"It is an honour to receive this recognition as an industry leading product from EDN China. The EPC2010 is one member of our family of eGaN FETs being adopted by customers as higher performance replacements for silicon-based MOSFETs," commented Alex Lidow, CEO of EPC.

EPC2010

EPC2010 is EPC's second-generation 200 Volt enhancement mode gallium nitride (eGaN) power transistor with high frequency switching, enhanced performance in a lead-free, RoHS package.

The EPC2010 FET is a 200 VDS device with a maximum RDS(ON) of 25 milliohms with 5 V applied to the gate. It has an increased pulsed current rating of 60 A (compared with 40 A for the EPC1010), improved RDS(ON) at very low gate voltages, and lower capacitance.

EPC says that compared to a state-of-the-art silicon power MOSFET with similar on-resistance, the EPC2010 is smaller and has many times superior switching performance. Applications that benefit from eGaN FET performance include RF envelope tracking, wireless power transmission, high-speed DC-DC power supplies, point-of-load converters, class D audio amplifiers, hard-switched and high frequency circuits.

Equipment and Materials

Aixtron receives first dry scrubbers for new R&D centres

Eleven CLEANSORB waste gas treatment systems will be used at Aixtron›s R&D centres for MOCVD equipment and processes in Germany and China

Aixtron SE has chosen CS Clean Systems dry bed scrubbers for its new R&D centres.

CLEANSORB dry bed absorber CS200PS PRIMELINE series with refillable CLEANSORB columns

In total, 11 CLEANSORB CS200SC models are to be installed at the Aixtron R&D Centre in Dornkaul, Aachen, Germany, as well as at the new training facility in Suzhou Industrial Park (SIP) in China. The Suzhou training centre is a joint venture between Aixtron and the prestigious Suzhou Institute of Nanotech and Nanobionics (SINANO).

When up-and-running, the CLEANSORB dry bed absorbers will be serviced directly from the CS CLEAN SYSTEMS China office based in Shanghai.

The gases and liquid organometallic precursors used in the MOVPE growth and etching of III-V epitaxial structures are critical in terms their toxic, pyrophoric, and corrosive natures. CLEANSORB dry chemisorber technology does not use activated carbon or other combustible materials. Hazardous gases are converted to stable solid by-products by dry chemical reaction at room temperature without the requirement for heating or the generation of contaminated waste water.

The hermetically sealed CLEANSORB absorber column design ensures that the MOCVD user never comes into contact with toxic MOCVD by-products. At the end of their absorbing lifetimes, CLEANSORB columns are returned to the local CS CLEAN SYSTEMS service partner for service. After refurbishment and refilling with fresh chemisorber, the absorber column is then shipped back to the customer for further use.

Mass flow meters and controllers with an EtherCAT interface

These digital metering and control devices are used in machinery used to produce compound semiconductor chips, LEDs and solar cells

Bronkhorst High-Tech is marketing the EtherCAT fieldbus interface on its thermal mass flow meters and controllers for gases and liquids, as well as its digital pressure controllers.

Mass Flow Controller for gases with EtherCAT Interface

Bronkhorst says it is the first and only supplier of these devices to offer this option.

EtherCAT is a highly flexible Ethernet network protocol with unique advantages. It operates at high speed, with high efficiency and offers simple configuration. It is therefore not surprising that EtherCAT has been adopted rapidly within the worldwide market for control and automation.

Bronkhorst has many years of experience with fieldbus communication. With its “multi-bus” concept the company offers flexibility by equipping their digital instruments with interface boards for DeviceNet, Profibus-DP, Modbus or FLOW-BUS. The wide range of digital metering and control devices is applied in many different markets, e.g. the food & beverage and chemical industries, gas and fluid analysis equipment, glass and tool coating processes, testing fuel cells for the automotive industry and in machinery used to produce electronic chips, LED lights and solar cells.

New instruments for LED characterisation

Instrument Systems is launching a new series of CCD array spectrometers and a current source. Both have been specially designed to assess LEDs

The CAS 120 series of measuring instruments has been specifically developed for price-sensitive applications in spectral light measurement, such as LED production or quality assurance. Although costs have been reduced, technical innovations deliver even higher levels of reliability.

The CAS 120 is an optical spectrometer which analyses the spectral characteristics of light radiation. Having additional optical probes and absolute calibration turns this type of measurement system into a spectroradiometer.

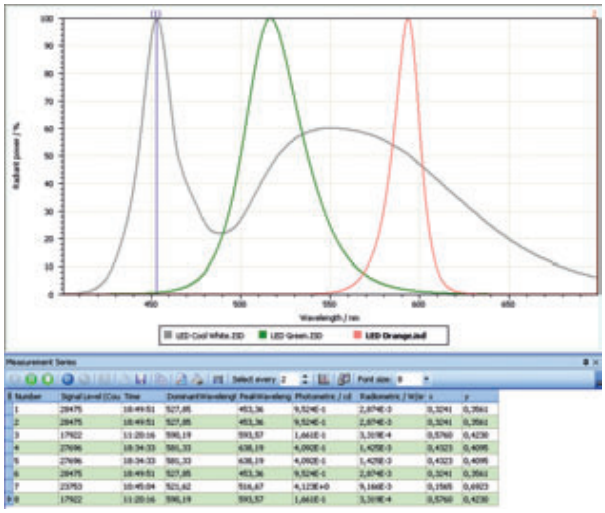
CAS 120 CCD array spectroradiometer

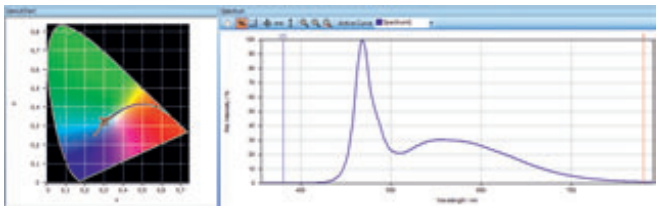
A Crossed Czerny Turner Spectrograph with back-illuminated CCD detector forms the core of the spectrometer. This means that the CAS 120 guarantees exceptionally low stray light and a very high level of optical precision.

Cost-intensive cooling of the CCD detector with 2048 x 14 pixels was deliberately omitted for the CAS 120. Instead, the temperature of the CCD detector is recorded each time a spectrum is measured, and an innovative algorithm automatically corrects the signal.

The newly developed filter wheel with density filters OD 1 to OD 4 comes without any mechanical position switches and always guarantees exact filter positions. It expands the total dynamic range of the CAS 120 to 8 decades, enabling the measurement of low and high light intensities without manual intervention in the test procedure.

The CAS 120 is equipped with a USB interface and a TTL trigger I/O. The hardware trigger permits synchronisation with other instruments which is essential for exact measurement results during fast production testing.





Examples of data from a CAS 120 spectroradiometer shown on SpecWin Pro analysis software

Instrument Systems supplies a DLL and a LabVIEW driver for use in production environments and at automated measurement stations. SpecWin Pro and SpecWin Light spectral software packages have been developed for a wide range of laboratory applications with functions for analysis and documentation of test results.

The firm is also marketing the LSM 350 4-quadrant source and measurement unit specifically designed to meet the requirements for production testing of LEDs and LED wafers. High test speeds and the multi-channel capability make the LSM 350 an attractive solution for supplying current or voltage to LEDs with low to medium power output.

LSM 350 basic module in bench enclosure

High test speeds and the multichannel capability make the LSM 350 an attractive solution for supplying current or voltage to LEDs with low to medium power output. Combination with high-precision array spectrometers from Instrument Systems creates a complete solution for optical and electrical testing carried out on LEDs.

As a bipolar current and voltage source, the LSM 350 offers all functions necessary for testing LEDs fast. The automatic polarity test feature can be used for single and multi-chip LEDs. Dedicated measurement ranges permit particularly precise testing at low forward currents of 1 µA, and measurement of reverse currents in the nA range.

The modular concept includes an option to measure breakdown voltages up to 40 V. Very short settling times reduce the test cycles by up to 40% compared to those of most standard current sources.

The LSM 350 is fully integrated in the LED Tester. The turnkey system with the high-precision array spectrometers in the CAS 140CT or CAS 120 series allows test routines to be set up with fully automated testing and binning of LEDs and for testing LED wafers. The associated software permits a large number of different functions and evaluation options.

System solution for LED Tester

AXT to grow with another plant in China

The facility will expand the firm's gallium arsenide, indium phosphide and germanium substrate manufacturing capacity. It will complement the company's current 190,000 square foot facility in Beijing

AXT has agreed with the Administrative Commission of Tianjin Economy and Technology Development Zone to establish a second manufacturing facility in Tianjin, China.

The arrangement provides AXT with land use rights for approximately 32 acres of industrial land located in Yixian Scientific and Industrial Park to construct a compound semiconductor substrate manufacturing facility that would be completed in phases by 2017.

AXT has committed to a $12.5 million investment in the construction of the facility over the next two years in exchange for land use rights, enterprise and individual income tax rebates, employee hiring and development subsidies, and other benefits.

"We are very pleased for the opportunity to begin planning our future expansion in such a vibrant and dynamic area of China and in cooperation with the Administrative Commission of Tianjin Economy and Technology Development Zone," said Morris Young, chief executive officer.

"While our current facility in Beijing continues to provide us with ample capacity to grow our business for the next 18 to 24 months, we believe that a second manufacturing facility in Tianjin will provide us with additional capacity for many years to come, particularly in light of positive trends in the demand for wireless devices, the proliferation of LEDs and the adoption of photovoltaic technology. The positive financial considerations of this arrangement, coupled with what we believe to be our longer-term capacity needs, provide compelling incentives to proceed with our expansion plans at this time. This arrangement allows us to begin planning for growth and redundancy in our business in a measured and incremental way that is suitable both to the current economic conditions and the sizeable opportunity ahead," he concluded.

Hiden Analytical celebrates 30 year anniversary

The manufacturer of instruments used in the compound semiconductor industry has gradually expanded ; it now has representations through Europe, Asia and through North and South America

In 1982 Hiden Analytical, then a new start-up company in England, commenced manufacture of quadrupole mass spectrometers for the vacuum processing element of the semiconductor fabrication industry.

Application areas expanded as new products developed, initially to include general gas analysis followed by later innovations introduced to address the specific area of direct external ion measurement for plasma process diagnostics and for secondary ion monitoring (the SIMS technique).

