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Automaker view

GaN transistors must improve to win deployment in electric vehicles

Nanotubes

Opportunities for electronic devices

SiC devices

New products hit the market

Phosphors

New architecture improves the light bulb

Research

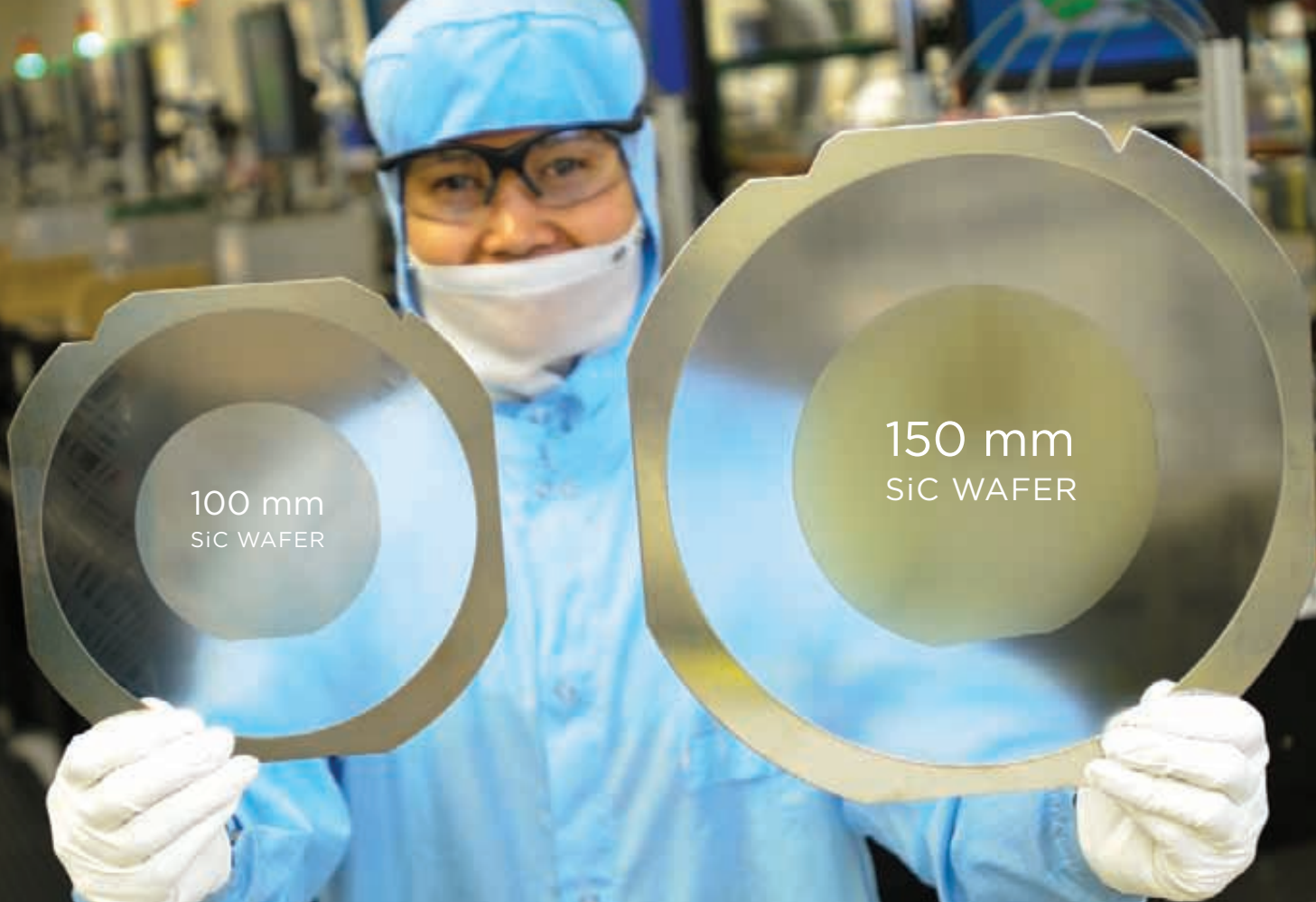
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Focusing on the present

TECH-BASED industries are renowned for looking forward. And taking that view is a lot of fun. Making new products that can revolutionise the way that people live their daily lives is exciting, challenging, and what's more, there tends to be the promise of netting a healthy profit.

In comparison, it's generally far less exciting to build better products for existing markets. That's because the goals aren't those that tend to get the heart racing, with the focus on material costs, yield, production times and reliability.

At *Compound Semiconductor*, we are a big supporter of novel technologies for emerging markets, and in every issue you'll find a handful of features detailing advances in chip technology that can serve new products. But occasionally, we discover that a company with a radically different technology is targeting an existing market and threatening to take away the business of the leading suppliers.

In this issue, you'll be able to read a story of this ilk – an account of how the Stanford University start-up Solar Junction has widened its goals from just being a supplier of triple-junction cells for the concentrating photovoltaic (CPV) market to a developer of similar products for powering satellites (see page 24 for details).

The CPV market could be massive, and it's attracted tremendous interest from companies, but it is yet to fulfil its promise. Its time should come, but this year it will probably be worth around \$50 million. In comparison, the satellite industry is worth four times this, and in this arena the multi-junction cell doesn't have to compete with the likes of silicon, CdTe and CIGS cells. Given this monopoly, it's hardly surprising that Solar Junction is going after this market with its record-breaking technology that features a dilute nitride cell for the bottom junction.

In the space market, Solar Junction's device architecture will not just attract attention for high efficiencies – the entire structure is lattice-matched, so it should be better at powering a satellite year after year, as this orbits the earth and is bombarded by various types of ionizing radiation.

To me, one of the most exciting aspects of Solar Junction's technology is that it offers a relatively straightforward pathway to significantly higher efficiencies. The triple-junction cell operates at 32 percent efficiency, and this could be increased by four percentage points by building the design on germanium, which is used as a fourth junction. Five and six junction cells could then follow, by replacing one dilute nitride junction with a pair of them and adding a new material for the top junction. Efficiencies hitting 40 percent could follow.

Watching Solar Junction's quest to hit that market over the next few years should match the excitement found in keeping tabs on the unveiling of new chips for new markets.

Dr Richard Stevenson
Editor



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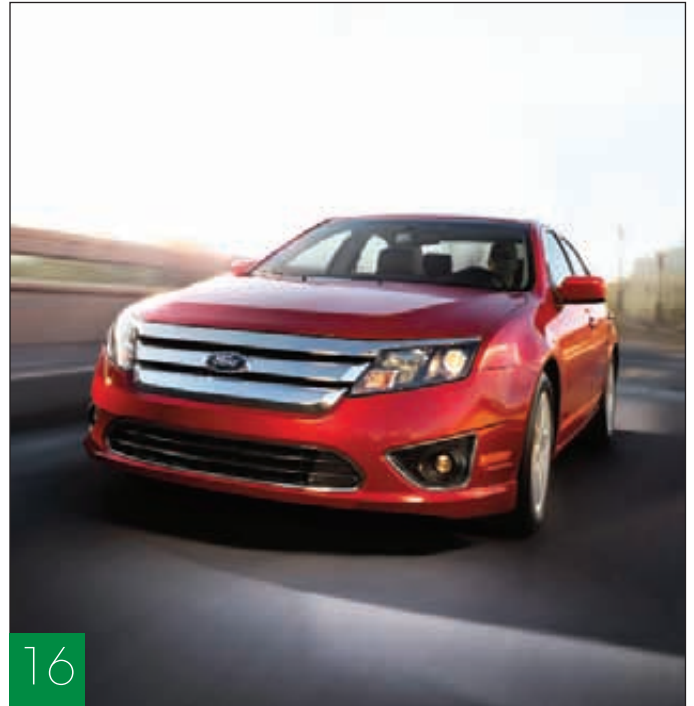
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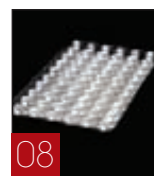
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Soraa wins DoE project for GaN substrates

SORAA, a developer of GaN on GaN solid-state lighting technology, has been selected by Advanced Research Projects Agency-Energy (ARPA-E) to lead a project on the development of bulk GaN substrates.

Using GaN as a substrate holds promise for many industries, but has immediate applications for LEDs, which Soraa manufactures.

A major advancement in a commercially viable new substrate is a promising disruptive technology in the areas of higher efficiency and performance.

GaN on GaN LEDs are of particular interest because they have demonstrated much higher performance than traditional lighting technologies and thus offer the potential for major energy savings.

Soraa claims to be the only LED manufacturer in the world shipping products based on superior GaN on GaN LEDs.

Currently, Soraa says this is the only ARPA-E funded LED substrate project. According to Soraa Founder Shuji Nakamura, breakthroughs in GaN substrates can have far-reaching implications. "I have spent many decades of my life working on gallium nitride for LEDs because I believe this is a very important development and holds great promise for more energy efficient technology in lighting, power electronics and more."

Most of the LEDs of today are made by depositing GaN on non-native substrates, typically sapphire or SiC.

However, many companies are now focussing their efforts on growing GaN on silicon. This is for a number of reasons. Firstly, silicon substrates are very cheap compared to the alternatives. They are also robust and come in large diameters.

What's more, the infrastructure within silicon fabs could potentially allow the manufacture of GaN on silicon without having to buy more growth and other equipment. All these factors combined could reduce overall costs dramatically.

To date, adoption of GaN on GaN technology for large-scale applications has been inhibited by high costs due in part to the absence of inexpensive native GaN substrates. Creating a made-in-U.S.A. solution to the challenges of bulk GaN production will benefit the company, the LED industry, and the American consumer with more energy efficient, less expensive and more readily available components.

LEDs lend themselves well to the new substrate because it greatly enhances performance - as in the quality of the light - as a benefit in addition to energy efficiency. Because of innate physical properties of the compound, GaN on GaN LEDs can withstand higher power densities than diodes made with other substrates. This means a much brighter diode and only one LED light emitter per lamp.



Soraa says manufacturers using other substrates have to use three, four and even more to get the same brightness. Multiple sources of light within a lamp mean fuzzy shadows and not the crisp light required of an MR-16 for best use in commercial, museum or high-end consumer applications. The MR-16 lamps or bulbs are Soraa's first commercially available product.

ARPA-E, a new agency within the U.S. Department of Energy that invests exclusively in transformational energy technologies, began funding Soraa as a consortium member for this project in 2011.

ARPA-E's recent decision to make Soraa the lead organisation on the project means that the firm will become the prime contractor working with ARPA-E to commercialise GaN substrate technology.

Applications for GaN substrates have the potential to reduce U.S. energy consumption by over 30 percent. Those same applications represent potential markets, including laser diodes and power electronics, of over \$50 billion annually, according to a US Department of Energy study.

University enlists Aixtron to develop GaN-on-Silicon

AIXTRON SE has a new MOCVD system order from existing customer National Central University (NCU) in Taiwan. NCU has placed an order for one 1 x 6-inch Aixtron Close Coupled Showerhead MOCVD system, which will be dedicated to the growth of GaN epitaxial structures on 6-inch silicon substrates for use in the research and development of power management devices.

Aixtron's local support team has installed and commissioned the new reactor in the

cleanroom facility at NCU's Microwave and Optoelectronic Devices Laboratory.

Jen-Inn Chyi, Chair Professor of Electrical Engineering at the National Central University of Taiwan, comments, "Demand for low-cost GaN-based power devices in high-efficiency and high-power systems continues to increase. To satisfy this need we therefore plan to transfer our specially developed semiconductor materials technology to industry, for a pilot initially, and then for large-scale production."

Chyi continues, "In order to succeed in this venture, the very best deposition equipment will be required, such as the Aixtron multi-wafer MOCVD system on order. This system is an excellent match for the heteroepitaxial growth of gallium nitride structures on large area silicon wafers, with a view to providing high-performance devices as cost-efficiently as possible. Furthermore, the excellent reputation of the Aixtron support service gives us great confidence for this very important new project."

SiC sector to soar 37 percent per year, says M&M

CURRENTLY, the overall SiC power semiconductors market accounts for less than 1 percent of the total power semiconductors market, but over the next ten years, the entire base of power semiconductors & electronics players is expected to penetrate this new value chain, thereby rapidly increasing the percentage share.

The global SiC semiconductor devices' market revenue is estimated to be roughly \$218 million in 2012 and forecasted to reach \$5.34 billion by end of 2022, according to the report "Silicon Carbide (SiC) Semiconductor Materials and Devices (Discretos & Chips) Market, Global Forecasts & Analysis (2012-2022)" by MarketsandMarkets.

In the case of the SiC power semiconductor market, the phenomenal growth rate of approximately 35 to 50 percent year-over-year is expected to

continue for the following years and the forecasted revenue for SiC power semiconductors is more than \$4 billion by the end of 2022. This is assuming a compound annual growth rate (CAGR) of 45.65 percent, and will allow SiC to substantially penetrate the global power semiconductors market and occupy a 13 percent volume share in 2022.

Initially, the SiC opto-semiconductors market revenue was higher than that of power semiconductors, but in 2011, the situation reversed. The SiC opto-semiconductors market is expected to grow at a CAGR of 25 percent and cross \$600 million by 2022. The main reason for the relatively lower CAGR of SiC opto-semiconductors is the shift of industry preference to sapphire and silicon as substrates over SiC, mainly due to the rising demand of epitaxial GaN in high brightness and ultra-high brightness LEDs.

The high cost of SiC as compared to silicon and sapphire substrates is another of the major factors which will hamper that side of the market.

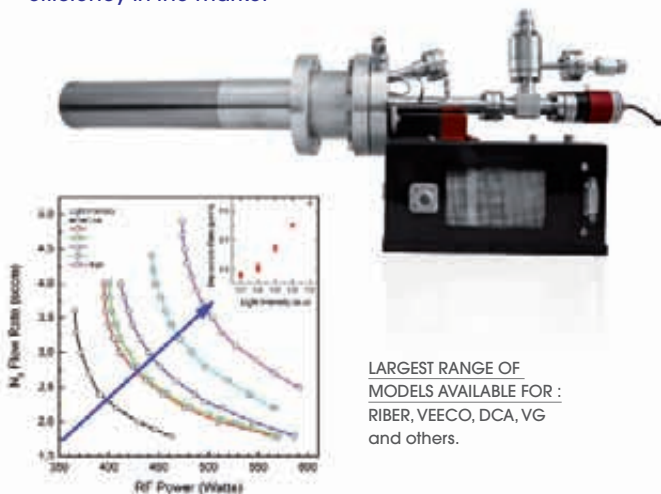
The SiC opto-semiconductors market and high temperature semiconductor markets are currently niche segments, but are expected to grow at healthy CAGRs.

Important players who are among the top ten in the overall SiC semiconductor market, have also deeply established bases in the SiC opto & high temperature semiconductor market segments.

The SiC high-temperature semiconductors market is expected to grow at a CAGR of 22 percent from 2012 to 2022, crossing \$350 million by 2022. This growth is not as fast as power semiconductors, primary because it is a niche area, with lesser focus on industry players and fewer industry players.

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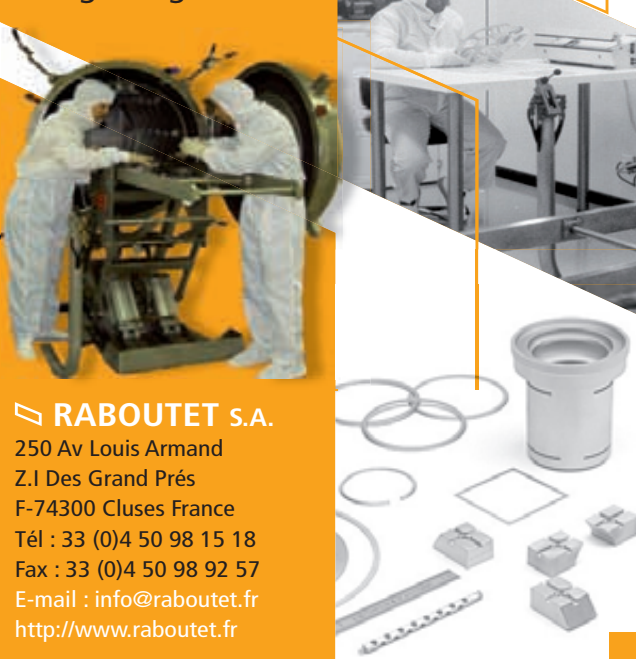
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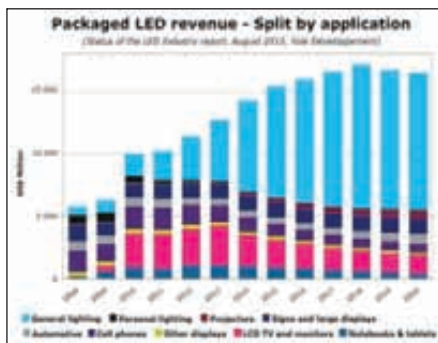
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China's GaN MOCVD reactor rockets

THE capacity for GaN LED epitaxy increased dramatically in 2010 and 2011. This increase took place across all regions but was most dramatic in China, where an increase by a factor twenty of reactor capacity took place between Q4 2009 and Q1 2012.

"Most emerging Chinese LED epiwafer and die manufacturers are still lagging significantly behind their competitors in term of technology maturity and LED performance," says Eric Virey, Senior Analyst, LED at Yole Développement.

The bulk of those new companies are not yet capable of manufacturing LEDs to address the large display and general lighting applications that are currently driving the market. In the mid-term,



consolidation of the Chinese LED industry will occur (scenario in the central government's new five-year plan), and China should become a major player in the LED industry.

Another factor is that new business models are mandatory to capture the

added value of LED lighting. Ultimately, the long life of Solid State Lighting (SSL) technology will totally change the lighting market by dramatically increasing the length of the replacement cycles. The replacement market will be strongly impacted, pushing traditional players of the lighting industry to define new strategies to capture profit. These include technologies include intelligent lighting and different lighting solutions.

"In addition, as value is moving to the top of the value chain (module and luminaire levels), several players that were originally involved only at LED device levels will develop strategies of vertical integration in order to capture more value," adds Tom Pearsall, General Secretary, EPIC.

Toshiba to mass produce white LEDs

TOSHIBA is to start mass production of white light-emitting diodes from October, this year.

The electronics giant will construct a new LED production line at its 200mm wafer facility at Kaga Toshiba Electronics, a production base for discrete products in northern Japan.

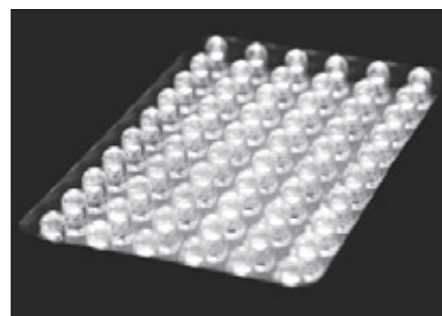
As Toshiba puts it, the energy efficiency and long life of white LED is winning wide-scale application in general purpose lighting and television back-lighting.

The market size is expected to increase from some 700 billion yen, or US\$8.75 billion, to a projected 1 trillion yen by 2013.

The company is applying GaN-on-Silicon technology to the development of white LEDs, and has collaborated with US-based LED lighting developer, Bridgelux, on white LED chip development since January 2012.

By combining Bridgelux's crystal growth and LED chip structure, and Toshiba's advanced silicon process and manufacturing technology, the partners have succeeded in developing a prototype chip with a maximum optical output of 614mW.

Toshiba says it will build on this achievement to start mass production of white LEDs. The company hopes to



enhance its discrete components business by better establishing its white LEDs production in addition to power devices.

In May this year, Bridgelux and Toshiba claimed the industry's top class 8 inch GaN on Silicon LED chip, emitting 614mW, less than 3.1V at 350mA, with 1.1mm square chip.

Rubicon allowed fabrication patent

US-BASED sapphire substrate developer, Rubicon Technology, revealed that the US Patent and Trademark Office have allowed its patent application entitled, "Intelligent Machines and Process for Production of Monocrystalline Products with Goniometer Continual Feedback."

The patent covers Rubicon's equipment and process developed to perform in-situ orientation of its sapphire crystals within

the various fabrication tools used by the company. As the company explains, manufacturers have different requirements for the crystal planar orientation of the sapphire products used in various applications.

However, the new patented orientation technology provides greater precision in sapphire planar orientation and eliminates time-consuming steps by performing the orientation at the fabrication tool.

"Rubicon is known by many for its expertise in crystal growth technology, but our technological leadership extends from raw material through finished sapphire wafers," said Raja Parvez, president and chief executive of Rubicon Technology.

"This patent reflects one of many technological innovations we've put in place to meet our customers' exacting and evolving requirements."

SETi wins \$1.6 million contract to purify water with AlGaN LEDs

Sensor Electronic Technology, Inc. (SETi) has been awarded a program from the Office of Naval Research (ONR) to develop a self-contained portable water purification system for warfighters.

The system will incorporate SETi's UV LED technology for water quality monitoring and disinfection. The aim of the program is to develop a portable unit that can provide a small team of warfighters with a self-sustainable source of potable water from any fresh water source.

Stand-alone UV LED water disinfection efficacy has already been demonstrated at SETi through a program funded by the National Science Foundation. However, this demonstration was designed for commercial use and will not meet the needs of the warfighter.

In order to achieve compliance with the rigorous standards of NSF P-248, SETi has teamed up with Cascade Designs, Inc (CDI) of Seattle, Washington, to combine novel mechanical filtration technologies with the effective disinfection of UV LEDs.

The system will also use SETi's UV LEDs to monitor the water "quality", optimising the system efficiency and effectiveness. Through funding this program ONR has demonstrated its commitment to a new type of water purification system that will benefit from the UV LED advantages, making it smaller, more robust and lower power than anything available today and will reduce the need for chemical disinfectants such as chlorine and iodine.

"Modern warfighters assume many risks on the battlefield; drinking contaminated water should not be a concern" says Cody Reese, Program Manager at ONR. "Just as visible-light LEDs have changed the face of lighting, ultraviolet LEDs have the potential to revolutionise water disinfection at all scales with a marked improvement to safety, durability, and energy consumption - from the mouth-piece of an individual drink tube, all the way to commercial-scale water treatment plants".

SETi, recently announced eight fold efficiency improvements of LEDs operating in the germicidal wavelength range, through a DARPA development program. "SETi is extremely excited to start this development program through

ONR" comments Remis Gaska, President and CEO of SETi, "it will lead on from our successes in DARPA and other military programs to develop a military application based on this new technology".

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Yole: LED prices must drop for success

GROWTH of the LED industry has come initially from the small display application and has been driven forward by the LCD display application. LED TV was expected to be the LED industry driver for 2011 but the reality was quite different.

That's according to the new report, "Status of the LED Industry," released by Yole Développement and EPIC. Lower adoption

of LEDs in the TV market and the entry of several new players, mostly from Asia, created a climate of overcapacity, pricing pressure and strong competition. As a result, packaged LED volume was about 30 percent lower than expected and revenue shrank due to strong ASP pressure. According to experts from R&D institute imec, the current price of LED

LCD TVs is overinflated and not justified over that of ordinary LCD TV's despite their superior quality.

"In 2012, most companies have moved to the new "El Dorado" of LED business: general lighting, which represents the next killer application for LEDs. But enabling massive adoption of the technology for such an application still requires a large decrease in the cost of LED-based products..." explains Pars Mukish, Market and Technology Analyst, LED at Yole Développement.

The report estimates that packaged LED revenue will reach a market size of \$11.4 billion in 2012 and will peak to \$17.1 billion by 2018. Growth will be driven both by the display (LCD TV) and general lighting applications until massive adoption of LEDs in lighting. From 2014, the third growth cycle of the LED business will accelerate with the general lighting application representing more than 50 percent of the overall packaged LED business. In terms of volume, LED die surface will increase from 22.5 billion mm² (2012) to 80 billion mm² (2018).

This will prompt substrate volume growth from 8 million x 2" equivalent (TIE) in 2011 to 39.5 million x 2" equivalent in 2018 with a CAGR of 26 percent. The cost of packaged LEDs still needs to be reduced by a factor ten in order to enable massive adoption in general lighting.

The adoption of LEDs for general lighting applications strongly depends on technology and manufacturing improvements. This is required to drive performance and cost of LED solutions to a trigger point where massive adoption could start. Industry consensus points out a cost reduction per lumen of packaged LEDs by a factor ten.

This can be achieved through a combination of manufacturing efficiency and performance improvement. These include access to larger size wafers and improvements in LED epitaxy which would drive down cost of ownership through yield and throughput.

Also, improved package and luminaire design will also enable significant cost reductions.

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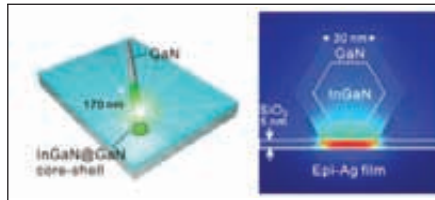
US researchers claim world's smallest laser

PHYSICISTS at The University of Texas at Austin, US, claim to have developed the world's smallest semiconductor laser, in collaboration with colleagues in Taiwan and China. Constructed from GaN, the researchers believe the laser marks a breakthrough for emerging photonic technology with applications from computing to medicine.

Miniaturisation of semiconductor lasers is key for the development of faster, smaller, more precise, and lower energy photon-based technologies, such as ultrafast computer chips, highly sensitive biosensors for detecting, treating and studying disease and next-generation communication technologies. Such photonic devices could use nanolasers to generate optical signals but the size and performance of photonic devices have been restricted by what's known as the three-dimensional optical diffraction limit.

"We have developed a nano-laser device that operates well below the 3-D diffraction limit," says Chih-Kang "Ken" Shih, professor of physics at The University of Texas at Austin. "We believe our research could have a large impact on nano-scale technologies."

Writing in the journal *Science*, Shih, graduate student Charlotte Sanders and colleagues report the first operation of a



continuous-wave, low-threshold laser below the 3-D diffraction limit, which emits a green light.

The device is constructed of a gallium nitride nano-rod that is partially filled with indium gallium nitride. The nano-rod is placed on top of a thin insulating layer of silicon that in turn covers a layer of silver film that is smooth at the atomic level.

According to Shih, his lab has been developing these materials for more than 15 years, and has built a MBE system to create the smooth silver thin film critical to the function of laser. The atomic-level smoothness is key to building photonic devices that don't scatter and lose plasmons, waves of electrons that can be used to move large amounts of data.

"Size mismatches between electronics and photonics have been a huge barrier to realise on-chip optical communications and computing systems," said Shangji Gwo, professor at National Tsing Hua University in Taiwan.

RFMD begins shipments to Samsung

RF MICRO DEVICES has begun production shipments of its ultra-high efficiency power amplifiers to Samsung in support of the highly anticipated next-generation Galaxy S3 4G LTE smartphone. RFMD expects to supply the majority of the 3G and 4G power amplifiers in Samsung's highest volume smartphones this calendar year.

The US chipmaker already supports multiple feature phones, smartphones and tablets for Samsung with a broad range of products, including PowerSmart power platforms, ultra-high efficiency power amplifiers, and other critical high-performance components. This most

recent 4G LTE smartphone to be supported by RFMD features a dual core multi-mode 3G/LTE modem.

Eric Creviston, president of RFMD's Cellular Products Group, says, "These shipments of RFMD's ultra-high efficiency 3G/4G power amplifiers to Samsung underscore our strong design momentum in next-generation mobile devices and our early market share leadership in the rapidly growing LTE market. We currently forecast robust growth in LTE in calendar 2012, as LTE devices grow from approximately 20 million units in calendar 2011 to greater than 100 million units in calendar 2012."

Gallium nitride power semi market set to soar

THE global gallium nitride power semiconductor market will reach a staggering \$1.75 billion by 2022, forecasts Markets and Markets. The US market research business expects the GaN power semiconductor market to reach \$12.60 million by the end of this year with a phenomenal year-on-year growth rate of 60 to 80 percent leading to the \$1.75 billion revenues by 2022.

Apart from power semiconductors, GaN is predominantly used in opto-semiconductors, for LEDs and laser diodes. Markets and Markets reckon total GaN semiconductor revenues - for both power and opto-semiconductors - will reach \$2.6 billion by 2022. GaN power devices currently draw most of their revenue from the ICT sector, as industry players have been focusing on nudging out silicon counterparts in a range of RF power devices.

However Markets and Markets believes GaN devices also have huge revenue potential in solar cell arrays, satellites, high-end power appliances in the military and aerospace sectors as well as automotives, especially electric and hybrid electric vehicles.

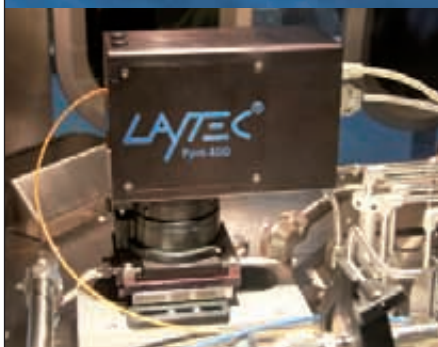
The GaN power semiconductor market accounts for less than 1 percent of the total power semiconductor market, and only has a handful of players.

This number is expected to increase quickly over the coming years, with several power semiconductor industry giants and new start-ups entering the GaN power semiconductors sector. As the analyst also highlights, GaN power ICs have also fuelled revenue growth, with new power ICs such as MMICs and RFICs being launched following extensive research efforts. This contributed to the entire GaN power semiconductors industry shifting to mass-production in 2011 with its success and revenue potential attracting several power semiconductor market giants.

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Osram expands in China

IN the presence of high-ranking representatives of the Jiangsu province, Osram laid the foundation of its new plant in the Chinese city of Wuxi. In doing so, the company is taking the next step in expanding its activities in China, the world's largest single lighting market.

LED chips will be packaged in housings at the backend facility, scheduled to be completed by the end of 2013. The production of the LED chips (frontend) will continue in the Regensburg (Germany) and Penang (Malaysia) plants.

"China is already today the biggest sales market with significant future potential. The new assembly plant enables us to better participate in the strong market growth in China and further extend our solid position in Asia," points out Wolfgang Dehen, CEO of Osram AG.

"Growing at a remarkable rate, Jiangsu Province's LED industry is at the forefront in China. We will fully support Osram's development in Wuxi with the highest quality service, and we also hope Osram can expand its investment in Wuxi to have the plant up and running as soon as possible," adds Xueyong Li, Governor of Jiangsu Province. The contracts for the new Wuxi location were signed in May this year.

The ceremony marked the beginning of the construction of the 100,000 square metre compound. Osram will invest a low three-digit million euro figure over the next five years whilst securing comprehensive support from its Chinese partners.

In the final completion stage, the new assembly plant will be able to accommodate up to 1,600 employees.

With the new plant in Wuxi, Osram is responding to the increasing demand for LED-based products in the fast-growing Asian market, thereby sustainably reinforcing its regional position in the growth region Asia.

This comes against the backdrop that the LED backend capacity at the Osram plant in Penang, where chips are both produced and packaged, is expected to reach its limits within the next few years.

In addition to its two frontend production plants, Osram will in future have two backend sites.

"With highly skilled personnel, a good infrastructure and experienced partners, Wuxi provides the best conditions for our new LED assembly," says Aldo Kamper, CEO of the Osram Opto Semiconductors business unit.

Siemens to spin-off Osram

Germany-based industrial conglomerate, Siemens, has shelved plans to float its lighting business, Osram, on the stock market and instead will spin off the company early next year.

Talking at his third quarter earnings conference call, chief executive, Peter Loscher, said: "Since market conditions continue to be volatile for an IPO, we have decided to pursue a spin-off to our shareholders as the most probable part of divestiture."

"This proposal requires shareholder approval at the next AGM in [early] 2013, and Siemens still intends to remain as anchor shareholder in Osram," he added.

The company's net profit of Euro 823 million, missed analysts' estimates of Euro 1.32 billion, due to an accounting charge, relating to Osram. Loscher warned



demand from China was slowing and said he doesn't expect recovery until 2013 at the earliest.

"Our focus above all is on increasing our productivity and efficiency," he added.

Osram Opto Semiconductors is the optoelectronics subsidiary of Osram, manufacturing optoelectronic semiconductor components including LEDs and high power laser diodes.

IQE claims finances on track

UK-based semiconductor wafer developer, IQE, is confident it will meet its full year, finance expectations.

The business expects to report first-half revenues of approximately £34 million and earnings before interest, tax, depreciation and amortisation of approximately £4 million with net debt of less than £8 million.

IQE says the Board remains confident of meeting its full year expectations, given the notable second half bias in revenues this year as a consequence of the de-stocking in second half of 2011 and first quarter of this year, and the transfer of RF Micro Devices' epitaxial operation to IQE in July this year.

The inventory correction with two major wireless customers in the latter part of 2011, as anticipated, impacted the first quarter of 2012.

Sales and customer order patterns returned to normal in the second quarter

and the Group exited the half-year strongly.

Customer qualifications have progressed well, and the outlook for wireless remains strong, driven largely by the increasing penetration of smartphones and 4G/LTE technology.

The major developments during the first half of the year were the completion of two strategic transactions: an exclusive supply contract and strategic investment in Solar Junction and the acquisition of the RF Micro Devices in-house epitaxial business.

As the company also highlights, following the Solar Junction deal, there have been some significant project announcements, including a milestone 450MW installation in Mexico, which confirms that the CPV market is rapidly gaining traction.

Solar Junction and IQE have received initial production orders and expect to capture a substantial share of this emerging market. The installation of tools is progressing well,

in line with the Board's expectations, and will be followed by a technology transfer. Once qualified, these tools will be used to satisfy existing production orders.

Transfer of the RF Micro Devices epitaxial operation to IQE was completed during July. This business is expected to deliver a stepped increase in IQE revenues and profitability in the second half of 2012. This deal complements the Solar Junction investment by bringing spare capacity to service the high-growth CPV market.

The business continues to make good progress across its optoelectronics and electronics businesses in development projects that span a number of emerging high-growth opportunities.

"The deals with Solar Junction and RF Micro Devices represent significant milestones in the execution of our growth strategy and will significantly enhance both our short and long term growth," said Drew Nelson, IQE's chief executive.



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InGaAs nanowire transistors outstrip silicon

Over the past decades, conventional microelectronics have become smaller and smaller as chip designers race to cram more transistors onto the silicon chip. However, as transistors continue to shrink, performance problems have surfaced and the devices are no longer the clean on-off switches they once were.

With the distance between a transistor's source and drain down to mere nanometres, current leakage between the two terminals is a massive problem. To plug the leak, researchers have raised the transistor's channel, source and drain out of the substrate, devising three-dimensional multi-gate transistors, such as the FinFET, with vertical architectures.

But while the likes of Intel and IBM integrate the latest silicon architectures into devices, researchers now hope to fabricate structures from compound semiconductors to boost performance even more.

The Japan-based Research Center for Integrated Quantum Electronics, Hokkaido University, is home to one such group. Here, Katushiro Tomioka, and colleagues, have spent several years trying to integrate vertically aligned InGaAs nanowires onto silicon.

In 2009, they unveiled a technique to selectively grow GaAs nano-wires on silicon, and have recently fabricated high performance vertical transistors, based on a novel surrounding-gate architecture. Here the actual transistor gate is wrapped around vertically-aligned InGaAs nano-wires, to better resist short channel effects, such as leakage. And this, asserts Tomioka, is where the future of transistors lies.

"The gate-architecture in mature Si-CMOS technologies has already changed from planar to Fin-gate, and sooner or later will move onto the surrounding gate architecture," he says. "Silicon channels will be replaced by InGaAs and germanium channels... and as Intel has suggested, heterogeneous integration of group III-V materials will become the basis of lower power and high speed CMOS."

To fabricate the vertical transistors, the researchers first grew an array of ten InGaAs nanowires on a silicon substrate.

They heat-treated the substrate in an arsine atmosphere to replace the outermost silicon atoms with arsenide atoms, ready for nanowire growth.

A silicon dioxide film was deposited onto the substrate surface with circular openings then formed on the film, using electron-beam lithography and wet chemical etching. Nano-wires were grown onto the openings, via metal-organic vapour phase epitaxy.

"So far, nano-wires have been grown by a vapour-liquid-solid method, but this cannot control their position," explains Tomioka. "We've used selective area growth, with position-defined masks... to align and integrate the nanowires onto the substrates."

Each nanowire was then coated with a hafnium oxide-based film and sputtered with tungsten metal to form the gate. By spin-coating the nanowires with a benzocyclobutene polymer (BCB), and using reactive ion etching to etch back the BCB, tungsten gates and hafnium-based film the researchers isolated the gate and drain regions.

Lastly, a metal drain and source were deposited onto either end of the structure to form the transistor. Crucially, the fabrication process reduced the lattice

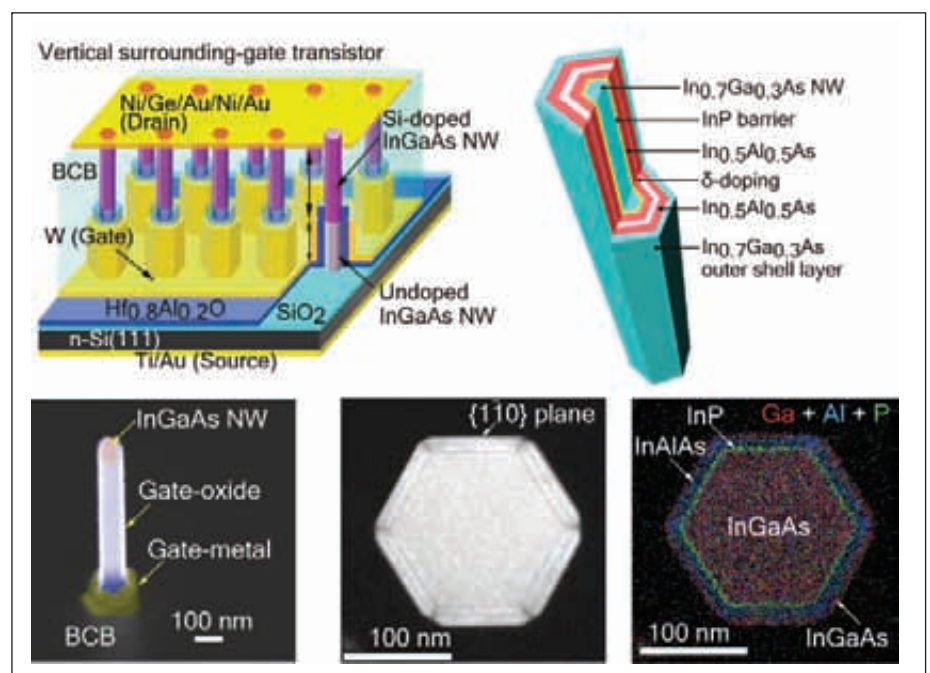
mismatches between the silicon substrate and InGaAs nanowires, that can lead to crystallographic defects and degrade device performance.

And while switching characteristics beat those of previously-built nanowire surrounding gate transistors, the researchers knew the device would have to perform better to satisfy the demands of next-generation electronics.

With this in mind, they went on to fabricate a similar device, but this time using "core-multishell nanowires", in which layers of InP, InAlAs and InGaAs are grown around an InGaAs core. The results have been startling.