1992 saw Hiden enter the field of microgravimetric gas sorption measurement in collaboration with the University of Birmingham, and dedicated sister-company Hiden Isochema was established to address this specific product area. A USA company was formed in 1996 to provide the US sales and service function for the full Hiden product range, with offices currently established in Michigan, New Hampshire and in California.

Now, in 2012, representation extends through Europe, Asia and through North and South America. The product range is extensive, with instrumentation for gas analysis through the pressure range from30 bar to ultrahigh vacuum, for catalyst characterisation, for plasma diagnostics, for SIMS measurement, for sorption science.

The needs of the R and D user continue to be a significant element of the overall business philosophy, with a dedicated product support team committed to providing custom-engineered system integration solutions and ongoing technical support.

Request your Free 30 Year Anniversary Edition Hiden Wall Planner and Desk Calendar now via the ‘Contact Us’ button on the homepage of our website. Desk Calendars are available in UK, USA, French, Italian and International formats.

Using the SEM to measure crystal structures

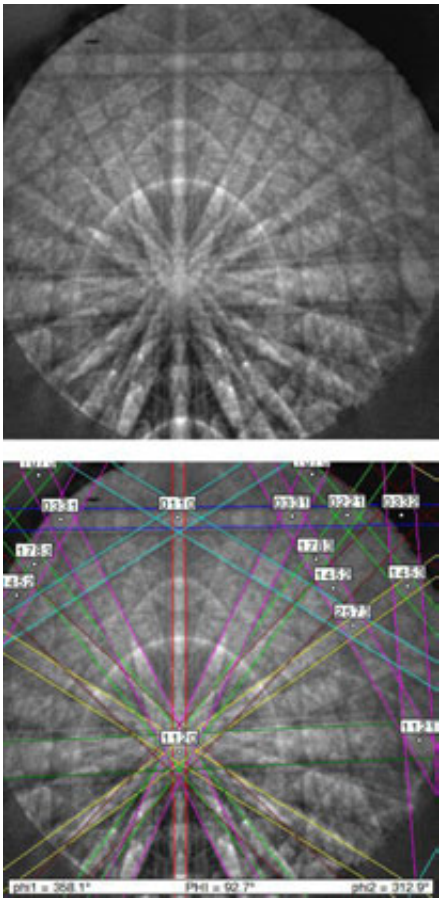
A new procedure to measure SEM samples greatly improves its ability to measure the crystal structure of nanoparticles and extremely thin films including indium gallium nitride

By altering sample position of materials in a scanning electron microscope (SEM), two scientists at NIST have been able to determine crystal structure of particles as small 10 nanometres (nm).

The technique, they say, should be applicable to a wide range of work, from crime scene forensics to environmental monitoring to process control in nanomanufacturing.

The technique is a new way of performing electron diffraction with an SEM. In standard SEM-based electron diffraction, the researcher analyses patterns that are formed by electrons that bounce back after striking atoms in the sample. If the sample is a crystalline material, with a regular pattern to the arrangement of atoms, these diffracted electrons form a pattern of lines that reveals the particular crystal

structure or “phase” and orientation of the material.



Top: Transmission electron diffraction pattern from a segment of an InGaN nanowire about 50 nm in diameter taken with an SEM using the new NIST technique clearly shows a unique pattern associated with crystal diffraction. Bottom: Same pattern but with an overlay showing the crystallographic indexing associated with the atomic structure of the material. (Credit: Geiss / NIST)

The information, say NIST’s Robert Keller and Roy Geiss, can be critical. “A common example is titanium dioxide, which can exist in a couple of different crystal phases. That difference significantly affects how the material behaves chemically, how reactive it is. You need to add crystallographic identification to the chemical composition to completely characterise the material.”

SEMs are often outfitted with an electron back-scatter diffraction (EBSD) detector for just this task. The problem, they say, is that below a certain size, the usual setup just doesn’t work. “You can determine the crystal structure of an isolated particle down to a size of about 100 to 120 nm, but below that the crystals are so small that you’re getting information about the sample holder instead.” A somewhat more exotic instrument, the transmission electron microscope (TEM), does much better , but samples below about 50 nm in size show very limited diffraction patterns because the higher-powered electron beam of the TEM just blasts through them.

The novel tweak developed by Keller and Geiss combines a little of each. They moved the SEM sample holder closer to the beam source and adjust the angles so that instead of imaging electrons bouncing back from the sample, the EBSD detector is actually seeing electrons that scatter forward through the sample in a manner similar to a TEM. (They also came up with a unique method of holding samples to obtain these results.)

They have shown that their technique produces reliable crystal phase information for nanoparticles as small as 10 nm across, as well as for single crystalline grains as small as 15 nm in an ultrathin film.

Electron diffraction in an SEM, says Keller, “in general represents the only approach capable of measuring the atomic structure, defect content, or crystallographic phase of single nanoparticles. This is a critical need in cases of extremely limited sampling of unknown particles. This work pushes electron diffraction to a new frontier by providing spatial resolution that rivals that possible in a TEM, and makes it available to anyone with an SEM. And that’s an ubiquitous tool in virtually all fields that require characterisation of solids.”

Typical applications, the researchers say, include pinpointing ammunition sources from gunshot residue at crime scenes; determining

the processing history of confiscated drugs; accurate characterisation of nanoparticles for health, safety and environmental impact studies; and optimising grain structure in high-performance electronics based on thin films and process and quality control in nanomanufacturing.

Further details of this work will be published in the paper, " Transmission EBSD from 10 nm domains in a scanning electron microscope", by R.R. Keller and R.H. Geiss in the *Journal of Microscopy*, 2011.

DOI: 10.1111/j.1365-2818.2011.03566.x. scheduled to appear in the March 2012 issue.

Materion Micro expands PVD precision parts cleaning capacity

The firm has also increased its new automated technology in its New York plant. The investment enhances vertically integrated offering for thin film deposition customers

Materion Microelectronics & Services, a unit of Materion Corporation, has completed a 50% capacity expansion at its facility in Wheatfield, New York, near Buffalo.

The site provides precision parts cleaning and surface treatment of physical vapour deposition (PVD) shield kits for manufacturers in such industries as wireless products, LEDs, medical consumables and photovoltaics.

The investment includes a fully automated robotic twin wire arc spray, increased precious metal refining capacity, new cleaning processes, and a clean room certified to Class 10,000. Materion claims to be the only vertically integrated global provider of thin film deposition materials, precision parts cleaning services, and precious metal recovery and refining.

The fully automated robotic twin wire arc spray is a leading-edge technology that increases the process lifetime of shielding used in particulate-sensitive processes. It does this by applying an under-layer surface coating to parts after they have been cleaned and the precious metals have been recovered. The coating provides an enhanced surface roughness that increases a part's adhesion properties in the vacuum chamber. This allows more material to be deposited and minimises random particles that would otherwise be deposited on the subsequent product.

After cleaning, all parts pass through a variety of inspections and tests to ensure dimensional tolerances and complete cleanliness. When customers receive their parts back they are ready to be installed into thin film chambers for deposition. Later, after the part has been used and returned to Materion, the under-layer coating can be quickly and easily removed for cleaning.

"The addition of the robotic twin wire arc spray demonstrates our commitment to process control and staying at the forefront of the industry," said Jim McMullen, Product Manager-Precision Parts Cleaning Services. "Because each part is individually programmed into the system we get tighter control over the coating process. This decreases variability and makes the coatings more consistent both within an individual part and from part to part. The result is faster turnaround and the potential for higher precious metal returns. Customers benefit from greater tool uptime, improved effective shield life, overall increased wafer and product yields, and a lower total cost of ownership."

McMullen noted that Materion also has precision parts cleaning facilities in Ireland and the Czech Republic. "And we are always looking at additional locations and services. It's our commitment to be our customers' first choice for all their PVD materials, parts and related services."

Materion Corporation is headquartered in

Mayfield Heights, Ohio. The Company, through its wholly owned subsidiaries, supplies highly engineered advanced enabling materials to global markets. Products include precious and non-precious specialty metals, inorganic chemicals and powders, specialty coatings, specialty engineered beryllium alloys, beryllium and beryllium composites, and engineered clad and plated metal systems.

Plasma-Therm gets a 5 star rating

VLSIresearch has awarded the semiconductor equipment manufacturer for its exceptional performance

VLSIresearch 's 5 star rating recognises companies that have received the highest ratings from their customers. It also honours companies who performed exceptionally across all rating categories including customer service, organisational performance, and equipment performance.

"We are very pleased by the VLSI 5 star rating," said Rich Gauldin, Director of Customer Focus. "Accomplishing this superior rating is testament to Plasma-Therm's hard work and dedication in our immediate market."

Wuhan National Lab approves Vistec's E-beam lithography system

The tool is used for advanced nano-lithography applications, particularly in direct writing of both R&D and production gallium arsenide devices

Vistec Lithography has announced that Wuhan National Laboratory for Optoelectronics (WNLO) at the Huazhong University of Science and Technology (HUST), has signed off its electron-beam lithography system Vistec EBPG5000pES.

Vistec EBPG5000+ electron-beam lithography system

The WNLO, HUST and Vistec consider this to be a major milestone in their strategic partnership.

The Vistec EBPG5000pES electron-beam lithography system will enable WNLO to further strengthen its position in photonics and optoelectronics research and development. "The EBPG5000pES facilitates us to achieve all the lithography challenges we are facing in our research. In respect to application support and service we know that we can count on the Vistec team as our strategic partner," stated Jinsong Xia, director of the Optoelectronic Micro & Nano Fabrication and Characterisation Facility (OMFC) at WNLO.

The Vistec EBPG5000pES is a high-end lithography tool based on reliable and well-proven system architecture. With its flexible electron-optical column and high brightness TFE source, allowing 50 and 100kV operation, the system provides a spot size down to < 2.2nm, thus enabling nano-lithography structures smaller than 8nm to be routinely generated. The system incorporates an interactive graphical user interface that provides ease of use for diverse, multiuser, university type environments.

"We are very pleased to have reached this significant milestone in our partnership with WNLO at HUST, who can be assured that Vistec will be supporting them to the very best," said Erwin Mueller, Managing Director

Vistec Lithography, B.V.. "The electron beam lithography system at WNLO is the first operational Vistec EBPG5000pES in the P.R. China, which opens great opportunities to a sustainable business development for Vistec in that region."

B&W Tek celebrates 15 years of photonics innovation

Originally established as a producer of green lasers in January of 1997, B&W Tek has grown into a provider for a wide range of spectroscopy applications

B&W Tek, an advanced instrumentation company producing optical spectroscopy and laser systems is celebrating its 15th anniversary in serving the photonics industry.