Not only does this transistor have a greatly increased on-state current and transconductance, compared to the original InGaAs-on silicon device, but device performance is better than that of your typical MOSFET. Having obtained these extremely high performances, the researchers now intend to fabricate a *p*-type field-effect-transistor using the same nanowires.

"Our research will be a milestone in the history of semiconductor applications," concludes Tomioka. "These devices will have the performance necessary for use in future silicon transistor technology."



Violet VCSELs poised for action?

Researchers from the University of California, Santa Barbara, have developed a non-polar, violet VCSEL, which they say opens the door to a host of new applications including pico-projectors for smartphones, mobile cinema and automotive lighting.

Developed by Shuji Nakamura and colleagues Daniel Feezell, Casey Holder and Stephen DenBaars, the single-mode VCSEL operates at room temperature, and is the latest of several optoelectronic devices the team has grown, using MOCVD, on *m*-plane GaN substrates.

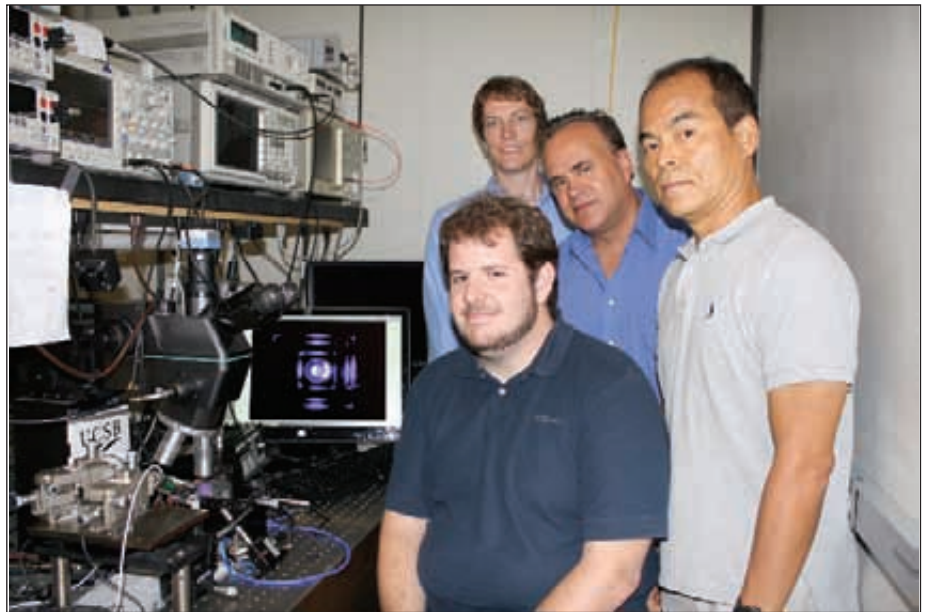
To date, most GaN-based devices have been grown on substrates sliced from the *c*-plane of a GaN crystal. Nakamura demonstrated the first *c*-plane (AlGaIn)N laser diode as early as 1996 and today *c*-plane devices can be found in myriad commercial products for high density optical storage, laser printing and displays.

But despite success, *c*-plane GaN substrates have a major drawback. Large polarised electric fields induce charge separation in quantum wells, restricting the recombination efficiency of electrons and holes, and ultimately, limiting a device's performance.

As Nakamura points out: "Non-polar nitride devices have the potential to outperform their polar counterparts, for example, you can get a much higher optical gain using *m*-plane substrates."

With this in mind, the UCSB researcher and colleagues have been developing devices, based on substrates cut from the *m*-plane within GaN crystals. In 2005, blue GaN LEDs were unveiled, followed by GaN violet laser diodes in 2007. Come 2009, Nakamura and colleagues had developed blue-green laser diodes, but now the team has upped the ante, by developing the GaN VCSEL.

While VCSELs tend to have a lower power output than edge-emitting lasers, the devices are cheaper and more efficient to manufacture. Edge-emitters cannot be tested until the end of production, while VCSEL arrays can be tested on the wafer, during fabrication. And because the VCSEL beam is emitted perpendicular to the laser's active region – as opposed to



parallel with an edge-emitter – as many as ten thousand devices can be processed simultaneously on a single 3-inch wafer.

Given this potential to cut costs, researchers worldwide have been earnestly developing GaN VCSELs that emit at room temperature. In 2007, Switzerland-based Ecole Polytechnique Fédérale de Lausanne (EPFL) researchers demonstrated blue lasing in an optically pumped AlInN/GaN VCSEL, while a year later, Nichia revealed the first electrically-pumped GaN VCSEL to emit continuous-wave violet light. Last year, the Japan-based optoelectronics developer also unveiled blue and green VCSELs, but not one of these VCSELs was grown on an *m*-plane substrate. Why?

"The easiest orientation is the *c*-plane, as it's the most common substrate you can find, and also the best orientation if you consider the price," says Eric Feltin, researcher at EPFL spin-off, Novagan. "UCSB has been working with *m*-plane substrates, and have fabricated good devices. But right now, high quality, *c*-plane substrates are more widely available."

Nakamura disagrees, highlighting how his group has, for some years now, used low defect density, *m*-plane substrates, made by Mitsubishi Chemical. Indeed, the Japan-based corporation started working on the novel substrate several years ago in an effort to produce next-generation

white LEDs. And as Feltin concedes, if the demand for *m*-plane substrates increases, it is possible that *c*-plane substrates could lose out.

So where next for the Nakamura's violet VCSEL? While some researchers have poured their energies into developing novel distributed Bragg reflectors to ease VCSEL fabrication and avoid the lattice mis-match strains that can crack epi-wafers, Nakamura claims dielectric DBRs are adequate. "We don't have to worry about lattice mis-matches and these are easy to make," he says.

And as he highlights, his group has developed a new processing technology to control the length of the VCSEL cavity. "While other groups use lapping and polishing, we have developed selective etching to control the VCSEL cavity length," he asserts. "By doing this we have demonstrated single mode [lasing] for the first time."

Still, research is clearly ongoing. At the time of writing, the violet VCSEL had a 70mA threshold current, using a 10 μ m aperture, and an output power of 19 μ W, under pulsed operation.

Nakamura is determined to build on this. "Yes it's a small power, but this is just a demonstration. We're going to minimise the optical losses and soon we will increase the power," he says. "Right now we are working very hard."

During the next decade a growing desire to increase automotive fuel efficiency and trim carbon dioxide emissions will spur sales of electrified vehicles. In turn, this will create a multi-billion dollar market for inverter power semiconductor devices.

This new market has already whetted the appetite of many wide bandgap device developers, as they aim to beat silicon hands-down with 'thousand times' better physical figures of merit. However, in the eyes of some automotive engineers, the case for discarding silicon is not as strong as some wide-bandgap device makers believe.

For example, some wide bandgap chip developers argue that their new, pricier devices can save money at the system level, because they can help to eliminate a dedicated power-electronics cooling loop that is needed to prevent silicon diodes and transistors from overheating. However, these engineers may not be aware that for a large automaker, the cost of the cooling circuit is a small fraction of what is paid for the silicon in

a full hybrid electric vehicle (HEV) inverter. In reality, automakers will not be willing to pay much more for a new type of device, even if it does offer better performance.

What is beyond question is that the prices of HEVs will have to get progressively closer to those of conventional vehicles to fulfill the anticipated boom of electrified vehicle sales. Power semiconductor manufacturers can play a critical role in making this happen. In particular, those developing GaN-on-silicon technology promise to combine the capabilities of wide bandgap semiconductors with the prices of silicon products. But are these GaN developers fully aware of the requirements of electric vehicle makers, and how they should tune their devices so that they become more attractive for the HEV inverter system?

Key pre-requisites for GaN devices, if they are going to compete side-by-side with silicon IGBTs, are a high-voltage rating for switches in the 600 V to 1200V range and growth on silicon substrates with sufficiently

Can GaN be the best power device for electrified vehicles?

GaN devices have the potential to capture a billion dollar power market for electrified vehicles. But if they are to be successful, they need to sell for little more than silicon products, have higher threshold voltages than they do today, show no signs of current collapse and deliver very high currents, argue Ming Su and Chingchi Chen from Ford Motor Company.



large diameters. As of today, 1200 V class devices have only been produced in labs, due to two constraints: The thickness required for the breakdown voltage and the mismatches between GaN and silicon. There are yet to be any demonstrations of scaling production of such high voltage transistors to 6 inch or larger wafers, an essential step for cost-effective device manufacturing.

Insufficient threshold voltages?

Other important requirements for switches in motor drive applications are that they are normally off and that they have a gate threshold voltage (V_{th}) large enough for noise and temperature margins. To meet these demands, modern silicon IGBTs are designed with a V_{th} that is at least 5 V.

If GaN devices are going to appeal to makers of electric vehicles, they need to mirror the gate control characteristics of the silicon IGBTs that they can supersede. Aside from the more complex cascode structure to hybridize silicon and GaN, the popular

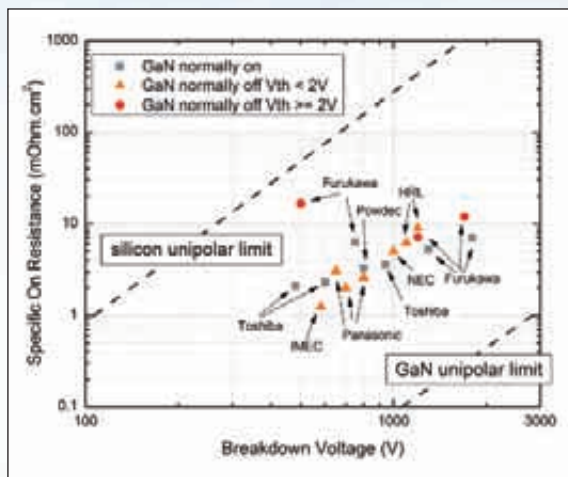


Fig. 1 There are very few reports of normally off GaN transistors with a threshold voltage of 2V or more. A threshold of 5 V or more is highly desired by makers of electrified vehicles





A Ford Focus Electric employs a silicon IGBT power module

approaches for making normally off GaN switches all face challenges. MOSFETs can be made normally off, but the low channel mobility leads to high resistance. Meanwhile, gate injection transistors (GIT), which have been developed by Panasonic and feature a *p*-AlGaIn cap layer for enhancement-mode gate control, have a limited gate junction potential that makes it very challenging to reach a high threshold voltage.

Another popular technique for constructing normally off

transistors is that of gate recess etching on a HEMT structure. Lacking a good etch stopper in the AlGaIn layer, this approach demands high-precision depth control, which could lead to a very low manufacturing yield and a wide spread in V_{th} distribution. In order to preserve the two-dimensional electron gas channel in the gate region, AlGaIn must be removed with great precision.

Normally-off GaN transistors can also be formed with a hybrid MIS-HFET architecture. In this type of device, low gate channel mobility can substantially impact the device on-state resistance. Furthermore, it is possible to bring V_{th} into the positive domain, at around 1V, by treating the gate region with fluorine ions. However, concerns over stability hinder wide acceptance of this method and its capability to reach higher threshold voltages.

The performance of devices produced by leading GaN research teams with architectures outlined above are summarized in Figure 1. These results show that the V_{th} level is generally too low for use in electric vehicles, and their on-state resistance is yet to be further reduced. Nevertheless, encouraging progress is frequently reported, such as a 1200V 7.1 mΩcm² hybrid MIS HFET in 2011 by Nariaki Ikeda from Furukawa Electric Company, Japan.

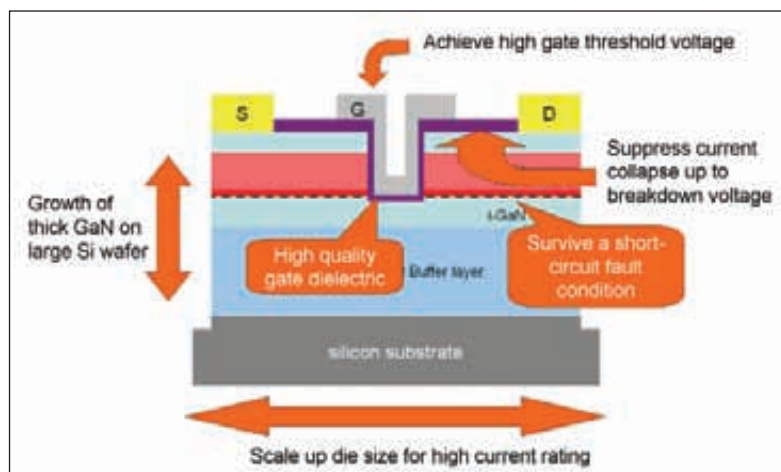


Fig. 2 Many challenges must be overcome in order to produce a robust, high-performance GaN transistor

Reliability issues

One of the biggest issues afflicting GaN HEMTs is current collapse. There are many ways to suppress this, such as SiN passivation, the addition of a GaN cap layer and the introduction of field plates. However, many researchers were only able to combat current collapse for devices operating at half or less of their breakdown voltage. Since the peak surface electric field plays a dominant role in the severity of current collapse, and becomes stronger at high voltage bias, further development is required to enable devices switch at up to the rated voltage.

Device robustness also needs to be proven. It is possible that long-term electron trapping and degradation of on-resistance will not be detected by the conventional dynamic R_{on} test. Instead, failure criteria will be defined in the component qualification tests.

Those within the GaN community rarely talk about the short-circuit withstand capability of the transistor. In traction inverters, a short-circuit event occurs when the motor windings are accidentally shorted. This subjects the on-state power switch to high drain bias and pushes it into a fault current mode. Extreme power dissipation follows, which must be halted by a prompt turn off of the gate drive circuit.

The typical required short-circuit tolerance time is 10 μ s, depending on the gate drive reaction speed. Since power dissipation density in this event is proportional to electric field strength and current density, GaN HEMT structures are expected to withstand much shorter duration than a vertical silicon IGBT. That's because these wide bandgap devices have a field strength in the drift region that can be ten times higher, in addition to a highly concentrated current path in the two-dimensional electron gas. To address these weaknesses, researchers will probably develop advanced gate protection circuits that reduce the tolerance time needed.

Last but not least, makers of electric vehicles have concerns relating to optimal gate dielectrics and achievable current ratings. GaN RF devices do not require an insulated gate, and GaN is not as fortunate as silicon or SiC to have a thermally grown native oxide. As researchers work with deposited insulators such as SiN_x, Al₂O₃ and SiO₂, leakage currents, interface states and long-term stability all come into play and make the search more challenging.

Furthermore, to be used in motor drive circuits requiring



300 A to 600 A rated devices, a single-die current capability of at least 100 A is needed to enter this market. GaN HEMTs are not naturally suited to such high currents, due to the lateral nature of the device, and on top of this, there are challenges associated with hitting high manufacturing yields for GaN-on-silicon technology, which carries orders of magnitude higher defects than silicon.

An integrated power control unit for the HEV inverter, containing silicon IGBT modules shown in the inset

However, despite all these concerns, GaN power devices are undoubtedly a promising technology for the electrified vehicle market. A highly competitive silicon IGBT industry sets high standards for challengers, but GaN material and device scientists have a chance of success if they acquire a strong understanding of what electric vehicle manufacturers need.

In short, wide bandgap device performance is a beautiful promise, but in-depth knowledge of customer needs must be taken on board if this ever-improving technology is to spawn a billion dollar market.

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Further reading

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If GaN devices are going to appeal to makers of electric vehicles,
they need to mirror the gate control characteristics of
the silicon IGBTs that they can supersede

EuroLED focuses on the biggest issues in solid-state lighting

Vast swings in MOCVD reactor shipments, stagnation in LED sales in the build up to the solid-state lighting revolution and technologies to slash the cost of chips for LED light bulbs featured at euroLED 2012. Richard Stevenson reports.

The LED industry is changing. Expenditure on capital equipment is rebounding after falling off a cliff; chip prices are in decline, with shipments soon to surge as penetration into the general illumination market starts to ramp; and some manufacturers are preparing to launch GaN-on-silicon devices that should drive down the prices of solid-state lighting products.

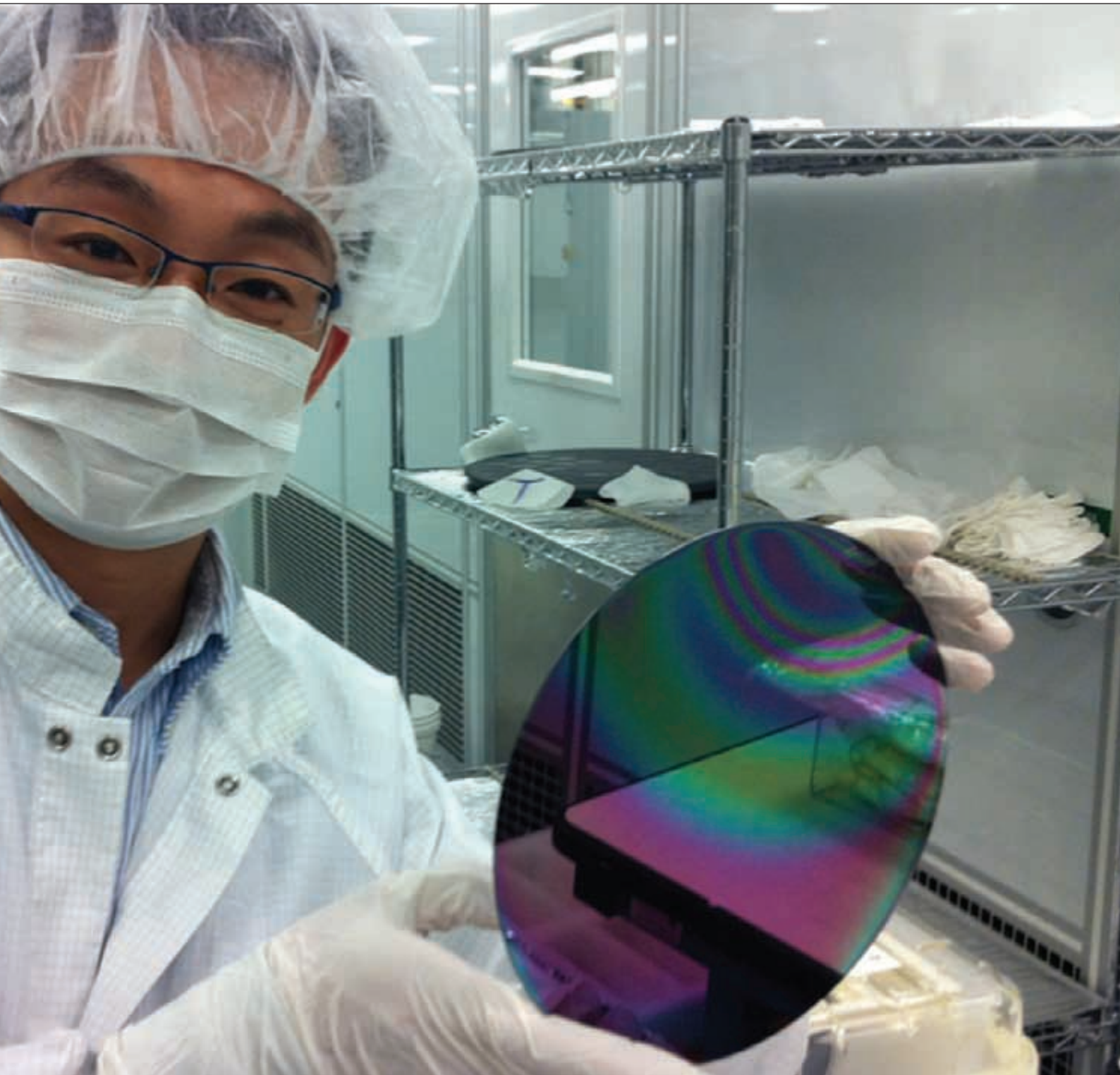
All of these trends were discussed at euroLED 2012, a two-day conference held on 14-15 June that combined a series of invited talks with an exhibition featuring 95 companies. This gathering, which was held at the spacious National Exhibition Centre on the outskirts of Birmingham, UK, kicked off with an overview of the latest LED market trends. According to analyst Jamie Fox from IMS Research (which has recently been acquired by IHS), the LED industry is between cycles, with sales of devices for TV backlighting nearing their peak and solid-state lighting still in its infancy.

“We are waiting for the lighting market to take off,” explained Fox. “Prices are currently a little too high for mass adoption, but 2013 and 2014 could be really big years.”

Back in 2010, GaN-based LED sales hit an all-time high of \$8 billion, a hike of almost \$3 billion over the previous year, thanks to massive growth in the number of devices deployed in TV backlighting. Last year, falling prices and weakening demand for LEDs for TV backlighting led to a slight fall in worldwide LED revenue compared to 2010. However, this year the uptake of products in the lighting sector should spur a rise in revenues that should continue for the next two years to more than \$10 billion per annum. “Even being conservative, we expect the market to increase by the end of this year,” remarked Fox.



Sales of LEDs to makers of TV backlights should net about \$2 billion in 2012, rise slightly in 2013, but fall back a little by 2016. This rise and fall in sales will occur because more and more TVs are being built with LED backlighting, but the number of chips for each unit is in decline. The number of LEDs in each unit is being reduced due to improvements in the performance of the LED-based system, in terms of the internal and external quantum efficiencies of the chip, the efficiency of light guides, panel transmissivity and optical film efficiency. Average LED revenue per TV is also declining, due to a



move away from just using light guides for backlighting. Low-cost TVs are now featuring a more direct lighting technology, which can halve the number of die required. Another trend is the adoption of larger, less efficient die that can trim the number of lightbars.

Data from IMS shows that the number of LEDs continues to fall in various sizes of TV. In the latter half of 2009, the average number of LEDs in 32-inch, 40-inch and 46-inch sets was 216, 288 and 350, respectively; by the start of the year all these numbers

had fallen by roughly 50 percent. According to Fox, the proportion of TVs backlit with LEDs is rising rapidly. Last year penetration stood at 38 percent, this year it should hit 63 percent, and next year it will account for 93 percent of the market. Fast forward another year to 2014, and all TVs will feature LED backlighting.

Lighting takes centre stage

Another significant milestone is also tipped to occur in 2014 – sales of LEDs to the general illumination market will overtake those to TV backlighting manufacturers.

Bridgelux aims to slash the GaN chip costs by producing devices on 200 mm silicon and processing wafers through under-utilised silicon fabs

When this happens, the number of LEDs shipped to the lighting sector will still be far less than that dispatched to backlighting manufacturers, but each product for the lighting sector will command a far higher price tag. Fox and his colleagues predict that just 2.4 percent of lamps and luminaires sold this year will be based on LEDs. This figure will rise throughout the decade, with massive year-over-year increases to 2014, and penetration exceeding 40 percent in 2020.

This revolution in lighting will drive a massive increase in the production of packaged LEDs with dimensions of 1 mm by 1 mm. This year 3.5 billion will be made, and this will climb by roughly an order of magnitude by 2020. Economies of scale will play a minor part in reducing the cost of making these high-power LEDs. However, the bigger factors behind the fall in average selling price will be overcapacity within the industry and growth in the number of competitors, particularly from China. According to IMS, these factors will contribute to a rapid decline in the average selling price of an LED suitable for deployment in a lamp from \$0.48 in 2012 to just \$0.10 in 2020.

Despite these price falls, total sales of LEDs for general lighting will rise, thanks to a massive growth in shipments. Packaged LED lighting sales will net \$1.8 billion this year, and are expected to peak at \$4.5 billion in 2016. The long lifetime of LEDs will then cause this market to steadily decline, but it will still be worth more than \$3 billion by the end of this decade.

While the chip making industry waits for the LED lighting market to take off, shipments of MOCVD tools for GaN epi-growth are fluctuating wildly. In the third quarter of 2010 they reached an all-time high of more than 200 reactors, before nose-diving to just 41 tools in the first quarter of this year. According to Fox, that quarter should be the nadir for MOCVD suppliers, and 281 tools are likely to be shipped this year.

Assuming a five-year life for MOCVD tools, it is possible that another 2300 tools could be sold between 2013 and 2016 to meet the growing demand for LED chips. However, the average lifetime of these tools will only be that short if manufacturers can convince chipmakers that their latest tools combine a substantial hike in yield and LED performance with a lower cost-of-ownership and a wider process window.

The market leader of MOCVD tools is changing hands. "Aixtron was ahead, but Veeco has caught up and we predict it will lead in 2012," revealed Fox. Veeco's success stems from the high uptime of its popular K465i reactor, and its high level of penetration in the Chinese market, which has recently accounted for more than half of all shipments. Some of the biggest customers in recent times are Epistar affiliates based in China, such as ULED, Epicrystal (Epistar Changzhou) and Kaifa Jung Lighting (Epistar Xiamen).

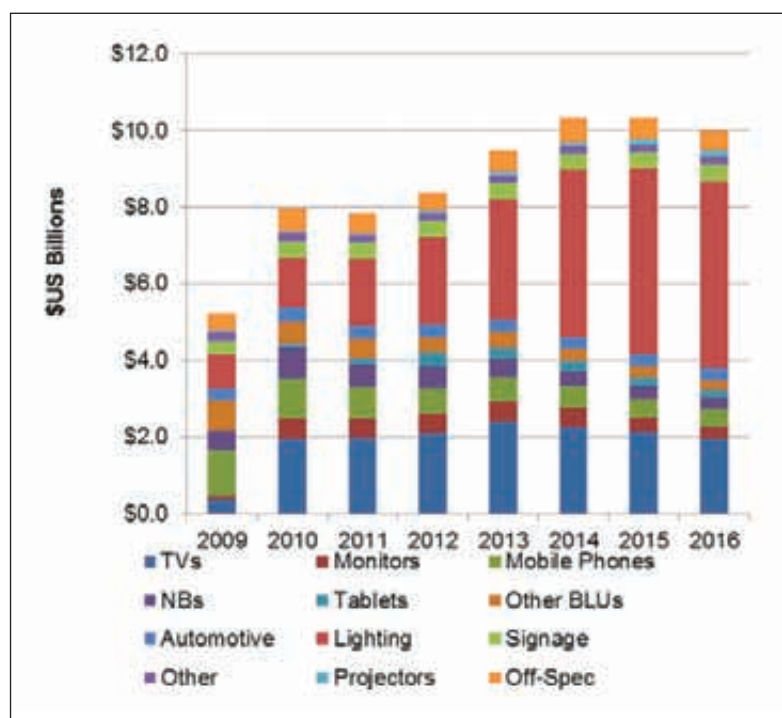
Improving LED performance

One company that has always been at the forefront of GaN LED development is Japanese firm Nichia. At euroLED 2012, Deputy Managing Director for Nichia Europe, Hideki Kaneguchi, updated delegates on the company's recent progress, both in the lab and in production.

The company is still to better its record efficacy of 249 lm/W at 20 mA, a figure first reported at Photonics West in 2009. The best devices in the fab fall well short of this, delivering up to 170 lm/W. The internal quantum efficiency of these LEDs already exceeds 80 percent, and Kaneguchi argued that increases in efficacy must now come from better light extraction – from both the chip and the package.

He also compared the performance of the company's record-breaking 'small chip' LED with a 1 mm² device from the lab producing 180 lm/W. The larger variant has a higher forward voltage – 3.21 V compared to 2.89 V – and its external quantum efficiency is 73.6 percent, down from 84.3 percent. Peak emission for both LEDs is similar – the small chip emits at 444 nm, 3 nm longer than its bigger cousin.

According to Kaneguchi, Nichia will soon release new versions of four LED products from its portfolio. These successors will be: Low-watt LEDs that have an efficacy of 140 lm/W at 65 mA, and produce a peak output of



Data from market research firm IMS highlights the growth in LED lighting that will take place during this decade

about 50 lumens; multi-chip devices operating at an efficacy of 125 lm/W at 350 mA, and delivering an output of up to 240 lumens; powerful, single-chip LEDs with a peak output of 380 lumens, and an efficacy of 115 lm/W at 350 mA; and chip-on-board packages with a ceramic base that can deliver up to 2200 lumens and emit 110 lm/W at 32 mA per chip.

This wide range of products gives flexibility to the manufacturers of LED light bulbs. For example, they can select a single chip-on-board package for their bulb, or turn to ten single die.

Bulbs that result can combine high efficacy with a colour quality exceeding that of a tri-phosphor fluorescent lamp. This produces R_a and R_g values of 85 and 8; in comparison, conventional and ultra-high-CRI LEDs from Nichia have R_a and R_g values of 74 and 18, and 97 and 96, respectively. Values for R_a of over 90 allow bulbs to be used for speciality and professional lighting.

Nichia's spokesman finished his talk by outlining key challenges for white LEDs and their ultraviolet siblings. Targets for white emission include a higher CRI (R_a greater than 95), tighter colour bins, a forward voltage of just 2.8 V and an efficacy of initially 180 lm/W and subsequently 200 lm/W. In addition, the company is aiming for a thermal droop of no less than 95 percent at a junction temperature of 85 °C. "Minimizing this gap is a big challenge for us," admitted Kaneguchi.

In the ultraviolet regime, increasing power is the primary goal. Devices emitting tens of milliwatts in the 255-300 nm range are planned, as well as those producing several watts at longer wavelengths.

From sapphire to silicon

To generate a healthy profit as LED prices fall, device manufacturers will have to cut chip production costs. Switching the substrate from sapphire to silicon is one way to do this, and this approach brings additional benefits, according to Tom Van den bussche, European Marketing Director of Bridgelux. Silicon substrates enable wafer processing on 200 mm silicon lines; they open the door to the manufacture of larger die, which could lead to increased integration; and they could enable new designs of LED.

According to Van den bussche, fabrication of GaN-on-silicon LEDs typically begins with the growth of strain management layers on the substrate, followed by deposition of the light-emitting structure. A mirror is deposited on top of this epitaxial stack, before a second silicon substrate is bonded to the top of the structure. The resulting composite is then flipped over, and the substrate used for epi-growth removed to expose a GaN surface, which is etched to increase light extraction. Adding contacts completes the LED production



The dislocation densities in Bridgelux's GaN-on-silicon LEDs are very low, enabling the devices to deliver high efficacies

process. Switching from sapphire to silicon tends to lead to a hike in defect density, due to a greater lattice mismatch between the substrate and epilayers. However, the insertion of a stack of layers that manage strain and reduce defects enables the threading dislocation density in Bridgelux's LED epistuctures to be as low as just $3-6 \times 10^8 \text{ cm}^{-2}$.

High material quality enables the fabrication of LEDs with impressive characteristics, including reduced droop, a very low operating voltage and low thermal resistance. Driven at 350 mA, blue-emitting chips operate at 2.82 V and deliver 0.59 W at a wall plug efficiency (WPE) of 59 percent. Crank up the current to 1 A by increasing the bias to 3.21 V, and the chip emits 1.52 W at a WPE of 47 percent.

Van den bussche presented data showing that Bridgelux LEDs significantly outperform GaN-on-silicon rivals developed by Osram Opto Semiconductors, Samsung and Lattice Power. The performance of Osram's LEDs is closest to that of those made by Bridgelux – the output power of Osram's blue chip is slightly higher, but its emission wavelength of 438 nm is too short for optimal pumping of a phosphor. Bridgelux is the only company to report the efficacy of a warm-white GaN-on-silicon LED, which produces 127 lm/W.

Prototype production of LEDs on silicon is underway at Bridgelux, and commercial launch is slated for 2013. When this class of LED hits the market, it will usher in a new era for the LED industry, and hope to spur the production of LED bulbs with a price tag that is attractive to most consumers. Exactly what that price will be is debatable – maybe it will be a major talking point at the next euroLED meeting, scheduled for June 2013.

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A new roadmap for space solar cells

Today's conventional triple-junction cells seem to offer little room for improvement, with average production efficiencies hovering just below 30 percent. This can be increased by ten percentage points with a switch to six junction cells incorporating two dilute nitride layers, say Simone Missirian, Jeff Allen, Vijit Sabnis and Homan Yuen from Solar Junction.



Laboratory). This new benchmark for photovoltaic performance is the result of our novel materials technology, which we call A-SLAM (adjustable spectrum lattice matched). It will achieve far more than just netting an efficiency record – it is already the foundation for a flexible multi-generational roadmap to reach 50 percent conversion efficiency and beyond.

The core technology that we have developed can also bring a new level of efficiency to solar cells deployed on commercial and military satellites. We are adapting our technology to address these markets, which place a premium on high efficiency and high reliability.

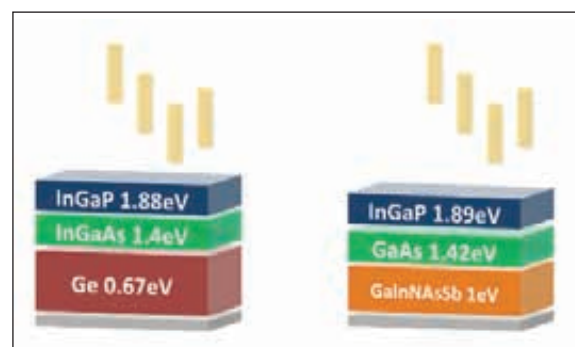
Today's satellite market

The vast majority of satellites launched today are powered by triple-junction solar cells with average efficiencies of just below 30 percent. These feature three junctions, connected in series, with progressively narrower bandgaps from the top to the bottom junction. This arrangement – traditionally a germanium bottom junction, and middle and top cells made from InGaAs and InGaP, respectively (see Figure 1) – divides the solar spectrum, making good use of the available energy by increasing the voltage delivered by the solar cell, and significantly improving the efficiency when compared to a single junction solar cell.

Increasing the efficiency of solar cells for space applications is quite beneficial, as it enables higher power production and ultimately allows the satellite manufacturer to make a number of favourable economic trade-offs. For instance, higher efficiency solar cells allow the use of a smaller, lower-mass solar array to meet a given power requirement. The cost to launch a satellite is of the order of \$10,000 per pound, so this reduction in solar array mass leads to a significantly lower launch cost. Alternatively, higher efficiency cells can generate more power and enable the satellite to carry a higher-value payload, such as a greater number of transponders. This leads to a higher revenue stream for the satellite operator and improved return-on-investment for the asset.

Unfortunately, the traditional architecture of space cells (the combination of InGaP, GaAs and germanium) has reached technological maturity, and during the last few years conversion efficiencies have stagnated at the 28.5-29.5 percent level. A new materials system is required to meet the ever-increasing power requirements of next generation satellites and resume the historical rate of progress – an annual increase in absolute efficiency of

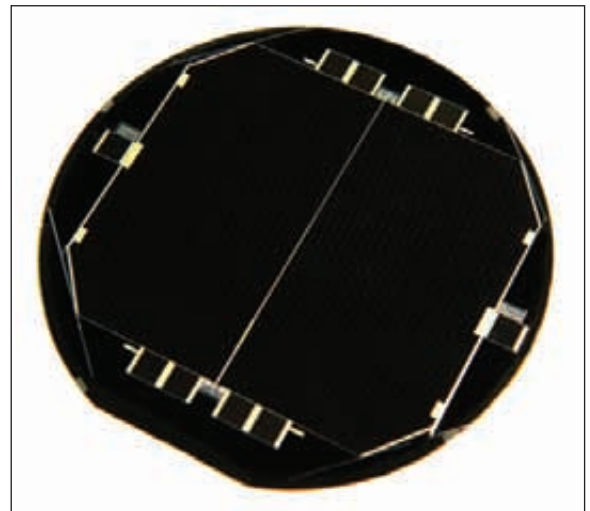
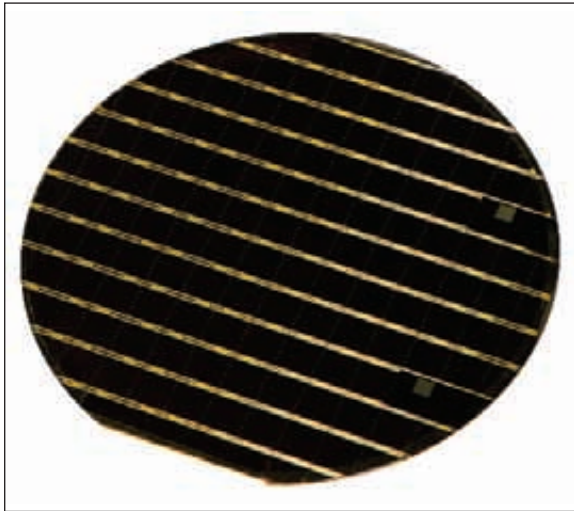
Figure 1. Conventional triple junction cells (left) have a germanium bottom junction, an InGaAs middle junction and an InGaP top junction. Solar Junction's triple-junction cells (right) replace the germanium cell with one built from GaInNASb



Growth of the terrestrial solar industry hinges on reductions in energy costs. One way to do this is to manufacture cells that are more efficient than their predecessors, but cost no more to make. This can either boost the power produced by a solar power system of a given price – or allow a smaller, cheaper-to-build system to generate the equivalent power of its forerunners.

At Solar Junction, headquartered in San Jose, California, we have increased the efficiency of triple-junction cells for concentrating photovoltaic (CPV) systems, which are designed to track the position of the sun across the sky and focus sunlight on cells with mirrors or lenses. Our cells feature high-quality InGaAsNSb junctions, and can deliver a record-breaking efficiency of 43.5 percent at 925 suns (figures that have been verified by the National Renewable Energy

Figure 2. Solar Junction's wafers processed with CPV cells have an area of 0.7 cm², far less than that of space cells, which are 26 cm² in size. The CPV wafer has approximately 100 cells while the space configuration has only two cells per wafer (or in some cases, one cell per wafer)



about 1 percent.

Dilute nitrides

The superior efficiencies of our cells stem from the switch from a germanium junction to one built from InGaAsNSb (see Figure 1). This increases the bandgap of the low energy cell from 0.67 eV to 1.0 eV and leads to a greater energy harvest of incoming photons. Higher efficiency results from an increase in output voltage while maintaining adequate current through the junction.

Building a bottom junction from a dilute nitride subcell is not a new idea. Throughout the previous decade numerous research institutes and commercial entities tried to do just this, but they were never able to grow dilute nitride junctions with sufficient material quality for high-performance photovoltaics. These failures drove the industry to abandon dilute nitrides in favour of the inverted metamorphic (IMM) approach.

The IMM has showed promise in terms of efficiency improvements. However, that is only one part of what makes a technology attractive for space. Unlike CPV, lower system costs are achieved with large area cells, and the cells must also withstand exposure to ionizing radiation without suffering catastrophic loss in performance. What the space market does share with the CPV industry is sensitivity to cost and low tolerance for technology risk. This presents several challenges for IMM technology; it is tricky to produce, involving the growth of epitaxial layers in reverse order, incorporation of thick strain-relief layers, and epitaxial lift-off and wafer bonding to realize the 1eV subcell.

This complex fabrication adds significantly to manufacturing costs, and the space industry is concerned over use of lattice-mismatched materials that may exhibit accelerated degradation under the extreme thermal stress environments in space. Solar arrays on commercial satellites can experience temperatures below -170 °C and as high as 100 °C for thousands of cycles. What's more, there are complications associated with integrating the cell into industry standard solar arrays, and this creates a large and potentially unacceptable risk for the space power market. We have succeeded where so many others have failed,

thanks to a breakthrough in materials technology. This has resulted from exploiting the advantages of MBE, combined with proprietary hardware modifications and process IP. Our efforts at developing processes to grow high-quality InGaAsNSb have borne much fruit – this dilute nitride is truly a remarkable material. When properly grown, it possesses a continuously variable bandgap ranging from 0.8 eV to 1.4 eV while remaining lattice matched to the materials above and below. Lattice matching is an incredibly important attribute for cells targeting the space environment. This industry is very conservative, with long duration on-orbit performance of deployed cells used as the ultimate assessment for reliability. As of today, all radiation-hard multi-junction solar cells that power spacecraft are lattice matched.

The variable bandgap of InGaAsNSb enables the design of a device with up to six junctions, including two from different compositions of dilute nitride. Extending the number of subcells increases the device's overall efficiency, and has enabled us to put together a multi-generational technology roadmap to higher and higher efficiencies for cells designed for use in space (the AMO spectrum).

Manufacturers of solar arrays for satellites use large area cells that are 26 cm² to 30 cm² in size, which are shaped in a manner that maximizes wafer utilization while maintaining the highest cell efficiency (see Figure 2). These cells have a relatively large active area, and in order to combine acceptable yields with competitive costs, manufacturers must use very well controlled production techniques that deliver incredibly low defect densities. If there is one single catastrophic defect present on the wafer, due to either epitaxial growth or subsequent processing, the space format will suffer a 50 or 100 percent yield loss, compared to a hit of just 1 percent for the smaller area cell built for concentrating photovoltaic systems.

High quality epitaxial growth is essential for the production of uniform, consistent multi-junction cells. MBE has many strengths when compared to MOCVD, including the ability to produce better layer uniformity, fewer defects, and more abrupt interfaces with lower impurity levels. Biasing one of our 24 cm² space cells so that it produces



Figure 3. Biasing the top junction so that it produces electroluminescence enables assessments of the uniformity and material quality of this junction

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electroluminescence from the top junction highlights the qualities of MBE (see Figure 3). This layer produces highly uniform emission, and there are very few dark spots, which are indicative of shunts in the epitaxial layers. Our cells have a conversion efficiency of 29-30 percent (AM0 spectrum), and their voltage output is higher than that of the incumbents' present-day production cells, thanks to the higher voltage of the dilute nitride sub-cell (see Figure 4). This plot also highlights opportunities for further cell improvement, such as optimisation of the fill factor, which for the cells produced to date were impaired by a sub-optimum top grid metal design.

To be considered for use on spacecraft, solar cells must demonstrate reliable, high efficiency operation in a space environment. This means that multi-junction stacks must be able to withstand constant exposure to radiation over the 15-year operational life of the satellite. Device degradation in this environment largely results from bombardment by ionizing radiation, causing dislocations in the lattice structure. Designers of solar arrays account for this degradation by using thicker radiation shields and adding more cells to the array, increasing both weight and cost of the satellite. This is required to ensure the array can deliver enough power to operate the payload and bus subsystems through the entire operating life of the satellite. What these designers are looking for are solar cells that not only exhibit a high initial efficiency, but also show a minimal and predictable shift in performance with accumulated radiation exposure. In addition, they want to employ devices that still deliver high power at the end of 15 years on orbit. Any solar cell technology that exhibits rapid performance loss when exposed to a high radiation environment is simply unacceptable.

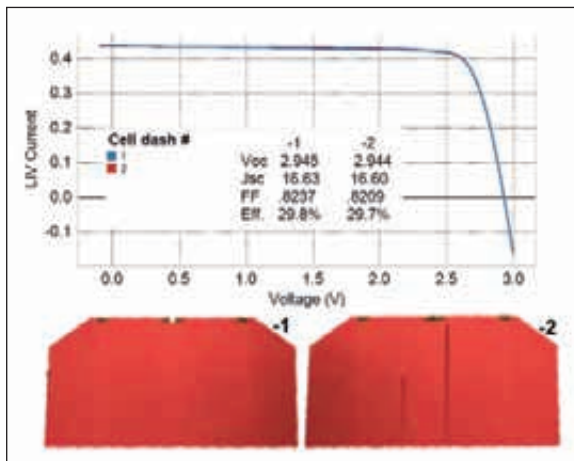


Figure 4. Current-voltage sweeps for two Solar Junction 24 cm² cells fabricated on the same wafer reveal the improvement in voltage afforded by the dilute nitride subcell. This pair of novel triple-junction cells have an open circuit voltage of 2.85 V, about 200 mV higher than that of present day space cells. The current-voltage plots for the two cells are virtually indistinguishable, illustrating the high degree of intra-wafer uniformity achieved in the epitaxial growth and cell processing. Electroluminescence images also reveal the high degree of uniformity within the cells, and from cell to cell

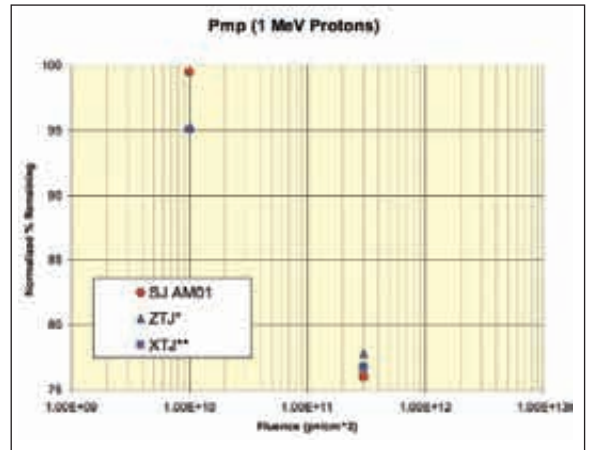


Figure 5. Results for cells from Solar Junction (SJ AM01), Boeing-Spectrolab (XTJ) and Emcore Corporation (ZTJ) under exposure to proton radiation at 1 MeV energy and several fluences, the highest being 3x10¹¹ p+/cm² (note that the data for Emcore and Boeing Spectrolab is taken from published radiation performance for commercially available triple-junction solar cells). Exposure to the cells is more than the equivalent damage expected from 15 years of operation in a geostationary orbit. The normalized remaining power factor for an early development-stage, dilute-nitride-containing solar cell that is not fully optimized for radiation exposure is measured at 76 percent after an exposure of 3x10¹¹ cm², and is equivalent to the best available technology in the market

Extensive testing reveals that our cells exhibit excellent tolerance to high radiation exposure. They appear to perform as well as those of commercially available triple-junction solar cells from Boeing-Spectrolab and Emcore Corporation under bombardment from doses of radiation commonly used to evaluate solar cells destined for use on spacecraft (see Figure 5). This exposure exceeds the damage expected from 15 years of operation in a geostationary orbit. These results demonstrate that the radiation performance of our dilute-nitride-containing solar cells is more than sufficient for long-term operation in the harsh environment of space. In addition, they reveal that at the lower fluence, our device retains more of its initial power than that of the incumbent's solar cells.

We are now pursuing several low risk pathways to optimize the radiation performance of our cell. Our expectation is that the normalized remaining power factor will quickly improve to in excess of 85 percent when exposed to the equivalent fluence of a 15-year geostationary orbit mission. Hitting this goal will make our technology far superior to any other high efficiency approach.

Pathways to higher efficiency

It has taken us little more than a year to produce cells that deliver an equivalent performance to the products of leading triple-junction suppliers. This rapid, tremendous progress stems from the incorporation of a high quality 1eV subcell, which we expect to soon

enable an average production efficiency of 32 percent (AM0) for the InGaP/GaAs/InGaAsNSb device. Although impressive, this superior triple junction is just the beginning of what is possible with our dilute nitride technology. We have developed a roadmap that will enable sustained performance improvement by incorporating additional subcells into the lattice-matched architecture. This will ultimately lead to a six-junction configuration with anticipated AM0 efficiency of over 40 percent.

All of the steps required to go from a triple-junction cell to a six-junction variant are relatively simple and straightforward (see Figure 6 for an overview). They begin by building the existing design on a germanium substrate with an active 0.67eV subcell. This active junction, which will be similar to those presently used in commercially available triple-junction products, will increase the voltage produced by the solar cell and propel efficiency to the 35-36 percent range. One tremendously attractive feature of this particular design is that it is a drop-in replacement (equivalent form, fit and function) for today's 29 percent efficient triple-junction cells. This will be our 'go to market' product for the space segment.

Our five-junction design involves the addition of aluminium to the InGaAs subcell to shift the bandgap slightly, plus a switch from one dilute nitride junction to two – the 0.99 eV junction used in the four-junction cell is replaced by two with energy gaps of 0.93 eV and

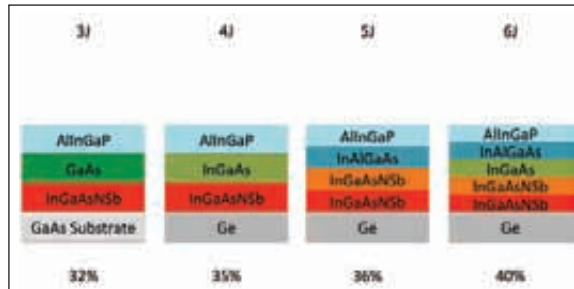


Figure 6. Solar Junction has a roadmap that promises to propel cell efficiency to 40 percent through the addition of extra junctions

1.18 eV. Forming these should be very straightforward, because today we regularly grow photovoltaic-quality InGaAsNSb materials with bandgaps from 0.88 eV through 1.4 eV.

The final node of this roadmap focuses on the addition of a higher bandgap top cell, alongside adjustments to the bandgap of several others to optimise overall performance. This enables proper allocation of the spectrum throughout the device. Modifications include the incorporation of aluminium in the top two junctions to enable better harvesting of the high-energy portion of the solar spectrum. This should enable cells for space to hit 40 percent, an efficiency milestone for the photovoltaic industry that will equip satellites with more power and allow them to carry out more tasks than they do today.

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Manufacturers unveil a raft of new SiC products

SiC chipmakers from all over the world have been recently releasing SiC products, including high-current diodes and high-voltage MOSFETs and JFETs. Many of these devices, and some of the modules that were built with them, were unveiled at the fourth International SiC Power Electronics Applications Workshop. Enriquer Lamoureux reports from this event.

When work begins on a new type of compound semiconductor, conferences on this theme tend to focus on material issues. Following progress, devices are then discussed as much as epilayers and substrates, enabling the community to reach an even greater level of maturity. At this point, the number of conferences in this field multiplies, with some focusing on commercial products and manufacturing processes.

This evolution from materials to devices and products has occurred in the SiC community. In this field, the

number of conferences is on the up, and at International SiC Power Electronics Applications Workshop that was held in Stockholm in late May, chipmakers from all around the world gathered to unveil a raft of new products.

One of the most established manufacturers in this industry is the US chip and substrate manufacturer Cree. At this meeting the company's Director of Marketing for Power Products, Paul Kierstad, presented two recently released products in the 1700 V range: A 40 mΩ MOSFET and a 50 A Schottky diode. In partnership APE Inc., Cree used this pair of products to develop a 40 kW inverter with an efficiency in excess of 98.5 percent.

An attractive feature of the SiC MOSFET is its ruggedness – it outperforms other types of switch, especially when it comes to operation in the avalanche regime. According to Kierstad, Cree has demonstrated that its MOSFET can withstand repetitive avalanche with an energy of 1.5 J, which is one-to-two orders of magnitude higher than that for a silicon MOSFET.

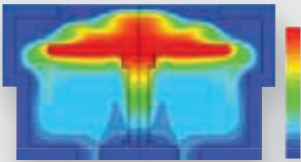
Another strength of the MOSFET is that its resistance ($R_{ds(on)}$) varies less with changes in temperature than that of other switches. Mineo Miura from Rohm highlighted this benefit in a talk that also revealed that the Japanese firm will release two SiC devices this year: A Schottky barrier diode and a MOSFET. Both have been used in the construction of a 120 A SiC module that features five switches placed in parallel.

The commercial availability of SiC Schottky diodes goes back to 2001, when Infineon brought the first product to market. In Stockholm, an application engineer from the company, Uwe Jansen, unveiled Infineon's fifth generation of Schottky diode. Compared to second-generation devices, its attributes include better performance (defined as the product of lower forward voltage and junction capacitance) for a lower cost.



The fourth international SiC power electronics applications workshop was held at the Kista Science Tower, Stockholm, on 29-30 May

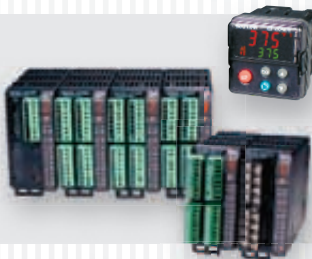
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Paul Kierstad (Cree), Uwe Jansen (Infineon) Joachim Wuerfl (Braun Institute) and Philippe Roussel (Yole Développement) during a panel discussion on the merits of GaN and SiC



Jansen also announced that the company is releasing a 1200 V, 100 mΩ SiC JFET that features an internal body diode. The operation of this normally on device is simplified with a dedicated IC driver that enables normally off operation. To do this, a low-voltage silicon PMOS transistor is placed in series with the JFET, a configuration that ensures a safe off state when the device is turned on. When it is in normal operation, the PMOS is not switched and it is kept in the on-state. The driver IC directly controls the JFET, leading to more efficient, better gate driving than a cascode approach. This superiority stems from the lower capacitance of JFET gates compared to a MOSFET.

Efforts at developing a buried-grid, SiC junction-barrier-Schottky-diode were described by engineer Mietek Bakowski from the Swedish research institute Acreo. He explained that advances in epitaxy enabled the fabrication of a doped buried-grid architecture using SiC. The merits of this diode include an improved 'trade-off' between on-state performance and reverse characteristics. Strengths when operating in the latter regime include an extremely low leakage current for the diode when it is operated in a blocking state.

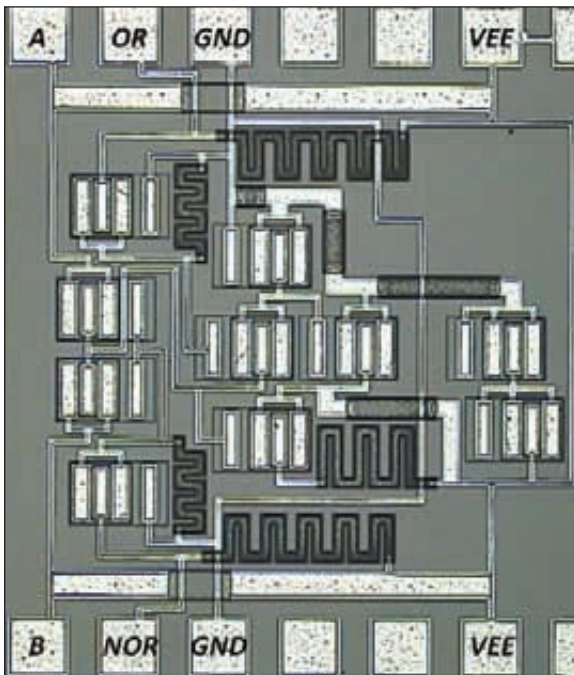


Figure 1.. Researchers at the Royal Institute of Technology in Stockholm have built a NOR gate based on SiC bipolar emitter-controlled logic technology

Bipolar power modules

Delegates in Stockholm also witnessed multi-national chipmaker Fairchild Semiconductor discuss its SiC products in development. This firm will soon release 1200 V-15 A (57 mΩ) and 1200 V-50 A (19 mΩ) switches built from SiC bipolar transistors. Both variants will be released in two different packages: A plastic TO-247 for high-efficiency operation and a TO-258 for high-temperature operations. These products can deliver a gain of 100 at 25 °C, falling to 60 at 150 °C. According to the company, this reduction in gain as temperature increases is relatively small for bipolar technology, which has traditionally struggled in this area. To help to spur the integration of these devices into commercial products, Fairchild has also developed a dedicated base driver and a simulation model for the LTspice simulator.

The firm has also created a 1200 V, 300 A power module in partnership with Kiel University and Danfoss, a manufacturer of power modules and cooling solutions for power electronics. This power module is based on SiC BJTs from Fairchild and Cree's SiC diodes. In this project the 24 die – 12 transistors and 12 diodes – were sintered in a transfer-moulded module, rather than a framed module. Higher efficiency results, thanks to lower parasitics that stem from a more compact design and reduced wire bonding. Greater device reliability under temperature cycling and a higher operating temperature are other benefits of the sintering process.

During the design of the module, great care was given to select the most suitable leadframe dimensions, so that the product could handle large currents (a conductor cross section greater than 4mm²). Air gaps and creeping distances – both pin-to-pin and pin-to-cooler – were taken into account when choosing the mechanical dimensions for the assembly. When this module is pressed onto a water-cooling device with a mounting bracket, the die-to-water thermal resistance is just 0.8K/W.

Aside from its prowess at handling high currents and voltages, SiC is often championed as a tremendous material for operating at high temperatures. To take full advantage of this attribute, Liam Mills, design and development lead engineer at Semelab, UK, showcased a new module based on a SiN substrate. This offers direct interfacing (no base plate), a hermetic package and multilayer possibilities, hence reducing inductance. Mills claimed that this module delivers excellent results, in terms of its thermal resistance and robustness to temperature cycling.

This effort by Semelab highlights the progress made to increase the operating temperatures that can be accommodated by packing technology. However, there is still a substantial difference between the temperature SiC can handle and the temperature that traditional driving electronics can withstand. One company trying to shrink this gap is the Belgium-based fabless outfit Cissoid. At the gathering in Stockholm this company detailed its high-temperature, half-bridge isolated-gate-

driver reference design, HADES. According to Cissoïd, this unit can be placed as close as possible to the power devices and can drive a wide range of devices. This includes traditional silicon MOSFETs and IGBTs, plus the latest generation of wide bandgap enhancement unipolar semiconductor devices, such as bipolar and normally on JFETs. The HADES design is compatible with a 1200 V supply, and it can operate at more than 200 kHz. Polyimide is used to make the demonstration board, and all components, transformer included, can operate up to 225 °C (175 °C ambient).

A more radical approach is needed to reach far higher temperatures, such as 400 °C or more. Carl Michael Zetterling's group from the Royal Institute of Technology in Stockholm are pursuing this goal and trying to produce driver ICs that combine higher operating temperatures with the ability to withstand high levels of radiation. Zetterling told the delegates gathered in Stockholm that their IC development had taken many directions, including characterising transistors, investigating radiation hardness and developing high-temperature metallization processes that could lead to the design and the construction of emitter-coupled logic OR and NOR gates made in SiC bipolar technology.

Battling with GaN

One of the biggest differences between this conference and its forerunners was the inclusion of a session dedicated to a rival wide bandgap semiconductor, GaN. In Stockholm, several representatives from this community were invited to present their latest developments. This included Joachim Wuerfl from the Ferdinand Braun Institute of Germany, who is part of a team developing GaN transistors and diodes for the European Space Agency. Efforts have led to the fabrication of a GaN HEMT that delivers a maximum output of 200 V and 50 A, and combines a threshold voltage of 1.2 V with a resistance of 85 mΩ. Switching to an under-bump package creates a superior version, which delivers an output of 250 V and 75 A and has 75 mΩ resistance.

Engineers at Panasonic have also used silicon as the foundation for making several devices. Company spokesman Nobuyuki Otsuka described an epitaxial process on 6-inch silicon, which involves the deposition of a GaN and AlN superlattice to reduce stress and prevent wafer cracking. Efforts at device fabrication have focused on a gate injection transistor, which combines normally off operation and low on-resistance. This formed a building block for a monolithic three-phase inverter and a bidirectional switch for AC supplies equipped with two gates. Otsuka also mentioned a 9.4 kV diode.

One of the advantages of these GaN devices over their SiC rivals is that their geometry is lateral, rather than vertical. This enables the fabrication of a monolithic inverter featuring six transistors on a single die. Monolithic inverters combine very high integration with very low parasitic inductances.

However, despite constant development and important investment in the GaN domain, this market is still dwarfed by that of SiC. According to analyst Philippe Roussel from Yole Développement, France, it will take two years for GaN to catch up with SiC if sales of GaN-on-silicon products take off – and far longer if they don't. The supremacy of SiC for products operating at over 1kV is beyond question, but GaN could be a tough competitor at 600 V and 900 V.

The SiC industry will fight very hard to hold on to this sub-kV market. "Cree will not let go the 900 V market," said Paul Kierstad, who remarked that the cost-per-device for SiC has plummeted since these products first appeared on the market. Further competition between suppliers, including entrants from China, is likely to drive prices even lower.

Today's SiC products are produced primarily on 3-inch and 4-inch substrates. Moving to larger substrate sizes will help to trim manufacturing costs, although such a move has to be weighed against initial capital expenses associated with putting together lines for handling larger wafers. In 2010, Cree demonstrated 150 mm SiC substrates, and it will soon release a version of this. Is there sufficient demand for a substrate of this size? Probably. The power device market is tipped to grow at a compound annual growth rate of 8 percent through to 2020 – by which time it will be worth \$35 billion – and SiC devices promise to gain market share from the incumbent, silicon. In short, SiC devices should have a strong commercial future.

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Industrial applications

One of the highlights of the fourth ISiCPEAW conference was the presentation of several applications using SiC components. This included an account by Carl Ho from ABB Switzerland of the benefits of using SiC devices in a photovoltaic inverter. Replacing silicon diodes with SiC equivalents in the pre-regulator of 2.5kW photovoltaic inverter helped to improve efficiency by 1 percentage point. This gain might seem very small, but it leads to lower thermal dissipation and a smaller cooling system. It is then possible to slash the pre-regulator size by almost 50 percent, and trim its manufacturing costs. Ultimately, the user benefits from more compact, more efficient equipment that potentially has a lower price tag, while the engineer designing the equipment delights in the high breakdown voltages of the SiC switches, as well as their high operating frequency, which allows simplification of the inverter topology. It is even possible to lower the component count. Meanwhile, Shashank Krishnamurthy from the research centre of United Technologies, CT, showcased a high-frequency, SiC-based 5.5 kW inverter for aerospace applications. This unit, which was built from SiC MOSFETs and SiC Schottky diodes, had a pulse-width modulation frequency of 400 kHz. This enabled the construction of a very compact transformer and lighter passive filters.

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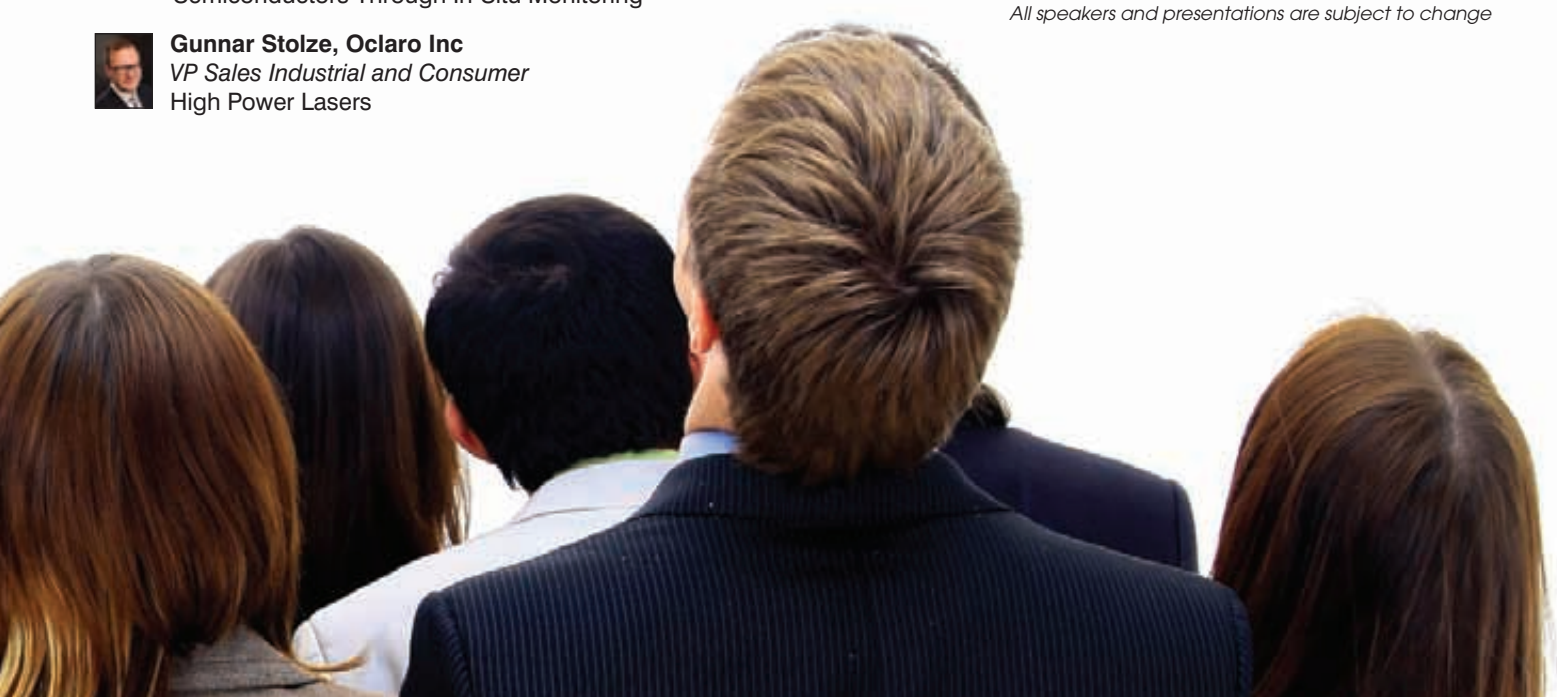


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Remote phosphors yield better light bulbs

Separating the phosphor from the blue-emitting chip is a great way to improve the performance of LED light bulbs, according to Mitch Jansen from Intematix. With this architecture bulbs are brighter, their emission more uniform, and they last far longer, thanks to superior thermal management.

To capture the lucrative general illumination market with solid-state devices, manufacturers of lighting products must generate white emission with LEDs. There are two ways to do this: Colour mixing three or four monochromatic LEDs spanning the visible spectrum; or combining a blue-emitting chip with longer-wavelength phosphors.

Although the former approach has several strengths, including the promise of very high efficacies and a spectral output that is similar to that produced by fluorescent sources, the combination of a blue LED and

phosphor is more attractive, thanks to its superior spectral coverage and greater simplicity. This simplification occurs because it is easier to drive and control one type of LED while maintaining a colour balance, rather than driving different types of devices – such as red, green and blue sources. Characteristics of individual LEDs change with time and their driving conditions must be monitored and adjusted periodically in order to enable the lighting product to deliver the same colour over its lifetime.

When phosphors are used, they determine all aspects









		
L1 LED Implementations	L3 System Implementations	L3 System Implementations
		
a. Phosphor powders	b. 2D Chromalit™	c. 3D Chromalit™ Shapes

Figure 1. Phosphor materials are widely used in direct white conversion at the LED level (1a) and can also be used in remote phosphor configurations (1b and c)

of the quality of light, from colour temperature (CCT) to colour rendering index (CRI). Today, phosphors are generally applied directly to the top of the blue-emitting chips, and in many cases this is followed by further encapsulation in a silicone dome to improve light extraction (see Figure 1 (a)). However, it is possible to use a remote phosphor, which can be coated on two-dimensional shapes, or formed into three-dimensional ones (See Figure 1 (b) and 1 (c)). Going down this route, designers of lighting system must consider optics, thermal management and electronics for building a complete system.

At Intematix, a phosphor manufacturer based in Fremont, CA, we have been investigating the challenges and benefits of building lighting systems using remote phosphors (see Figure 2). This is pumped with a blue LED, using what can be described as a mixing chamber configuration. Surfaces around the LEDs and around the remote phosphor are coated with highly reflective materials, enabling the 'recycling' of photons, leading to

greater light extraction from the system, greater efficacy and lower costs.

Recycling can be highly beneficial, because phosphors are lambertian emitters. This means that photons are emitted from the phosphor in an isotropic manner, rather than just a narrow beam. This causes half of them to initially travel back towards the LED chips which act as absorbers. The reflective surfaces in the mixing chambers significantly improve the ultimate photon extraction.

Our experiments with a standard 2700 K remote phosphor show that reality tallies with this theory. Regardless of whether we use a standard mixing chamber producing about 450 lumens, or a highly absorptive mixing chamber delivering about 235 lumens, almost 50 percent of the light output travels back to the source.

Reflective materials are not just used in mixing chambers – they also line a traditional white LED

Another benefit that stems from separating blue LEDs from phosphors is a lower operating temperature, which results from distributing thermal energy over a larger space. This ultimately improves reliability at the system level.

Thanks to distribution of heat and light over far larger areas, flux and thermal densities at the phosphor level are much lower than those found in conventional white LED systems

package. However, in most cases the die reflectivity is much lower than that of the reflective materials that line up a mixing chamber, and the ratio of the reflective area to the absorbing area is much smaller in an LED package than in a remote phosphor system.

Another benefit that stems from separating blue LEDs from phosphors is a lower operating temperature, which results from distributing thermal energy over a larger space. This ultimately improves reliability at the system level. Thanks to distribution of heat and light over far larger areas, flux and thermal densities at the phosphor level are much lower than those found in conventional white LED systems. In both traditional and remote phosphor architectures, heating not only occurs in the chip, due to light-generation in the LED; it also occurs in the phosphor, due to absorption and down-conversion of blue light. When remote phosphors are used, heating in this material can be removed through convection and radiation.

The combination of efficient mixing chamber designs and better thermal distribution at the system level can result in system level efficiency improvements as high as 30 percent compared to white LED systems.

Other optical benefits can be achieved from designs incorporating remote phosphors. This material acts as a single lambertian source, enabling excellent colour distribution. Driving a system with multiple blue LEDs results in very little colour separation in the emitted light. This effect, also known as "colour over angle", is a

significant issue in white LEDs and is usually solved at the system level by mixing the emission of multiple white LEDs. In addition, remote phosphor systems achieve a colour distribution of better than 3 SDCM (standard deviation of colour matching). This is good enough to eliminate the need for an optical diffuser, which is often employed to mix and homogenize emission from white LEDs. Removing the diffuser trims the bill of materials for the lighting system, and also leads to higher efficacies, because diffusers reduce overall light output.

High-volume manufacture of white LEDs doesn't yield devices with identical characteristics, so products are separated into bins. This presents significant logistical challenges. To enable high quality light at the system level – a high CRI, a consistent colour-over-angle and a value for SDCM of less than 3 – LEDs must be binned for colour and colour uniformity. This issue disappears when LED-based lighting systems are built from blue LEDs and remote phosphor elements. All the necessary CCTs and CRIs can be achieved with a reduced number of remote phosphor parts, resulting in a simpler supply chain. Product obsolescence can also be addressed in a simpler way, because as the performance of blue LED chips improve, one can maintain the same performance and system footprint while using fewer blue LEDs.

One attractive feature in remote phosphor systems is the ability to swap remote phosphor elements. This means that the same basic systems can deliver a variety of illumination conditions, an attractive feature in some instances, such as on movie and television sets where



Figure 2. Intematix ChromaLit lighting systems use blue LEDs in a mixing chamber to provide higher system performance and simplification of the optical interface

When remote phosphors are deposited on a planar surface, they offer glare-free, consistent light. This is not possible with the point source of single LEDs, unless a heavy diffuser is used, which has an unwanted side effect – lower efficacy

filming requires different ambient illumination conditions for different scenes.

Phosphor architectures

When remote phosphors are deposited on a planar surface, they offer glare-free, consistent light. This is not possible with the point source of single LEDs, unless a heavy diffuser is used, which has an unwanted side effect – lower efficacy. Thanks to the benefits of remote phosphor technology, it is starting to see adoption in under cabinet lighting, television and film lighting, and downlights. These designs benefit greatly from the superior quality of light achieved with remote phosphor systems, which reduces variations between fixtures and enables uniform and consistent lighting.

Three-dimensional remote phosphors are gaining acceptance in high-power LED replacement lamps, which will be the next ‘killer’ application for this type of solid-state device. One example of this is our novel 75-W equivalent reference design (see Figures 3 and 4),

which meets Energy Star requirements, including intensity over angle. This lamp features our ChromaLit Contour remote phosphor and an efficient, flow-through heatsink delivering superior thermal performance over that of LED-based lamps using conventional white-emitting devices. Other components include eight Philips Lumileds Luxeon ES 1000 mW blue LEDs, Furukawa reflective material for the mixing chamber and an iWatt driver rated at 85 percent efficiency. This bulb produces a minimum output of 1100 lumen, has an efficacy in excess of 70 lumens-per-watt, and its AC power consumption is under 16 W.

Lamps that qualify for Energy Star status must deliver omni-directional emission characteristics. Meeting this is tough with traditional LEDs. It requires additional optical elements, because the emission from this type of LED is much more directional than that of remote phosphor. Strong diffusers can counter this by shaping the beam and reducing glare, but it is still tough to create a lamp that delivers wide-angle, uniform

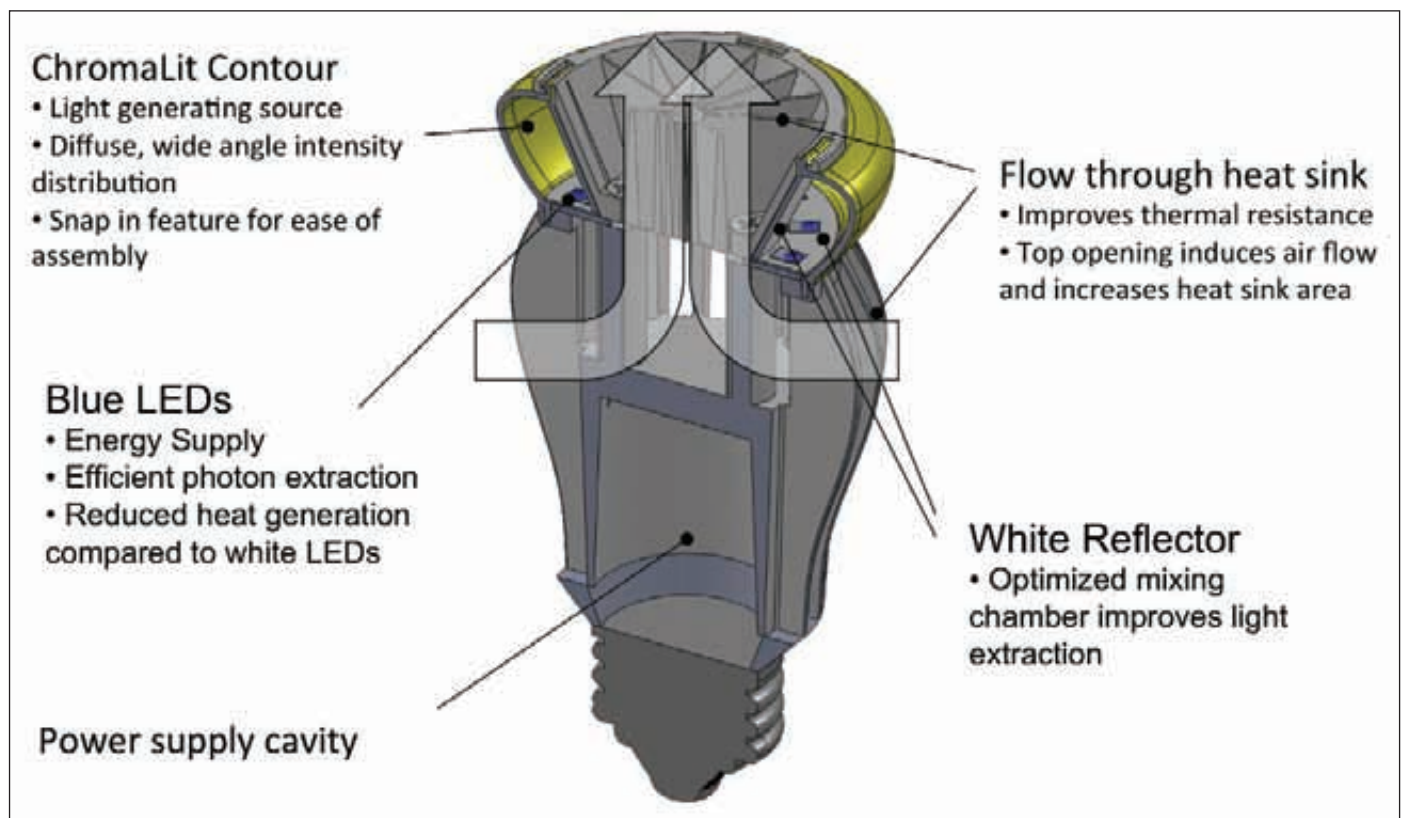


Figure 3. The Intematix 75W lamp reference design combines the benefits of a remote phosphor with an efficient flow-through heat sink design



Figure 4. A 75 W equivalent lamp operating in power-off condition (a) and power-on condition (b). The thermal profile of the lamp (c) shows that the remote phosphor is just 82°C

emission. Mounting LEDs vertically can help to address some of these issues, but such designs often run into thermal and cost issues.

In stark contrast, lamps built with remote phosphors do not need an external diffuser to deliver omnidirectional, glare-free emission that meets the Energy Star requirements in flux distribution (see Figure 5). This is partly due to the uniquely designed remote phosphor shape, which combines uniform directionality with uniform diffuse emission that is free from hot spots.

Conventional LEDs lamps run hot, often reaching temperatures in excess of 90 °C at the heat sink, with heat removal only occurring via conduction through the LED heat sink. Turning to remote phosphors makes a massive difference, and ultimately enables higher efficacies and a longer operating life because heat is shared between the heat sink and the remote phosphor surfaces. Measurements with thermocouples and thermal imaging cameras show that when our 75 W-equivalent, remote-phosphor bulb produces 1150 lumens at an ambient temperature of 25 °C, its heat sink and remote phosphor are at 60 °C and 82 °C, respectively.

Assembly of bulbs using remote phosphors is straightforward, and there are lots of CCT and CRI options to choose from. Our products cover colour temperatures from 2700 K to 5000 K and deliver CRIs above 80. Output of up to 1600 lumens is possible, which is sufficient for making a 100 W equivalent lamp. Our products are attracting significant interest; expect to see volume production of lamps before the end of 2012.

What's more, the benefits of remote phosphors are not restricted to one shape of bulb. In candle-shaped bulbs they can create spectacular chandelier sources, and even in mundane applications, such as outdoor camping lanterns, they can deliver great improvements in the quality of light produced. Remote phosphors can

also deliver incredibly high CRI values in downlights used for hospitality and retail, enabling tomatoes and meats to look ready to eat. And they also have the potential to create a pleasant office environment, by placing them in LED-based products with a linear design. In short, remote phosphors are here to stay, and how widely they are used will only be limited by the imagination of lighting designers.