In the last 15 years, B&W Tek has experienced substantial growth not only in size and value, but in skills and core competencies. Headquartered in Newark, Delaware, B&W Tek's growing global influence stems not only from its offices in the United States, Germany, China, and Japan; but also from its extensive network of international distributors who are based in over 18 countries.

All key components are designed and manufactured in-house, allowing OEM customers to take any assortment of B&W Tek's ready-to-use, off-the-shelf modular products to create a solution all their own, or take advantage of B&W Tek's industrial design and custom development services to create a brand new solution in as little as 90 days.

By coupling these core technologies such as lasers, fibre optic spectrometers, Raman systems, software, and countless accessories with custom design and manufacturing capabilities, B&W Tek has used its renewed focus on total solutions to break into dozens of industries outside of photonics. With the development of "turnkey" spectroscopy systems such as the SpectraRad, NanoRam, and PolymerIQ the solid-state lighting, pharmaceutical, and polymer processing fields are just some of the newest to benefit from B&W Tek's products and services.

"Since our establishment, we've emphasised strong vertical integration in order to provide our customers with the highest quality products while still fitting into their budgets," says Robert Chimenti, Marketing Manager at B&W Tek. "We're a one stop shop that provides all of your optical spectroscopy needs in one place, as well as the experience and knowledge to craft a solution for almost any application."

Providing instrumentation is just part of delivering a solution and the added value of technical knowledge is really what sets B&W Tek apart. The research and development team at B&W Tek consists of over 30 engineers in varying disciplines, each with an advanced degree in their field. B&W Tek's ever growing applications staff has expertise in physics, optics, chemistry, biology and engineering in order to provide quality service and support. In 2011, in an effort to share this knowledge and expertise with the academic community, B&W Tek launched the New Horizons academic partnership program to support scientists performing cutting edge research. Based on the early success of the program, the company is currently developing plans to expand on this program in 2012 and beyond.

SSEC bolsters sales force in critical regions

The firm has appointed two industry sales veterans; one will be responsible for coordinating the early adaption of 450mm wafers. The other will take on the role of Country Manager for Japan and Korea

Semiconductor equipment manufacturer Solid State Equipment (SSEC) has announced the addition of two new people to fuel the

company's growth in currently under-addressed markets.

Jim Murphy and Kojitsu Goto (KG) joined SSEC on January 1 2012. Murphy and Goto will assist in expanding SSEC's presence in their respective areas.

Murphy will be responsible for Strategic Accounts on a global basis, including coordinating the early adaption of 450mm wafers. "Jim comes with extensive industry experience and has a solid track record of accomplishment. We expect Jim to expand our presence at IDMs (Integrated Device Manufacturers) with the same success we are enjoying with foundries," said John Voltz, Director of Field Operations at SSEC.

Goto will be assuming the role of Country Manager for Japan and Korea – markets that represent an impressive percentage of capital expenditures for the types of equipment manufactured at SSEC. Voltz, added."These are challenging and highly competitive markets with large global companies and small local companies vying for the business. Considering KG's past success, we are confident his perseverance will get us traction in these markets to help us grow."

Voltz concluded, "We're thrilled to have Jim and KG on board as they add bench strength to our existing sales force and support the increasing number of customers that are choosing SSEC."

B&W Tek to demonstrate tiny fibre-optic Raman probe

The micro lensed tool will be exhibited at SPIE's BiOS & Photonics West conferences

B&W Tek, an advanced instrumentation company producing optical spectroscopy and laser systems, has revealed the BAC200 Raman probe.

The firm says this is the first fibre optic Raman probe capable of delivering the performance of a larger probe; it has a diameter of less than 4mm with enhanced optical collection power.

The BAC200's design enables both immersion and direct contact measurements, allowing for measurements and applications previously not possible with standard Raman probes. The fused silica tip is housed in a stainless steel needle tube, allowing for a scratch resistant, easy to clean probe. Unlike other commercially available lensed fibre optic probes, the optical elements in the BAC200 are permanently fixed in alignment, with no possibility of movement due to impact or vibrations.

"The small size, flexibility, and durability of the BAC200 micro Raman probe make it ideal for analysis in small sample size biological and biomedical applications," says Travis Thompson, Raman Product Specialist at B&W Tek. "This marks a leap forward for scientists performing molecular level spectroscopic analysis by allowing them to perform in vivo analyses of specimens without creating apertures any larger than 4mm."

B&W Tek will be performing a live demonstration of the new BAC200 micro Raman probe at the BiOS and Photonics West exhibits in San Francisco at booth numbers

8401 and 401 respectively.

Plasma-Therm recognised for manufacturing excellence

The semiconductor equipment manufacturer says the preparation for the judging process uncovered unexpected benefits by identifying the positive points as well as areas for improvement

Plasma-Therm was named a finalist for the 2011 Manufacturer of the Year Award.

Each company was evaluated on its commitment to their business, their customers and their employees. A total of sixteen finalists were chosen in four categories for the award. The areas of focus included: leadership, strategic planning, customer and market focus, measurement, analysis and knowledge management, workforce focus, and process management.

“We are very proud to have been selected as a Finalist for the Manufacturer of the Year Award. This achievement recognises the hard work and dedication of our entire team here at Plasma-Therm,” said Scott Craver, Director of Operations. “The preparation for the judging process, analysis and evaluation of our business processes uncovered unexpected benefits. Not only did it identify the positive things we are doing, it also highlighted the areas where we need improvement; this will help us provide even greater value to our customers.”

Winners were announced at the Annual Manufacturers’ Summit and Global Marketplace on December 1, 2011 in Orlando, Florida.

SMG Indium secures $7.5 million funding

SMG intends to issue 2 million shares of common stock at $3.75 per share and expects to use 85% of the gross proceeds to purchase and stockpile the metal indium and 15% for general corporate purposes

SMG Indium Resources (SMG) has entered into a definitive purchase agreement to sell $7.5 million of its common stock in a private placement offering to entities affiliated with Raging Capital Management LLC.

“We are pleased that our largest shareholder, Raging Capital Management LLC, continues to believe in our corporate vision and has decided to increase its investment in our Company. We have agreed to issue common stock at a 10% premium to the closing bid price and essentially at parity to our Net Market Value (“NMV”) which was last reported on our website on December 31, 2011 at $3.76 per share. With the proceeds, we will continue to expand our strategic stockpile of indium,” said Alan C. Benjamin, chief executive officer of SMG Indium Resources.

“We believe the supply/demand fundamentals of the indium market are very compelling, and we are excited to be shareholders in what we believe is the world’s largest strategic stockpile of the metal. Further, the Company has successfully acquired an additional 25 metric tons of indium since the initial public offering,” said William C. Martin, Chairman and Chief Investment Officer of Raging Capital Management, LLC.

Indium is strongly linked to the burgeoning digital economy. Indium in the form of indium tin oxide (“ITO”) creates the optically transparent electrodes that drive LCD displays on TVs, computer monitors, laptops, tablets, smartphones and touchscreens. The demand for LCD glass has continued to grow even during the recession. Additionally, the unique

chemical properties of indium compounds make them essential to fabricating products in some of the most exciting emerging technologies, including LEDs, high speed semiconductors in the form of InGaAs and InP as well as the next generation of thin-film solar panels known as CIGS.

Primary production of indium is constrained by both physical occurrence (it is produced entirely as a by-product of industrial metal smelting) and by geographic occurrence (over 50% of the world's primary production and in excess of 70% of reserves are located in China). Primary production has been stagnant for the past five years and has not been rising to meet growing demand.

Last year, the Department of Energy released its first Critical Materials Strategy report. The report found that four clean energy technologies used materials at risk of supply disruptions in the next five years. In that report, the supply of five rare earth elements and indium were assessed as being most critical in the short term.

The Company believes the indium market is in a structural supply deficit. However, economic uncertainty, generated by the fiscal crisis in Europe, has led display manufacturers to draw down inventories, even as end-user sales of TVs, tablets and cell phones have continued to grow.

This has resulted in lower than expected demand for LCD driven raw materials and as a result the current price of indium has fallen to $570 per kilogram. Although the price of indium can always drop further amidst uncertainty, the Company believes this price level represents an excellent opportunity to further increase its stockpile.

An investment in SMGI represents an investment in a Company whose value is tied to a commodity linked to growth in the technology sector, as well as an investment in a hard asset, indium bullion. We believe SMG Indium Resources Ltd. maintains the largest strategic stockpile of indium outside of the People's Republic of China.

Bronkhorst High-Tech BV launches new website

The thermal mass flow meters and controller manufacturer's new website, launched on January 1st 2012, has a modern and contemporary design. MFCs are widely used in the production of compound semiconductors

The corporate website is in English and Chinese, but Bronkhorst's worldwide branch offices will also soon be launching their own new websites in German, French, Dutch, English and Japanese.

For easy navigation there is a menu at the top and a clear site map with direct links in the footer of each page. The new site also links to Bronkhorst High-Tech's Social Media accounts on Twitter, LinkedIn and Facebook.

AIP sells Brooks Instrument and Ichor Systems

The private equity group has sold off Brooks, an MFC manufacturer, and Ichor, a gas and fluid management product producer, which both serve the LED market

American Industrial Partners (AIP), which is

focused on acquiring and improving North American-headquartered industrial businesses, has announced the sale of Brooks Instrument ("Brooks") and Ichor Systems ("Ichor").

The terms of both transactions have not been disclosed.

Brooks is a global provider of low flow and pressure / vacuum analytical instruments to a worldwide customer base in a variety of end markets including microelectronics, LED, and alternative energy. AIP acquired Brooks from Emerson Electric in December 2007, and the sale marks the second significant realisation for American Industrial Partners Capital Fund IV, L.P ("Fund IV") in the past week.

Headquartered in Hatfield, PA, Brooks has around 800 employees in 18 locations in 13 countries. The company's products are used to regulate the flow rates of gases and liquids in laboratory and process environments and include thermal mass flow controllers used in MOCVD reactors. MFCs are mission critical and configured to address the specific technical requirements in the growth of compound semiconductors. Brooks serves over 9,000 customers in 75 countries with an installed base of over 1.5 million instruments.

"The Brooks investment is a demonstrative case study of the effectiveness of American Industrial Partners' operating approach," said Eric Baroyan, a Partner at AIP. "Our team is primarily comprised of engineers and operators who support management in achieving the growth objectives for their business. By acquiring and commercialising intellectual property, supporting new product development, developing efficient manufacturing processes, optimising procurement, and consolidating a global manufacturing footprint, Brooks more than doubled revenue and tripled EBITDA during our investment period."

Clark Hale, Chief Executive Officer of Brooks, said, "Brooks has long been a highly-respected brand with a loyal global customer base. However, it was the support and commitment of the entire American Industrial Partners team that enabled us to achieve the step change in product offerings, operating efficiency, and financial performance over the last few years. We greatly value American Industrial Partners' contribution to the success of our company and look forward to continued growth under new ownership.

On December 30, 2011, AIP also sold Ichor Systems to Francisco Partners, another technology-focused private equity firm.

Ichor is a designer and manufacturer of process tools, gas delivery modules, and chemical delivery modules purchased by original equipment manufacturers (OEMs) for use in the global semiconductor, alternative energy, LED, data storage, and flat panel display markets. AIP acquired Ichor in October 2009 at the trough of the semiconductor equipment market.

Headquartered in Tualatin, OR, Ichor employs about 540 people over a global footprint, including operations in Malaysia and Singapore. The Company's gas and fluid management products and systems are used to produce microelectronic semiconductor chips, solar panels, LEDs, superconductor wire and thin film magnetic heads. Ichor has established strategic relationships with leading OEMs and serves as a design partner and outsourced manufacturer for its customers' most critical products.

"We see a real opportunity for Ichor Systems to build upon its operational strengths, global workforce and deep industry relationships to drive growth," said Andrew Kowal, a partner at Francisco Partners and head of the firm's semiconductor and hardware investment activities. "Francisco Partners brings significant experience from more than a decade of investments in the semiconductor and related industries, and we will work closely with Ichor Systems' management team to capitalise on these opportunities."

Dipanjan Deb, managing partner of Francisco Partners, added, “The investment in Ichor Systems represents the latest in a series of semiconductor investments we have made over the years and reflects our continued commitment to investing in the semiconductor and capital equipment industries. We plan to build upon Ichor Systems’ successes and will provide the resources needed to expand the company’s market leadership.”

David Shimmon, chief executive officer of Ichor Systems said, “American Industrial Partners had both a unique insight into the semi industry at its 2009 trough and the deep technical skills to successfully work with management to execute numerous operational enhancements. During management’s partnership with American Industrial Partners, Ichor has diversified into entirely new product markets and developed industry leading operational capabilities in Asia. The Ichor team greatly values American Industrial Partners’ contribution to the success of the company and, with this chapter in our development now concluded, we look forward to continued growth.”

He added, “In Francisco Partners, we have found the truly unique partner who brings historical investment experience in our specific market, a rich network, and strong expertise in the semiconductor, LED, and technology markets broadly,” said. “We look forward to leveraging Francisco Partners’ insights and capabilities as we support and grow with our customers.”

Nocilis Materials launches new SiGe foundry

The spin-out from the Royal Institute of Technology, KTH, Sweden is to provide services for Silicon-based materials (including Silicon Germanium) for customers all over the world
With niches in the IR & THz uncooled detector markets, Nocilis produces thermoelectric structures based on group IV materials.

The company is now marketing what it says is the first dedicated foundry established for supplying advanced Silicon-based materials.

Epitaxy services include RPCVD epitaxial growth on 4-, 6- and 8-inch substrates with the following descriptions:

* P-, As- and B-doped Silicon and SiGeSnC layers (doping level of 1015- 1019 cm-3 in Silicon. For Silicon alloys, doping capability is dependant on the material design)
* Selective epitaxy of doped and undoped SiGeC layers on patterned substrates
* Multilayer structures (superlattices) of Silicon or Germanium-based materials
* Unstrained Germanium on Silicon
* Compressive and tensile strained SiGe layers
* Strained Silicon on relaxed SiGe layers
* Tensile strained Germanium layers (on-going)

Further services are offered for materials characterisation of epitaxial films. These include:

* High-resolution scanning electron microscopy (HRSEM) in planar and cross-sectional view
* High-resolution x-ray diffraction (HRXRD): Reciprocal lattice mapping (RLM), grazing angle measurement, strain measurement and layer profile over the substrate area. This data provides the interfacial roughness, composition and strain parallel to and perpendicular to the plane.

Tegal sells over 30 patents from Nanolayer Deposition Portfolio

To date, approximately $3.6 million has been received

California based Tegal Corporation has awarded patents to multiple bidders for three of the four bid lots of Tegal's NLD Patent Portfolio recently offered for sale for an aggregate consideration of approximately $4 million.

Tegal manufactures equipment used to develop and produce devices such as LEDs, filtering and sensing devices present in advanced smart phones and PV solar cells.

Tegal sold over 30 patents from the NLD portfolio—which includes more than 35 U.S. and international patents in the areas of pulsed-chemical vapour deposition (CVD), plasma-enhanced atomic-layer deposition (ALD) and NLD.

NLD is a process technology that bridges the gap between high throughput, non-conformal chemical vapour deposition and lower throughput, highly conformal atomic layer deposition (ALD). Tegal offered the patent portfolio for sale earlier this year in an effort to complete the divestment of its semiconductor capital equipment assets.

In March 2010, Tegal sold its legacy thin-film etch and physical vapor deposition (PVD) product lines to OEM Group, Inc. of Gilbert AZ, and in February of this year, sold its deep reactive ion etch (DRIE) assets to SPTS of Newport, Wales, UK.

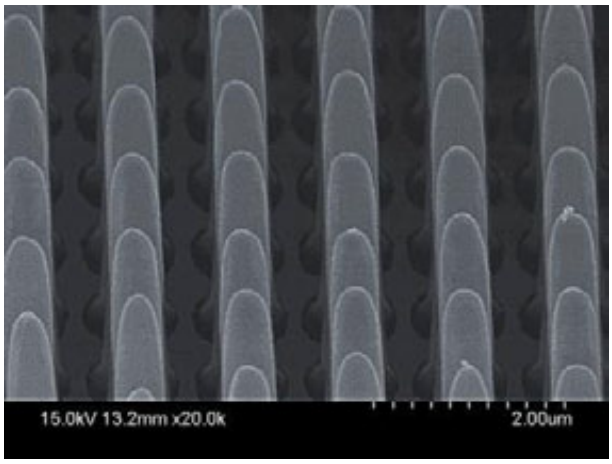
The company reports that discussions are ongoing for placement of Lot 4 of the portfolio, which applies to copper barrier and low-k dielectric technology. "Interest in Lot 4 is coming primarily from IC device manufacturers, comments Robert Ditizio, Tegal's Chief Technologist, whereas interest in Lots 1 through 3 was driven largely by equipment manufacturers."

Making GaAs etching easy

The "MacEtch" wet etch solution ensures that only the areas touching metal are etched away, and high-aspect-ratio structures are formed as the metal sinks into the wafer. After etching , the metal can be cleaned from the surface without damaging it

Creating semiconductor structures for high-end optoelectronic devices just got easier, thanks to University of Illinois researchers.

The team developed a method to chemically etch patterned arrays in GaAs, which is used in solar cells, lasers, LEDs, field effect transistors (FETs), capacitors and sensors. Led by electrical and computer engineering professor Xiuling Li, the researchers describe their technique in the journal Nano Letters.



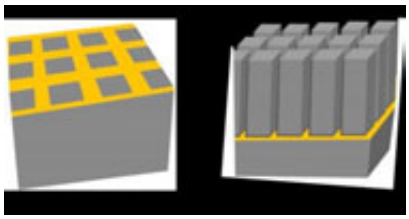
A scanning electron microscope image of "nanopillars " etched in GaAs via metal-assisted chemical etching (Credit: Xiuling Li)

As semiconductor's physical properties vary, wafers are etched into structures that tune their electrical and optical properties and connectivity before they are made into chips.

Semiconductors are commonly etched with two techniques; "wet" etching uses a chemical solution to erode the semiconductor in all directions, while "dry" etching uses a directed beam of ions to bombard the surface, carving

out a directed pattern. Such patterns are required for high-aspect-ratio nanostructures, or tiny shapes that have a large ratio of height to width. High-aspect-ratio structures are essential to many high-end optoelectronic device applications.

Unfortunately, III-V semiconductors like GaAs can be difficult to dry etch, as the high-energy ion blasts damage the semiconductor's surface making them more susceptible to damage than silicon.



Metal-assisted chemical etching uses two steps. First, a thin layer of gold is patterned on top of a semiconductor wafer with soft lithography (left). The gold catalyses a chemical reaction that etches the semiconductor form the top down, creating three-dimensional structures for optoelectronic applications (right)

To address this problem, Li and her group turned to metal-assisted chemical etching (MacEtch), a wet-etching approach they had previously developed for silicon. Unlike other wet methods, MacEtch works in one direction, from the top down. It is faster and less expensive than many dry etch techniques, according to Li. Her group revisited the MacEtch technique, optimising the chemical solution and reaction conditions for GaAs.

The process has two steps. First, a thin film of metal is patterned on the GaAs surface. Then, the semiconductor with the metal pattern is immersed in the MacEtch chemical solution. The metal catalyses the reaction so that only the areas touching metal are etched away, and high-aspect-ratio structures are formed as the metal sinks into the wafer. When the etching is done, the metal can be cleaned from the surface without damaging it.

"It is a big deal to be able to etch GaAs this way," Li said. "The realisation of high-aspect-ratio III-V nanostructure arrays by wet etching can potentially transform the fabrication of semiconductor lasers where surface grating is currently fabricated by dry etching, which is expensive and causes surface damage."

To create metal film patterns on the GaAs surface, Li's team used a patterning technique pioneered by John Rogers, the Lee J. Flory-Founder Chair and a professor of materials science and engineering at Illinois University . Their research teams joined forces to optimise the method, called soft lithography, for chemical compatibility while protecting the GaAs surface. Soft lithography is applied to the whole semiconductor wafer, as opposed to small segments, creating patterns over large areas – without expensive optical equipment.

"The combination of soft lithography and MacEtch make the perfect combination to produce large-area, high-aspect-ratio III-V nanostructures in a low-cost fashion," said Li, who is affiliated with the Micro and Nanotechnology Laboratory, the Frederick Seitz Materials Research Laboratory and the Beckman Institute for Advanced Science and Technology at Illinois University.