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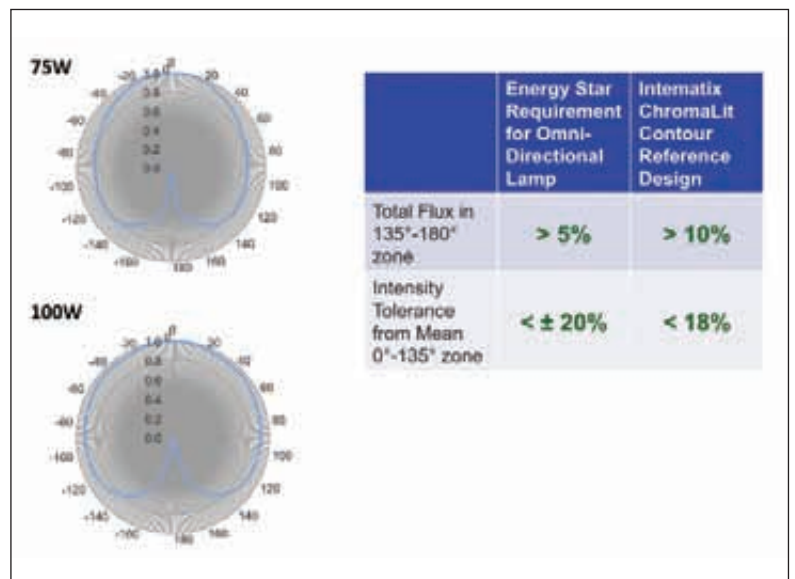


Figure 5. Intematix 75 W equivalent reference design produces more than 10 percent of its total flux in the 1350 to 1800 angular distribution zone, which is considerably more than the 5 percent requirement stipulated by Energy Star. Another requirement decreed by this US body is an intensity distribution tolerance, measured from the mean, of less than 20 percent between 0° and 135° - in this design it is just over 18 percent

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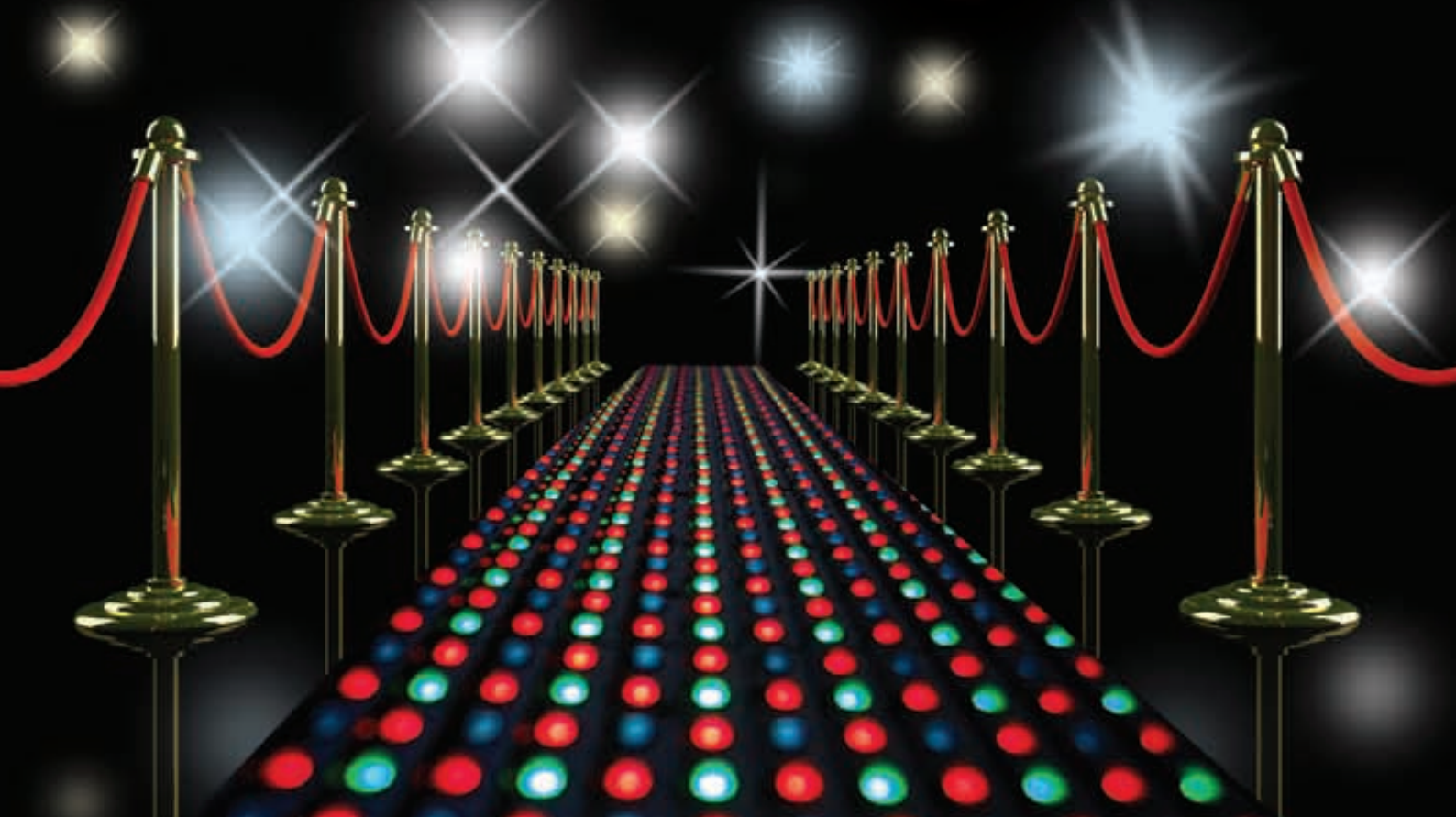
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Silicon removal yields high-voltage, low-cost GaN HEMTs

The high-voltage capability of GaN-on-silicon HEMTs is hindered by conduction within the substrate. Get rid of it and it is possible to realize blocking voltages of 2 kV with AlGaN buffers just 600 nm thick, says imec's Puneet Srivastava, Kai Cheng, Jo Das, Stefaan Decoutere, Robert Pierre Mertens and Gustaaf Borghs.

Wide bandgap nitrides are great materials for realizing high-voltage power devices operating at high temperatures. Their superiority over silicon, the incumbent material for making power electronics, stems from a great set of intrinsic characteristics. They include a high-electric-field strength, low intrinsic carrier concentrations and the formation of a two-dimensional electron gas at the interface of AlGaN and GaN. This sheet of charge formed at the interface acts as a transistor channel and promises to enable the construction of smaller, more efficient power supplies, because it enables the fabrication of devices with higher current density, lower on-state resistance and faster switching.

Ideally, GaN substrates should form the foundation for III-N transistors, but they are far too expensive for making commercial products for power electronics. This means that today the best way to develop competitively priced devices is to use silicon substrates. There are downsides associated with growth on silicon, such as large lattice and thermal mismatches with the nitride layers, but they can be addressed with careful stress management. This allows repeatable growth of 2-3 μm -thick nitride films in a manufacturing environment without layer cracking or wafer breakage.

Unfortunately, in addition to these issues, silicon substrates limit device performance at high voltages. The origin of this weakness is a parasitic electrical conduction path along the nitride buffer layer and

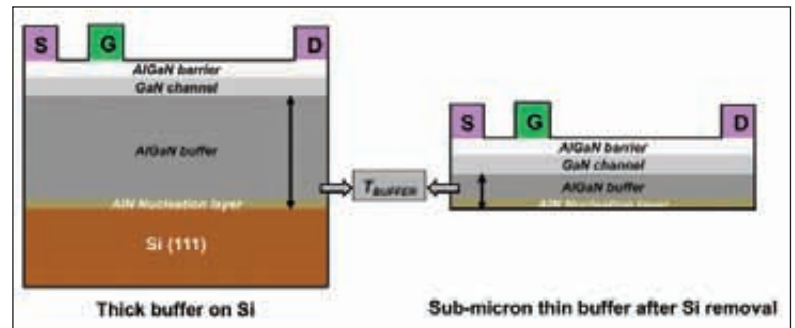


Figure 1. Switching from a conventional GaN HEMT architecture to a variant that has had the silicon substrate removed enables high blocking voltages with a buffer thickness of just 600 nm

silicon interface, which occurs at higher voltages between the drain and the source electrodes of the HEMT. This conduction path, which is unlikely to be found when devices are grown on sapphire, SiC or sapphire substrates, holds back the operating voltage of GaN-on-silicon transistors.

High-voltage pathways

One option for enhancing the high-voltage capabilities of GaN-on-silicon HEMTs is to increase the buffer thickness, which leads to a rise in vertical buffer resistance. This approach has been pursued by researchers at Yokohama R&D Labs at Furukawa Electric Company, Japan, and has led to the fabrication of power transistors with 7 μm -thick buffers and a breakdown voltage in excess of 2 kV.

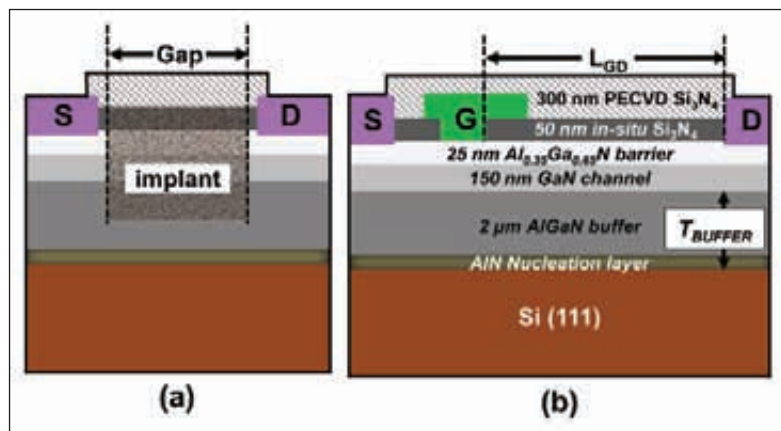


Figure 2. Cross-sections of (a) buffer isolation test structure and (b) DHFET with layer structures and geometries. The source and drain contacts are Ti/Al/Mo/Au and the gate contact is based on Ni/Au

Converting this type of device into a successful product will not be easy. This is because the growth of thick nitride layers on silicon creates a significant level of stress, causing wafers to bow and even crack. It is also very challenging to scale the epitaxial process from 4-inch substrates to larger sizes. Production costs are also higher on smaller wafers, while thicker buffer layers hamper production yields.

At imec, an internationally renowned research institution in Leuven, Belgium, we have developed an alternative approach that does not require a thick buffer for realizing GaN HEMTs with a high-breakdown voltage.

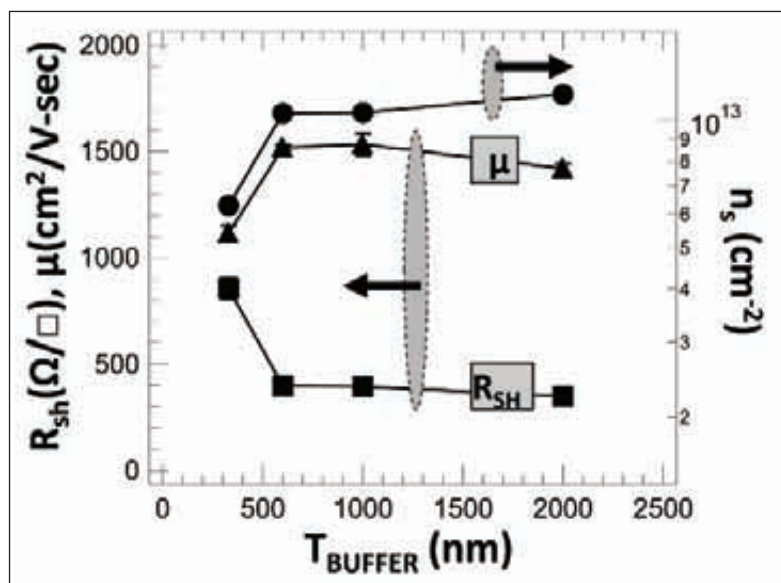


Figure 3. Sheet resistance (R_{SH}), mobility (μ) and carrier concentration (n_s) measurements show that when the thickness of the buffer exceeds 600 nm, how thick it is has no impact on the transport properties of the two-dimensional electron gas formed at the AlGaIn/GaN interface

We have found that the breakdown voltage of our GaN-on-silicon double-heterostructure FETs (DHFETs) can be increased significantly by removing silicon (see Figure 1). One of the keys to our success is the optimized sub-micron AlGaIn buffer on the silicon substrate.

Measurements on buffer isolation test structures reveal that after the removal of silicon, the breakdown voltage of our transistors does not depend on the buffer thickness at all. Instead, breakdown voltages for the buffer structures and the devices have a linear dependence on ohmic gaps and gate-drain distances, and can exceed 2 kV. This demonstrates that optimization of thin buffers, followed by silicon substrate removal, is a promising route to manufacturing low-cost, high-voltage GaN devices.

Fabrication of DHFETs begins with MOCVD growth of a $\text{Al}_{0.35}\text{Ga}_{0.65}\text{N}/\text{GaN}/\text{Al}_{0.18}\text{Ga}_{0.82}\text{N}$ heterostructure on silicon (111), followed by *in-situ* deposition of a Si_3N_4 cap. The thicknesses of the $\text{Al}_{0.35}\text{Ga}_{0.65}\text{N}$ barrier layer and the GaN channel are fixed at 25 nm and 150 nm, but the buffer has been varied from 330 nm to 600 nm, 1 μm and 2 μm (see Figure 2). Several steps are used to process these epiwafers into devices: Ohmic contact formation, device isolation (implantation), gate recess etching, Schottky-gate metallization and deposition of a thick final passivation layer by plasma-enhanced CVD. A range of breakdown voltages result, which have been produced with various gate-drain distances for DHFETs and with varying ohmic gaps for buffer structures.

Probing the structure

To determine the impact of buffer thickness on layer quality, we have characterized the electrical properties of the GaN channel prior to silicon removal. Measurements reveal that reductions in the AlGaIn buffer thickness down to 600 nm have no impact on sheet resistance, mobility or sheet carrier concentration (see Figure 3). This explains why devices with an AlGaIn buffer of 600 nm, 1 μm and 2 μm all produce a similar saturation current, which is 0.60 A/mm. Trimming the buffer to 330 nm is a step too far, however, because it significantly reduces channel conduction, leading to a 30 percent hike in on-resistance and a 40 percent fall in saturation current. The root cause for all this degradation is an increase in dislocation density.

We have evaluated the impact of substrate removal by transferring the device structure onto sapphire via a bonding layer and then etching away at the silicon substrate with chemicals (see Figure 4). The structures that resulted can be seen in images produced with a focused ion beam (see Figure 4 (c) and 4(d)). An attractive feature of our novel HEMTs that have undergone silicon substrate removal is that they do not suffer from breakdown voltage saturation. What's more, this breakdown voltage shows a linear increase with ohmic gaps and gate-drain distance. (Note that we define the breakdown voltage in conventional devices

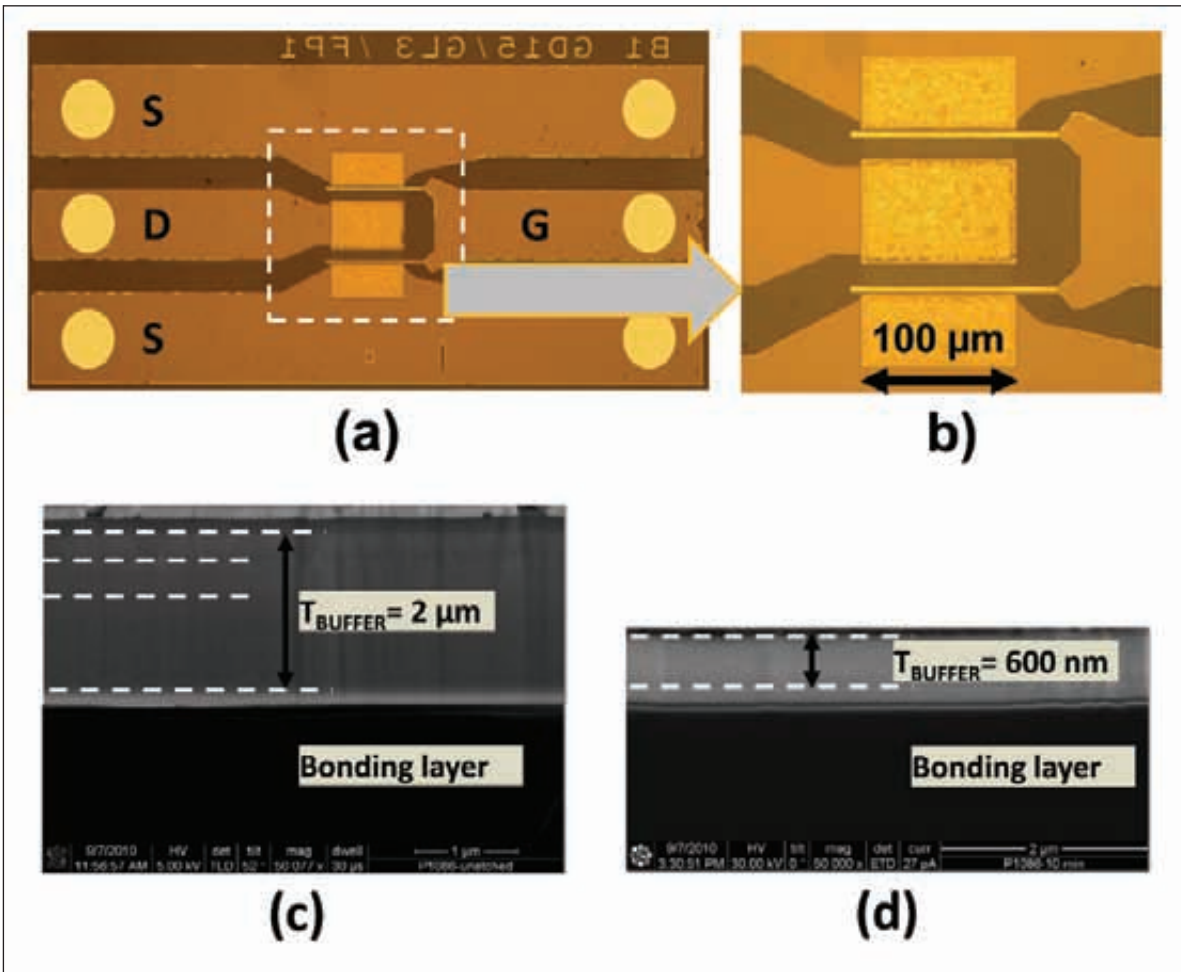


Figure 4. (a) An optical photograph of a processed device after silicon removal and contacts opening of the source, gate and drain pads (b) enlarged view of a device active area showing a crack-free layer (c) focused ion beam cross-sectional image of a device layer with 2 μm-thick buffer and (d) focused ion beam cross-sectional image of a device layer with 600 nm-thick buffer

with the silicon substrate as that resulting in a leakage current of 1 mA/mm; for transistors that have had silicon removed, our criterion is adjusted to the voltage that causes the III-N layers to physically break down).

We have found that the electric field strength in the buffer is approximately 2.5 MV/cm (see Figure 5). In the device this plummets to just 1 MV/cm (see Figure 5(b)), due to the non-linear electric field for the DHFET– it peaks at the drain side of the gate electrode. Devices fabricated with a gate-drain length of 20 μm deliver a breakdown voltage in excess of 2 kV for buffer thicknesses of 600 nm or more (see Figure 6). When the buffer is at least this thick, once silicon is removed the breakdown voltage does not depend on buffer thickness. Instead, it is governed by the peak electric

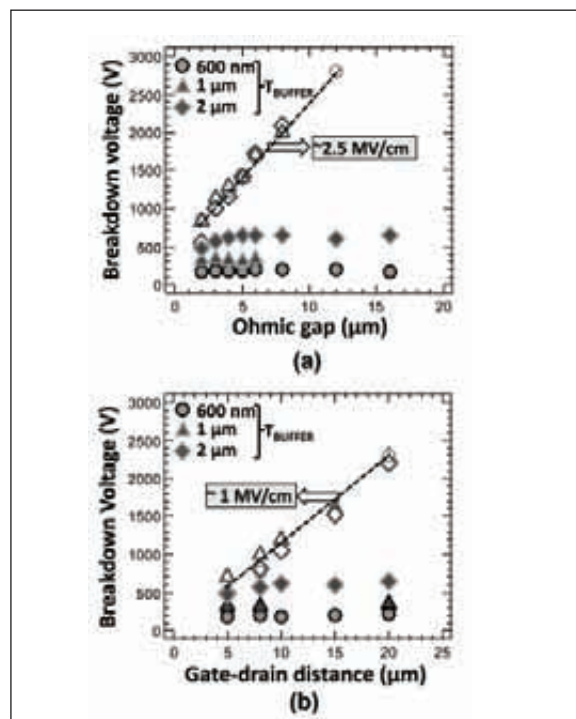


Figure 5 (Right). (a) Buffer breakdown voltage versus ohmic gaps and (b) device breakdown voltage versus gate-drain distance for different buffer thicknesses. Solid circles show the values for breakdown voltage with silicon substrates; the corresponding open circles show the results of measurements after silicon removal

fields occurring in the structures, which lead to physical wear out of the nitride materials. Our efforts show that the growth of thin buffers for GaN devices on 6-inch silicon wafers followed by silicon removal, is a very promising approach for making low cost, high voltage GaN devices with a high yield. What's more, there are no major hurdles to moving to larger substrates, which will spur reductions in cost and help wide bandgap electronics to move from a niche to a mainstream market.

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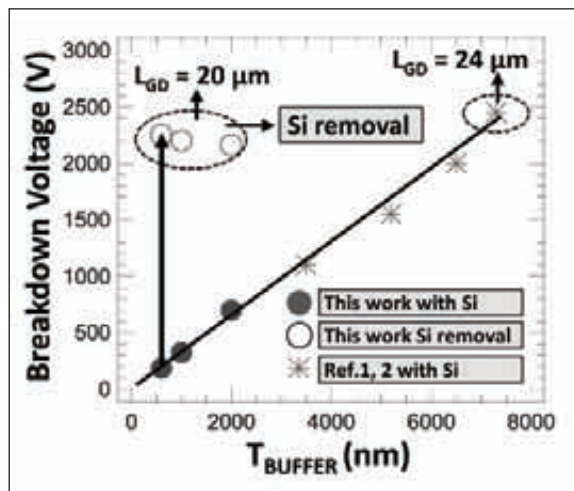


Figure 6. Devices with breakdown voltages of over 2 kV can be realized with buffer layers as thin as just 600 nm after silicon substrate removal. If the silicon substrate is not removed, 7 μm -thick buffers are needed to reach a 2 kV breakdown voltage. Ref. 1, 2 refers to the devices reported in N. Ikeda et. al. 21st ISPSD, 2009, Barcelona, Spain

Further reading

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Unleashing the potential of carbon nanotubes in various devices

Low cost carbon nanotube deposition on 300 mm substrates opens up lucrative opportunities in medical, electronics and power industries.

Richard Stevenson reports.

Carbon nanotubes have great attributes. Depending on their geometry, they can combine semiconducting or metallic levels of conductivity with an incredibly high aspect ratio, a phenomenal current density of 10^9 A cm⁻² and great strength – this allotrope of carbon has the highest Young's modulus of any solid. In addition, carbon nanotubes can support ballistic electron transport, and they have a very high thermal conductivity of up to 4000 W/m.K and an inert nature that stems from the nature of the bonds.

Given this great set of intrinsic characteristics, one would expect that carbon nanotubes, which were first discovered in 1991, to have spawned a multi-million dollar industry. But that's not the case – their deployment is essentially limited to three niche applications, which all use the bulk form of this material. Today, these tubes are strengthening carbon electrodes in lithium batteries; forming strong composite materials used in the blades of wind turbines; and creating strong, lightweight golf clubs and tennis rackets with eye-watering price tags.

To unleash the potential of non-bulk forms of carbon nanotubes, which could create and enhance many different types of device, the European Commission has invested € 5.3 million in a €8.4 million, three-year 'Technotubes' project involving 12 academic and industrial partners. They are the University of Cambridge, Aixtron, Philips, imec, Thales Research and Technology, Thales Electron Devices, Cambridge CMOS sensors, Fritz Haber Institute, the Technical University of Berlin, the Technical University of Denmark, ETH Zurich and CNR-Trieste.

This recently completed programme that was led by John Robertson from the Department of Engineering at the University of Cambridge had several goals. These included the construction of the first equipment for production of carbon nanotubes on 300 mm substrates, and the development of: High-conductivity interconnects for improving microelectronics; time-modulated cold-cathodes for X-ray scanners and tomography; and enhanced surfaces for microfluidics.

Scaling production

When the project kicked off in May 2009, Aixtron's reactor portfolio included commercial tools for depositing carbon nanotubes on substrates up to 150 mm in diameter. This company's primary task in the Technotubes programme has been

to develop a new tool for nanotube growth on a 300 mm platform that meets the needs of the other players in the project.

Speaking at the project's closing meeting, Ken Teo, Director of Nanoinstruments at Aixtron, explained that they have developed a reactor for 300 mm wafers with a robot-loading system and a suite of monitoring tools – it is fitted with multiple infrared pyrometers, an *in-situ* camera and analysis ports. This reactor uses C₂H₂, C₂H₄ and CH₄ as the gas sources; argon and nitrogen as inert sources; and hydrogen and ammonia as reducing gases (see Figure 1 for details). Like the MOCVD process, the substrate is heated from below, and growth of material proceeds via decomposition of source gases on the wafer surface.

Initially, engineers at Aixtron developed a 300 mm 'R&D' tool – a blueprint for the commercially launched BM 300 that requires manual loading and has no heating of the substrate from above – before they went on to build a production reactor.

This tool, the BM 300T, is in the process of internal qualification. It has a wafer temperature uniformity of 4 °C and it has been used to produce various forms of carbon nanotubes (see Figure 2). This includes single-walled variants that could find application in

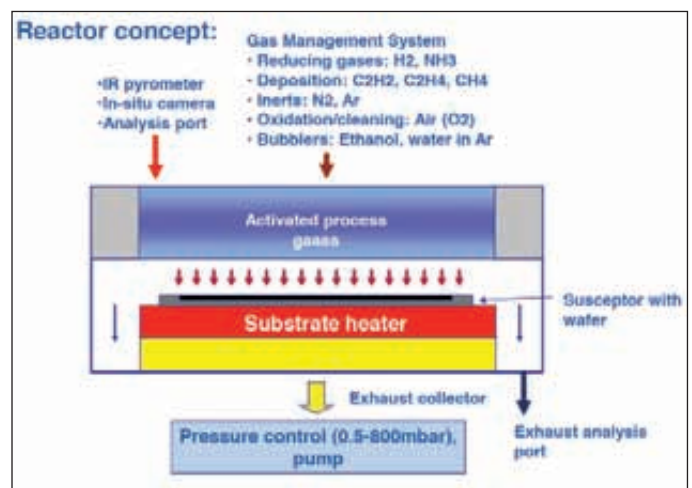


Figure 1. One of the elements of the Technotubes project has been the design of a reactor for forming carbon nanotubes on 300 mm substrates

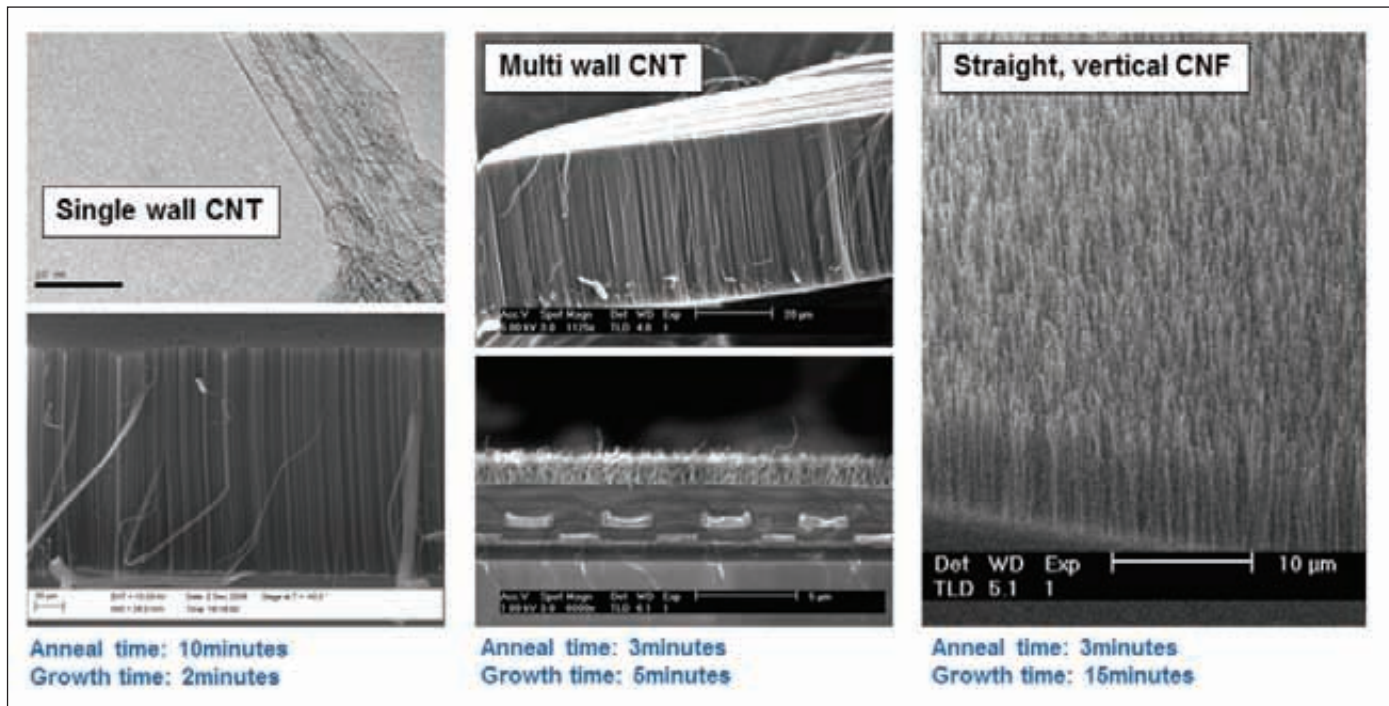


Figure 2. Different types of nanotube can be formed through adjustments to anneal times, growth times and growth temperatures

sensors and interconnects and are produced with anneal and growth times of 10 minutes and 2 minutes, respectively. Trim the anneal time to 3 minutes and extend the deposition time to 5 minutes and it is possible to make multi-wall carbon nanotubes that could find deployment in X-rays sources and interconnects. Straight, vertical, carbon nanofibres that could be used in X-ray sources, cell probes and microfluidics, can also be formed in the BM 300T with another set of growth conditions.

Teo wrapped up his presentation by providing an estimate of the production prices for carbon nanotube manufacture. His calculations are based on three production machines that would share a robot-handling system, pumps and infrastructure. If the life of the tool is ten years, utility is 85 percent and capital expenditure is €5.05 million, the cost-per-wafer and cost-per-inch for a substrate coated in carbon nanotubes will be € 21 and € 0.17, respectively.

Aiding Moore's law

Seven partners in the Technotubes project are working together to develop deposition processes for various aspects of microelectronics. Carbon nanotubes are viewed as promising materials for making through-silicon vias and interfaces with great thermal properties. According to the International Technology Roadmap for Semiconductors, fast-forward ten years and the current density in copper could be limiting further scaling of transistor sizes in cutting-edge logic circuits. Single-walled carbon nanotubes are a very attractive alternative to copper because they have a theoretical current density limit that is more than two orders of magnitude higher, and their high aspect ratio makes them suitable for filling vias.

Carbon nanotubes can make an impact in the silicon foundries of the 2020s if they are formed with a density of at least $3 \times 10^{13} \text{ cm}^{-2}$, because this can ensure a sufficiently low electrical resistance. Partners in the Technotubes project have got to within 50 percent

of that density with three different approaches: Improving the catalyst support layer; using a patent-pending, multi-cycle catalyst deposition technology; and employing catalyst carburisation, a process pioneered by Toshiba.

Ideally, carbon nanotube growth processes should be applicable to a range of substrates. Deposition on conductive substrates – such as CoSi_2 , TiN and tantalum – is needed to form interconnects, while growth on copper leads to good thermal interfaces. The European team of researchers has shown that carbon nanotubes can be created on conductive platforms with a high areal density by depositing a catalyst film. This is restructured into islands that initiate tube growth. One method for doing this is to create a Co_xF_y film on CoSi_2 by reactive ion etching in SF_6 , followed by reduction in hydrogen gas to form cobalt spheres that define the locations



Robot loading is one of the features of Aixtron's BM 300T, which is in the process of internal qualification

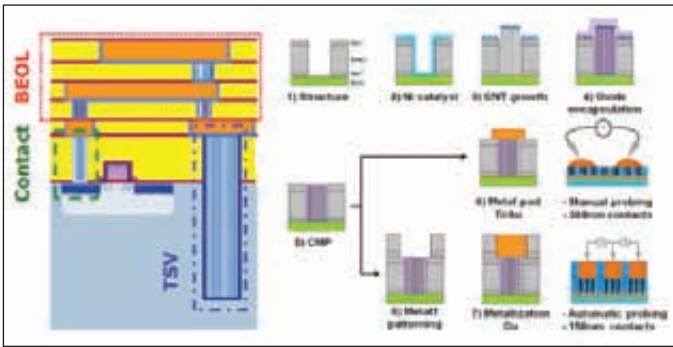


Figure 3. (Above). Researchers in the Technotubes programme developed processes to form contacts with carbon nanotubes



Figure 4. (Right). Cathodes constructed from carbon nanotubes have been used in X-ray imaging tools

of the nanotubes. Efforts on 200 mm silicon-wafer-processing of carbon nanotubes in the microelectronics work package have led to an integrated process flow for carbon-nanotube vertical interconnects, which are built on metal contacts and attached to top metal contacts (see Figure 3). Another aspect of this strand of the Technotubes project has involved the use of carbon nanotubes as a very high thermal conductivity interface between high-power GaN LEDs and their packaging materials. Working together, Philips Lumileds and the University of Cambridge have developed carbon nanotube heat spreaders on copper.

X-ray sources

Philips was also involved in another aspect of the Technotubes project – the development of carbon nanotube cathodes for X-ray tubes. These sources of radiation, which are used in radiography equipment, generate X-rays via the collision of high-energy electrons into an anode. Conventional X-ray tubes, which feature a thermionic cathode and a rotating anode in an evacuated tube, consume a tremendous amount of energy. Typical currents, voltages and powers are 1A, 150 kV and 120 kW, respectively. Requirements for next-generation X-ray tubes include higher operating currents, plus a smaller spot size for the X-ray source that can improve spatial resolution. It is also possible to realise gains in temporal resolution with higher peak powers and faster switching times, and if a moving source is replaced by multiple ones with fast switching times, mechanical movement can be eliminated from X-ray imaging systems. Switching from conventional cathodes to those based on carbon nanotubes can address all these areas. As part of the Technotubes project, researchers have targeted the development of carbon nanotube arrays delivering 1 A cm^{-2} . These must be fabricated by a scalable, industrially viable growth process that enables the production of nanotube cathodes at a cost that is competitive with the incumbent technology. Efforts directed at these goals have revealed that heating the underlying substrate from room temperature to $350 \text{ }^\circ\text{C}$ increases the current density, lowers the threshold voltage and improves current stability. This team has also incorporated its carbon nanotube

emitter arrays in ‘non-medical’, low-power, transmissive anode X-ray tubes. Images of light bulbs have been taken using total emission currents of 0.1 mA to 0.2 mA (see Figure 4).

Another team within the Technotubes programme has developed carbon nanotube-based microfluidic components and surfaces. These could find application in three markets: The \$3 billion chromatography market that is growing at 10 percent per year; the \$1.2 billion electrophysiology sector that is increasing in value by 6 percent per year; and the \$0.5 billion market for ultra-capacitors for providing fast energy storage. This market, which will expand as renewables are used for a greater proportion of electricity generation, is tipped to grow at 18 percent per year. In the chromatography industry, nanotubes can be inserted in the channels of microfluidic chromatography devices to enable different types of molecules to be separated by the speed they travel through the tubes. With this approach, the researchers have separated amines and gone on to build a prototype chromatography chip system.

When conventional microelectrode cells are used in electrophysiology, they provide a poor interface between the probes and the specimen, leading to poor measurements and even death of the cell. Thanks to the very small diameter of carbon nanotubes, they cause far less damage. If the density of the tubes is too high, they cannot penetrate the cell, so researchers in the Technotubes project have developed a process to form nanotubes on an array of titanium columns spaced about $2 \mu\text{m}$ apart. One of the requirements for ultra-capacitors for energy storage is a high surface area to combine a high power density with a high energy density. These demands can be met with high-density nanotube forests, formed by direct growth on aluminium foil. Efforts in this direction have created a dense array of $25 \mu\text{m}$ -high tubes on $10 \mu\text{m}$ -thick aluminium foil (see Figure 5).

This work, plus that of all the other projects in the Technotube programme, showcases the potential of carbon nanotubes for making electronic devices. If commercial success follows, the revenue generated in medical, electronic and power industries could soon overshadow today’s sales of the bulk form of carbon nanotubes.

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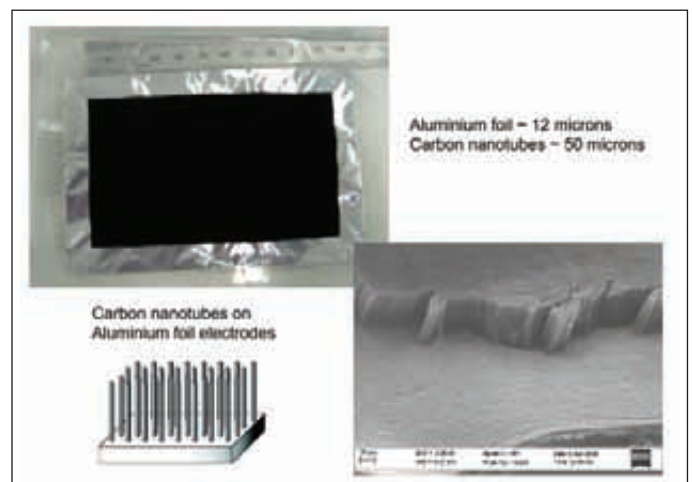


Figure 5. The combination of large surface area and low weight make carbon nanotubes, which can be deposited on aluminium foil, an attractive candidate for building ultra-capacitors

Semi-polar green lasers fulfil pico-projector requirements

Optimisation of cavity lengths and facet reflectivity yields powerful, efficient semi-polar lasers

SONY and Sumitomo Electric Industries have produced a portfolio of green lasers that are setting new benchmarks for output power and spectral coverage. Semi-polar devices produced by these companies, which started working together in 2010, deliver output powers of up to 168 mW, emit at wavelengths of up to 536.6 nm, and have a lifetime of more than 5000 hours when operating continuously at an output of 50 mW.

Thanks to this great set of characteristics, these devices are very attractive candidates for the green source in pico-projectors. According to the team, requirements for laser projection include an output power in excess of 50 mW, a wall-plug efficiency (WPE) of more than 4.5 percent, and a lasing wavelength of at least 515 nm – and preferably 525 nm or more. According to Shimpei Takagi from Sumitomo, wavelengths above 525 nm are needed to realise a good colour gamut.

The best GaN plane for making a green laser is a hot topic within the nitride community. The likes of Nichi and Osram have developed green lasers on the conventional *c*-plane of GaN, while others have turned to semi-polar planes.

Researchers from Sony and Sumitomo claim that the semi-polar plane has several benefits over its more traditional cousin: It is easier to grow green-emitting InGaN quantum wells with a high degree of homogeneity; piezoelectric fields are weaker, leading to a higher radiative recombination efficiency; and for emission wavelengths beyond 520 nm, the threshold current density is far lower. The nitride community has used several semi-polar planes to build green lasers and the Japanese team believes that the {20 $\bar{2}$ 1} orientation produces the best devices.