Next, the researchers hope to further optimise conditions for GaAs etching and establish parameters for MacEtch of other III-V semiconductors. Then, they hope to demonstrate device fabrication, including distributed Bragg reflector lasers and photonic crystals.

"MacEtch is a universal method as long as the right condition for deferential etching with and without metal can be found," Li said.

The Department of Energy and the National Science Foundation supported this work.

More details of this research are in the paper, "Formation of High Aspect Ratio GaAs

Nanostructures With Metal-Assisted Chemical Etching," which is available online at http://pubs.acs.org/doi/full/10.1021/nl202708d.

Thailand flooding slices II-VI financial guidance

The flooding of the company's manufacturing facilities at its Chokchai campus in Pathum Thani means the company may never again manufacture at the Chokchai location

II-VI Incorporated has provided an update on the impact of the Thailand flooding and revised guidance for the second fiscal quarter ending December 31, 2011 and the fiscal year ending June 30, 2012.

As the Company originally reported in its October 25, 2011 earnings release, on October 24, 2011, Fabrinet, a company that manufactures certain products for the Company (specifically for the Company's recently acquired Aegis Lightwave, Inc. subsidiary (Aegis)), and manufactures products for certain of the Company's customers using II-VI products, reported that flood waters had infiltrated the manufacturing facilities at its Chokchai campus in Pathum Thani, Thailand.

Subsequent information released by Fabrinet indicated that production at the Chokchai location will not recommence during the quarter ending December 31, 2011, and likely for significantly longer, and Fabrinet acknowledged that it may never again manufacture at the Chokchai location.

Since then, II-VI has completed its initial assessment of the damages and the impact from the Thailand flooding on its results of operations for the second fiscal quarter ending December 31, 2011 and the fiscal year 2012 full year projected results. The Company has implemented recovery plans for production that was impacted by the Thailand flooding.

II-VI currently estimates that it will record in its second fiscal quarter ending December 31, 2011 an after-tax impairment charge for Aegis' damaged machinery, equipment and inventory that were located at the Chokchai location. It will also take into account recovery related expenses totalling between $0.5 million and $1.0 million or approximately $0.01 to $0.02 per share diluted, before the consideration of any insurance recoveries which may be available to the Company.

The Company's revised outlook incorporates the expected loss of revenues on Aegis products, the additional costs required for alternative manufacturing and assessing flood damages, and the write-off of damaged machinery, equipment and inventory.

In addition to the Aegis events, the Company's Pacific Rare Specialty Metals & Chemicals, Inc. (PRM) tellurium inventory has experienced a significant decline in the market price of that minor metal during the current fiscal quarter believed to be driven by volatility in the global photovoltaic market.

If this decline in pricing for tellurium continues until December 31, 2011, it is expected to result in an after-tax write down of PRM's tellurium inventory of approximately $1.8 million to $2.2 million or approximately $0.03 per share diluted. Revenue and profit forecasts for PRM have been updated and are included in the Company's revised outlook for the quarter ending December 31, 2011 and the fiscal year ending June 30, 2012.

Outlook

For the second fiscal quarter ending December 31, 2011, the Company currently forecasts revenues to range from $127 million to $129 million and earnings per share to range from $0.17 to $0.19. For the fiscal year ending June 30, 2012, the Company currently expects revenues to range from $550 million to $560 million and earnings per share to range from $1.05 to $1.10.

II-VI Incorporated is a vertically-integrated manufacturing company that creates and markets products for diversified markets including industrial manufacturing, military and aerospace, high-power electronics and telecommunications, and thermoelectronics applications. Headquartered in Saxonburg, Pennsylvania, the Company produces numerous crystalline compounds including zinc selenide for infrared laser optics, silicon carbide for high-power electronic and microwave applications, and bismuth telluride for thermoelectric coolers.

SPTS and Sumitomo joint venture to be big in Japan

The new company, SPP Technologies (SPT), is targeting device manufacturers of LEDs, RF power devices and MEMS.

SPTS Technologies (SPTS) is launching a JV with its former parent company, Sumitomo Precision Products Co, Ltd. (SPP) to serve the Japanese market.

SPTS designs, develops and manufactures capital equipment used to produce electronic and micro-devices for a number of high growth end-markets including micro electro-mechanical systems (MEMS), power management, advanced packaging, high speed RF components, and high brightness LEDs. With over 500 employees across 19 countries, SPTS supplies micro-device manufacturers from its main manufacturing facilities in Newport, Wales and San Jose, California.

SPP has previously supplied certain SPTS systems in Japan through its Micro Technology Division, with local manufacturing under license from SPTS and custom development and support tailored to the Japanese market. In addition, SPTS sold spare parts and other systems in Japan through its wholly owned subsidiary, SPTS K.K., with the cooperation and support of SPP.

As planned from the time of the acquisition of SPTS from SPP in June 2011, a new subsidiary of SPP, SPP Technologies Co., Ltd. (SPT) has been launched with co-investment from SPTS, to combine the SPP Micro Technology business and SPTS K.K. to provide comprehensive solutions to meet the requirements of Japanese customers through the wide range of SPTS products.

“We are very pleased to announce the final step in our MBO process, with the formation of a new relationship with SPP to better serve Japanese customers,” said William Johnson, president and CEO of SPTS. “SPP has been a leader in MEMS manufacturing equipment for 30 years, and SPTS looks forward to expanding our relationship with SPP as our markets evolve and grow in the future.”

SPP president, Susumu Kaminaga agreed and commented, “From 1992 when SPP began distributing Surface Technology Systems (STS) products in Japan and subsequently acquired STS in 1995, SPP has been dedicated to providing Japanese customers with products suited to their unique requirements. The formation of the joint venture ensures the continuation and broadening of that focus by increased cooperation with SPTS.”

Dr. Philippe Roussel to present at CS Europe Conference 2012

Defining the next steps for the Compound Semiconductor Industry,Dr. Philippe Roussel of Yole Développement will present the talk “Wide Bandgap device market update”.

Following the success of CS Europe 2011, next year’s conference is expanding to 2 days and offers a fantastic mix/quality of speakers making it the must attend industry event for 2012.

Register at www.cseurope.net & book your delegate place now as numbers will be limited. The conference takes place on 12th/13th March 2012 at Hilton Hotel, Frankfurt, Germany.

A networking dinner will also be held on the night of 12th March.

Conference Chair

Dr Andrew W Nelson, President & CEO, IQE

Conference Schedule:

Markets and III-V CMOS - Morning 12th March

A mix of insightful market research presentations & cutting-edge research destined to shape tomorrow's compound semiconductor industry with talks including:

Compound Semiconductor Markets: Current Status and Future Prospects - Asif Anwar, Director – Strategic Technologies Practice, Strategy Analytics

The Market for LEDs in Lighting- Mr. Philip Smallwood, Lighting Market Analyst, IMS Research

Wide Bandgap device marketupdate - Dr. Philippe ROUSSEL, Senior Project Manager, Yole Développement

European efforts to develop III-Vs on 200 and 300 mm silicon- Dr. Matty Caymax, Chief Scientist, Imec

An Overview of the DARPA Diverse Accessible Heterogeneous Integration (DAHI) Program- Sanjay Raman, Program Manager, Defense Advanced Research Projects Agency/Microsystems Technology Office

The Integration of silicon CMOS with III-Vs- Professor Iain Thayne, University of Glasgow

III-Vs on 200 mm Si for VLSI– Dr Richard Hill, Project Manager, Sematech

III-V 3D Transistors- Peide Ye, Professor of Electrical and Computer Engineering, Purdue University

LEDs, lasers, PV and electronics - Afternoon of 12th March & full day of 13th March

KEYNOTE SPEAKER*: III-V on Silicon: Challenges and Opportunities*- Robert S. Chau, Intel Senior Fellow, Intel

SiC and GaN Electronics- Dr. John Palmour, Cree co-founder and chief technology officer Power & RF, Cree

Ammono's ammonothermal method to make GaN substrates– Dr. Robert Dwiliński, President, CEO, Ammonno S.A.

Tomorrow's RF chips for mobile devices- Todd Gillenwater, VP of Technology and Advanced Development, RFMD

Building a Successful III-V Pure Play Foundry- Dr. John Atherton, Associate Vice President, WIN Semiconductors

Scalable "on-silicon" solutions (GaN-on-Si and Ge-on-Si) using rare oxide buffer layers– Dr. Michael Lebby, General Manager & Chief Technology Officer, Translucent Inc.

III-Nitride Lasers Based on Nonpolar/ Semipolar Substrates- Dr James W. Raring, VP Laser Engineering, Soraa Inc.

Markets and Applications for SiC Transistors - Dieter Liesabeths, Vice President Sales & Marketing, SemiSouth Laboratories, Inc.

Perspective of an LED Manufacturer- Professor Iain Black, VP WW Manufacturing Engineering, Technology & Innovation, Philips Lumileds Lighting Company

The CPV Market following the acquisition of Quantasol technology - Jan-Gustav Werthen, JDSU, Senior Director

Commercialisation of GaN on SI based Power Devices at International Rectifier- Dr. Michael A. Briere, International Rectifier

GaN the enabler for true SDR- Professor Rik Jos, RF Technology Fellow & Innovation Manager, NXP Semiconductors

Holistic Approach to MOCVD vacuum & Abatement- Dr Mike Czerniak, Product Marketing Manager, EdwardsVacuum Ltd

Advances in Wide Bandgap Semiconductors for Power Electronics- Dr. Markus Behet, Global market manager, Power Electronics, Dow Corning

Large diameter GaN-on-Si epiwafers for power electronics- Dr Mariane Germain, Co-Founder & CEO, EpiGaN

Achieveing Gan & GaAs RF Design Success through Product & Foundry Innovation– Mr Bryan Bothwell, Strategy and Business Development Manager – Foundry Services, TriQuint Semiconductor

Damage - free Deposition on LED devices- Dr Silvia Schwyn Thöny, Senior Process Engineer, Evatec Ltd

Temporary Bonding: An enabling technology for RF and power compound semiconductor devices - Dr Thomas Uhrmann, Business Development Manager, EV Group (EVG)

Brewer and SUSS to commercialise ZoneBOND process

The joint effort combines both companies' expertise to provide a complete material, equipment and process solution, optimised for each individual customer's process needs in thin wafer handling.

Brewer Science, the inventor of ZoneBOND technology and expert in materials and processes for thin wafer handling, and SUSS MicroTec are joining forces in commercialising ZoneBOND technology for thin wafer handling.

SUSS MicroTec is now offering the Brewer Science ZoneBOND process on the XBC300 and XBS300 platforms, targeted for high volume bonding and debonding of 200/300mm wafers using silicon or glass carriers.

Brewer Science offers products specifically designed for the successful implementation of its ZoneBOND process including materials for carrier preparation, adhesives, removers, as well as small scale debonding equipment.

ZoneBOND technology is an innovative solution for wafer handling that provides excellent total thickness variation (TTV) control, high-temperature stability, and low-stress debonding. Customers will benefit through higher yield at debonding, higher throughput, and lower cost of ownership.

This joint effort combines both companies' expertise to provide a complete material, equipment and process solution, optimized for each individual customer's process needs.

Brewer Science is a global technology leader in creating, developing, and manufacturing specialty materials, equipment, and process solutions for applications in semiconductors, advanced packaging/3-D ICs, MEMS, sensors, displays, LEDs, and printed electronics. The company's 30 years of in-depth knowledge and expertise in materials science, chemistry, physics, optics, modelling, and process integration distinguish it from all other material suppliers worldwide.

Novel Devices

Heat purifies quantum dots and nanorod lights

When six month old CdSe/CdS nanocrystals in solution were subjected to ultraviolet light, luminescence increased by seven times

Scientists from Berkeley Lab have discovered why a promising technique for making quantum dots and nanorods has so far been a disappointment.

Better still, they've also discovered how to correct the problem.

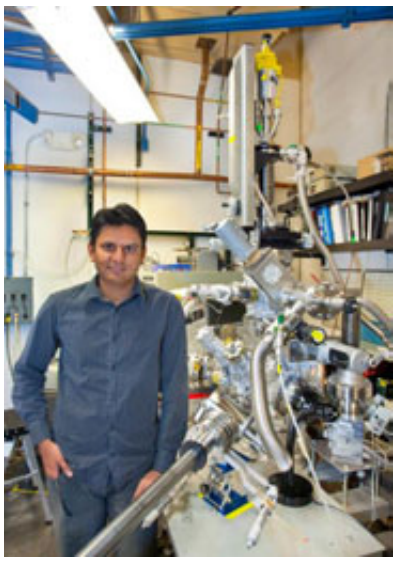
The research was led by chemist Paul Alivisatos, director of Berkeley Lab, U.S. Department of Energy (DOE), and Prashant Jain, a chemist now with the University of Illinois. The team has discovered why nanocrystals made from multiple components in solution via the exchange of cations (positive ions) have been poor light emitters.

The problem, they found, stems from impurities in the final product. The team also demonstrated that these impurities can be removed through heat.

Panel on left shows luminescence of CdSe/CuS nanocrystals prepared by cation-exchange prior to purification. Right panel shows luminescence of same nanocrystals after impurities have been removed.

"By heating these nanocrystals to 1000 C, we were able to remove the impurities and increase their luminescence by 400-fold within 30 hours," says Jain, a member of Alivisatos' research group when this work was done. "When the impurities were removed the optoelectronic properties of nanocrystals made through cation-exchange were comparable in quality to dots and nanorods conventionally synthesised."

Says Alivisatos, "With our new findings, the cation-exchange technique really becomes a method that can be widely used to make novel high optoelectronic grade nanocrystals."



Prashant Jain, former member of Paul Alivisatos' research group now with the University of Illinois. (Photo by Roy Kaltschmidt, Berkeley Lab Public Affairs)

Quantum dots and nanorods are light-emitting semiconductor nanocrystals that have a broad range of applications, including bio-imaging, solar energy and display screen technologies. Typically, these nanocrystals are synthesised from colloids – particles suspended in solution.

As an alternative, Alivisatos and his research group developed a new solution-based synthesis technique in which nanocrystals

are chemically transformed by exchanging or replacing all of the cations in the crystal lattice with another type of cation.

This cation-exchange technique makes it possible to produce new types of core/shell nanocrystals that are inaccessible through conventional synthesis. Core/shell nanocrystals are heterostructures in which one type of semiconductor is enclosed within another, for example, a cadmium selenide (CdSe) core and a cadmium sulphide (CdS) shell.

"While holding promise for the simple and inexpensive fabrication of multicomponent nanocrystals, the cation-exchange technique has yielded quantum dots and nanorods that perform poorly in optical and electronic devices," says Alivisatos, a world authority on nanocrystal synthesis who holds a joint appointment with the University of California (UC) Berkeley, where he is the Larry and Diane Bock professor of Nanotechnology.

As Jain tells the story, he was in the process of disposing of CdSe/CdS nanocrystals in solution that were six months old when out of habit he tested the nanocrystals under ultraviolet light. To his surprise he observed significant luminescence. Subsequent spectral measurements and comparing the new data to the old showed that the luminescence of the nanocrystals had increased by at least sevenfold.

"It was an accidental finding and very exciting," Jain says, "but since no one wants to wait six months for their samples to become high quality I decided to heat the nanocrystals to speed up whatever process was causing their luminescence to increase."

Jain and the team suspected and subsequent study confirmed that impurities – original cations that end up being left behind in the crystal lattice during the exchange process – were the culprit.

"Even a few cation impurities in a nanocrystal are enough to be effective at trapping useful, energetic charge-carriers," Jain says. "In most quantum dots or nanorods, charge-carriers are delocalized over the entire nanocrystal, making it easy for them to find impurities, no matter how few there might be, within the nanocrystal. By heating the solution to remove these impurities and shut off this impurity-mediated trapping, we give the charge-carriers enough time to radiatively combine and thereby boost luminescence."

Since charge-carriers are also instrumental in electronic transport, photovoltaic performance, and photocatalytic processes, Jain says that shutting off impurity-mediated trapping should also boost these optoelectronic properties in nanocrystals synthesised via the cation-exchange technique.

This research was supported by the DOE Office of Science.

Further details of this work have been published in the paper, "Highly Luminescent Nanocrystals from Removal of Impurity Atoms Residual From Ion Exchange Synthesis, " by P.K. Jain *et al,*published online in *Angewandte Chemie,*124, Issue 5 on 25 Jan 2012. DOI: 10.1002/ange.201107452

One giant leap for IR technology

Removing gallium from III-V type-II superlattice materials delivers a massive hike in minority carrier lifetime. Thanks to this, these superlattice detectors have the potential to start challenging expensive state-of-the-art HgCdTe infrared imagers

Researchers have successfully demonstrated that InAs/InAsSb Type-II superlattice (T2SL) materials could be a better alternative to conventional InAs/InGaSb T2SLs.

This discovery was made by scientists at Arizona State University and MBE foundry IQE.

Time-resolved photoluminescence of the gallium-free LWIR superlattice exhibited a lower-limit 412 ns minority carrier lifetime at 77 K, more than an order of magnitude increase compared to 30 ns for conventional LWIR InAs/InGaSb T2SL type structures.

Researchers at the US Army Research Laboratory say they have, for the first time, measured lifetimes approaching the reported record (~1 µs) for HgCdTe alloys. This, they say, could pose a realistic alternative to HgCdTe for high performance IR detector and focal plane array (FPA) applications.

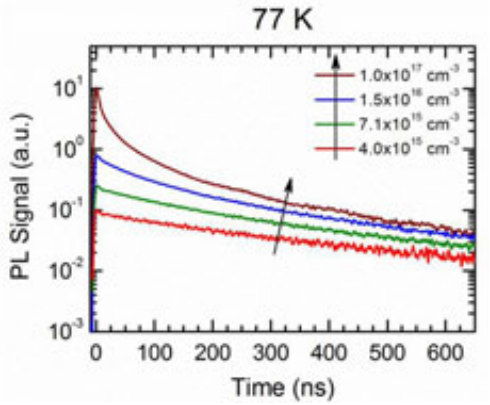


Figure 1: Time-resolved photoluminescence measurements of an InAs/InAs0.72Sb0.28 T2SL at 77 K for excess carrier densities ranging from 4 x 1015 to 1 x 1017 cm-3

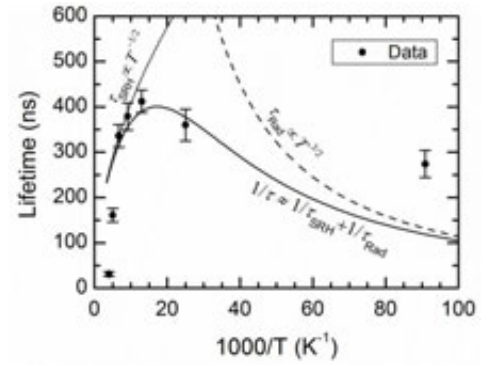


Figure 2 : Carrier lifetimes extracted from the PL decay are shown as points as a function of 1000/T. Also plotted are the temperature dependences of the SRH lifetime (tSRH µ T1/2 , dotted line), radiative lifetime (tRad µ T3/2, dashed line), and a combination of both SRH and radiative lifetimes (solid line).

State-of-the-art infrared imagers made using HgCdTe technology suffer from high costs due to expensive substrates, device processing, a decreasing yield with longer cut-off wavelength, and the need for a low-temperature cryogenic dewar.

The breakthrough in the minority carrier lifetime demonstrated in an InAs/InAsSb T2SL could eventually enable infrared imagers to be manufactured with much lower costs using commercial III-V processes and the vast resources of MBE foundries.

What›s more, T2SL materials have long been predicted to possess longer carrier lifetimes than HgCdTe due to the suppression of Auger recombination. However, Shockley-Read-Hall recombination in the previous conventional III-V T2SL materials prevented the demonstration of the theoretical high performance and limited the minority carrier lifetime to ~30 ns in the LWIR (8-12 µm) range.

With the drastic increase in the carrier lifetime observed in the gallium-free InAs/InAsSb T2SL, future T2SL photodetectors should have much lower dark currents and enable operation at much higher temperatures, allowing the use of lower-cost, smaller-sized cryogenic coolers.

With the recent advances in the size and availability of 4 inch GaSb substrates, future infrared FPA assemblies would cost much less and expand commercial applications into new areas such as the automotive, law enforcement, environmental monitoring, and safety surveillance industries.

The researchers at Arizona State University and their collaborators are very optimistic about the future of gallium-free T2SL materials and the potential to improve the material with further bandgap engineering and defect reduction.

It is worth noting that the carrier lifetime currently observed demonstrates a lower bound as the sample structures in this study have not been completely optimised. Better understanding of the recombination mechanisms, as well as improved bandgap designs are expected to further advance the existing gallium-free T2SL performance.