The team fabricated a series of ridge-waveguide lasers on {20 $\bar{2}$ 1} GaN substrates with a threading dislocation density of less than $1 \times 10^6 \text{ cm}^{-2}$. These semi-polar devices featured InAlGaN

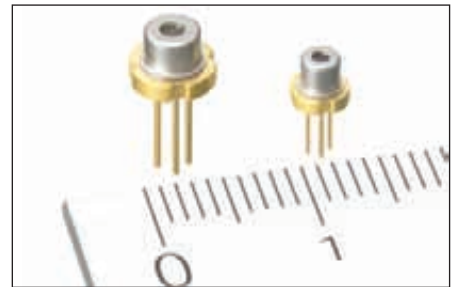
cladding layers, InGaN waveguides and an InGaN multiple quantum well with a well thickness of 2-3 nm. Photolithography and dry etching formed ridge waveguide structures with 1.5-2 μm widths, and cleaving created 500 μm cavities with facets that were subsequently coated with dielectric films.

Very high output powers at emission wavelengths above 520 nm resulted from optimisation of the cavity length and mirror reflectivity (see table for details). “We optimized cavity length by both calculation and experiments,” explains Takagi. “Cavity length and proper selection of reflectivity have a major impact on device performance.” Improvements in both these areas enabled a four-fold increase in slope efficiency compared to devices reported by Sumitomo in 2010.

The WPE of the team’s lasers is very high, but decreases at longer wavelengths. Lasers emitting in the 525-530 nm range have a WPE of more than 8 percent, falling to just above 5 percent for the 536.6 nm chip, which is claimed to produce the longest emission wavelength for any green laser. This series of devices has a significantly higher WPE than those reported in 2010, thanks in part to a superior doping profile that reduced the threshold voltage from 6.4 V to 4.7 V.

Impressive performance at high temperatures is possible with these semi-polar lasers. At 80 °C, devices can deliver 90 mW, indicating that they are suitable for deployment in portable devices that are only able to house heat sinks with limited capability.

One issue being debated by semi-polar laser developers from various institutions is the extent of the benefit of the electron-blocking layer in the device. Recently, Dmitry Sizov and co-workers from Corning argued that this layer plays a minor role in device operation. In contrast, the Japanese team have found that the electron-blocking layer suppressed carrier



The Sumitomo-Sony partnership has set a new benchmark for power output of long-wavelength nitride lasers

Emission wavelength (nm)	Output power (mW)
522.0	168
525.1	167
531.3	105
532.1	107
535.7	75

Semi-polar green lasers combine wall-plug efficiencies of more than 5 percent with output power of up to 168 mW and long lifetimes

leakage and helps the laser to produce a high characteristic temperature (T_0). The researchers have also performed reliability measurements on lasers emitting at 527.5 - 530.8 nm. They defined the lifetime as the estimated time for a 30 percent increase in operating current. “For GaN-based lasers for Blu-ray Discs, this is a standard definition,” points out Katsunori Yanashima, a member of the Advanced Materials Laboratory at Sony.

Operating at 50 mW and 55 °C, these lasers had a lifetime of 5000 hours, and when the output increased to 70 mW, lifetime shortened to 2000 hours. The team claims that these values for lifetime are longer than those reported for *c*-plane lasers, thanks to weaker polarization fields, better material homogeneity in the quantum wells and a low resistivity of the *p*-contact. Improvements to the latter characteristic stemmed from optimisation of the magnesium dopant concentration and its activation treatment.

The collaboration is now trying to increase the output power and efficiency of its semi-polar lasers.

S. Takagi et al. *Appl. Phys. Express* 5 082102 (2012)

K. Yanashima et al. *Appl. Phys. Express* 5 082103 (2012)

Efficiency increase for deep UV LEDs

Better material quality and chip encapsulation drive up the power and efficiency of deep UV LEDs

A US TEAM claims to have raised the bar for the output power of UV LEDs with a peak emission wavelength of 365 nm or less. The partnership between Sensor Electronic Technology, Rensselaer Polytechnic Institute and the US Army Research Laboratory has fabricated a 278 nm LED delivering 9.3 mW at 20 mA and 30 mW at 100 mA.

This powerful chip, which features high-quality encapsulation and high internal efficiency, will help the development of UV LEDs for homeland security, medical sensing, curing and sterilization.

Traditionally, UV LED efficiency has been held back by a high density of crystal defects and low light extraction. In most UV LEDs, light extraction is hampered by absorption in the *p*-type contact and a lack of die encapsulation. Many polymers are unsuitable for encapsulation, because they

absorb the light and degrade.

Last year this US team built a UV LED that could address some of these weaknesses. Devices were modified through the insertion of transparent *p*-type cladding and contact layers, and the introduction of a novel *p*-type reflective stack with a reflectivity of 70 percent at 275 nm. Now, UV LED performance has been further improved. A cut in the dislocation density in the active region has boosted internal quantum efficiency, and the introduction of a robust polymer that encapsulates the device has increased light extraction.

The team's latest UV LEDs are grown by migration-enhanced MOCVD on sapphire and feature a *p*-type short period superlattice. "This is transparent to UV emission making possible multiple pass light extraction," explains Tim Bettles, Director of Business Development at Sensor

Electronic Technology. UV LEDs were formed by dicing wafers into 350 μm by 350 μm chips, processing them with an approach that ensured uniform current spreading and flip-chip mounting them in TO-39 packages to collect as much emission as possible through the sapphire side. Encapsulation with a UV-transparent, stable material that was shaped and chosen for its particular refractive index boosted light extraction from the packaged LED. When driven at 20 mA, encapsulation boosted output power from 6.9 mW to 9.3 mW.

The team will not disclose its latest goals. However, it is possible that they will try and reduce the forward voltage of the device – a drive current of 20 mA requires biasing at 8.4 V.

M. Shatalov et al. *Appl. Phys. Express* 5 082101 (2012)

Multiple factors are blamed for droop in blue LEDs

Theorists point the finger at carrier leakage, compositional fluctuations and threading dislocations

Calculations from a US-Italian partnership offer a new view on the role of Auger processes in droop, the decline in LED efficiency as its current is cranked up. The researchers from Boston University and Politecnico di Torino, Italy, claim that indirect Auger processes are only a contributing factor to droop in blue LEDs, and play a bigger part in green and yellow variants.

The conclusions of this team's work differ from the findings of those of Chris Van de Walle's team from the University of California, Santa Barbara (UCSB) – this is the only other group to have performed and reported the results of a full-band calculation of Auger rates in InGaN. Both teams agree that direct Auger recombination is very weak in bulk InGaN and indirect Auger processes are far stronger. How much stronger is the crux of the debate.

The west coast team claims that these Auger-based processes are the primary cause of droop for all LEDs emitting from the ultraviolet to the yellow, while the US-Italian collaboration argues that they are only one of several important factors. Team member Francesco Bertazzi from Boston University and Politecnico di Torino says that the strength of their approach is the combination of the incorporation of realistic electronic structures and *ab-initio* phonon dispersion relations. "The effects of phonons are formally included to the infinite order by means of a spectral density function, thus avoiding the divergence problem inherent in second-order perturbation theory." When the team performs its perturbation theory calculations, they find that phonon-related processes involving two electrons and one hole have a broadly similar strength to those involving two holes and one electron.

Those involved in the debate over the origin of droop number far more than just the US-Italian partnership and the UCSB theorists. Many other theorists and experimentalists have worked on this topic, and many of their claims over the origin of droop can be divided into two camps: Auger and electron leakage.

However, arguing that it can only be one of these two causes is fundamentally flawed, according to Michele Goano from Politecnico di Torino, for the same reasons it was wrong to argue more than 20 year's ago that just one process could explain the behaviour in InGaAsP alloys. Back then Witold Bardyszewski – who is now at the University of Warsaw, Poland, but was then at the University of Lund, Sweden – co-wrote a paper explaining that Auger recombination can promote carriers to higher energy states, where they can undergo carrier leakage. In other words, it is impossible to treat leakage and Auger recombination as two distinct, unrelated processes.

"In our opinion, carrier leakage is one of the main causes of droop in blue LEDs, but several other mechanisms come into play, from compositional fluctuations to threading dislocations and so on. Each may be important, depending on the LED structures," explains Goano. He and his co-workers are now trying to refine their calculations so that they can determine Auger coefficients in quantum wells, rather than bulk material. Results could be different, due to the breaking of the conservation of momentum along the confined direction.

F. Bertazzi et al. *Appl. Phys. Lett.* 101 011111 (2012)

Cubic SiC leaps forward in quality

A novel growth process developed at Linköping University, Sweden, promises to enable boron-doped cubic SiC to fulfil its great potential as a base material in highly efficient solar cells

Cubic SiC is the black sheep of the SiC family. While devices based on hexagonal 6H and 4H-SiC polytypes are commercially available, the metastable nature of the cubic material has perplexed crystal growers. However, recent findings suggest that the quest to master 3C-SiC may not be an enigma, and quality cubic materials can be produced.

So why pursue cubic SiC? For starters, the 3C-SiC is the only SiC polytype with a zinc-blende crystallographic structure, giving isotropic physical properties and holding potential in MOS, biomedical and solar applications. Another attractive feature of the material is a smaller bandgap compared to hexagonal polytypes, lowering the interface state density in the 3C-SiC/SiO₂ material system and ensuring a higher channel mobility in MOSFET devices. What's more, it is more biocompatible than silicon or other SiC polytypes, lending itself to biomedical applications.

Crucially, however, recent studies have shown cubic SiC could be used as the base material in highly efficient solar cells. Multi-junction cells employ materials with a range of bandgaps and can hit efficiencies of 40 percent or more. However, fabrication challenges arising from lattice mismatches between the different materials have hampered commercial development. For example, devices with 50 percent efficiencies may be realised, but these require tens of different growth fabrication steps.

The intermediate bandgap solar cell offers an alternative to the multi-junction solar cell concept. This simpler design contains



Figure 1: Cubic SiC grown on silicon shows severe bending



Figure 2. Sublimation growth at 1800 °C is comparable to 2200-2300 °C used in conventional PVT

a semiconductor base with a metal-like intermediate band, or impurity band, avoiding the lattice mismatch issues prevalent in the multi-junction concept. What's more, thanks to so-called photon re-cycling, introducing only a single dopant to the intermediate bandgap solar cell can boost efficiencies to 60 percent. Photon recycling involves the emission of luminescent photons that may be subsequently absorbed.

One of the strengths of a single bandgap cell is that it only requires one photon to deliver one electron. This means that in a high performance cell the overall quantum efficiency can approach 100 percent.

Excitingly, cubic SiC offers great promise here. It has a bandgap of 2.2 eV and boron is an acceptor at 0.7 eV, which makes the material the perfect semiconductor to fit with models. However, first, high quality material needs to be developed.

Raising quality

Unlike hexagonal SiC, cubic SiC will not form at the high temperatures used in physical vapour transport (PVT) growth. The material can be grown on silicon or using PVT growth on hexagonal SiC at reduced temperatures, but today only a few development projects are underway. The problem is that 3C-SiC grown on

foreign substrates such as silicon becomes highly stressed due to a 20 percent lattice mismatch and 8 percent thermal mismatch. This leads to a high density of defects – mostly stacking faults – causing the silicon wafer to bend, especially as the thickness of the 3C-SiC film exceeds 10 µm (Figure 1).

To overcome this problem, researchers from the Department of Physics, Chemistry and Biology at Linköping University, Sweden, have developed a low-temperature growth method that allows cubic SiC to form on hexagonal silicon substrates (see Figure 2 and 3). It is known that the lattice and thermal matching between the cubic film and the hexagonal substrate are excellent, the results show the film thickness has a profound effect on the quality of the 3C-SiC material. Importantly, carrier lifetime – critical to a device's electronic and optoelectronic properties – is on a par with that in hexagonal SiC polytypes.

SiC for optoelectronics is an emerging research field. The semiconductor has been used to make a rare earth metal-free white LED for general lighting purposes. Researchers have shown that fluorescent SiC can be used to convert ultraviolet light to violet light, by careful control of dopants such as nitrogen, boron and aluminium. This brings hope that cubic SiC doped with boron could be suitable for a solar cell material.

The team have developed growth conditions, which allow exceeding the supersaturation threshold for 2D nucleation of 3C-SiC on step terraces of low off-axis substrates as a route to facilitate

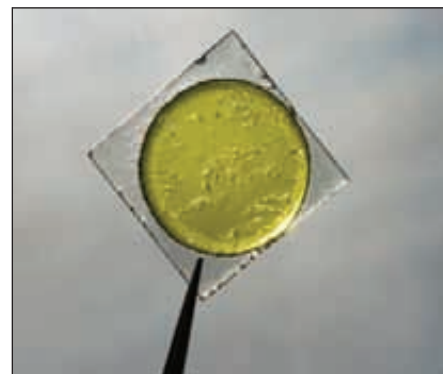


Figure 3: Cubic SiC grown on hexagonal SiC

3C-SiC nucleation and progressive domain enlargement by step flow growth.

With their approach there is a pronounced nucleation at the edge of the samples, and domains extend in the off-axis direction. The domain enlargement mechanism is demonstrated by growth at longer deposition times in which the increasing layer thickness has a profound effect on the quality of the 3C-SiC material.

Only a few dominating domains remain with increasing thickness by the step flow governed crystal growth mechanism.

The quality of the material improves with increasing thickness, with XRD analysis indicating comparable results to commercial hexagonal SiC. Carrier lifetime is a few microseconds, substantially more than the typical 1 μ s lifetime in as-grown 4H-SiC.

Other researchers have increased the carrier lifetime of this material to 9.5 μ s after thermal treatment, and 18-19 μ s via a post carbon-implantation and anneal treatment.

However, we have shown that the crystal quality in extremely thick 3C-SiC, grown by

sublimation epitaxy, is significantly better than previous attempts. Microwave photoconductivity decay measurements show as-grown 3C-SiC to have a far longer carrier lifetime of 8.2 μ s, which is comparable to the carrier lifetime in post growth treated CVD-grown 4H-SiC layers.

These results, and the observation that 3C-SiC can be luminescent, reveals the potential optoelectronic possibilities of this material.

J. W. Sun et al. *Appl. Phys. Lett.* **100** 252101 (2012)

N-face HEMTs close in on their conventional cousins

Reducing gate lengths to 30 nm and removing sidewalls speed N-face HEMTs to 275 GHz

RESEARCHERS at the University of California, Santa Barbara, claim that they have broken the speed record for N-face metal-insulator-semiconductor (MIS) HEMTs.

Reducing device dimensions compared to early generations of N-face HEMTs, including a reduction in gate length to 30 nm, increased the team's cut-off frequency (f_T) to 210 GHz. And removing the SiN sidewall spacer layers wrought further improvement, with f_T leaping to 275 GHz.

N-face HEMTs have several advantages over more conventional Ga-polar equivalents, according to corresponding author Nidhi. This includes a lower contact resistance, which stems from a modification to the contact – it is now through a lower bandgap material, rather than a high bandgap one. "This helps to reduce the parasitic access resistance and hence improve the high frequency performance of the device."

Another strength of N-face HEMTs are their superior two-dimensional electron gas confinement, which results from the high bandgap, charge-inducing barrier in this device architecture. According to Nidhi, N-face devices can realise a lower output conductance, which ultimately enables higher values for f_T and the maximum oscillation frequency, f_{max} .

What's more, N-face HEMTs can make better use of InAlN, an alloy that can enable a very high electron density in the channel. Increasing the thickness of this

ternary increases the induced charge density.

With Ga-face devices, the InAlN layer is sandwiched between the GaN channel and the gate, and if it's too thick, it leads to short-channel effects that deteriorate device performance.

"For N-face devices, since the InAlN is below the GaN channel, the InAlN barrier can be grown thick. This induces a lot of charge in the channel without affecting the gate-to-channel resistance or the aspect ratio of the device," explains Nidhi. The upshot is the promise of better high-frequency performance.

The team's previous generation of N-face transistors had a 120 nm gate length. In comparison, the latest devices have a 30 nm gate and the thickness of the gate dielectric and GaN channel have also been reduced to prevent short channel effects. This should enable the transistor to turn on and off as fast as possible.

Reducing the thickness of the GaN channel has two important consequences: An increase in charge density, due to surface depletion; and an increase in the likelihood of scattering, diminishing electron mobility in the channel. Both of these consequences can increase the channel sheet resistance and degrade device performance.

To reduce surface depletion, the team employed a charge-inducing barrier. This combined a 40 nm-thick graded AlGaIn layer with a 5 nm-thick $Al_{0.4}Ga_{0.6}N$ layer

and a 2 nm-thick AlN layer, which sits next to the GaN channel. The AlN interlayer prevents charge penetration into the barrier, and ultimately stops alloy scattering from increasing.

Device fabrication began with MOCVD growth of the epi-structure, which has a 7 nm-thick channel and a 3 nm-thick SiN_x layer, followed by blanket deposition of a gate stack, electron-beam lithography to define the tungsten-based gate, and subsequent etching of the gate stack. PECVD formed 40 nm-thick spacers around the gate, before MBE re-growth added a highly doped, graded InGaIn/InN stack. Etching removed polycrystalline growth on the gate finger, before isolated mesas were created with Ti/Au ohmic contacts.

Measurements on these HEMTs revealed a saturation drain current density of 1.8 A/mm and a peak transconductance of 450 mS/mm. Values for f_T were obtained by extrapolating current gain data produced by an Agilent network analyser capable of measurements up to 67 GHz.

Nidhi says that the next goal is to reduce tungsten gate resistance, so that the device can realise a high f_{max} . "Other students are working towards combining this self-aligned N-face device technology with T-shaped gold-based gates to achieve, simultaneously, high f_T and f_{max} ."

Nidhi et al. *IEEE Electron Device Lett.* **33** 961 (2012)

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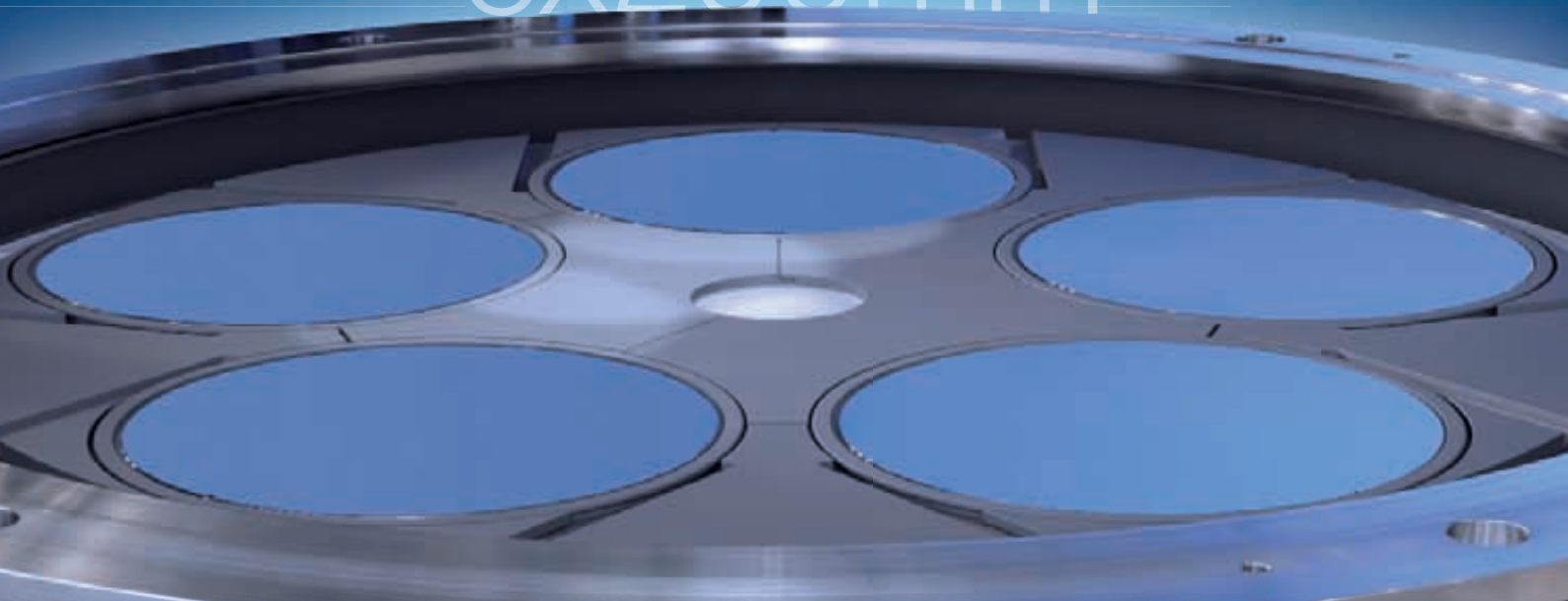
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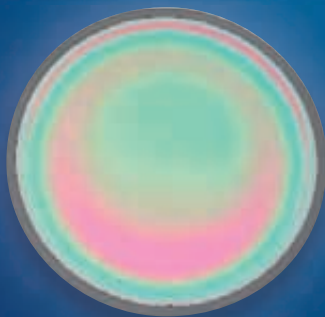
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LEDs

Yole: Sapphire supply and demand back on track

Although potential oversupply for sapphire substrates used in the LED industry is looming, the market should self correct as many new entrants scale or pull back projects

Following the massive material shortage in 2010, sapphire material and finished wafer prices remained high throughout early 2011.

This is according to Yole Développement's latest report, "Sapphire Market, Technology & Market report - November 2011"

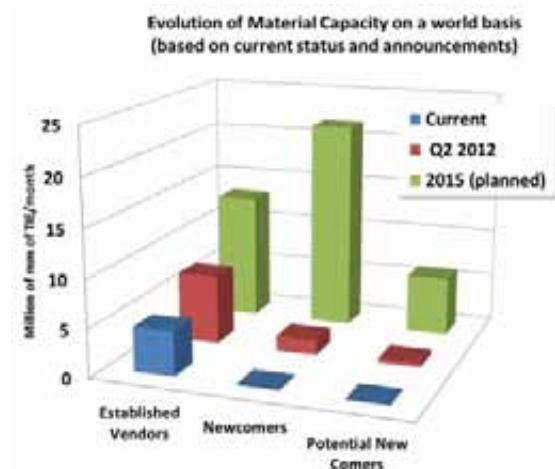
The situation was aggravated as wafer and LED manufacturers preparing for a massive intake of LED in the LCD TV market started building up sapphire inventory for fear that supply might remain short. But a softer than expected LED TV market and an increasing sapphire capacity coming from established vendors 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.



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 three times actual demand, a situation unlikely to actually materialise.

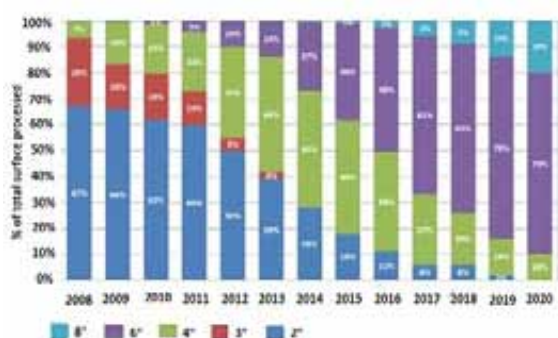


Most of the new entrants have little to no prior experience in sapphire crystal growth and wafer manufacturing. While the availability of "turn-key solutions" from various growth equipment suppliers has lowered the barrier to entry, reaching and sustaining high quality and high yields in sapphire crystal 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 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 of less than \$5 that will allow them to maintain positive margins and weather the storm. Midterm, we expect that this situation will weed out the weakest players and trigger the withdrawal of many potential new entrants.

The transition to large diameter wafers is well underway and past and predicted data is shown in the graph below.



Sapphire Substrates for LEDs: Diameter trends to 2012

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.

But 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 we believe 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.

Yole Développement's report samples over 170 companies.

Sapphire makers include Almecs, Alpha Crystal

Technology , BIEMT, Blue Optical, Changzhi Hongyuan Technology Crystal Co, Ltd, Crystal Applied Technology, DC Wafers, DJ laser, ECEC (Zhejiang East Crystal Electronic Co), GCL, GT Solar, Haotian Optoelectronics Technology Co, Harbin Gongda (Aurora Sapphire), Heifei Crystalbridge , Optoelectronic Materials, Iljin Display, Jiaozuo City Crystal Photoelectric, KCC, Kyocera, Lan Yu, Monocrystal, Namiki, NCB Network, Neosemitech, NGC China Transmission, OCI, Darewin Opto, Rubicon, Rybinsk Crystals, Saint-Gobain, San Chih Semiconductor, Sapphire Materials, Sapphire Tech, SAS, Shinkosha, Silian, Siltron / LG, Sumitomo Metal Mining, Swiss Wafers AG, Tera Xtal, Union Light technology, USI Opto (Acme Corporation), Wafer Works, Zhenjiang Huantai Silicon Science and Technology.

Crystal Growth Equipment Makers include Apeks, Arc energy, Crystal Tech, Dai Ichi Giken, GT Solar, Omega, Pryroda Engineering and Thermal Technology amongst others.

Raw Material suppliers include Haemaroo, KC Corporation, Sasol/Ceralox, EMT, RSA Le Rubis, Spolchemis, Baikowski, Comadur, Nippon Light Metal, Sumitomo, Taimei Chemical, Zibo Xinmeiyu, Heibe Pengda Advanced Material and Suzhou Crystal.

JPSA's metal dicing system maximises LED dies per wafer

The supplier of laser micromachining tools will ship several of its new IX-6100-MD laser systems to a prominent LED manufacturer in Asia in Q3 2012

J P Sercel Associates (JPSA) has released the IX-6100-MD for scribing and dicing metal layers such as molybdenum, copper, nickel, gold, silver, zinc and their alloys used in the LED manufacturing process.

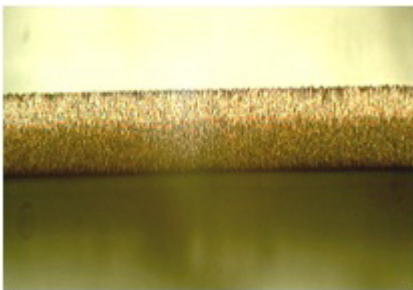
The IX-6100-MD is equipped with JPSA's latest proprietary vision and scribe placement technology allowing reduction in die street size and enabling more LED dies per wafer.

JPSA will be shipping several IX-6100-MD laser

systems in Q3 to a leading LED manufacture in Asia where the systems will be utilised for singulation of high-power LED devices that use the metal substrate to assist in LED heat dissipation.

The IX-6100-MD was selected because of the high-throughput, increased die yield and low cost of ownership of the system.

The key technology in IX-6100-MD is JPSA's proprietary beam delivery system that allows the shape of the laser beam to be independently adjusted in two dimensions. This allows for optimisation of laser energy used for cutting and enables a minimal kerf width of 20µm to be achieved while minimising the heat affected zone.



Cross section of 60-µm copper

In making the announcement, JPSA's CEO Jeffrey Sercel, says, "The IX-6100-MD combines JPSA's proprietary scribing technique with laser processes designed to achieve full singulation of metal devices. The IX-6100-MD can be configured by JPSA with a range of lasers and options to optimize production performance for each customer's specific material combinations."

The IX-6100 series of micromachining systems can be equipped with JPSA's IAP (Integrated Automation Platform) for automated wafer handling in production environments. The IX-6100 is similar to the company's IX-6600 platform that is the industry-standard tool used for laser lift-off (LLO) of LED devices in an associated manufacturing process.

JPSA products and services include UV excimer, DPSS and ultra-fast laser micromachining systems, UV and VUV laser beam delivery systems, laser materials processing development, optical damage testing, and excimer laser refurbishment services.

Jiangsu Soul & Goolite merger to enhance LED market

The merger will enable Jiangsu to have its own LED chip packing line and LED power supply production line

In 2012, the European Union, Japan and Canada started to prevent the sale of incandescent bulbs. The United States also has a partial ban on incandescents. This should aid the growth of the global LED lighting market.

Although the European debt crisis has influenced the market, Australia, Russia, Brazil, India, China and other countries have performed well and the global LED lighting market is still flourishing.

Taking advantage of this situation, Jiangsu Soul Optoelectronic Technology Co., Ltd merged with Goolite optoelectronic Co., Ltd at the beginning of June this year, establishing a subsidiary company in Shenzhen in July.

The new company will incorporate the original team members of Goolite and acquire the Goolite brand. This consolidation should be a solid foundation for the global LED market.

Soul has more than ten chip packaging lines, power supply and lighting products lines, covering an area of 12,000 square metres and having more than 200 staff members and over 20 senior technical personnel in R&D.

The firm has had a long-term cooperative relationship with Fudan University and Suzhou University.

Soul says it has distinct advantages in LED light source design, LED chip capsulation, LED power supply and intelligent controlling.

Philips to set up LED lighting plant in Chengdu

The fully integrated “LED Professional Lighting Solutions” manufacturing site should optimise production, warehousing logistics and shorten delivery time to customers in the east

Philips (China) Investment held a ceremony for its LED Professional Lighting Solutions manufacturing facility in Chengdu High-tech Industrial Development Zone.

This marks that the bilateral cooperation between Philips and Chengdu has entered a new phase since the two sides signed the LED strategic cooperation agreement last December.

Philips will build a fully integrated LED Professional Lighting Solutions manufacturing site to optimise the allocation of resources including production, warehousing and logistics. The site will help to control production efficiency and quality and shorten delivery time to customers.

Philips will focus on providing more customised products to meet the unique requirements of different customers with great speed. The firm will also work with Chinese customers to help upgrade their lighting in all segments and applications. To this end, Philips will organise a professional service team to ensure everything is OK from designing upon a client’s request to final product delivery.

It is expected that the site will start production in 2013.

Chengdu, as Philips’ second headquarters in China, is an important economic and culture centre in the west region, with a speciality in developing high-tech industries and the advanced manufacturing industry.

Established in 1988, the Chengdu Hi-Tech Zone ranks 4th among China’s 88th state-level hi-tech zones and is strongly supported by national provincial and municipal authorities. With a planned area of 130 km², CDHT is divided into the south and the west park.

There are 29,163 companies registered in the Hi-Tech Zone, among which nearly 1000 companies are foreign invested enterprises, including over 100

Fortune 500 companies and those invested by well-known international corporations.

To a certain degree, a large trend of Fortune Global 500’s moving forward to western China allows Chengdu to host the 2013 Fortune Global Forum. CDHT is fully prepared for further collaboration with more globally well-known enterprises. The vast potential and the unprecedented expansion of western China’s market as well as China’s new round of “Go West” strategy is aimed to speed up the development of the entire area.

Osram and Samsung bury the hatchet

The companies have also signed a separate memorandum of understanding to explore the possibilities of jointly developing future LED-based products

Osram AG and Samsung Electronics Co., Ltd. have reached an agreement to settle all patent suits between them worldwide.

The patent suits have been filed in various countries amongst others Germany, South Korea and in the United States of America. The parties will dismiss all suits as expeditiously as possible, with a settlement consequently expected to be finalised by the end of August, 2012.

As part of the settlement, the parties have reached license agreements for their respective LED patent portfolios. The parties have also signed a separate memorandum of understanding to explore the possibilities of jointly developing future LED-based products.

“We are glad to enter with Samsung in a new area of partnership-based competition. We respect the intellectual property rights of other companies and it is our ongoing policy to reach license agreements with other manufacturers of LED products. Along these lines, we appreciate this out-of-court settlement with Samsung,” said Wolfgang Dehen, CEO of Osram AG.

“With the patent suits now behind us, we look forward to building a strategic relationship with Osram on a number of different fronts. There is a great deal of respect and also competition between

the two companies. We believe the two companies now have an opportunity to significantly contribute to the LED industry and offer better products to our customers,” said Namseong Cho, Executive VP and General Manager of Samsung Electronics’ LED Business.

Osram AG, based in Munich, Germany, is a wholly-owned subsidiary of Siemens AG and one of the two leading light manufacturers in the world. Over 70 percent of its revenue comes from energy efficient products. The company has around 41,000 employees worldwide, supplying customers in 150 countries from its 44 production sites in 16 countries (as of September 30, 2011).

Samsung Electronics Co., Ltd. is an innovator in semiconductor, telecommunication, digital media and digital convergence technologies and employs approximately 206,000 people in 197 offices across 72 countries. The company operates two separate organisations to coordinate its nine independent business units: Digital Media & Communications, comprising Visual Display, Mobile Communications, Telecommunication Systems, Digital Appliances, IT Solutions, and Digital Imaging; and Device Solutions, consisting of Memory, System LSI and LED.

Jilin University orders Aixtron reactor for LED research

The Chinese university will use the 3 x 2-inch wafer CCS reactor to grow gallium nitride materials for UV and white LEDs

Aixtron SE has a new MOCVD system order from existing customer Jilin University China.

The contract is for one CCS reactor in a 3 x 2-inch wafer configuration, which will be dedicated to the growth of GaN materials for UV and white LEDs.

One of Aixtron’s local support teams has installed and commissioned the new reactor in a state-of-the-art clean-room facility at Jilin University in Changchun, China.

Zhang, of the Jilin University, State Key Laboratory

on Integrated Optoelectronics, comments, “We already have experience and a very good understanding of Aixtron systems, and we were particularly impressed with the reactor’s ergonomics and security. The system has set the standard amongst the world’s best laboratories, thus we intend to join those ranks.”

Zhang continues, “Our intention is to develop exciting new material structures that will lead to greater understanding and to production of gallium nitride materials for UV and white LEDs. This is a challenging task, but we are confident that the combination of the process technology capabilities of the CCS reactor and strong backing from the local Aixtron support team will enable us to achieve our aims quickly and efficiently.”

Cree LEDs light up seven schools in Virginia

The exterior luminaires, which incorporate Cree’s nitride based LEDs, reduce energy costs by 65 percent

Newport News Public School District in Virginia recently installed more than 185 Cree LED exterior luminaires, becoming the first Virginia school district in the area with a significant LED lighting installation.

The district selected Cree THE EDGE security, area and parking structure luminaires to illuminate the exteriors of seven schools: General Stanford Elementary, Greenwood Elementary, Lee Hall Elementary, Palmer Elementary, Crittenden Middle, Booker T. Washington Middle and Denbigh High.

“These energy efficient lights virtually eliminate maintenance, provide the district with dramatic energy savings and also reflect the community’s commitment to sustainability,” says Keith Webb, executive director of plant services for the Newport News Public School District. “The LED lighting furthers our goal of enhancing and bettering the learning environment, while saving money for the schools and tax payers.”

In 2008, Newport News School District spent \$5.6 million on energy costs. In the past four years, the school district has implemented a number of

energy-saving projects, including the installation of Cree LED luminaires. Officials estimate the LED lighting upgrade resulted in significant annual energy savings of 139,000 kWh and reduction in annual lighting energy costs at the seven facilities by 65 percent, reducing carbon emissions by 191,000 pounds. Officials also estimate a payback of three years for the installation and expect ongoing operational savings due to the extended lifetime of Cree luminaires and the reduced maintenance needs.

THE EDGE luminaires replaced 189 high-pressure sodium and 150 incandescent fixtures, delivering enhanced colour quality, uniformity and optimized illumination performance to each of the school's exteriors. The parking lots at all seven schools now meet the sustainable illumination requirements of each school, which helps reduce energy and maintenance costs for the district and tax payers.



EDGE parking luminaire

Energy-efficient and long-lasting, Cree THE EDGE area, parking and security luminaires illuminate exterior corridors, walkways and entryways and provide increased visibility around the building perimeters. The high-performance lights provide added safety and security for the school district's students, parents and staff during night time activities and events.

"Cree leads the industry in providing energy-efficient and reliable lighting for outdoor applications," comments Christopher Ruud, vice president global sales, Cree lighting. "Using THE EDGE luminaires with BetaLED technology, Newport News Public School District demonstrates the financial and performance benefits of switching out incandescent and high-pressure sodium lighting for energy-efficient LEDs."

Ceradyne invests in GMSI to enhance LED services

GMSI's proprietary CVD method of applying SiC ceramic coating on precision machined graphite shapes is used in the manufacture of LEDs

Ceradyne has acquired a minority interest with an option to acquire all of Tempe, Arizona-based Graphite Machining Services and Innovations, LLC (GMSI).

Ceradyne currently develops, manufactures, and markets advanced technical ceramic products and components for defence, industrial, energy, automotive/diesel, and commercial applications. The firm now wants to penetrate the LED lighting market and is doing so in acquiring this stake in GMSI.

GMSI has developed a proprietary method of applying a chemical vapour deposited (CVD) SiC ceramic coating on precision machined graphite shapes. The resultant product is used in the manufacture of LEDs for the rapidly growing solid state lighting market.

GMSI's expertise and technology have been focused on the precision machining of ultra-high quality graphite shapes since its founding in 1984. The demand for state-of-the-art components for use in the MOCVD process in the manufacturing of LEDs has led to GMSI's shift in technology and manufacturing capacity to serve the LED and other semiconductor markets.

This acquisition of GMSI will not materially affect Ceradyne's 2012 financial performance.

David Reed, president of Ceradyne's North American Operations, comments, "We are excited about this relatively small but high technology investment in GMSI. It fits very well with our diversification strategy, coupled with our interest in building out Ceradyne's advanced technical ceramics portfolio. Furthermore, the market for efficient, environmentally friendly LED lighting systems is expected to grow very rapidly over the next ten years."

"The GMSI facility in Tempe is absolutely first class and GMSI's president, Peter Guercio, and

his partners, Rex Dillman and Dale Beeck, are excellent additions to Ceradyne's entrepreneurial, technology-driven culture," adds Reed.

Peter Guercio, GMSI's president, concludes, "The relationship with Ceradyne is perfect. It is clear to us with the growth opportunities we see ahead that we will need the resources of a larger technology operation. Ceradyne and its advanced technical ceramic focus is the ideal partner. We are looking forward to our growth in the burgeoning LED markets."

Logwin to manage LED logistics for Optogan

The firm is currently providing storage and transportation for Optogan's nitride based LED products. Logwin will also soon be providing incoming goods checking and quality inspections, the assembly of lighting units and returns processing

Vertically integrated manufacturer of LED components, Optogan, has recruited logistics specialist Logwin to manage distribution of its products in Europe and Asia.

Headquartered in the Russian city of St. Petersburg, Optogan opened a production site in Landshut in Bavaria at the end of 2011. At the same time the company commissioned the logistics service provider Logwin to manage its global supply chain. "Our entire goods handling is now in Logwin's hands," says Markus Zeiler, General Manager at Optogan. "This challenge can only be met with international presence and powerful networks."

Logistics for Optogan are centred on the Logwin warehouses in Karlsfeld near Munich and Taipei, Taiwan. Each location serves as the distribution centre for its region. Up to 7,600 pallet storage positions are available in Karlsfeld and in Taipei for the storage of Optogan products on a non-mixed basis. Since LEDs are highly sensitive products, high standards regarding equipment, cleanliness, fire protection and security apply in the warehouses and while the goods are being handled.

Besides storage and transportation, Logwin will soon be providing incoming goods checking and

quality inspections, the assembly of lighting units and returns processing.