Further details of the work have been published in the paper, "Significantly improved minority carrier lifetime observed in a long-wavelength infrared III-V type-II superlattice comprised of InAs/InAsSb", by E. H. Steenbergen *et al, Applied Physics Letters*, 99, 251110 (2011); DOI:10.1063/1.3671398.

This work is partially supported by AFOSR and an ARO MURI program. Figures are reprinted with permission of E.H. Steenbergen and the co-authors of the paper.

Viewing GaN nanostructures in 3 dimensions

Individual gallium nitride nanowires as small as 60 nanometres show piezoelectric behaviour in 3D up to six times of that exhibited by bulk GaN

Just 100 nanometres in diameter, nanowires are often considered one-dimensional.

But researchers at Northwestern University have recently reported that individual GaN nanowires show strong piezoelectricity – a type of charge-generation caused by mechanical stress – in three dimensions.

GaN is among the most technologically relevant semiconducting materials and is ubiquitous today in optoelectronic elements such as blue lasers (for example in blue-ray players) and LEDs. More recently, nanogenerators based on GaN nanowires were shown to be capable of converting mechanical energy (such as biomechanical motion) to electrical energy.

"Although nanowires are one-dimensional nanostructures, some properties – such as piezoelectricity, the linear form of electro-mechanical coupling – are three-dimensional in nature," Espinosa said. "We thought these nanowires should show piezoelectricity in 3D, and aimed at obtaining all the piezoelectric constants for individual nanowires, similar to the bulk material."

The findings revealed that individual GaN nanowires as small as 60 nanometres show piezoelectric behaviour in 3D up to six times of their bulk counterpart. Since the generated charge scales linearly with piezoelectric constants, this finding implies that nanowires are up to six times more efficient in converting mechanical to electrical energy.

To obtain the measurements, researchers applied an electric field in different directions in single nanowire and measured small displacements, often in picometre (10-12 m) range. The group devised a method based on scanning probe microscopy leveraging high-precision displacement measurement capability of an atomic force microscope.

"The measurements were very challenging, since we needed to accurately measure displacements 100 times smaller than the size of the hydrogen atom," said Majid Minary, a postdoctoral fellow and lead author of the study.

These results are exciting especially considering the recent demonstration of nanogenerators based on GaN nanowires, for powering of self-powered nanodevices.

The findings, led by Horacio Espinosa, James N. and Nancy J. Farley Professor in Manufacturing and Entrepreneurship at the McCormick School of Engineering and Applied Science, were published in the online paper, " Individual GaN Nanowires Exhibit Strong Piezoelectricity in 3D", by Majid Minary-Jolandan *et al,* in *Nano Letters,* DOI: 10.1021/

nl204043y

Cracking thin-solid GaN films into nanobelts

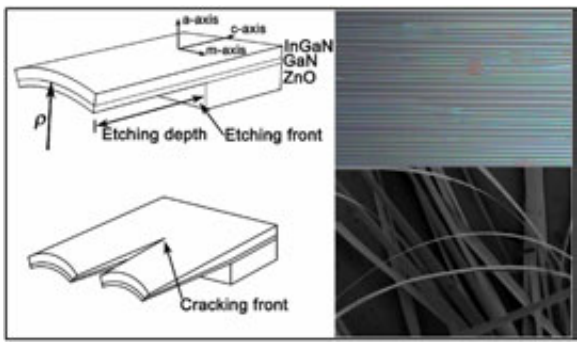
IMRE researchers reveal a novel technique for fabricating gallium nitride based nanobelts with enhanced functions and applications

Researchers from Institute of Materials Research and Engineering (IMRE), Singapore, claim to have fabricated InGaN/GaN hetero-structured nanobelts that set a new benchmark for performance.

The team can control the structure and doping of these belts, which makes them more attractive candidates for piezotronic and optoelectronic devices.

It is possible to make the nanobelts as long as desired, and they can be arranged in parallel arrays for integration into devices.

Fabrication involves MOCVD growth of an InGaN/GaN bilayer film that has an asymmetric elastic stress. When the bilayer film is detached from its substrate, the strain relaxation of the bilayer film drives itself to curve and crack along a certain direction, guided by the asymmetrically stored stress.



To asymmetrically store the elastic stress, *r*-plane sapphire was selected as the substrate, so that the*c*-axis of the GaN-related layers lies in the growing plane (i.e., parallel to the surface plane). For easy detachment of the bilayer film, ZnO sacrificial template was introduced before the MOCVD growth of InGaN/GaN heterostructure.

MOCVD deposition enables the control of the doping and thickness of the InGaN/GaN bilayer. The ZnO template was first epitaxially grown on an *r*-plane sapphire substrate by rf-magnetron sputtering. A 50 nm GaN film was then epitaxially grown by MOCVD on the ZnO sacrificial template.

To improve the crystal quality, magnesium-doping was employed as the surfactant to enhance the mobility of the adatoms on the growing surface. The structure was ended by a 150 nm InGaN thin film grown on the GaN layer, forming the InGaN/GaN bilayer. The in-plane asymmetrical stress induced by ZnO and InGaN was stored in the InGaN/GaN bilayer. When the ZnO buffer layer was laterally etched off, the bilayer was detached and cracked.

Guiding by the asymmetrical stress, the cracks propagate within the bilayer along the *c*-axis (lying parallel to the surface plane), forming the parallel nanobelts array. The length of the nanobelts can be varied, determined by the sample size while parallel nanobelts array can be transferred to any desired substrates with the help of wax.

The crack density and the width of the InGaN/GaN nanobelts are simply controlled by the amount of elastic stress stored in the bilayer film, which is dependent on the indium composition within the InGaN layer and the InGaN-to-GaN thickness ratio.

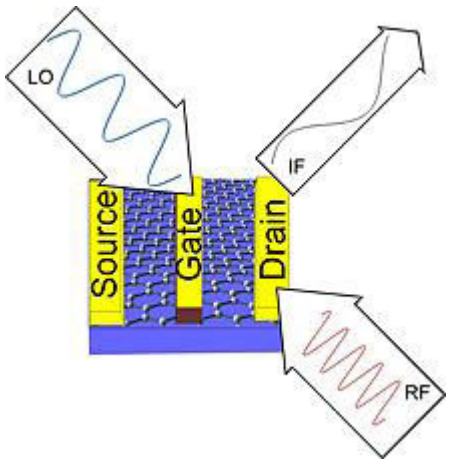
Further details of this work will be described in a paper accepted for publication by H. F. Liu *et al* in*Nano Energy*.

Speeding up future electronics with graphene mixer

The mixer provides new opportunities as it enables compact circuit technology, potential to reach high frequencies and integration with silicon technology

Researchers at Chalmers say they have, for the first time, demonstrated a novel sub-harmonic graphene FET mixer at microwave frequencies.

A mixer is a key building block in all electronic systems. An electronic mixer is a device that combines two or more electronic signals into one or two composite output signals. Future applications at THz frequencies such as radar systems for security and safety, radio astronomy, process monitoring and environmental monitoring will require large arrays of mixers for high-resolution imaging and high-speed data acquisition. Such mixer arrays or multi-pixel receivers need new type of devices that are not only sensitive but also power-efficient and compact.

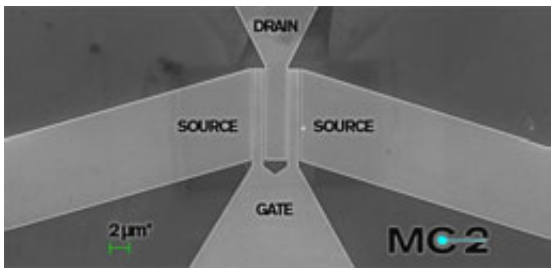


Schematic picture of a subharmonic graphene-FET mixer. The LO and RF signals are fed to the gate and drain terminals, respectively, and the IF signal is extracted from the drain terminal

The ability in graphene to switch between hole or electron carrier transport via the field effect enables a unique niche for graphene for RF IC applications. Thanks to this symmetrical electrical characteristic, the researchers at Chalmers have managed to build the G-FET sub-harmonic resistive mixer using only one transistor.

Hence, no extra feeding circuits are required, which makes the mixer circuit more compact as opposed to conventional mixers. As a consequence, the new type of mixer requires less wafer area when constructed and can open up for advanced sensor arrays, for example for imaging at millimetre waves and even sub millimetre waves as G-FET technology progress.

“The performance of the mixer can be improved by further optimising the circuit, as well as fabricating a G-FET device with a higher on-off current ratio”, says Jan Stake, professor of the research team. “Using a G□FET in this new topology enables us to extend its operation to higher frequencies, thereby exploiting the exceptional properties of graphene. This paves the way for future technologies operating at extremely high frequencies.”



In addition to enabling compact circuits, the G-FET provides potential to reach high frequencies thanks to the high velocity in graphene, and the fact that a sub-harmonic mixer only requires half the local oscillator (LO) frequency compared to a fundamental mixer. This property is attractive especially at high frequencies (THz) where there is a lack of sources providing sufficient LO-power.

Moreover, the G-FET can be integrated with silicon technology. For example, it is CMOS compatible (Complementary Metal Oxide

Semiconductor) and among other things it can be used in CMOS electronics for backend processing on a single chip.

Graphene, which was first demonstrated in 2004, has rapidly gone from curiosity driven to applied research.

The work is published in the paper, "A Subharmonic Graphene FET Mixer" , by O. Habibpour *et al* in IEEE Electron Device Letters, 33(1), 71 -73, January 2012. 10.1109/LED.2011.2170655

The Swedish Foundation of Strategic Research supported this work.

Unison to advance steep ultra-shallow junction technology

The Dainippon Screen and Sematech partnership combines individual strengths to develop sub 14 nm semiconductor manufacturing using high mobility materials

Dainippon Screen Manufacturing has entered into a partnership to accelerate development and commercialisation of advanced semiconductor doping technology with Sematech, a global consortium of the world's leading chip manufacturers.

Screen and Sematech will collaborate on techniques for monolayer doping and activation methods that are compatible with ultra-shallow junctions for planar and non-planar device technologies (e.g., FinFETs, nanowires, memories) in silicon and non-silicon high mobility materials.

To achieve faster transistor speeds and lower power dissipation, device fabrication will require innovative solutions to minimise leakage resulting from process damage and electrostatic control. Ultra-shallow, abrupt, damage-free junctions with high active dopant concentrations are essential for better off-state leakage control in modern highly scaled nano-electronics.

With the advent of non-planar device architectures and high mobility compound semiconductors, doping conformality and minimal lattice damage are increasingly important, and cooperative research efforts are needed to meet ITRS roadmap requirements. A promising defect-free and conformal doping alternative, monolayer doping, will be investigated, and developed for commercial use.

"This partnership with Screen is a key component of our overall strategy to develop critical infrastructure needed for major industry transitions. Innovative process technologies like monolayer doping are essential to enable transitions to non-planar and to non-silicon high mobility channels, while minimising processing induced damage, cost and complexity," said Dan Armbrust, president and CEO of Sematech. "We are excited to combine our materials and process technology strengths with Screen's leading tool engineering strengths to bring innovative solutions for next generation device manufacturers."

"We are very pleased to collaborate with Sematech and its leading-edge industry partners on advanced doping techniques for next generation devices," said Tadahiro Suhara, President of the Semiconductor Equipment Company at Screen. "We believe that this alliance could be a key driver for improving annealing processes and address associated defect issues for manufacturers to continue scaling of CMOS devices."

Photocurrent electrons overpower solar photons

Researchers from NREL have developed a solar cell using PbSe quantum dots which exhibits multiple exciton generation

The U.S. Department of Energy's National Renewable Energy Laboratory (NREL) says they have developed the first solar cell that produces a photocurrent that has an external quantum efficiency (EQE) greater than 100 percent when photo-excited with photons from the high energy region of the solar spectrum.

The EQE for photocurrent, usually expressed as a percentage, is the number of electrons flowing per second in the external circuit of a solar cell divided by the number of photons per second of a specific energy (or wavelength) that enter the solar cell. The scientists believe none of the solar cells to date exhibit photocurrent EQEs above 100 percent at any wavelength in the solar spectrum.

The EQE developed by NREL reached a peak value of 114 percent.

The newly reported work marks a promising step toward developing next generation solar cells for both solar electricity and solar fuels that will be competitive with, or perhaps less costly than, energy from fossil or nuclear fuels.

Multiple Exciton Generation (MEG) is key to making this possible. In this process, a single absorbed photon of appropriately high energy can produce more than one electron-hole pair per absorbed photon.

NREL scientist Arthur J. Nozik first predicted in a 2001 publication that MEG would be more efficient in semiconductor quantum dots than in bulk semiconductors. Quantum dots are tiny crystals of semiconductor, with sizes in the range of 1-20 nm.

On this scale, semiconductors exhibit quantum effects ; the bandgap rapidly increases with decreasing quantum dot size and correlated electron-hole pairs (excitons) are created at room temperature. What›s more, they exhibit enhanced coupling of electronic particles (electrons and positive holes) through Coulombic forces and improve enhancement of the MEG process.

Quantum dots, by confining charge carriers within their tiny volumes, can harvest excess energy that otherwise would be lost as heat – and therefore greatly increase the efficiency of converting photons into usable free energy.

The researchers achieved the 114 percent external quantum efficiency with a layered cell consisting of antireflection-coated glass with a thin layer of a transparent conductor, a nanostructured zinc oxide layer, a quantum dot layer of PbSe treated with ethanedithol and hydrazine, and a thin layer of gold for the top electrode.

In a 2006 publication, NREL scientists Mark Hanna and Arthur J. Nozik showed that ideal MEG in solar cells based on quantum dots could increase the theoretical thermodynamic power conversion efficiency of solar cells by about 35 percent relative to today's conventional solar cells.

Furthermore, the fabrication of Quantum Dot Solar Cells is also amenable to inexpensive, high-throughput roll-to-roll manufacturing.

Such potentially highly efficient cells, coupled with their low cost per unit area, are called «Third (or Next) Generation Solar Cells». Present day commercial photovoltaic solar cells are based on bulk semiconductors, such as silicon, CdTe, or CIGS, or on III-V multi-junction tandem cells. All of these cells are referred to as» First- or Second-Generation Solar Cells».

MEG, also referred to as Carrier Multiplication (CM), was first demonstrated experimentally in colloidal solutions of quantum dots in 2004 by Richard Schaller and Victor Klimov of the

DOE's Los Alamos National Laboratory.

Since then, many researchers around the world, including teams at NREL, have confirmed MEG in many different semiconductor quantum dots. However, nearly all of these positive MEG results, with a few exceptions, were based on ultrafast time-resolved spectroscopic measurements of isolated quantum dots dispersed as particles in liquid colloidal solutions.

The new results published in Science by the NREL research team is the first report of MEG manifested as an external photocurrent quantum yield greater than 100 percent measured in operating quantum dot solar cells at low light intensity; these cells showed significant power conversion efficiencies (defined as the total power generated divided by the input power) as high as 4.5 percent with simulated sunlight.

While these solar cells are un-optimised and exhibit relatively low power conversion efficiency (which is a product of the photocurrent and photovoltage), the demonstration of MEG in the photocurrent of a solar cell has important implications because it opens new and unexplored approaches to improve solar cell efficiencies.

Another important aspect of the new results is that they agree with the previous time-resolved spectroscopic measurements of MEG and hence validate these earlier MEG results. Excellent agreement follows when the EQE is corrected for the number of photons that are actually absorbed in the photoactive regions of the cell. In this case, the determined quantum yield is called the internal quantum efficiency (IQE).

The IQE is greater than the EQE because a significant fraction of the incident photons are lost through reflection and absorption in non-photocurrent producing regions of the cell. A peak internal quantum yield of 130% was found taking these reflection and absorption losses into account.

This research was supported by the Centre for Advanced Solar Photophysics, an Energy Frontier Research Centre funded by the DOE Office of Science, Office of Basic Energy Sciences. Scientists affiliated with the University of Colorado at Boulder also contributed to the study.

Further details of this work are published in the online publication, "Peak External Photocurrent Quantum Efficiency Exceeding 100 percent via MEG in a Quantum Dot Solar Cell ", *Science*, published online on 16 December 2011, Vol. 334 no. 6062 pp. 1530-1533.

DOI: 10.1126/science.1209845

Dr. Philippe Roussel to present at CS Europe Conference 2012

Defining the next steps for the Compound Semiconductor Industry,Dr. Philippe Roussel of Yole Développement will present the talk "Wide Bandgap device market update".

Following the success of CS Europe 2011, next year's conference is expanding to 2 days and offers a fantastic mix/quality of speakers making it the must attend industry event for 2012.

Register at www.cseurope.net & book your delegate place now as numbers will be limited. The conference takes place on 12th/13th March 2012 at Hilton Hotel, Frankfurt, Germany.

A networking dinner will also be held on the night of 12th March.

Conference Chair

Dr Andrew W Nelson, President & CEO, IQE

Conference Schedule:

Markets and III-V CMOS - Morning 12th March

A mix of insightful market research presentations & cutting-edge research destined to shape tomorrow's compound semiconductor industry with talks including:

Compound Semiconductor Markets: Current Status and Future Prospects - Asif Anwar, Director – Strategic Technologies Practice, Strategy Analytics

The Market for LEDs in Lighting- Mr. Philip Smallwood, Lighting Market Analyst, IMS Research

Wide Bandgap device marketupdate - Dr. Philippe ROUSSEL, Senior Project Manager, Yole Développement

European efforts to develop III-Vs on 200 and 300 mm silicon- Dr. Matty Caymax, Chief Scientist, Imec

An Overview of the DARPA Diverse Accessible Heterogeneous Integration (DAHI) Program- Sanjay Raman, Program Manager, Defense Advanced Research Projects Agency/Microsystems Technology Office

The Integration of silicon CMOS with III-Vs- Professor Iain Thayne, University of Glasgow

III-Vs on 200 mm Si for VLSI– Dr Richard Hill, Project Manager, Sematech

III-V 3D Transistors- Peide Ye, Professor of Electrical and Computer Engineering, Purdue University

LEDs, lasers, PV and electronics - Afternoon of 12th March & full day of 13th March

KEYNOTE SPEAKER*: III-V on Silicon: Challenges and Opportunities*- Robert S. Chau, Intel Senior Fellow, Intel

SiC and GaN Electronics- Dr. John Palmour, Cree co-founder and chief technology officer Power & RF, Cree

Ammono's ammonothermal method to make GaN substrates– Dr. Robert Dwiliński, President, CEO, Ammonno S.A.

Tomorrow's RF chips for mobile devices- Todd Gillenwater, VP of Technology and Advanced Development, RFMD

Building a Successful III-V Pure Play Foundry- Dr. John Atherton, Associate Vice President, WIN Semiconductors

Scalable "on-silicon" solutions (GaN-on-Si and Ge-on-Si) using rare oxide buffer layers– Dr. Michael Lebby, General Manager & Chief Technology Officer, Translucent Inc.

III-Nitride Lasers Based on Nonpolar/ Semipolar Substrates- Dr James W. Raring, VP Laser Engineering, Soraa Inc.

Markets and Applications for SiC Transistors - Dieter Liesabeths, Vice President Sales & Marketing, SemiSouth Laboratories, Inc.

Perspective of an LED Manufacturer- Professor Iain Black, VP WW Manufacturing Engineering, Technology & Innovation, Philips Lumileds Lighting Company

The CPV Market following the acquisition of Quantasol technology - Jan-Gustav Werthen, JDSU, Senior Director

Commercialisation of GaN on SI based Power Devices at International Rectifier- Dr. Michael A. Briere, International Rectifier

GaN the enabler for true SDR- Professor Rik Jos, RF Technology Fellow & Innovation Manager, NXP Semiconductors

Holistic Approach to MOCVD vacuum & Abatement- Dr Mike Czerniak, Product Marketing Manager, EdwardsVacuum Ltd

Advances in Wide Bandgap Semiconductors for Power Electronics- Dr. Markus Behet, Global market manager, Power Electronics, Dow Corning

Large diameter GaN-on-Si epiwafers for power electronics- Dr Mariane Germain, Co-Founder & CEO, EpiGaN

Achieveing Gan & GaAs RF Design Success through Product & Foundry Innovation– Mr Bryan Bothwell, Strategy and Business Development Manager – Foundry Services, TriQuint Semiconductor

Damage - free Deposition on LED devices- Dr Silvia Schwyn Thöny, Senior Process Engineer, Evatec Ltd

Temporary Bonding: An enabling technology for RF and power compound semiconductor devices - Dr Thomas Uhrmann, Business Development Manager, EV Group (EVG)