"Optogan is particularly interesting for us for two reasons," explains Marc Styrnal, Manager Sales & Key Accounts Solutions at Logwin. "First, because it is a company undergoing dynamic growth whose development we can accompany constructively. Second, because Optogan's products fit in well with our striving for sustainability."

Logwin stores finished and semi-finished goods from Optogan at its location in Karlsfeld, and is responsible for order picking and distribution throughout Europe. The logistics specialist organises the shipment of smaller quantities using CEP services and distributes other consignments via its own networks.

Logwin's second distribution centre in Taipei is responsible for the distribution of LEDs within Asia. At the same time, it is from here that the logistics service provider organises Optogan's entire air freight operations together with its location in Munich. Whether global import and export of finished goods or international shipments with semi-finished goods between Germany, Russia and Taiwan, Logwin organises air freight transportation, arranges insurance and takes care of customs formalities.

"Optogan relies on fast and flexible solutions in procurement and distribution, which is why air cargo is the right choice," says Eva-Maria Jackermeier, Senior Sales Manager Air + Ocean at Logwin. "In the further course of the project we will develop additional concepts together with Optogan and thus play an active role in setting up logistics structures."

It is not just collaboration in logistics that connects Logwin and Optogan. Logwin is now also the lighting manufacturer's customer. A section of the warehouse in Karlsfeld is currently being equipped with LED lighting from Optogan. "We are delighted with this decision," says Markus Zeiler. "Logwin will benefit from energy savings and the lower maintenance effort involved."

The average lifespan of LEDs is around ten years. Whereas in the past lighting elements suspended from the high warehouse ceilings had to be replaced on a regular basis, this work will in future be reduced to a minimum. "We hope the installation

of Optogan LEDs will lead to improvements in the working conditions of our employees,” says Marc Styrnal. “Because LEDs provide a more pleasant light, consistent brightness and they do not flicker.”

Albeo advances LED fixture technology

The firm has been granted four patents related to “Chip-in-Fixture” technology which promises to lower LED fixture costs to below that of fluorescent lighting. This is hoped to pave the way to making LED the dominant lighting choice

With the recent granting of four new patents, Albeo Technologies is advancing its strategy of LED fixture innovation.

The new patents protect fundamental innovations in LED chip integration, fixture construction and electronic architecture that significantly reduce costs and improve efficiency.

The company's most recent patent is for a “chip-in-fixture” (CIF) LED lighting platform. This innovation covers the integration of unpackaged LED chips directly on the inside surface of the external shell of the fixture, to substantially reduce the raw material cost of LED fixtures and dramatically improve performance.

The CIF design minimises thermal resistance by eliminating printed circuit boards, heat sinks, and the actual LED package. With this foundational patent, Albeo has developed working prototypes for next generation commercial and industrial LED fixtures. The company expects to begin marketing these fixtures in 2013.

“The chip-in-fixture patent is a fundamental change in the state-of-the-art at the fixture level,” says Albeo Technologies Co-Founder and CEO Jeff Bisberg. “By removing many of the materials and layers currently used in LED fixtures, we are able to both reduce costs and improve efficiency. In the very near future, we anticipate this type of fixture design will allow LED fixtures to surpass fluorescent lighting in value, performance and even upfront cost.”

A second patent granted details a method of interconnecting light-emitting diodes and phosphors between two layers, such as glass or plastic, to build unique, flat, white light-emitting structures. The patent protects a new way to combine LEDs and

phosphor that are extremely thin and provide very high performance.

The third details a unique method of dissipating heat generated by LEDs by configuring a printed circuit board with conductors on the front side, so that heat is dissipated from the LED to the conductors. This faster heat dissipation cools the LED fixture more rapidly, to maintain a higher efficiency at lower costs.

The final patent is related to a method for communication between LED fixture cases and AC powered LED modules to control the on/off and dimming with Pulse Width Modulation (PWM), without the need of a ground to reference to the control signal.

Optogan impresses Turkish ministry

On a visit to Turkey, Optogan President and CEO presented the X10 model prototype gallium nitride LED chip which is capable of producing between 10 to 500W of light

Key leaders of Optogan LED Solutions, went to Turkey to meet principal members of government and industry.

Senior members of the LED innovator were hosted by exclusive distributor, Ledison Patan, which is responsible for the Turkish, Middle East and North African regions.

The meetings focussed on recent statements by Minister of Energy and Natural Resources, Taner Yildiz, regarding energy conservation within public institutions and Turkey's approach to LED technology.

Optogan President and CEO, Maxim Odnoblyudov gave a presentation to the Ministry on LED technology developed by Optogan and presented their key technology, the X10 model prototype LED chip which can produce between 10 to 500 W of light. This was well received by officials who were excited by the developments that Optogan has made and solutions that LED technology can offer.

Deputy Minister Murat Mercan said “As Turkey is just beginning to understand LED, with your know-

how, we need your support and suggestions to utilise this technology.”

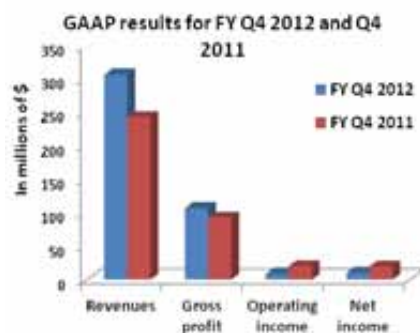
Optogan and Ledison Patan then presented the X10 prototype to the Ministry as a symbol of their ongoing support.

Cree revenues on the up

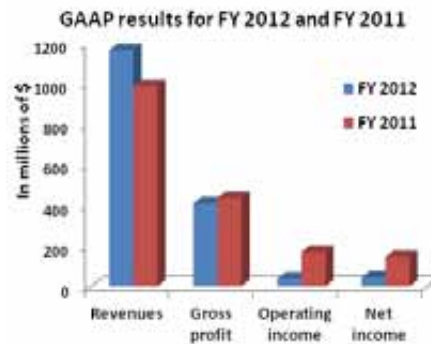
Although LED lighting adoption continues to increase, the firm has found that the macroeconomic environment is impacting its growth outlook in the near future

Durham based LED and power device manufacturer Cree has announced revenue of \$306.8 million for its fourth quarter of fiscal 2012, ended June 24, 2012.

This represents a 26% increase compared to revenue of \$243.0 million reported for the fourth quarter of fiscal 2011 and an 8% increase compared to the third quarter of fiscal 2012. GAAP net income for the fourth quarter was \$10.0 million, or \$0.09 per diluted share, a decrease of 49% year-over-year compared to GAAP net income of \$19.8 million, or \$0.18 per diluted share, for the fourth quarter of fiscal 2011.



For fiscal year 2012, Cree reported revenue of \$1.16 billion, an 18% increase compared to revenue of \$988 million for fiscal 2011. GAAP net income was \$44 million, or \$0.39 per diluted share, a decrease of 70% compared to \$147 million, or \$1.33 per diluted share for fiscal 2011. Cree generated \$242 million of operating cash flow and \$130 million of free cash flow (cash flow from operations less capital expenditures) during fiscal 2012.



“We finished the year strong in our fiscal fourth quarter with record revenue and non-GAAP earnings per share on the high end of our target range,” noted Chuck Swoboda, Cree Chairman and CEO.

“Overall, LED lighting adoption continues to increase and we remain focused on being the leader in innovation to grow our business by enabling our customers to realise the tremendous benefits of LED technology. While we are encouraged by our progress, the macroeconomic environment is impacting our growth outlook in the near term,” he added.

Gross margin decreased 10 basis points from Q3 of fiscal 2012 to 34.8% while cash and investments increased \$34 million from Q3 of fiscal 2012 to \$745 million. Accounts receivable (net) decreased \$16 million from Q3 of fiscal 2012 to \$152 million, with days sales outstanding of 45. Inventory decreased \$8 million from Q3 of fiscal 2012 to \$189 million and represents 85 days of inventory.

Business Outlook:

For its first quarter of fiscal 2013 ending September 23, 2012, Cree targets revenue in a range of \$305 million to \$325 million with GAAP gross margin targeted to be around 36%. The GAAP gross margin targets include stock-based compensation expense of approximately \$2.1 million. Operating expenses are targeted to increase by approximately \$2 million on a GAAP basis. The tax rate is targeted at 19.0% for fiscal Q1. GAAP net income is targeted at \$10 million to \$16 million, or \$0.09 to \$0.14 per diluted share. The GAAP net income target is based on an estimated 116.0 million diluted weighted average shares.

Rubicon orders multiple profilers for sapphire production

The cost-effective, precision optical profilers for micron-scale surface analysis, will be used in the precision manufacturing of sapphire substrates used for HBLED growth

Rubicon Technology has ordered multiple units of the Zeta 300 series optical profiler for its sapphire substrate and wafer production from San Jose based Zeta Instruments.

Rubicon's sapphire substrates and products to the LED, semiconductor, and optical industries, are claimed to be sensitive to the LED manufacturer's costs of wafer failure late in the production cycle. The firm will use the Zeta-300 series optical profilers for inspection and metrology of sapphire substrates to help improve wafer yield and lower costs for their LED customers.



Zeta 300 optical profiler

Known for cost-effective advanced functionality, Zeta's novel high-precision metrology systems have gained strong traction across the LED industry. The latest in the innovative suite of optical profilers, the Zeta-300 series was specifically designed to address the stringent specifications of the Patterned Sapphire Substrate (PSS) market. It combines PSS metrology and defect review in a system that is unique in the sapphire industry, enabling detailed measurement of PSS structure dimensions as well as wafer defect inspection on the same system.

"We have evaluated many tools for the production

environment and the Zeta 300™ series, delivers the best combination of speed and accuracy for precision metrology applications," says Raja M. Parvez, president and CEO of Rubicon Technology. "Zeta's systems are integral to assuring our products meet and surpass our own internal quality specifications and those of our customers."

The Zeta-300 series leverages Zeta's patented Z-Dot technology to deliver high repeatability and accuracy for the measurement of LED-patterned/etched substrates, photo-resist and stacked structures on transparent surfaces. Regarded as having one of the best optics and algorithm combinations, these profilers provide rapid and reliable data acquisition and analysis. In side-to-side comparisons with competitive offerings the Zeta-300 series is claimed to consistently deliver the highest repeatability and accuracy for PSS measurements in the LED industry.

Coupled with application-specific software and a companion automated wafer handler, the Zeta-380 provides imaging and measurement capabilities superior to those of laser confocal microscopes. The Zeta-380 measures and detects defects falling outside the industry certification levels that may not be detected by competing offerings. Zeta's intuitive and innovative system design also offers a greater ease of use while lowering overall cost of ownership.

Rusmin Kudinar, president of Zeta Instruments, adds, "Having one of the world's largest and most esteemed PSS wafer suppliers select the Zeta-300 series as integral to its manufacturing process is powerful validation of our product strategy and development efforts. We look forward to an ongoing trusted partnership with Rubicon as they continuously pave the way advancing sapphire technology."

II-VI reveals record bookings but falling profits

US optoelectronics components maker posts mixed quarterly results II-VI revenues for the quarter increased 4% to \$136,910,000 from \$131,783,000 in the fourth quarter of last fiscal year, while revenues, year-on-year increased 6% to a record \$534,630,000 from \$502,801,000.

As the company highlights, bookings remain strong, increasing by 8% to \$141,959,000 for this quarter, compared to \$131,177,000 in the fourth quarter of last fiscal year. Bookings were up 3% year-on-year to a record \$534,865,000 compared to \$520,238,000 for last fiscal year.

However, net earnings for the quarter were down to \$14,446,000 from \$22,039,000 in the fourth quarter of last year. Annual earnings came in at \$60,306,000, down from \$82,682,000 for last fiscal year.

“For the quarter, company revenues increased 4% from the year-ago period, while earnings decreased,” says Francis Kramer, president and chief executive officer. “During the fourth quarter – and for the third quarter in a row - PRM both wrote-down inventory and realised depressed margins on product sales due to declines in the index pricing of tellurium; and, for the first time, the same was true for selenium.”

“In the Advanced Products Group, our Marlow business unit realised lower revenues and earnings due to decreased customer demand,” he added.

Cree reveals 170 lumens per watt LED bulb

The US semiconductor manufacturer says breakthrough innovations have optimised performance and driven costs down.

Cree has unveiled a 170L/W prototype LED light bulb, less than a year after showcasing the 152L/W concept LED bulb. The innovations behind the high-performance 170L/W LED bulb are enabling significantly higher efficacy and lower costs, says Cree. And as the company also points out, the latest development demonstrates the its commitment to accelerate the adoption of LED lighting by addressing initial cost and payback, key barriers to widespread LED lighting adoption. The LEDs are based on Cree’s so-called SC³ Technology Platform, including silicon carbide technology and feature advancements in the LED chip architecture and phosphor. “Optimising each LED design element was critical in achieving the performance reached by Cree’s new prototype LED bulb,” said Nick Medendorp, vice president of research and development, Cree lighting. “The technology embodied in the new 170L/W concept LED bulb is enabling us to develop higher-performance and lower-cost Cree LED luminaires. By pushing the

limits of what is possible, Cree continues to strive to develop new technology that uses less energy and provides unmatched light quality and value to our customers,” he added. Third party testing by independent lab OnSpeX confirmed that the new 170L/W prototype LED bulb delivered more than 1250 lumens and consumes only 7.3W. The bulb uses Cree TrueWhite Technology to deliver a CRI of 90+. As an efficiency comparison, a traditional 75W incandescent light bulb produces 1100 lumens, which is only 14.6L/W.

Luminus opens Taiwan office

LED manufacturer hopes to capture more of the growing Asian market with new, Taiwan-based office.

Big Chip nitride LED manufacturer, Luminus Devices, has opened an office in Taiwan in response to growing demand in the Asian market. The office offers sales support, customer service, field application engineering, and operational engineering to key customers, suppliers and contract manufacturing partners in Asia. Located in Taoyuan County, the office is managed by Robin Hung, sales director for the Asia Region.

According to Luminus, he will be overseeing a growing staff that will be responsible for managing current relationships and future business opportunities in display, entertainment and speciality lighting vertical markets across Asia.

“Opening an office in Taiwan expands our global commercial and technical support reach as the office’s location provides a strategic hub for Luminus Devices,” said Keith Ward, president and chief executive.

“The Taiwan office is central to Asia, which is the hotspot for LED technology and manufacturing... many of our channel partners are located in the region, and the new office will allow the company to improve communications and business with these partners.”

Azzurro receives millions of Euros for 200mm GaN-on-Si process

Local government awards Euro 2.6 million to Azzurro for large wafer development

Azzurro Semiconductors, Germany-based developer of GaN-on-Si wafers, has bagged Euro 2.6 million in government funds from the European Regional Development Fund and the Free State of Saxony. The company will use the funds to drive its GaN on 200mm silicon wafer technology forward and strengthen its competitive position. With GaN-on-Si technology, Azzurro addresses two huge growth markets, LEDs and power semiconductors. The company asserts that its large diameter wafers allow the industry to fabricate power semiconductors and LEDs using existing, standard semiconductor production sites, thereby cutting costs.

According to the company, its performance data on 150mm wafers is “already unique” and it will now extend its lead to 200mm substrates. “Based on the technology grant, we can execute the strategic development of our 200mm technology platform for power semiconductors and LEDs and quickly attend to the strong customer demand,” said Stephan Lutgen, Vice President Technology at Azzurro.

Genesis Photonics pours millions into production

Taiwan-based GaN chip maker, Genesis Photonics, to complete production of China plant by the third quarter of this year

Taiwan-based manufacturer of GaN-based LED epiwafers and chips, Genesis Photonics, is to invest US\$35million, this year, in constructing a plant in Kunshan, southern China, reports Digitimes. The plant, expected to be complete by the third quarter of this year, is a joint venture between Genesis and the Kunshan municipal government. Construction started in September 2010 and the total investment comes in at US\$200 million.

According to Digitimes, the Kunshan government is providing 51% of the funds with Genesis contributing the remainder. The plant will procure two-inch MOCVD equipment and expects to have a monthly capacity of up to 30,000 epitaxial wafers as

commercial production begins. Genesis has been focusing on green LED chips for outdoor billboards in China, but as the demand for white LEDs has grown, blue LEDs chips now account for some 80% the chip maker’s production. Looking to the future, Genesis intends to have three production bases in the Greater China region.

Veeco hosts MOVCD meeting for Taiwan-based LED players

LED manufacturers flocked to Veeco’s MOCVD user meeting to debate manufacturing challenges



Veeco Instruments reveals that more than 150 LED manufacturing customers attended its MOCVD User Meeting in Tainan, Taiwan.

As the company reports, players from most of Taiwan’s top LED manufacturers such as Epistar Corporation, FOREPI, Genesis Photonics, Huga Optotech, Tekcore, Epileds and Arima Optoelectronics attended.

Speaking about “The Trend of LED Chips for Lighting” at the event, Charles Li, Genesis Photonics vice president of research and development addressed key drivers that he believes will help to commercialise LEDs for general lighting, such as cost reduction, which can be achieved by developing better high current LED chip technology.

Other topics presented at the meeting included “Driving Down LED Manufacturing Costs with TurboDisc MOCVD Products”, from Veeco’s senior director of business development, Jia Lee, and an update on “GaN on Silicon LED Manufacturing” from Kenny Sun, Veeco’s director of the Taiwan

Technology Center (TTC), located in Hsinchu Park.

Tim Liu, Veeco's vice president and Greater China country manager, concluded: "We are pleased to have had the opportunity to engage with Taiwan's leading LED manufacturers. Our MOCVD User Meeting provides an excellent forum where we focus on our customers' manufacturing challenges and provide solutions to maximise their productivity and yield, while reducing costs."

Veeco recently introduced a new suite of MOCVD systems based on its TurboDisc technology to accelerate worldwide adoption of LED lighting by reducing manufacturing costs.

LED industry faces tough times, reports Research in China

Chinese analyst firm, Research in China, warns the nation's LED industry may not live up to expectations

LED manufacturers saw substantial price declines in 2011, and can expect much of the same until 2014, reports China-based business analyst Research in China. According to the analyst firm, many Chinese companies entered the LED industry around 2009, as manufacturers of notebook computers and monitors started replacing cold cathode fluorescent lamps backlight units with LED versions. Since then, LED prices have fallen and front-end epitaxy developers in particular have suffered steep price declines.

The over-supply of LEDs that followed has been compounded by shrinking LED-TV shipments in Q2 2011 and the adoption of LED chips with higher brightness. Research in China asserts companies in Taiwan and South Korea have been hardest hit by the declining price. And while the number of Chinese LED chip projects initiated between 2009 and 2010 totalled 46, only 20 were put into production.

Of the remaining 26, 16 have failed to go into operation, and ten have been cancelled or saw little progress. Crucially, the original 46 projects planned to buy 1220 MOCVDs, but only 436 MOCVDs have

actually been purchased. LED lighting Research in China also believes the China LED lighting industry, which has rallied much optimism amongst LED manufacturers, is by no means as promising as expected.

According to the analyst, a large disparity between the price of LEDs and compact fluorescent lamps (CFLs) still exists, where even the price of the lowest-priced LED bulb is about five times higher than the a CFL. Taking a worldwide view, China in Research says Japan has the largest LED lighting market. Global sales of LED bulbs reached 41 million units in 2011, of which Japan accounted for 62%, and Europe made up 16% of these. Fueled by the boom of Japanese market, Japan-based nitride semiconductor developer, Nichia, continues to widen the gap with its rivals, with revenue from LED chips is estimated to surpass US\$3 billion.

Meanwhile, dragged down by the European economy, Lumileds and OSRAM Opto Semiconductor present a weak performance. And as China in Research points out, these companies still lag far behind Cree, Nichia and Toyoda Gosei in terms of technology.

Top 27 LED Companies by Revenue, 2010-2012 (Unit: Million USD)

Companies	2010	2011	2012E
NICHIA	2246	2605	3208
SAMSUNG LED	1140	1148	1262
CREE	818	988	1138
LG INNOTEK	783	818	828
OSRAM Opto	822	780	808
Seoul Semiconductor	726	678	795
LITEON	514	536	655
Everlight	553	633	630
Epistar	626	601	621
Toyota Gosei	438	395	600
Lumileds	...	...	...
SHARP	...	...	...
Lextar	...	...	...
Kingbright Electronics	...	...	...
Optotech	...	...	...
Unity Opto	...	...	...
CITIZEN	...	...	...
Wellpower Optronics	...	...	...
Sanan Optoelectronics	...	...	...
Nationstar	...	...	...
Formosa Epitaxy	...	...	...
Harvateck	...	...	...
Chi Mei Lighting	...	...	...
Bright LED Electronics	...	...	...
Genesis Photonics	...	...	...
Huga Optotech	...	...	...
Edison Opto	...	...	...

source: RIC <Global and China LED Industry Report, 2011-2012>

Oclaro urges shareholders to vote for Opnext merger

Additional Oclaro votes are needed to close Opnext merger, so voting deadline is extended
US-based Oclaro, manufacturer of laser diodes, is asking its shareholders to approve the proposed merger with fibre optics components manufacturer, Opnext, US, alongside an increase in authorised shares, to deliver sufficient shares to Opnext stockholders. At their respective meetings, stockholders of Opnext approved the merger of the two companies, this being their final milestone needed to close the merger.

Meanwhile, Oclaro received approximately 46% of the greater than 50% majority vote needed to approve this proposal and close the merger. Of the votes, approximately 89% were in favour of the proposal.

“The Oclaro and Opnext teams have been working diligently and our integration plans are on schedule,” said Alain Couder, chairman and CEO, Oclaro. “We are ready to operate as a single company and look forward to taking our place as the number two global provider of optical components, modules and subsystems.”

Australia funds silicon carbide chip production

Griffith University researchers win Aus\$1million from government and work with UK equipment maker, SPTS Technologies, to commercialise SiC-on-silicon production.

Australia-based Queensland Micro- and Nanotechnology Centre, Griffith University, has won Aus\$1million in funding from the Queensland State Government to develop production processes for silicon carbide microchips.

The research centre has been developing SiC-on-silicon substrates for a wide variety of applications including LEDs, micro-electro-mechanical systems (MEMS) and power integrated electronics. According to Professor Sima Dimitrijević, lead researcher at the University’s Micro- and Nanotechnology Centre, research breakthroughs

include low temperature epitaxy of cubic SiC on Si as well as the development of MOS purity oxides for SiC MOS devices.

“The superior properties of silicon carbide enable smaller, more efficient, sensitive and robust devices that can operate in harsh chemical and temperature environments,” he adds. Researchers at the Centre have also been working alongside UK-based semiconductor equipment manufacturer, SPTS Technologies, to commercialise SiC-on-silicon technology. Having demonstrated low temperature epitaxial growth of SiC films directly onto low-cost silicon wafers, the partners intend to develop thermal processing equipment to commercialise the technology. “Our industry partner will help us take the next critical step of making our SiC production processes ready for industry to adopt,” adds Centre operation director, Alan Iacopi.

“There is a potentially enormous global market and our breakthroughs have far reaching implications in terms of engaging with international industry and bringing frontier technologies to Queensland.”

SemiLEDs C35 LED uses “Color-Precision” technology

The new technology offers customers greater flexibility when making colour choices

SemiLEDs Corporation has unveiled its new C35 LED emitter incorporating the new Enhanced Vertical (EV) LED chip. It features narrow binning, low thermal resistance and a special optical design.

The C35 is SemiLEDs’ first series of products to feature new Color-Precision technology, which will offer customers greater flexibility when making colour choices. The C35 can yield consistent colour within a single 7-step, 4-step or 2-step MacAdam ellipse centred in ANSI defined standard colour spaces.

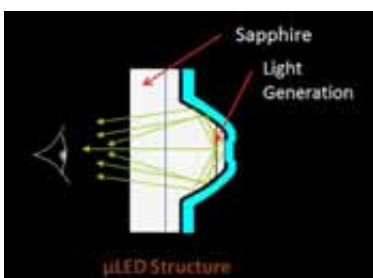
What’s more, the C35 utilises a ceramic submount which gives it low thermal resistance ($R_{th} < 8^{\circ}\text{C/W}$). Lower thermal resistance allows heat to be effectively driven from an LED’s junction, both extending the lifetime of the LED and providing better light quality, and reliability. Luminaires will experience more stable lumen maintenance and

consistent correlated colour temperature over time due to the C35 advantages in thermal management, making it ideal for general lighting applications.

Another key feature of the C35 is the special optical design that makes it easy to integrate with secondary optics. This design ensures light is distributed uniformly across the beam and diminishes the “yellow ring” effect typically found in white LEDs.

InfiniLED to advance MicroLED technology with Tyndall’s facilities

A new agreement between the two organisations allows InfiniLED to develop devices from raw materials to full systems with the use of Tyndall’s compound semiconductor cleanroom facilities. InfiniLED, a portfolio company of ScienceWorks Ventures plc and a Tyndall National Institute (UCC) spin-out, has signed an access agreement with Tyndall National Institute, Cork (Tyndall). This agreement allows InfiniLED’s engineers to work within the institute’s ISO 9001 Certified Compound Semiconductor cleanrooms to fabricate μ LED (MicroLED) technology. In MicroLEDs, a parabolic structure is etched on the back of the LED wafer to focus the light generated into a collimated beam - the core differentiator of the μ LED technology. These structures are effectively micro optics integrated directly at the LED wafer level.



There are a number of benefits of the MicroLED over conventional LEDs. The MicroLED is a planar LED structure based on a sapphire wafer – one of the simplest, lowest and most common LED wafer technologies used in conventional LEDs. Also, a MicroLED pixel can vary in size from approximately 10 to 25 μ m and the emitting surface is minimised to the region near the focal point of the

parabolic structure resulting in the collimated light. What’s more, the light is projected perpendicular to the sapphire and does not get trapped and even better, the MicroLED concept can be applied to all LED materials (blue, green, red, NIR, UV). “The access agreement is an exciting step forward for InfiniLED.

The skills, infrastructure, ISO certification and capabilities at the Tyndall National Institute are unique with Ireland and the UK. This is reflected in the quality of the research emerging from the institute.

For InfiniLED to be able to access these capabilities will enable us to deliver products to customers in an efficient and timely manner” points out Joe O’Keefe, CEO of InfiniLED.

“It will also allow InfiniLED to build on our technology base and to further enhance the performance. The availability of wafer growth, chip fabrication and advanced photonic packaging & test facilities at the Tyndall National Institute allows InfiniLED to develop devices from raw materials to full systems without incurring the cost of acquiring such equipment and facilities itself.

It means that InfiniLED can provide a range of solutions to customers based on μ LED technology in a form that is most suited to their requirements,” adds O’Keefe. “This access agreement further strengthens the two way relationship between Tyndall National Institute and InfiniLED. It demonstrates Tyndall’s flexibility in working with Irish indigenous spin out companies and assisting them in their growth trajectory.

Tyndall will continue to work with InfiniLED’s technology and team to incorporate the μ LED into future Tyndall client companies system solutions while InfiniLED brings their own extensive market and customer knowledge in their identified target growth areas .

This is another example of the importance of the Government’s investment in ICT (Photonics) convergence into new markets at Tyndall and its impact on Ireland’s current and future economic success.. ” says Kieran Flynn, Head of Business Development at the Tyndall National Institute.

“The μ LED technology brings huge technological

advances to customers by controlling the light directly at the point where it is created. As well as our core devices, InfiniLED also delivers unique solutions for customer needs. This engagement with Tyndall allows InfiniLED to develop solutions that are tailored at the chip level and to include all the required optical and control supports.

This enables InfiniLED to deliver plug-and-play solutions to customers across a range of markets including diagnostic devices, LED printing, microscopy and others.” emphasises Bill Henry, Chief Commercial Officer of InfiniLED. Post-investment, ScienceWorks remains InfiniLED’s largest shareholder along with senior management.

InfiniLED develops a range of LED light source modules based on its patented μ LED technology, which it has licensed from Tyndall. InfiniLED has a number of on-going development contracts with international customers. It is aiming to bring the first μ LED- based products to the market before the end of 2012. The areas of application for InfiniLED technology range from diagnostic testing devices to consumer products.

The microLED technology was invented by a team of researchers led by Brian Corbett at Tyndall National Institute, supported and funded by Enterprise Ireland. Under the Enterprise Ireland Business Partner Programme, entrepreneur Joe O’Keeffe, who has already spun out a series of successful companies, evaluated the commercial potential of the μ LED.

InfiniLED was launched in April 2011 and was co-founded by Bill Henry, Chief Commercial Officer of InfiniLED. He had worked on the development of the technology and the commercial opportunities while at Tyndall. The securing of this investment marks the next step in moving this world-class Irish research from the lab into the market place.

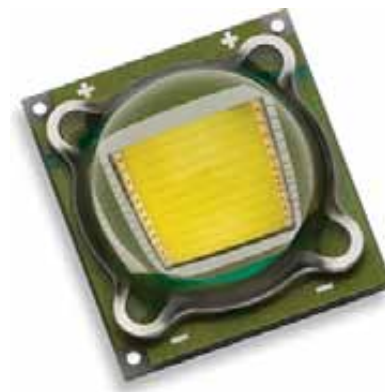
It will allow InfiniLED to build its team, to ramp-up development of the technology and to target new opportunities.

Luminus’ LEDs oust lasers in Smart Vision projectors

The new SP30 series projectors incorporate Luminus’ Big Chip nitride LEDs and are claimed to set a new performance standard

Luminus Devices has announced that its Big Chip LED technology has been selected by Smart Vision Lights for their new product line of illumination sources.

The SST-90 LED is at the heart of Smart Vision Lights’ SP30 Series LED structured light pattern projector for the machine vision industry.



Luminus SST-90 LED

When compared to laser based pattern projectors, Luminus’ LEDs enable higher resolution lines with sharper edges and more uniform illumination, and without laser speckle artifacts.

“Luminus has an established track record of displacing traditional high power illumination sources with its Big Chip LED technology,” says Chuck DeMilo, Global Director of Product Marketing at Luminus. “In general lighting and entertainment lighting we are enabling the conversion from metal halide to LED. In projection display we are displacing UHP mercury sources. Now in machine vision we are seeing success in converting laser based systems to LED.”

Matt Pinter, Design Engineer from Smart Vision Lights adds, “We selected the Luminus SST-90 for the large die footprint and high lumen output. The SST-90 gives us better uniformity across the pattern and provides much higher output than typical 1mm² LEDs. The new SP30 Series structured light LED

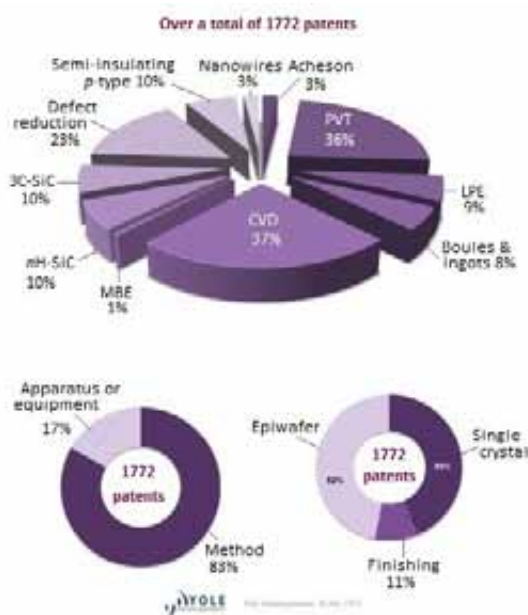
source is selling really well. We are competing against and taking business from lasers.”

Number of SiC patents don't tally with revenues

Although Japan holds 72% of patents related to silicon carbide wafer growth, the US holds a larger proportion in terms of revenue

Despite a cumulative raw wafer and epi wafer market that won't exceed \$80 million in 2012, the corpus of related patents of SiC growth comprises over 1772 patent families and more than 350 companies since 1928. Eighty-three percent of patents relate to a method while 17% of them claim an apparatus.

This is according to Yole Développement's latest report, "SiC Patent Analysis single crystal, wafer and epiwafer manufacturing".



Since 1978, the main technique used to grow bulk single-crystals of SiC is PVT (Physical Vapour Transport). The seeded sublimation method represents 36% of published patents. The PVT technique mostly deals with the hexagonal polytype nH-SiC (n=2,4,6).

An alternative route to growing SiC is Liquid Phase Epitaxy (LPE), with early efforts dating back to

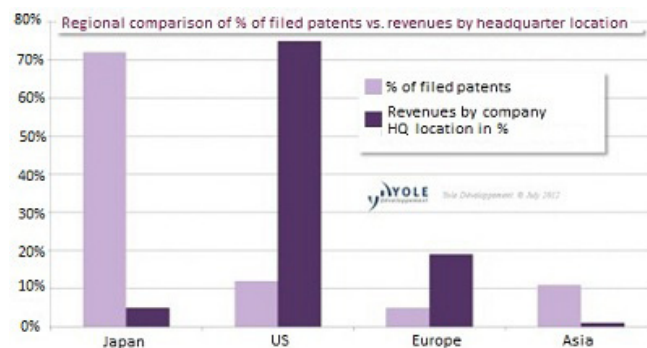
1961. This technique enables the grow of crystals with low dislocation densities at relatively low temperatures, which is particularly attractive for cubic polytype 3C-SiC.

About 37% of patents relate to a Chemical Vapour Deposition technique (CVD) which is almost exclusively used today to manufacture SiC epiwafers. Molecular Beam Epitaxy (MBE) is only mentioned in 1% of patents. The polytype (hexagonal or cubic) is explicitly claimed in 15% of patents. Numerous strategies to reduce crystal defects (micropipes, carrots ...) and make semi-insulating material are proposed in 23% and 10% of patents respectively.

Roughly 350 applicants are involved in SiC crystal/epiwafer technology. They are mainly located in Japan, which holds 72% of patents and the US, which possesses 12% of patents. The five major applicants based on their patents number are Denso, Sumitomo, Nippon Steel, Bridgestone and Toyota. They represent about 35% of studied patents.

US firm Cree occupies 6th position. This balance is totally uncorrelated from the reality of the market where 75% of the SiC wafer business is generated by US-based companies, namely Cree, II-VI or Dow Corning.

Japan is only responsible for 5% of the revenues (at least before Rohm acquired SiCrystal). Similar observations are seen in Europe and Asia (not including Japan) where the number of patents/revenues ratio is very weak at the moment.



Although Japan is currently leading the IP in SiC technology, Korea and China are catching up. Japan has become increasingly involved in SiC technology since the 1980's. The United States was the earliest player and is still active. In contrast, only

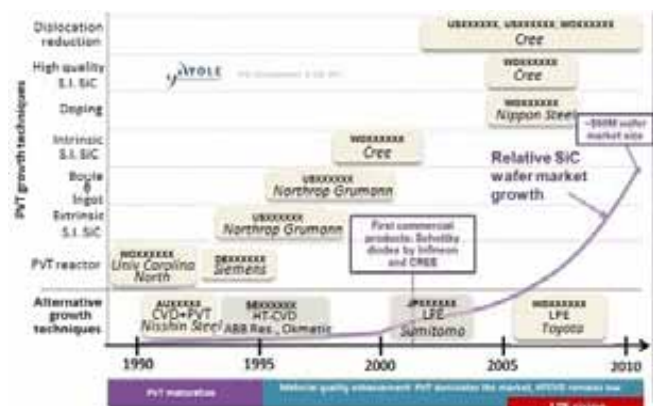
3 Japanese companies are commercially active in SiC material: These are Showa Denko (epiwafer), Bridgestone (wafer) and Nippon Steel (wafer and epiwafer).

During the last five years, with the establishment of some new companies, China and Korea have emerged as new players. Chinese firms include Epiworld, TianYue, TYSTC and Tankeblue. Korean firm SKC is also another contender. However, the market share held by these companies is currently very low.

It may seem obvious that IP considerations do not create a differentiating factor for success in the SiC substrate business.

Cree is leading this industry with about half the global market share, and has an excellent reputation in terms of quality, diameter and reproducibility. However, Cree does not own the widest patent portfolio. Thus, know-how and patent numbers do not seem to correlate.

The only field where number of patents and business size appears to be more balanced is in Semi-Insulating (S.I.) SiC technology where both Cree (Vanadium-free) and II-VI (Vanadium-doped) have extensively patented their respective developments.



The barriers to the entry in the SiC substrate world are very high. Today, state-of-the-art technology deals with 6" diameter wafers with very low dislocation densities. According to Yole, only Cree seems able to offer such a product today. But why is this the case?

Firstly, Cree has been widely funded by DoD, DoE, DARPA and Navy contracts during the last 20 years,

meaning the US firm has had a large advantage over its competitors. Cree has been able to invest a lot of time and money in R&D and improve the technology for both LED and Power Electronics.

So mastering SiC growth is a combination of money and development time, that cannot be compressed. Also, cross-fertilisation between its LED and Power businesses have allowed Cree to benefit from LED mass manufacturing, which is probably less stringent than power at wafer level, to fuel the power electronics side.

Apart from receiving funding to develop the technology, the only options to enter quickly in the SiC substrate battlefield appears to be through M&A (Merger & Acquisition) of an existing activity or to buy a license and related know-how, paying royalties in return.

But who is for sale?

Virtually nobody is at this current time. Beyond the top five SiC substrate leaders, Yole doesn't see a clear positioning of companies who may want to participate in a sale or merger of their business.

Ultimately, new developments based on LPE (Liquid Phase Epitaxy), made by Toyota, Denso or Sumitomo, as well as 3C-SiC (Cubic) which may disrupt the current PVT domination, could be the deciding factor.

Two inch free-standing SI GaN substrates on the market

PAM-Xiamen, a Chinese supplier of ultra-high purity crystalline gallium nitride and aluminium gallium nitride materials is marketing its semi-insulating substrates for LED growth

Xiamen Powerway Advanced Material (PAM-Xiamen) has announced the availability of 2" size native semi-insulating GaN (SI GaN) substrates. This new product represents a natural addition to PAM-Xiamen's native SI GaN substrate product line, which also includes 10mm x 10mm, 25mm x 25mm and 38mm x 38mm substrates.

Dr. Shaka, a spokesperson for the company, said, "We are pleased to offer larger native SI GaN to

our customers including many who are developing better and more reliable high frequency high power GaN transistors. Our 50mm dia. native SI GaN product has excellent resistivity properties just like our smaller SI GaN substrates, as corroborated by recent electrical resistivity mapping measurements carried out. The larger size and availability improve our native SI GaN boule growth and wafering processes.”

“Our customers can now benefit from the increased device yield expected when developing advanced transistors on a larger square substrate. Our larger square SI GaN substrates are natural by products of our ongoing efforts, currently we are devoted to continuously develop round three-inch and four-inch native SI GaN substrates,” continued Shaka. Pam-Xiamen’s improved SI GaN product line has benefited from strong technical support from Native University and Laboratory Centre. Founded in 1990, PAM-Xiamen is a manufacturer of compound semiconductor materials in China.

Pam-Xiamen develops advanced crystal growth and epitaxy technologies, manufacturing processes, engineered substrates and semiconductor devices and wafers. Pam-Xiamen has been involved in GaN research since 2001. In 2009, the firm began mass production of GaN-on-sapphire and freestanding GaN single crystal wafer substrates which are used in UHB-LED and laser diode manufacturing. Grown by hydride vapour phase epitaxy (HVPE), Pam-Xiamen’s native (free-standing) GaN can be grown in customer-defined orientations. These include polar (*c*-plane Ga-face or N-face) and non-polar (*a*-plane and *m*-plane), GaN and AlN templates grown on sapphire and silicon or SiC substrates, and ultra-high purity polycrystalline GaN.

LED forward lighting market to nearly double by 2020

The main growth drivers to this increase are styling, functionality and energy savings

A market report by McKinsey & Company predicts a sharp increase in LED lighting adoption in the automotive category by the end of the decade.

In 2011, LEDs claimed a 12 percent share, contributing to the overall category’s revenue of

\$18.1 billion.

Researchers expect to see a spike of 22 percentage points by 2020, increasing the LED share to 34 percent of the overall automotive lighting market. This forecast is based on the anticipated growth in the adoption of LED headlights and daytime running light systems by automakers during the next eight years, says David Hulick, Osram marketing director, Specialty Solid State Lighting.

Hulick points to three major trends driving the LED adoption rate upward. The first is styling and aesthetics. New LED systems empower designers with a more flexible palette, enabling new shapes, colours and mounting configurations that were not possible until recently.

Secondly, functionality and safety are also a factor. LEDs offer solutions for better vision and reduced glare, and operate at a colour temperature that is close to natural sunlight.

Last but not least, LEDs use significantly less energy than standard halogens. For example, Osram’s JOULE technology, uses just 14W of electricity compared with 65W for a conventional bulb.

“An efficient LED headlamp system can extend an electric vehicle’s range on a charge by nearly six miles (9.5 km). So, whether the goal is reduced fuel consumption or enhanced styling - be it for a hybrid or standard engine - LED lighting is simply the best technology available,” points out Hulick.

Osram’s proprietary technology - called JOULE JFL2 - integrates the light source and the socket into one easy-to-use package, making it compatible among different vehicle makes and models. The technology debuted in the U.S. this year on three vehicle models using LED in a completely new way including the Cadillac XTS and the Cadillac ATS.



Osram's goal was to provide automakers with an attractive solution to implement LED technology in various applications without paying the premium price tag that typically comes with it.

LEDs offer a multitude of other features that benefit both automakers and consumers. They are robust, having an extended life and being resistant to shock and vibration. Also their compact size enables lower profiles, and new applications and designs like light guides and 3D configurations. Directional emitters also improve optical system efficiency and the infinite management of light is possible with the high-tech electronics within LEDs.

"Until recently, LEDs were most common in centre high mounted stop lamps and taillights, with headlights having been a novelty feature in very high-end vehicles," concludes Hulick. "Now the industry is seeing growth in daytime running lights and headlight applications."

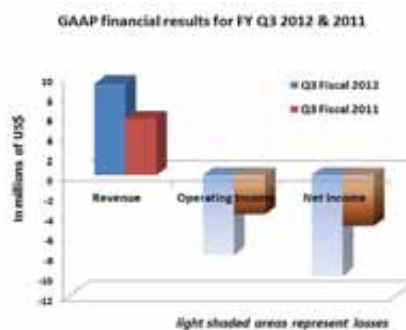
And while in the very near term the industry will experience an increase in daytime running lights and headlamp usage, unique LED light guides and multiple light source lamps, McKinsey predicts that the technology will continue to change and advance. In the future, it is also predicted that technology will advance and result in the deployment of smart headlamps that sense the driving environment and adjust illumination accordingly.

SemiLEDs margins slashed by excess capacity and patent litigation

The firm's margins were negatively impacted in the third quarter of fiscal 2012 by excess capacity charge of \$1.6 million and a provision for potential litigation settlement of \$1.5 million

Taiwanese LED chipmaker, SemiLEDs has announced its financial results for the third quarter of fiscal year 2012, ended May 31, 2012.

Revenue for the third quarter of fiscal 2012 was \$9.2 million, a 64% increase compared to \$5.6 million in the third quarter of fiscal 2011.



"While we have been prudent in our spending this past year, we have continued to invest in research and development. We are excited about the prospects for our recently announced Enhanced Vertical (EV) LED product series. These products, which we are introducing globally, increase our addressable market and are the foundation for future revenue growth. We have already received interest and have some customers that have begun the evaluation process," said Trung Doan, Chairman and CEO of SemiLEDs.

"We look forward to announcing more innovative products in the months to come that will further strengthen our position in the market place," concluded Doan.

GAAP net loss attributable to SemiLEDs stockholders for the third quarter of fiscal 2012 was \$10.0 million, or a net loss of \$0.36 per diluted share, compared to GAAP net loss attributable to SemiLEDs stockholders of \$5.1 million, or a net loss of \$0.19 per diluted share, for the third quarter of fiscal 2011.

GAAP gross margin for the third quarter of fiscal 2012 was negative 11%, compared with positive gross margin for the third quarter of fiscal 2011 of 9%. Operating margin for the third quarter of fiscal 2012 was negative 87%, compared with negative 70% in the third quarter of fiscal 2011. Margins were negatively impacted in the third quarter of fiscal 2012 by excess capacity charge of \$1.6 million and a provision for potential litigation settlement of \$1.5 million.

SemiLEDs agreed to make a one-time payment to Cree for past damages and to an injunction, effective October 1st, 2012, to stop the importation and sale of SemiLEDs' accused products in the United States. The parties have agreed to withdraw the remaining claims without prejudice to the right to

assert their respective claims in the future.

The Company's cash and cash equivalents were \$62.9 million at the end of the third quarter of fiscal 2012, compared to the second quarter ending balance of \$66.4 million. Cash used in operating activities was \$2.5 million in the third quarter of fiscal 2012.

SemiLEDs discussed these financial results in a conference call yesterday. A replay of the webcast is available on the Investors section of the Company's website and will remain available for approximately 90 calendar days.

Oxford Instruments unveils new PlasmaPro 100 system

The latest tool offers impressive hardware and process solutions for both Production and R & D customers in HBLEd, semiconductor Electronics, and photovoltaics

Oxford Instruments has launched the PlasmaPro 100 system, its latest generation etch and deposition tool.



The NEW PlasmaPro 100 tool has up to 200mm single wafer production capability, offering excellent uniformity and high throughput on a range of applications

The system is ideally suited to many key market applications, including HBLEd, Semiconductor Electronics, Failure Analysis and Photovoltaics. The, innovative system that has been developed by Oxford Instruments to address the exacting needs of Production users, who demand the very latest technological innovations. This latest system offers an evolution of PECVD hardware delivering step changes in deposition rate of high quality SiO₂ and SiN_x, with corresponding reductions in cleaning overhead. It also features the latest generation of Cobra ICP source which delivers improvements in

etch rate and feature control capability. With robotic handler and capability and 'Plug and Play' hardware and optimised processes, the enhanced system control infrastructure and software interface delivers improved diagnostics, reliability and serviceability for the customer.

Providing a common platform for all Oxford Instruments Plasma Technology's processes and technologies, the PlasmaPro 100 is a highly configurable system, with process chambers that are available as standalone modules or in cluster configurations. "All our tools boast industry leading technology and automation that are well proven with over 90% uptime", comments Senior Product Manager Ian McKinlay, "This latest product release offers genuine process improvements delivering excellent uniformity and high throughput processes on a range of applications. With access to our exclusive library of over 6,000 process recipes, built up over 25 years as a leading plasma tool manufacturer, our customers are guaranteed an excellent product with comprehensive, market leading backup."

Soitec and Silian to optimise GaN template wafers for more efficient LEDs

The firms are together using a novel epitaxy approach to increase productivity of gallium nitride LED wafers to accelerate the adoption of solid-state lighting

Soitec and Chongqing Silian Optoelectronics Science & Technology Co., Ltd. (Silian), a supplier of materials, devices and systems for the lighting industry, have partnered to jointly develop GaN template wafers using hydride vapour phase epitaxy (HVPE). The resulting GaN template wafers present breakthrough cost savings in manufacturing LEDs.

The companies' joint development agreement aims at validating the manufacturability and enabling the commercialisation of GaN template wafers using Silian's sapphire substrates and Soitec's unique HVPE technology. The partner companies plan to begin sampling GaN template wafers this year.

Chantal Arena, vice president and general

manager of Soitec Phoenix Labs, where the HVPE technology was developed, comments, "Our strategy was to use production-proven silicon epitaxy equipment features and add our innovative gallium source and delivery system to create a high productivity HVPE equipment. We then successfully developed high growth rate processes that combined with our low cost precursor leads to a more cost effective GaN template than the ones produced by MOVPE."

"Silian is excited to work with Soitec and adopt its HVPE technology," says David Reid, COO of Silian. "With our extensive sapphire substrate manufacturing expansion activities in China, we are very well positioned to take advantage of this opportunity and offer these high quality templates in a cost effective manner to our sapphire substrate customers."

"This development of HVPE technology introduces a revolutionary business model and allows LED makers to free up as much as 60 percent of their MOVPE capacity. LED makers can now focus on improving the more custom-designed layers that make up the light-emitting part of an LED," adds André-Jacques Auberton-Hervé, president and CEO of Soitec. "In addition to this business opportunity, we are exploring the possibility of expanding our cooperation with Silian into the field of LED lighting, leveraging Soitec's expertise in epitaxial growth developed by our Soitec Phoenix Labs subsidiary in Arizona."

Chairman Xiaobo Xiang of China Silian Instruments Group, Silian's holding company, concludes, "Soitec and Silian have very attractive complementary technologies. Therefore, we look forward to exploring with Soitec the mutual beneficial business opportunities offered by the vast markets of materials, LEDs and lighting."

Mini 850nm infrared LED revealed by Osram

The mini Midled is claimed to provide the highest radiant intensity of its size class

The infrared Mini Midled from Osram Opto Semiconductors is only 0.9 mm high but this tiny device produces a narrow and intense beam of

infrared light.

With its radiant intensity of 60 mW per steradian (mW/sr) at 100 mA, it outperforms other comparable devices.

This low-profile surface-mountable emitter is ideal particularly for proximity sensors in devices where space is limited and for light barriers.



The narrow intense light beams from the new Mini Midled from Osram Opto Semiconductors are ideal for light barriers and proximity sensors as they offer zero crosstalk

In many sensor applications it is not only the optical power of an emitter that is important but also whether the available light is widely spread or concentrated in a narrow high-power beam. This is characterised by the half-angle. The radiant intensity (measured in watts per steradian) indicates the optical power within a solid angle and therefore defines the intensity of the emitted light beam.

The great advantage of the new Mini Midled is its half-angle of 17°, producing a narrow light beam and a radiant intensity of 60 mW/sr at 100 mA. This is achieved by focusing the light with a metalised reflector integrated in the device. The new infrared LED offers a high output despite its exceptionally small dimensions of just 2.3 x 1.95 x 0.9 mm.

The Mini Midled is the second SMT device from Osram Opto Semiconductors in MID (Molded Interconnected Device) technology, following the 1.6 mm high Midled. Thanks to new package technologies, Osram has managed to reduce the total height of the new infrared emitter to less than 1mm but the new device can still be processed in the usual way.

Small and powerful infrared diodes with a wavelength of 850 nm, such as the low-profile narrow-beam Mini Midled, offer major benefits in applications where there is little space but high

radiant intensity is needed. Typical applications include light barriers, smart phones and optical touch screens.

Bianka Schnabel, Marketing Manager at Osram Opto Semiconductors, has high expectations for the new mini emitter. "The low-profile Mini Midled is particularly suitable as an emitter for proximity sensors in smart phones and similar devices because it takes up very little space and yet delivers high power. Thanks to its sophisticated design, it also considerably reduces optical crosstalk so no optical shielding is required, which makes life easier for designers."

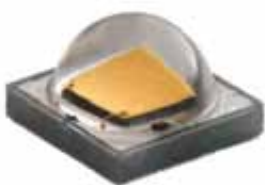
Proximity sensors are a combination of an emitter and a detector. The emitter illuminates an approaching object, and the light reflected from the object is received by the detector. For proximity sensors to operate properly it is crucial that no light from the emitter should reach the detector directly (crosstalk). This is precisely what often happens with devices that are not equipped with a metalised reflector. But with the Mini Midled there is no need for shielding and the overall design is much simpler.

The non-metalised surfaces are dark coloured so the Mini Midled can be mounted inconspicuously behind a smart phone cover.

Cree XLamp XP-G2 LEDs boost efficiency by 20%

The XP-G2 nitride LED can enable a broad range of high-lumen applications, from indoor and outdoor to portable and lamp retrofits

Cree is introducing the XLamp XP-G2 LED to deliver luminaire manufacturers up to 20 percent more lumens per watt and 2.5 times the lumens-per-dollar over the original XP-G LED.



Cree XP-G2 LED

The brighter, more efficient XP-G2 LED provides customers an immediate boost in performance and enables manufacturers to use fewer LEDs to get the same brightness at lower cost or increase brightness levels using the same LED count and power.

Characterised and binned at 850 C, the new XP-G2 LED leverages the same footprint (3.45mm x 3.45mm) and is compatible optically with the original XP-G LED - providing drop-in-ready performance enhancements to shorten the LED fixture design cycle and improve customer time to market. The XP-G2 LED can enable a broad range of high-lumen applications, from indoor and outdoor to portable and lamp retrofits.

"We have many designs using Cree's XLamp XP-G LED," notes William Weiss, partner and director of technology, MSi Solid State Lighting. "The new XP-G2 allows us to take full advantage of the benefits of Cree's latest technology without any significant design changes, improving time-to-market."

Built on the SC(3) Technology Platform, the XP-G2 LEDs combine high light output, reliability and efficacy to deliver up to 151 lumens per watt at 350 mA, 850 C or 165 lumens per watt at 350mA, 250 C in cool white (both at 6000K).

In warm white (3000K), the XP-G2 LED delivers up to 133 lumens per watt at 350 mA, 850 C or 145 lumens per watt at 350mA, 250 C. The SC(3) Technology Platform leverages Cree's advanced silicon carbide technology, features advancements in LED chip architecture and phosphor and showcases a new package design to deliver the most advanced lighting-class LED components in the industry.

Luminaire makers seeking ENERGY STAR qualification will have access to specification and performance data, including LM-80 reports, which can speed time to market. XP-G2 LEDs are a "successor" product to the original XP-G LED for LM-80 data - accelerating qualification of luminaires using just 3000 hours of LM-80 data, instead of the normal 6000 hours. The XP-G2 LED is also UL-recognised and features a level 4 rating.

Cree XLamp XP-G2 LED samples are available now and production quantities are available with standard lead times.

Packaged LEDs in SSL general lighting to hit 4.6 billion units in 2012

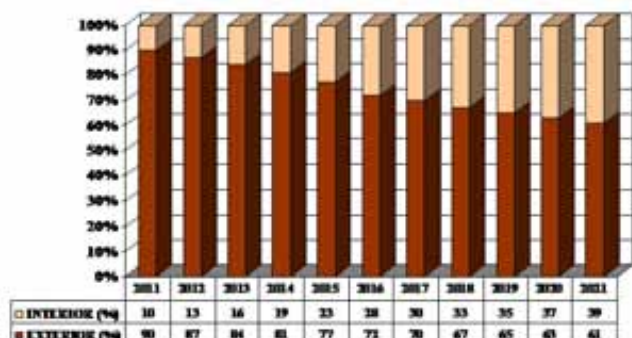
The global consumption value of component-level LEDs in SSL general lighting applications will increase at 37% per year from 2011-2016. Between 2016-2021, the annual average growth rate will be even higher, at 51%

Only 10% of the LEDs used in General Lighting were attributed to Interior lamps in 2011. However, by 2021 the relative market share of LEDs in Interior lighting is forecast to reach 39%.

This is according to ElectroniCast Consultants' report, "LEDs Used in General Lighting : Global Market Forecast and Analysis (2011-2021)." The consultant firm also says the worldwide volume of packaged LEDs in solid-state lighting (SSL) general lighting will reach nearly 4.6 billion units in 2012.

The global consumption value of component-level (packaged) LEDs in SSL general lighting applications will increase at 37 percent per year (2011-2016). What's more, there should be faster overall growth in the second-half of the forecast period (2016-2021), with an overall annual average growth rate of 51 percent.

LEDs used in Solid State Lighting (SSL) General Lighting Global Market Forecast (Value Basis, \$Million)



The use of packaged LEDs in residential, commercial and government exterior general lighting lamps (street, parking-lot, roadway-tunnels, bridges, landscaping, pool/fountain, buildings, architectural and other general lighting) applications, in 2011, represented nearly 90 percent

share of worldwide consumption.

However, ElectroniCast predicts that in the year 2021, the relative market share of component-level LED use in exterior lamps is forecast to decrease significantly to 61 percent. Having said that, a substantial increase in value is anticipated.

Extending LED lifetime by eliminating the driver

Newsun says the lifetime of lamps employing its AC LED are increased as there is no driver. Instead the lifetime is dependent on the nitride chip lifetime

After seven years of research and development in collaboration with Professor Edson Products, Chinese firm, Newsun has successfully developed a real AC POWER LED; it does not have a shunt connection and is composed of only AC power chips.

Newsun says with the LED, there is no need for a transformer to change the power from AC to DC. What's more it doesn't need an LED driver. Not needing either a transformer or driver means that the light source only needs a tiny space.



TK-AC01
 Produce size: 8mm
 Color temp.: 2700-6500K
 Lum: 100-120LM
 Wattage: 1W
 Voltage: AC230V/120V

The LED operates at 85 lumens/Watt and has a CRI of 82 at a relatively low temperature. Newsun says that lamps employing the LED have a very long life because in most cases, the lifetime is based on the life of the driver. And as this LED doesn't have one, it is not affected by this, but by the chip lifetime. The firm also says the price of its AC LED is similar to that of a DC LED.

With a new production line currently under

construction, the product is available in bulk quantities and sample orders are also accepted.

GaN developer mLED to expand with £348,000 funding

Apart from increasing its personnel, the company intends to use the equity funding to enhance its intellectual property and market its proprietary gallium nitride LED technology to initial customers

Braveheart Investment Group has made a further investment in mLED Limited, the micro LED company.

Based in Glasgow, mLED is an innovator in microLED technology, with product applications identified in a number of key growth markets. A spin-off from the Institute of Photonics of the University of Strathclyde, the company was launched in June 2010 with £150,000 seed funding.

In the latest funding round, led by Braveheart, mLED has secured an additional £378,000 from Braveheart's network of private clients, the Scottish Enterprise Co-Investment Fund and members of both mLED's board and technical advisory council.

The additional equity funding will enable the company to increase its personnel, enhance its intellectual property and market its proprietary technology to initial customers.

Geoffrey Thomson, Chief Executive of Braveheart Investment Group plc, says, "We are pleased to support this company which has pioneering technology and an impressive management team."

mLED says its new generation of ultra-high brightness micro-emitter arrays (microLEDs) is opening up major new segments within the nascent embedded pico projector market. Pico projectors can be found in a broad array of portable devices from bar code scanners to smartphones.

mLED claims its breakthrough harnesses pioneering developments in the area of programmable micro-pixelated LED technology, bringing an order of magnitude improvement in light intensity over current micro-display approaches.

The firm is developing a roadmap of products aimed at a range of high volume embedded applications

and is already commercially engaged with some of the world's leading system integrators.

The proprietary microLED technology was developed over a 10 year period at the Institute of Photonics at the University of Strathclyde, where over £7million was invested in research leading to the core patent. Since inception, the university spin-off, mLED, has filed further related patents and has built significant application expertise.

Telecoms

JDSU completes acquisition of GenComm

The innovator of networks and high-powered commercial lasers for a range of applications has purchased the a provider of wireless test and measurement products

JDSU has completed the acquisition of GenComm, a provider of wireless test and measurement solutions based in Seoul, South Korea.

JDSU announced its intent to acquire GenComm on August 14th, 2012.

GenComm's solutions were previously distributed by JDSU under an OEM relationship and are used by tier one service providers, wireless network manufacturers and contractors around the world to quickly provision wireless services that help them create new revenue streams and improve wireless service for millions of users worldwide.

"We welcome the talented employees of GenComm to JDSU and look forward to working with them on new ways to advance wireless networks as part of the world's leading provider of communications network test solutions," says David Heard, president of JDSU's Communications Test and Measurement business segment.

Digi-Key to distribute Hittite products

The firm will globally distribute Hittite's products which are developed using gallium arsenide, gallium nitride, and indium phosphide technology

Global electronic components distributor Digi-Key Corporation has signed a global distribution agreement with Hittite Microwave Corporation, a supplier of complete MMIC-based solutions for communication and military markets.

Founded in 1985, Hittite Microwave designs and develops high performance integrated circuits, modules, subsystems, and instrumentation for

technically demanding digital, RF, microwave and millimetre wave applications covering DC to 110 GHz.

"Microwave and RF technology are widespread in numerous industries today," says Mark Zack, vice president, global semiconductor product at Digi-Key. "The broad selection of high-performance product offered by Hittite will add a unique dimension to our line card, and we are pleased to enter into this partnership."

Hittite's Digital Integrated Circuit (IC), Radio Frequency Integrated Circuit (RFIC) and Monolithic Microwave Integrated Circuit (MMIC) products are developed using GaAs and Silicon based semiconductor processes. These GaAs, GaN, InGaP/GaAs, InP, SOI, SiGe, CMOS and BiCMOS semiconductor processes utilise MESFET, HEMT, pHEMT, mHEMT, HBT and PIN devices. Their product portfolio covers 35 product lines and includes over 1,025 standard products.

Hittite products can be purchased now on Digi-Key's international websites.

Advantech Wireless releases GaN whitepaper

The company's paper discusses gallium nitride based solid state power amplifiers for satellite communication

Advantech Wireless, a Canadian-based manufacturer of broadcast-quality Satellite, RF Equipment and Microwave Systems has released a new whitepaper titled, "A new generation of Gallium Nitride (GaN) based Solid State Power Amplifiers for Satellite Communication".

The paper explores the technology and benefits of incorporating GaN into a line of high power amplifiers.

Energy efficiency and going "Green" is very important throughout the world. The Advantech Wireless whitepaper identifies and explains how it is possible to achieve significant reductions in energy consumption, space and weight while maintaining linearity and significant output power.

The introduction of GaN High Electron Mobility Transistors (HEMT) in early 2000 has left an undeniable mark on the entire satellite communication landscape.

“It is now possible for the first time since the introduction of the Solid State Microwave Technology to design and manufacture Power Amplifiers that exceed by several orders of magnitude the reliability, linearity, power density and energy efficiency of all existing technologies, being GaAs, LDMOS, or TWT” states Cristi Damian, VP Product Line Management and Business Development at Advantech Wireless.

Over the past 6 years, Advantech Wireless has developed a full line of GaN based SSPAs and BUCs/SSPBs (Block Up Converter integrated with SSPA). The product line was launched at Satellite 2010 in Washington, included up to 200W Ku-band offering, the first product line worldwide.

Since then, major deployments in both the commercial and military markets have been taken place with thousands of devices now operating in the field. GaN is a mature, stable and high reliability technology with low OPEX.

By using patent pending technologies and in close cooperation with key technology suppliers, Advantech Wireless says it has managed to perfect the design, and raise the performance of GaN based SSPA/SSPB above all existing technologies.

RFMD reveals devices for wireless applications

The two new modules, which employ gallium arsenide technology, operate between 5MHz and 4000MHz

RFMD has unveiled two new multifunctional devices based on GaAs pHEMT and silicon CMOS technology.

The RFSA2644 and RFSA2654 are suited to transceiver RF and IF applications, 2G, 3G, LTE, WiMax/WiFi, wireless data, satellite terminals, test equipment, CATV, cable modems and data network equipment.

Both modules, which have 6-bit digital step attenuators, feature high linearity over their entire 31.5dB gain control range with step accuracy in 0.5dB steps. They are programmed via a serial mode control interface that is both 3V and 5V compatible. The devices also offer a rugged Class 1C HBM ESD rating via on-chip ESD circuitry and the MCM packages are footprint-compatible with most 24-pin, 4mm x 4mm, QFN packages.

The RFSA2644 operates between 50MHz and 4000MHz while the RFSA2654 is suited to 5MHz to 2000MHz applications with IP3 above 50dBm for all steps.



Both the RFSA2644 and RFSA2654 are currently available in production quantities. Pricing begins at \$1.76 each for 750 pieces.

Waltzing closer to using spintronics in computing

Using gallium arsenide / aluminium gallium arsenide based quantum well structures, scientists have demonstrated new possibilities of increasing energy efficiency in electronics

Advances in spintronics, an elusive field of electronics, could enable a new class of magnetic-based semiconductor transistors which could result in more energy efficient electronic devices.

Aiming to use electron spins for storing, transporting and processing information, scientists from IBM Research and ETH Zurich have revealed what they say is the first-ever direct mapping of the formation of a persistent spin helix in a semiconductor.

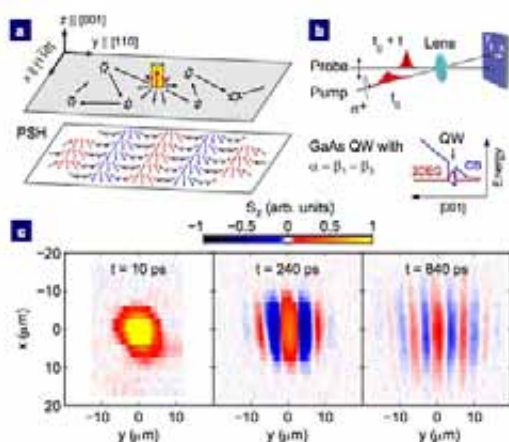
The scientists made the discovery by investigating the spin in GaAs/AlGaAs quantum well structures grown by researchers at ETH Zurich.

IBM Research believes it is the first to have synchronised electron spins and image the formation of a persistent spin helix.

Until now, it was unclear whether or not electron spins possessed the capability to preserve the encoded information long enough before rotating. The scientists from IBM Research and the Solid State Physics Laboratory at ETH Zurich demonstrated that synchronising electrons extends the spin lifetime of the electron by thirty times to 1.1 nanoseconds - the same time it takes for an existing 1 GHz processor to cycle.

Today's computing technology encodes and processes data by the electrical charge of electrons. However, this technique is limited as semiconductor dimensions continue to shrink to the point where the flow of electrons can no longer be controlled.

Spintronics could surmount this approaching impasse by harnessing the spin of electrons instead of their charge.



Direct mapping of the persistent spin helix formation. (a) Diffusive expansion of a local spin excitation (top), where the spin polarisation evolves into a PSH mode (bottom). The arrows and the colours indicate the direction of S and the magnitude of S_z respectively. (b) Schematic of time-resolved Kerr rotation microscopy (see methods) and profile of conduction-band energy of the 12nm wide GaAs/AIGaAs QW sample investigated. (c) Experimental observation of the PSH. Spatial maps of $S_z(x,y)$ are shown for three different times t . (Credit: Nature Physics/IBM Research - Zurich, John Galvez)

This new understanding in spintronics not only gives scientists unprecedented control over the magnetic movements inside devices but also opens up new possibilities for creating more energy efficient electronics.

The scientists observed how electron spins move tens of microns (μm) in a semiconductor with their orientations synchronously rotating along the path similar to a couple dancing the waltz, the Viennese ballroom dance where couples rotate.

Gian Salis of the Physics of Nanoscale Systems research group at IBM Research in Zurich explains, "If all couples start with the women facing north, after a while the rotating pairs are oriented in different directions. We can now lock the rotation speed of the dancers to the direction they move. This results in a perfect choreography where all the women in a certain area face the same direction. This control and ability to manipulate and observe the spin is an important step in the development of spin-based transistors that are electrically programmable."

IBM scientists used ultra short laser pulses to monitor the evolution of thousands of electron spins that were created simultaneously in a very small spot. Atypically, where such spins would randomly rotate and quickly lose their orientation, the scientists could observe how these spins arrange neatly into a regular stripe-like pattern, the so-called "persistent spin helix".

The theory of locking the spin rotation was originally proposed back in 2003. Since then, some experiments have found indications of such locking, but until now it had never been directly observed, according to the researchers.

IBM scientists imaged the synchronous 'waltz' of the electron spins by using a time-resolved scanning microscope technique. The synchronisation of the electron spin rotation made it possible to observe the spins travel for more than $10\mu\text{m}$, increasing the possibility of using the spin for processing logical operations, both quickly and energy-efficiently.

The reason for the synchronous spin motion is a carefully engineered spin-orbit interaction, a physical mechanism that couples the spin with the motion of the electron.

Transferring spin electronics from the laboratory to the market still remains a major challenge, however. This is because spintronics research takes place at very low temperatures at which electron spins interact minimally with the environment. In the case of this particular research IBM scientists worked at 400 Kelvin (-2330 C or -3870 F).

So this is a major hurdle to overcome before the technology can even be considered in a commercial environment.

The work detailed here was financially supported by the Swiss National Science Foundation through National Centre of Competence in Research Nanoscale Sciences and NCCR Quantum Science and Technology.

Further details of the research have been published in the online paper, "Direct mapping of the formation of a persistent spin helix" by M.P. Walser *et al*, *Nature Physics*, DOI 10.1038/NPHYS2383

RFMD'S CATV GaN amplifiers in the spotlight

The amplifiers, one of which uses both gallium arsenide and gallium nitride technology, have been awarded for their novel cable technology

RF Micro Devices has received "Product of the Year" Awards from Cable Spotlight for three of its broadband cable television (CATV) products.

Cable Spotlight is a cable technology website. It's Third Annual Cable Spotlight Product of the Year Awards highlight innovative cable technology products brought to market in 2011.

The award winning products are the RFAM2790 integrated EDGE QAM amplifier, the RFCM2680 GaAs/GaN power doubler and the RFPP2870 push-pull amplifier.

Driven by explosive consumer demand for digital content, operators of multi-system networks are seeking more bandwidth, higher output, and lower distortion, while also requiring lower power consumption to reduce operating expenses. RFMD's award-winning CATV products all use advanced compound semiconductor technology.

Norm Hilgendorf, president of RFMD's Multi-Market Products Group, says, "RFMD's best-in-class CATV transmission products are optimised to satisfy the industry's ever-increasing requirements for bandwidth and signal purity. We are honoured to be recognised by Cable Spotlight for our CATV amplifiers, and we look forward to introducing additional devices that feature superior power density, high power efficiency, and rugged dependability."

"RFMD has proven its dedication to quality and excellence while addressing real needs in the marketplace. I am pleased to grant a 2011 Product of the Year Award for RFAM2790, RFCM2680, and RFPP2870," says Rich Tehrani, CEO, TMC. "RFMD's commitment to the advancement of the cable technology industry is commendable and I am looking forward to more innovation in the future."

The RFAM2790 functions as an Edge QAM amplifier or a push-pull amplifier with +46dBmV output power. Its inner-stage attenuator provides 8-28dB gain range and it features power-down functionality for power save mode. The part meets DOCSIS 3.0 specifications with 7dB margin.

The RFCM2680 is the world's first GaN-based surface mount power doubler. Capable of delivering +61dBmV output power, the RFCM2680 consumes 20% less current for the same linearity performance, compared to GaAs technology. The RFCM2680's surface mount package allows up to 50% savings in board area over industry-standard SOT115J packages.

The RFPP2870 is a GaN-based push-pull amplifier featuring high gain 28dB (minimum at 1003MHz) and excellent linearity at low distortion levels. It is available in an industry-standard SOT115J package.

M/A COM's HEMT targets radar applications

The firm's depletion mode HEMT microwave pulsed power transistor features broadband operation at +50 V. The gallium nitride device is suited to civilian and military pulsed radar applications

M/A-COM Technology Solutions, a supplier of

analogue semiconductor solutions, has revealed a new highly efficient 40 W pulsed power transistor.

The GaN based MAGX-002735-040L00 is optimised for civilian and military pulsed radar applications between 2.7 and 3.5 GHz.



MAGX-002735-040L00

The device is a gold metalized, internally matched, GaN on SiC RF power transistor. It exhibits excellent performance when operated at +50 V, class AB operation, 40 W peak output, using a 300 μ s pulse and 10% percent duty cycle pulsed signal.

The transistor provides high gain, efficiency, bandwidth, and ruggedness over a wide bandwidth for today's demanding needs.

Based on extensive HTOL RF accelerated life testing, quantifiable test results demonstrate this product is designed to provide an MTTF of 600 years or better.

"The 800 MHz of instantaneous bandwidth and rugged performance makes this versatile device an excellent choice as a driver stage or output stage for any s-band radar power amplifier application," said Gary Lopes, Senior Director for RF Power Technologies.

Manufactured in a thermally enhanced, Cu/Mo/Cu, flanged ceramic package, the MAGX-002735-040L00 boasts excellent thermal performance as well as high breakdown voltages that allow for reliable and stable operation in extreme mismatched load conditions. Operating at +50 V, class AB, the pulsed power transistor provides 40 W of peak power at 55 percent drain efficiency with a minimum gain of 10.5 dB across the full 2.7 to 3.5 GHz frequency band.

Production quantities and samples of MAGX-002735-040L00 are available from

Next-generation infrared detectors on silicon

Growing infrared detectors on large area substrates would enhance capabilities in astronomy, remote detection and medical diagnosis

Cheaper, larger and better infrared detectors grown on silicon wafers could give more scientists access to infrared astronomy and further spur the hunt for exoplanets and the study of the universe's acceleration.



Closer to home, the same technology could also advance remote sensing and medical imaging.

The National Science Foundation (NSF) has awarded the Rochester Institute of Technology \$1.2 million to develop, fabricate and test a new family of detectors grown on silicon wafer substrates by US-based imaging systems developer, Raytheon Visions Systems.

"If this is successful, the astronomy community will have a ready supply of affordable detectors that could be deployed on a wider range of facilities," says Don Figer, director of the Center for Detectors at RIT and lead scientist on the project. "Right now infrared detectors are so expensive that there are only a few on the world's biggest telescopes - Keck, Gemini, the Very Large Telescope."

"These are the only facilities that can afford them, and then they can only afford a few. They have big telescopes with big focal planes and tiny detectors in the middle," he adds.

Advancing infrared detectors using silicon wafers will leverage the existing infrastructure built around the semiconductor industry and drive down the cost of building detectors.

"The collaboration with RIT leverages over a

decade of technological advancements Raytheon has made in manufacturing large format MBE/Si focal planes,” says Elizabeth Corrales, program manager at Raytheon Vision Systems. “Infrared detectors with lower cost focal planes and improved performance will push the boundaries of infrared astronomy and continue Raytheon’s 30-year service to the astronomy community.”

Cost constraints limit the availability and scale of the current detector technology, which use small, scarcely produced cadmium zinc telluride wafers.

“Today, a typical state-of-the-art device has 2,048 by 2,048 pixels at a cost around \$350,000 to \$500,000,” Figer points out. “Detectors on large telescopes can cost a significant fraction of the total instrument budget. Very large, affordable infrared arrays will be essential for making optimum use of the proposed 30-metre class ground-based telescopes of the future.”

“The key to making larger - up to 14,000 by 14,000 pixels - and less expensive infrared detectors lies in using silicon wafer substrates, since large silicon wafers are common in the high-volume semiconductor industry and their coefficient of thermal expansion is well-matched to that of the silicon readout circuits,” Figer says.

For the last 15 years, scientists have pursued the use of silicon substitutes in the quest for large infrared detectors.

Until now, the crystal lattice mismatch between silicon and infrared materials has stymied advancement, causing defects that generate higher dark current, and thus higher noise, reduced quantum efficiency and increased image persistence.

Atoms in a silicon crystal are spaced closer together than those in infrared light-sensitive materials.

When the infrared material is grown on the silicon, defects are generated. Photo-generated charge that represents the signal can get stuck and lost, or pop out of the lattice and show up as a phantom signal. The difference in atomic spacing can create the false signal.

Raytheon has developed the prototype detector technology using molecular beam epitaxy to deposit

light-sensitive material onto silicon substrates while maintaining high vacuum throughout the many steps in the process.

“Raytheon has come up with an innovation to combine the silicon wafer with the mercury cadmium telluride light-sensitive layer in a way that eliminates all these bad effects,” Figer says. “Our proposal is to do a fabrication run of parts based on this new technology and then evaluate the technology in the laboratory and on a telescope.”

RIT and Raytheon will design and fabricate arrays of 1,024 by 1,024 pixels and 2,048 by 2,048 pixels and test them in the laboratories of the Center for Detector.

“Not only are silicon wafers much more affordable, but they can be made in much larger sizes because the wafers are now big,” Figer notes. “Instead of being a four-inch wafer, it can be 12 inches, for instance. We can make a 14,000-by-14,000-pixel detector. That has not been done. It could end up dominating the field in infrared detectors for the next 20 years.”

Noise can obscure signals coming from the faint objects in the universe.

Figer’s team will measure the detector performance using a system based on one he designed for the Space Telescope Science Institute to measure the performance of detectors to be flown on the James Webb Telescope.

Figer will also develop a new light-tight detector housing to keep the detector optically and thermally isolated from everything around it.

The box-within-a-box design is cooled to 60 Kelvin (-3500 F) to reduce the glow, or blackbody radiation, emitted from warmer objects around the detector and prevent additional noise.

The NSF funding to develop the technology will carry Figer and his team to the second phase of the project and the design of a much bigger device on the scale of 4,000 by 4,000 pixels. An international consortium of organisations is needed to fund the fabrication of these larger detectors.

“I am going around the world talking to directors of observatories currently in existence and future

observatories and asking them if they'd like to join a consortium of organisations, each of which contributes to, and benefits from, the development of the first run of 4K parts," he says. "This is the intermediate step before having a final product."

During the third and final phase of the program, Figer foresees RIT and Raytheon building an instrument for a large telescope.

"One of the strategic goals for the Center for Detectors is to start a big astronomical instrumentation program at RIT," he concludes. "There are only a handful of programs like that in the world. It's very competitive but it's also very fulfilling to both deploy the technology and use it for science in an astronomical instrument."

GaAs MMIC power detector for E-band from GigOptix

The firm has released samples of its new gallium arsenide detectors which operate over the 71 to 76 GHz and 81 to 86 GHz E-band frequency bands

Fabless analogue semiconductor firm GigOptix, has announced the engineering sample release of the EXE8602-DNT power detector die for high capacity wireless point-to-point E-band radios.

The EXE8602-DNT is a small form-factor GaAs MMIC die power detector designed to operate over the 71 to 76 GHz and 81 to 86 GHz E-band frequency bands for applications requiring power detection over a wide RF power range. Highly desirable features include consistent performance over temperature and output load variations from the typical 50-Ohm system impedance.

Operating with low DC power consumption, the MMIC produces reference and detector output voltages that can be compared to determine the RF power and which can be further processed to provide RF power in decibel units.

The MMIC provides high-capacity-radio manufacturers with an E-band power detector featuring low insertion loss, flat frequency response over each band and high RF power dynamic range with excellent sensitivity. The detector may be used to monitor transmitter operation, or to enable

closed-loop control of the transmitter's output power to ensure consistent operation.

"We are very excited to add the EXE8602-DNT power detector to GigOptix's growing portfolio of E-band solutions. The EXE8602-DNT enables E-band radios output power monitoring and control to best suit the conditions and the modulation scheme being utilised," says Pdraig O'Mathuna, VP/GM of GigOptix's RF/MMIC product line.

"In light of the growing demand for mobile data due to the advent of cloud computing, the migration of data services to the web and with the mass adoption of smartphones and tablets, E-band offers a much less congested frequency spectrum compared to existing legacy 6 to 38 GHz mobile backhaul bands along with 13 GHz of allocated frequency spectrum that enables very economical multi-Gigabit per second communication links. Indeed we believe that speeds of 10 Gbps and beyond commonly seen in optical interconnects will shortly be enabled in metro areas by E-band links," he notes.

In its most recent report, EJM Wireless Research forecast E-band point-to-point radio links as being one of the fastest growing segments in the wireless mobile backhaul market with greater than 100% CAGR to 2016.

UTC Aerospace reveals snapshot SWIR camera

The high-resolution indium gallium arsenide camera is able to capture images in smoke, fog and haze for use surveillance

UTC Aerospace Systems, a unit of United Technologies, introduced its next generation Sensors Unlimited shortwave infrared (SWIR) digital video camera at AUVSI Unmanned Systems North America Exhibition, in Las Vegas, Nevada.

This high-resolution InGaAs mil-rugged digital video camera features 30Hz full-frame rate and adds snapshot mode capability to the Sensors Unlimited high-definition SWIR product range. The camera, model GA1280JS, will be showcased at the UTC Aerospace Systems booth #2654 at Mandalay Bay Convention Centre.



GA1280JS SWIR camera

The camera weighs less than 120 grams or 4 ounces without lens and is less than 4.5 cubic inches or 74 cubic centimetres. This, allows for easy integration into aerial, mobile and hand-held imaging systems.

Ideally suited to low-light imaging and covert surveillance requirements, the SWIR camera is able to capture images through smoke, fog and haze, which makes the camera suitable for integration into a variety of surveillance and reconnaissance systems.

Cooling is not required with the JS-series InGaAs SWIR camera. What's more, it features on-board, automatic gain control and real-time non-uniformity corrections that improve urban night imaging, such as capturing a dark scene that contains bright light sources.

The Sensors Unlimited model GA1280JS has been tested to MIL-STD-810G for functional shock, vibration, thermal shock, storage temperature, altitude, humidity and acceleration.

Infrared technology veteran to strengthen Xenics sales force

The provider of high speed indium gallium arsenide cameras used in the surveillance industry has appointed a new sales manager

Xenics, a developer and manufacturer of advanced infrared detectors and customised imaging solutions covering the LWIR to the visible realm, has appointed Stuart Cohen as new sales manager at Xenics USA, Inc.

A 100% subsidiary of Belgium-based Xenics nv. Xenics USA, Inc., of Beverly, Massachusetts, provides sales and application support to its U.S. and Canadian customers.

By attracting the IR expert, Xenics believes it is strengthening its presence on the industrial and governmental security markets throughout North America.

Stuart Cohen comes to Xenics USA, Inc. with many years of managerial experience in the infrared industry. In his last position as product manager and sales manager of North America for NEC-Avio Infrared Technologies/ NEC Corporation of America, he was mainly responsible for governmental security and surveillance markets, developing a customer base of system integrators, with a special focus on LWIR OEM modules. Before this, Cohen spent a substantial part of his professional career in similar technical sales positions at Ericsson, based in the U.S., and at Texas Instruments.

"Foremost on my agenda at Xenics USA, Inc. is accelerating the expansion of our sales and support organisation," Cohen says. "We see a significant potential for growth and additional revenue in the scientific, industrial and security markets in North America. We are investing in these markets by hiring additional employees for technical and sales support, thereby strengthening our regional presence. We will also substantially grow our network of sales representatives in dedicated regions."

Stuart Cohen's long-term experience and well established connections in the U.S. will help guide Xenics' entry into the OEM core business segment.

"We have the broadest range of technologies in the industry covering the entire infrared realm," he claims. "We offer the highest-speed InGaAs cameras, and process capabilities that many of our competitors don't have. We are very well equipped for complex custom projects. And we offer utmost flexibility in these dedicated markets."

Xenics USA, Inc. was founded in 2011 to facilitate sales of the company's broad spectrum of advanced IR products and solutions and provide support to industrial and institutional customers throughout the U.S. and Canada, especially in the rapidly growing segments of security systems and in the institutional

and OEM markets for governmental projects.

This subsidiary of Xenics is headed by Luc DeBrouckere, an industry expert with 35 years of experience in infrared imaging.

“North America is a very important strategic market for us,” says Xenics founder and CEO Bob Grietens, President of Xenics worldwide. “Of course, we are facing embedded competition. But Xenics is well prepared to tackle these challenges based on our advanced products and solutions that need strong local support.”

Xenics USA showcased its latest developments in the unmanned systems market at AUVERSI 2012, in August, in Las Vegas, Nevada. The firm will also exhibit its products at ASIS between September 10th and 13th in Philadelphia, Pennsylvania addressing security professionals with prevention and mitigation strategies.

At both events the firm will demonstrate its portfolio of specific security systems based on advanced uncooled SWIR and LWIR OEM modules.

Xenics designs, manufactures and sells infrared detectors and cameras, both line-scan and 2-D, covering the infrared wavelength ranges from 0.4 to 14µm. In addition, the company delivers custom products according to the agreed specification and planning.

Oclaro and Opnext finalise merger

Telecom and datacom businesses hope to create a new leader in the optical industry

Optical communications provider, Oclaro, and optical module designer, Opnext, both of the US, have announced shareholder approval of their merger.

The combined company will continue to operate under the Oclaro name. “The new Oclaro boasts one of the broadest and vertically-integrated product lines in the industry. Our vision is that the power and speed of light will change the way we live and work,” said Alain Couder, chairman and CEO, Oclaro. “By transmitting data over fibre at

increasing speeds, our customers have made possible new and fast growing applications such as social networking, video streaming, and cloud computing.”

“The ability to control the power of lasers as a heat and energy source is transforming healthcare, material processing and consumer electronics. Through this merger, we have assembled the optical technologies, products and expertise at the heart of this new world of innovation,” he adds. Oclaro is now the second largest provider of optical components, modules and subsystems to the optical communications, industrial and consumer laser markets, with approximately \$833 million in combined revenues and around 3,200 employees worldwide. Alain Couder is the named chairman and CEO of the combined company, with Opnext Chairman and CEO Harry Bosco joining the board of directors. Opnext shareholders will receive a fixed ratio of 0.42 shares of Oclaro common stock for every share of Opnext common stock they own.

Global economy takes toll on semiconductors, says equity analyst

Five Star Equities, US, provides bleak stock outlook for Skyworks Solutions and other semiconductor heavyweights

The global economic slowdown has begun to take its toll on the semiconductor industry as recent reports have provided a bearish outlook for the industry, reports US equity analyst, Five Star Equities. The Philadelphia Semiconductor Index – a price-weighted index tracking 18 US semiconductor companies involved in the design, distribution, manufacture, and sale of semiconductors - has fallen roughly 20 percent since the end of March. “We were seeing signs of a return to growth. But the macro-economic environment is proving very challenging,” said analyst Doug Freedman of RBC Dominion Securities.

Five Star Equities has examined the outlook for companies in the Semiconductor Industry focusing on Skyworks Solutions and TriQuint Semiconductor. As the company reports, an analyst at Avian Securities, US, Blaine Carroll, recently stated that these semiconductor suppliers may fall short

of their quarterly estimates. Carroll also lowered his production estimates of the much anticipated iPhone to between 5 and 20 million from his previous expectations of 25 million iPhones in the second quarter. "Our original iPhone builds of 25M are too aggressive due to macro headwinds from Europe and the lull in front of iPhone 5," he explained. According to Five Star Equities, Skyworks Solutions shares have fallen more than 9 percent in the last month, but are still up over 50 percent for the year.

Emcore flood recovery operations on schedule

Emcore expects to fully recover from the Thailand floods and achieve pre-flood production levels by October 2012

Reconstruction of Emcore's Thailand-based primary contract manufacturing operations is running to plan, reports the US-based semiconductor components developer, with some lines operating at pre-flood run-rates.

In October 2011, Emcore announced that flood waters had severely impacted the inventory and production operations of its Thailand manufacturing, damaging product lines from its Telecom and Cable Television (CATV) market segments. The Photovoltaics segment remained unaffected.

Emcore has since shifted manufacturing to alternative locations, including an alternate facility of its contract manufacturer in Thailand as well as its own manufacturing facilities in China and the US.

The production line for integrable tunable laser assemblies for 40 and 100 Gb/s coherent telecom applications has been up and running since March in Thailand, while production line qualification has been completed and most customers successfully completed full-line audits and started taking shipments in April.

As of this quarter, the integrable tunable laser line is operating at pre-flood capacity run-rates while the CATV laser module and transmitter production lines in China reached pre-flood capacity levels in mid-July.

Emcore expects the Tunable XFP transceiver line at its contract manufacturer in Thailand to reach volume production levels by October 2012. In the meantime, this manufacturing is continuing in the company's own Newark, California facility.

"We are very appreciative of our customers' understanding, cooperation, and support during the rebuild of impacted production lines the past 9 months," said Jaime Reloj, vice president of business development, Emcore. "Based on the strong demand for certain product lines, such as integrable tunable laser assemblies, we are increasing production capacity to exceed pre-flood levels to support orders for 40 and 100 Gb/s coherent applications."

Emcore now expects increased shipments for its fiber optics segment in the coming quarters as manufacturing volume ramps to normal levels.

Oclaro urges shareholders to vote for Opnext merger

Additional Oclaro votes are needed to close Opnext merger, so voting deadline is extended US-based Oclaro, manufacturer of laser diodes, is asking its shareholders to approve the proposed merger with fibre optics components manufacturer, Opnext, US, alongside an increase in authorised shares, to deliver sufficient shares to Opnext stockholders.

At their respective meetings, stockholders of Opnext approved the merger of the two companies, this being their final milestone needed to close the merger. Meanwhile, Oclaro received approximately 46% of the greater than 50% majority vote needed to approve this proposal and close the merger. Of the votes, approximately 89% were in favour of the proposal.

"The Oclaro and Opnext teams have been working diligently and our integration plans are on schedule," said Alain Couder, chairman and CEO, Oclaro. "We are ready to operate as a single company and look forward to taking our place as the number two global provider of optical components, modules and subsystems."

EMCORE unveils latest 1550nm fibre-optic transmitters

J-Type Medallion 6000 transmitters promise 'exceptional' link performance in Japanese markets. Compound semiconductor components provider, EMCORE, has added the J-Type Medallion 6000 to its 1550nm Cable Television (CATV) fibre optic transmitter product portfolio. This series of externally modulated transmitters has been developed specifically for Japan and other markets requiring long distance and concurrent fibre optic transport of CATV and Satellite-Intermediate Frequency Signals (SAT-IF).

According to EMCORE, the J-Type Medallion 6000 supports operational bandwidths up to 2.8GHz with adjustable SBS (Stimulated Brillouin Scattering) suppression range from 11 to 17dBm, plus extended adjustable AGC (Automatic Gain Control), and high OMI (Optical Modulation Index) for exceptional link performance. In parallel, EMCORE is announcing the next-generation WEB GUI and Simple Network Management Protocol (SNMP) software service offering for the entire Medallion 6000 platform.

The new interfaces are said to offer many new advanced capabilities to serve the evolving and growing needs of the world's most advanced networks. The J-Type transmitter's performance is enabled by EMCORE's proprietary high power, narrow-linewidth CW (Continuous Wave) laser technology.

When deployed with one or more EMCORE optical amplifiers, transmissions of 100km and beyond have been demonstrated. The WEB GUI and SNMP enhancements bring a whole suite of advanced operator monitoring and configuration options to the platform, allowing for secure, simplified and future-ready functionality for the next generation of intelligent networks.

"The 6000 family of transmitters is also ideal for extending traditional CATV systems including headend consolidation, broadcast transport, and RF overlay for FTTH (Fiber-To-The-Home) PON (Passive Optical Network), and RfOG (Radio Frequency over Glass) projects in countries around the world," says Grant Olecko, product marketing

director at EMCORE Broadband. "This capability allows us to capitalise on a significant and growing market opportunity."

ANADIGICS amplifiers to boost smartphone efficiencies

New power amplifier family will "set the standard for 4G battery life"

ANADIGICS has unveiled its latest power amplifier family for WCDMA and LTE networks. According to the company, the ProEfficient power amplifiers have been optimised for the next generation of 4G devices, by delivering world-class efficiency across all power levels. These products are said to combine greater talk time in low-power mode with longer data application use in high-power mode. As Jerry Miller, vice president of business development and marketing at ANADIGICS, explains the devices will extend battery life across all operating conditions of modern smartphone and tablet devices, as well as lower overall system cost. "4G devices enable users to tap into ultra-fast broadband speeds, resulting in greater data use," explains Miller. "This change in use drives the power amplifier to operate more frequently in high power mode.

By delivering outstanding efficiency in both high and low power modes, the new power amplifiers will help manufacturers set the standard for 4G battery-life." The latest power amplifiers are manufactured on InGaP HBT MMIC technology to achieve efficiency at high and low power modes. The devices are optimised for use with average power tracking operation to reduce current consumption at medium and low operating powers. In addition, the power amplifiers are said to provide exceptional linearity to ensure a stable connection for clear voice and high-speed data. The devices target the most widely used 3G/4G frequency bands, such as bands 1, 2, 3/4/9/10, 5, and 8.

Infinera spreads its wings in Netherlands and Belgium

The firm's indium phosphide PIC based platform gives consumers the ability to use 100 Gigabit Ethernet services

Infinera and Eurofiber have announced the availability of 100 GbE services across Eurofiber's Netherlands and Belgium network based on the Infinera DTN platform.

Eurofiber operates a fibre optic network that extends through the Netherlands, Belgium and Germany. The network spans across 13,000 km with more than 5,400 connection sites and 590 industrial estates.

Eurofiber specialises in providing managed dark fibre connections, Ethernet services and Dense Wavelength Division Multiplexing (DWDM) based Optical Transmission Services to service providers and businesses throughout the region.

With a DWDM-network based on the Infinera DTN platform, Eurofiber is now able to extend the company's product portfolio by offering 100 GbE services to its customers. Offering 100 GbE enables Eurofiber to provide their customers with services to meet the rapidly growing bandwidth demands from Internet exchanges, data centres, cable companies and Internet service providers.

"About eight years ago, the first 10 GbE services entered the market," notes Bart Oskam, Managing Director of Eurofiber. "At that time, 10 Gb/s was a lot of bandwidth, even for Internet exchanges. Today, given the pace in which the demand for bandwidth is increasing, the demand for 100 GbE connections will grow much faster. Rather than aggregating multiple 10 GbE links to increase capacity, it is often more efficient to simply deploy a single 100 GbE connection. The Infinera DTN enables these new 100 GbE services from our existing network."

The Infinera DTN platform is designed for optical transport network operators and features 10GbE, 40 GbE and 100 GbE service interfaces for flexible applications across regional, long-haul, and subsea deployments. In addition, DWDM line-cards support 40 Gb/s per wavelength coherent optical transmission, allowing the DTN platform to scale up to 6.4 terabits per second (Tb/s) of transmission

capacity per fibre.

The widely-deployed DTN platform pioneered the integration of DWDM optical transmission with OTN digital switching in a single system without performance compromise, thus boosting network efficiencies. The Infinera DTN platform, powered by the highly reliable Photonic Integrated Circuit (PIC) technology, enables global network operators a simple, scalable and efficient solution to migrate their networks according to their bandwidth needs. Infinera's optical transport solution is deployed by 99 customers globally.

"Infinera's DTN platform, based on our award winning 100 Gb/s PIC, offers Eurofiber a solution that allows their existing network to offer new high-bandwidth services to meet the growing needs of their customers," concludes Tom Fallon, Infinera CEO. "We are pleased to work with Eurofiber to deploy a scalable, reliable and efficient optical transport network."

Eurofiber first deployed the Infinera DTN platform in 2009.

Opnext demonstrates InP 100Gbps 3,300km transmission

The record breaking trial is a clear demonstration that coherent indium phosphide 100Gbps PM-QPSK transmission technology is tolerant to a very large range of impairments

Opnext and SURFnet, the National Research and Education Network (NREN) in the Netherlands, have announced a successful 100Gbps coherent field trial between the National Supercomputing Centre, SARA, in Amsterdam and CERN (Conseil Européen pour la Recherche Nucléaire - European Organisation for Nuclear Research) in Geneva.

Opnext used its OTS-100FLX 100Gbps digital coherent subsystem for the field trial, utilising next-generation 100Gbps single carrier technology and soft decision forward error correction (SD-FEC) to optically link Amsterdam to Geneva with a transmission distance of 1,650km using only erbium doped fibre amplifiers (EDFAs).

To further demonstrate the subsystem's performance, the embedded fibre link comprised a combination of the relatively high-nonlinear TW+ and TWRS fibres. What's more, the circuit was optically looped back in Geneva, thus creating a 3,300km circuit. The looped-back 3,300km link operated error-free for more than 23 hours (BER < 10⁻¹⁵) over the entire C-band and over a range of launch powers, highlighting the true upgrade potential of this link to 8Tbps in the future using 100Gbps coherent transponders.

"This trial is another clear demonstration that coherent 100Gbps PM-QPSK transmission technology is tolerant to a very large range of impairments (i.e. chromatic dispersion, polarisation mode dispersion, noise) and allows the use of alien wavelengths in research networks over DWDM systems from multiple vendors," says Roeland Nuijts, Optical Network Architect for SURFnet. "Transmission distance and tolerance against different impairments will be critical going forward as we look to build out international networks across geographic and administrative borders in order to realize a global facility for research networking."

The Opnext subsystem consists of a suite of OTS-100FLX 100Gbps flexponder line cards and a newly released OTS-mini ETSI shelf with a 4RU small form factor.

"It is great to see the results of our 100Gbps coherent product development deliver both the capacity and reach needed to scale next-generation optical networks around the world," adds Mike Chan, President of Opnext's subsystems business unit. "SURFnet's 3,300km field trial really pushed us, and our 100Gbps coherent technology met the challenge."

RF Electronics

Tektronix reveals advanced RF monitoring tool

The firm's Sentry Edge II system is a scalable solution for post-QAM monitoring in the dynamic video environment, where quick problem isolation and resolution are essential

Tektronix has unveiled the Sentry Edge II, another product in its Sentry Video Quality Monitor line.

Sentry Edge II detects RF modulation and transport stream errors generated by equipment errors or failures.

With Sentry Edge II, video service providers (VSPs) now have access to the information needed to proactively monitor RF, before issues affect subscribers.



The Tektronix Sentry Edge II

The tool is a high-performance, scalable solution for post-QAM monitoring in the dynamic video environment, where quick problem isolation and resolution are essential. VSPs can use Sentry Edge II at the hub, headend or wherever QAM is used. Comprehensive high-quality RF measurements make it easier and faster to pinpoint issues. For example, high quality MER measurements up to 41dB allow providers to detect signal quality degradation sooner, so they can take action

before this issue impacts the subscriber's viewing experience.

Providers' business requirements were also taken into account in designing the product.

Sentry Edge II offers more tuners per unit than competing products, lowering the cost of edge monitoring. Providers can choose from two high-density models - 4 or 8 tuners - both designed to minimise rack space and power costs. RF signals up to 1GHz can be monitored, allowing monitoring of the additional services that providers have added to grow their business. QAM A, B, and C support meets providers' requirements worldwide.

"The video and audio errors that can ruin subscribers' QoE can originate anywhere in today's increasingly complex networks, so monitoring network-wide is vital for resolving these errors before they impact subscribers," says Eben Jenkins, general manager, Video Product Line at Tektronix. "The advanced monitoring capabilities of our new Sentry Edge II ideally complement the other members of the Sentry family, enabling video service providers to comprehensively monitor video content from the 'source to the edge' of their networks."

Monitoring the edge of your network is important for catching modulation errors that could impact the quality of service you provide to your subscribers. Tektronix Sentry Edge products detect transport stream and RF modulation errors generated from equipment errors or failures.

Additional service monitoring capabilities are available for QAM channels in the clear, including audio/video QoE, perceptual video quality (PVQ), and Ad Verification as well as EBIF, tru2way, MHP and DSM-CC carousel analysis. Sentry Edge II is available now.

RF Micro Devices sponsor CS International Conference in Frankfurt

RF Micro Devices (RFMD) have confirmed they will be Gold sponsors at the Compound Semiconductor industry's premier international event, CS International, which will be held in Frankfurt, Germany on 4th & 5th March 2013.

RFMD is a global leader in the design and manufacture of high-performance semiconductor components. RFMD's products enable worldwide mobility, provide enhanced connectivity and support advanced functionality in the cellular handset, wireless infrastructure, wireless local area network (WLAN), CATV/broadband and aerospace and defence markets.

RFMD is recognized for its diverse portfolio of semiconductor technologies and RF systems expertise and is a preferred supplier to the world's leading mobile device, customer premises and communications equipment providers.

The must attend event for 2013 is the third CS International conference in Frankfurt, Germany, where delegates will gain a comprehensive overview of the entire compound semiconductor industry.

Professionals from around the world will attend this two-day event to hear key insights and opportunities, from a range of leading analysts, and learn of the latest chip developments in LEDs, solar cells, lasers and power and RF electronics.

Delegates will get the opportunity to network with leading industry professionals of the III-V chip making industry and interact with suppliers.

Industry leaders from Intel, Cree, Epistar, Aixtron, TriQuint and over 25 other leading chipmakers will also be present and to share their perspective on the latest developments in device technology.

A Networking Conference Dinner will be held on the evening of the 4th March where the industry will recognise the success and development along the entire value chain of the Compound Semiconductor industry from research to completed device, focusing on the people, processes and products

that drive the industry forward through The CS Industry Awards 2013.

Further information on the conference and the awards is available on the CS International website at: www.cs-international.net

Registration is now open for 2013 event, delegates who book before October 31st 2012 can take advantage of an early bird rate saving of €57.



Comtech wins \$3.1 million contract for GaN RF switches

The contract will support the U.S. military for high-power solid-state gallium nitride devices. Comtech Telecommunications Corporation has announced that its New York-based subsidiary, Comtech PST Corp., has received a contract award valued at \$3.1 million for solid-state, high-power RF switches from a major domestic prime contractor. These switches provide for very broad frequency coverage and are key components in an integrated electronic countermeasures system used by the U.S. military.

Fred Kornberg, President and Chief Executive Officer of Comtech Telecommunications Corp., says, "This significant order demonstrates Comtech's technical strength in delivering solid-state, broadband high-power RF switches for military applications. We believe the market for our high-power RF switch products remains strong." Comtech PST Corp is an independent supplier of broadband, high-power, high performance GaN RF microwave amplifiers and switches for use in a broad spectrum of applications including defence, medical, satellite communications systems and instrumentation.

Comtech conducts business through three complementary segments: telecommunications transmission, RF microwave amplifiers and mobile data communications. The Company sells products to a diverse customer base in the global commercial and government communications markets.

Digi-Key to distribute Hittite III-V products

Digi-Key will provide customers with Hittite's gallium arsenide, nitride, indium phosphide, silicon germanium, CMOS and BiCMOS semiconductor products

Electronic components distributor Digi-Key Corporation has signed a global distribution agreement with Hittite Microwave Corporation, a supplier of complete MMIC-based solutions for the communication and military markets.

Founded in 1985, Hittite Microwave designs and develops high performance integrated circuits, modules, subsystems, and instrumentation for technically demanding digital, RF, and microwave applications.

"Microwave and RF technology are widespread in numerous industries today," says Mark Zack, vice president, global semiconductor product at Digi-Key. "The broad selection of high-performance product offered by Hittite will add a unique dimension to our line card, and we are pleased to enter into this partnership."

Hittite's Digital Integrated Circuit (IC), Radio Frequency Integrated Circuit (RFIC) and Monolithic Microwave Integrated Circuit (MMIC) products are developed using state-of-the-art GaAs and silicon based semiconductor processes. The firm's state-of-the-art GaAs, GaN, InGaP/GaAs, InP, SOI, SiGe, CMOS and BiCMOS semiconductor processes utilise MESFET, HEMT, pHEMT, mHEMT, HBT and PIN devices. Its product portfolio covers 35 product lines and includes over 1,025 standard products.

Hittite products can be purchased now through Digi-Key's international websites.

RFMD reveals devices for wireless applications

The two new modules, which employ gallium arsenide technology, operate between 5MHz and 4000MHz

RFMD has unveiled two new multifunctional devices based on GaAs pHEMT and silicon CMOS technology.

The RFSA2644 and RFSA2654 are suited to transceiver RF and IF applications, 2G, 3G, LTE, WiMax/WiFi, wireless data, satellite terminals, test equipment, CATV, cable modems and data network equipment.

Both modules, which have 6-bit digital step attenuators, feature high linearity over their entire 31.5dB gain control range with step accuracy in 0.5dB steps. They are programmed via a serial mode control interface that is both 3V and 5V compatible. The devices also offer a rugged Class 1C HBM ESD rating via on-chip ESD circuitry and the MCM packages are footprint-compatible with most 24-pin, 4mm x 4mm, QFN packages.

The RFSA2644 operates between 50MHz and 4000MHz while the RFSA2654 is suited to 5MHz to 2000MHz applications with IP3 above 50dBm for all steps.



Both the RFSA2644 and RFSA2654 are currently available in production quantities. Pricing begins at \$1.76 each for 750 pieces.

RFMD'S CATV GaN amplifiers in the spotlight

The amplifiers, one of which uses both gallium arsenide and gallium nitride technology, have been awarded for their novel cable technology. RF Micro Devices has received "Product of the Year" Awards from Cable Spotlight for three of its broadband cable television (CATV) products. Cable Spotlight is a cable technology website. It's Third Annual Cable Spotlight Product of the Year Awards highlight innovative cable technology products brought to market in 2011.

The award winning products are the RFAM2790 integrated EDGE QAM amplifier, the RFCM2680 GaAs/GaN power doubler and the RFPP2870 push-pull amplifier.

Driven by explosive consumer demand for digital content, operators of multi-system networks are seeking more bandwidth, higher output, and lower distortion, while also requiring lower power consumption to reduce operating expenses. RFMD's award-winning CATV products all use advanced compound semiconductor technology.

Norm Hilgendorf, president of RFMD's Multi-Market Products Group, says, "RFMD's best-in-class CATV transmission products are optimised to satisfy the industry's ever-increasing requirements for bandwidth and signal purity. We are honoured to be recognised by Cable Spotlight for our CATV amplifiers, and we look forward to introducing additional devices that feature superior power density, high power efficiency, and rugged dependability."

"RFMD has proven its dedication to quality and excellence while addressing real needs in the marketplace. I am pleased to grant a 2011 Product of the Year Award for RFAM2790, RFCM2680, and RFPP2870," says Rich Tehrani, CEO, TMC. "RFMD's commitment to the advancement of the cable technology industry is commendable and I am looking forward to more innovation in the future."

The RFAM2790 functions as an Edge QAM amplifier or a push-pull amplifier with +46dBmV output power. Its inner-stage attenuator provides 8-28dB gain range and it features power-down functionality for power save mode. The part meets DOCSIS 3.0 specifications with 7dB margin.

The RFCM2680 is the world's first GaN-based surface mount power doubler. Capable of delivering +61dBmV output power, the RFCM2680 consumes 20% less current for the same linearity performance, compared to GaAs technology. The RFCM2680's surface mount package allows up to 50% savings in board area over industry-standard SOT115J packages.

The RFPP2870 is a GaN-based push-pull amplifier featuring high gain 28dB (minimum at 1003MHz) and excellent linearity at low distortion levels. It is available in an industry-standard SOT115J package.

Telecom veteran jumps on Board at TriQuint

The new addition, Roderick Nelson, was responsible for the development and deployment of the first 3G networks in the U.S.

TriQuint Semiconductor, an RF solutions supplier and technology innovator, has expanded its board of directors with the addition of Roderick Nelson as a new independent director.

Nelson's career in the telecommunications industry spans over 25 years, ranging from AT&T Wireless to a number of start-up companies. He served as Executive Vice President and Chief Technology Officer of AT&T Wireless Services, based in Redmond, Washington, where he led the Technology Development Group responsible for the development and deployment of the first 3G networks in the U.S. His role was to define the future wireless network architecture and technology direction.

During his career, Roderick Nelson has worked closely with both national and international regulators and standards bodies on the creation of 3G specifications and standards. Highly regarded as a spokesperson and industry leader on the direction wireless technologies, he has developed strategies to make radio spectrum available for successful 3G deployments.

Currently, Nelson is a founding partner at Tritech Sales and Services, LLC, a specialised consulting practice, which provides business and technology strategy consulting as well as business development and distribution strength to accelerate clients' growth in the wireless ecosystem.

Nelson and Tritech have successfully positioned new technology solutions and vendors with leading operators in the U.S. and internationally, taking previously unknown vendors and solutions to carrier approval resulting in scaled revenue generation.

RFMW to distribute TriQuint high linearity amplifier

US electronics components distributor, RFMW, introduces 2W highly linear amplifiers from RF components maker, TriQuint Semiconductor. US components distributor, RFMW, is to provide design and sales support for TriQuint Semiconductor's TQP7M9106, high linearity amplifier with frequency coverage from 50MHz to 1.5GHz. This QFN 4x4mm packaged amplifier provides around 21dB of gain at 1GHz while drawing a 455mA of current from a 5V supply. According to RFMW, output IP3 is an astounding 50dBm making this amplifier useful in applications such as 3G/4G wireless infrastructure, small cell BTS transceivers, boosters, high power amplifiers and defence communications.

The TQP7M9106 is part of a family of highly linear amplifiers, QFN 4x4mm packaged devices that includes the TQM7M9104 which pushes the high end frequency to 4GHz. As RFMW also claims, the amplifier contains added patented features implemented on-chip that differentiates it from other products in the market.

It contains RF overdrive protection while the internal active bias allows the amplifier to operate off of a 5V supply and provides DC over-voltage protection. On-chip ESD protection also allows the amplifier to have a very robust Class 1C HBM ESD rating. According to RFMW, the device is ideal for 3G / 4G small cell base stations, high power amplifiers, repeaters, defence communications, or any other general wireless application in the 50-1500MHz frequency range.

TriQuint posts losses as mobile demand wanes

US chipmaker blames weak results on slow mobile device demand

US chipmaker TriQuint Semiconductor has posted quarterly losses, blaming its weak results on low demand for mobile devices.

Revenues for the second quarter of 2012 were \$178 million, down 22% from the same time last

year, and down 18% sequentially. Net losses came in at \$16.5 million this quarter, compared with a profit of \$16.6 million, in the previous year.

“TriQuint’s second quarter performance was in line with expectations,” said Ralph Quinsey, TriQuint president and chief executive.

“Mobile devices demand was soft in the second quarter as the smartphone industry prepares for a seasonally strong second half.” “However, our Defense and Networks revenue was slightly up year-to-date with a healthy outlook for the remainder of the year,” he added. “We believe TriQuint is well positioned for revenue growth and improved financial performance in the second half of 2012.”

TriQuint recently announced a \$12.3 million GaN DARPA contract to develop ultra-fast power switch technology and has introduced the industry’s first 802.11ac Wi-Fi RF module for next-generation smartphones and tablets.

RFMD reveals single-stage InGaP HBT power amplifiers

The latest power amplifiers are designed to be used in wireless infrastructure applications including base station transceivers and next-generation wireless network transceivers.

US-based RF integrated circuit developer, RF Micro Devices, has unveiled the RFPA2089, a single-stage InGaP HBT power amplifier specifically designed for wireless infrastructure applications. The device offers high-gain linear operation at a comparably low DC power making it ideal for next generation radios requiring high efficiency. As RFMD highlights, its external matching allows for use across various radio platforms. Key features include 60dBc ACPR at 13dBm WCDMA and 0.25W OP1dB.

The device promises excellent linearity-to-DC power ratio with a 17.6dB gain at 2.65GHz, single-supply 5V operation and class 2 (2000V) HBM ESD. According to RFMD, key applications include driver amplifier for base station transceivers, PA stage for commercial wireless infrastructure, IF

amplifier and 2G, 3G, LTE transceiver applications.

Anadigics powers Samsung Galaxy smartphone

Anadigics dual-band power amplifiers promise exceptional performance and integration for the Samsung Galaxy S III smartphone



Anadigics is shipping production volumes of its dual-band “High-Efficiency-at-Low-Power” (HELP3E) power amplifiers to Samsung Electronics for the new Galaxy S III smartphone. The Galaxy S III features a 4.8 inch HD Super AMOLED display, eight megapixel rear-facing camera, 1.5GHz dual-core processor, and Android 4.0 Ice Cream Sandwich operating system.

Anadigic’s AWC6323 power amplifier enables the Galaxy S III from Verizon Wireless, US, while its AWC6325 and ALT6725 power amplifiers are featured in the Galaxy S III from Sprint, US. “Anadigics’ power amplifiers continue to set the standard in both performance and integration,” said Michael Canonico, senior vice president of worldwide sales.

“They are supported by our team of applications engineers to help manufacturers quickly bring to market advanced smartphones with longer battery-life and uncompromising designs.”

The latest power amplifiers are manufactured using InGaP-Plus – Anadigics’ GaAs BiFET process technology - to achieve optimal efficiency across low-range and mid-range output power levels and provide low quiescent currents. As the company highlights, this level of performance helps to extend battery-life in handsets, smartphones, tablets, netbooks, and notebooks.

These 3 mm by 5 mm dual-band PAs feature two independent power amplifiers, RF couplers,

control logic and a voltage regulator in a single package, reducing printed circuit board (PCB) space requirements by greater than 20% compared with single band discrete solutions. The InGaP-Plus process uses previously developed process modules and is only moderately more complex than a stand-alone HBT flow. According to Anadigics, tens of millions of WLAN and cellular handset PAs have been manufactured using InGaP-Plus with yields comparable to HBT-only processes.

Military applications continue to drive GaN development

GaN technology boosts communications performance as military invests in next generation systems, reports Strategy Analytics

Military applications will continue to grow and drive the fundamental development of semiconductor technologies such as gallium nitride, reports Strategy Analytics in its "Defence Electronics Industry Review: June 2012".

The report was highlighted at the International Microwave Symposium, (IMS 2012) and details significant defence industry news, including product announcements, milestones, contract activity and defence industry financial performance.

Speaking at IMS 2012, Cree, Nitronex, NXP, RFMD, TriQuint and UMS confirmed the report's conclusions on the applicability of GaN to communications, electronic warfare, and radar needs.

"Panelists highlighted examples where GaN technology will improve performance, efficiency and bandwidth as the military invests in next generation systems," noted Eric Higham, ADS Service Director North America.

Toshiba's new X-band GaN hybrid IC (HIC) targeted at transmit-receive modules (TRMs) used in active electronically scanned array (AESA) and passive electronically scanned array (PESA) radar applications, is a key example.

"Semiconductor technologies also underpinned military system level activity in June," says Asif Anwar, Director of the ADS service at Strategy

Analytics. "Boeing and Raytheon received contracts related to AN/APG-79 AESA radar upgrades, while Northrop Grumman demonstrated the capabilities of the company's AN/AAQ-37 distributed aperture system (DAS) and AN/APG-81 AESA radar, both featured on the F-35."

Global economy takes toll on semiconductors, says equity analyst

Five Star Equities, US, provides bleak stock outlook for Skyworks Solutions and other semiconductor heavyweights

The global economic slowdown has begun to take its toll on the semiconductor industry as recent reports have provided a bearish outlook for the industry, reports US equity analyst, Five Star Equities. The Philadelphia Semiconductor Index – a price-weighted index tracking 18 US semiconductor companies involved in the design, distribution, manufacture, and sale of semiconductors - has fallen roughly 20 percent since the end of March. "We were seeing signs of a return to growth. But the macro-economic environment is proving very challenging," said analyst Doug Freedman of RBC Dominion Securities.

Five Star Equities has examined the outlook for companies in the Semiconductor Industry focusing on Skyworks Solutions and TriQuint Semiconductor. As the company reports, an analyst at Avian Securities, US, Blaine Carroll, recently stated that these semiconductor suppliers may fall short of their quarterly estimates. Carroll also lowered his production estimates of the much anticipated iPhone to between 5 and 20 million from his previous expectations of 25 million iPhones in the second quarter. "Our original iPhone builds of 25M are too aggressive due to macro headwinds from Europe and the lull in front of iPhone 5," he explained. According to Five Star Equities, Skyworks Solutions shares have fallen more than 9 percent in the last month, but are still up over 50 percent for the year.

Hittite unveils wideband downconverter operating from 700 to 3500MHz

Latest RFIC promises high linearity and wide bandwidth in a compact 3 x 3mm package US-based RF IC developer, Hittite Microwave, has released a new Broadband High IP3 Downconverter RFIC which operates from 700 to 3500MHz. The HMC1090LP3E is said to be ideal for space constrained frequency conversion applications in wireless infrastructure equipment such as base transceiver stations, remote radio units, small cells and repeaters.

The device is a high linearity down-converting mixer, optimised for multi-standard diversity receiver applications where low power consumption and small size are required. The highly integrated RFIC features a wideband limiting LO amplifier and can be used in any 3 GPP operating band from 700 to 3500 MHz. Unlike conventional narrow-band downconverter RFICs, this device supports both high-side and low-side LO injection over the entire RF band. The HMC1090LP3E integrates LO and IF amplifiers, LO and RF baluns and a wideband passive mixer core with bias control.

The unique architecture of this converter provides excellent LO/RF, LO/IF, and RF/IF isolations, while the RF and LO input ports are internally matched to 50Ω. The RFIC exhibits noise figure as low as 8.5dB and input IP3 up to +26 dBm making it ideal for demanding high linearity applications.

For narrow-band applications, the input IP3 performance of the device can be further optimised with simple external matching. Consuming typically less than 0.9W of DC power, the HMC1090LP3E provides additional power conservation options in time division duplex (TDD) applications. The device is housed in a compact RoHS compliant, 3 x 3 mm plastic QFN package, and is also available in dual channel format as the HMC990LP4E.

Skyworks posts lower profits but pleasing revenues

Third quarter revenues beat expectations thanks to rising smartphone and tablet demand

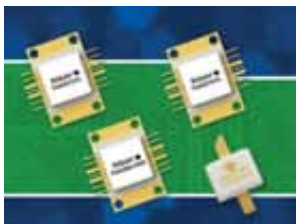
Analogue semiconductor developer, Skyworks, has reported a third-quarter profit of \$49.3 million, or 26 cents per share, down compared to \$51.5 million, or 27 cents per share, for the same time last year. Citing rising operating costs as the reason for decreasing profits, the business still reported higher revenues than expected, rising 9.3% to \$389million, compared to the third quarter of 2011.

The company's previous guidance for this quarter put revenues at \$383 million. "Skyworks outperformed our addressable markets last quarter and the stage is set for a strong back half of 2012," said David J. Aldrich, president and chief executive officer of Skyworks. "Our strategic diversification across OEMs and chipset partners is enabling us to produce strong operating results despite the macro economy.

We are gaining share within adjacent vertical markets including automotive, medical, avionics, military, location services and broadband communications." "At the same time, our innovative solutions are powering the world's most popular smartphones, tablets, home automation platforms and network infrastructure systems. In short, we have created a differentiated business model that is delivering demonstrable, best in class mobile internet growth with analogue semiconductor shareholder returns," he added. The company expects fourth-quarter earnings of 50 cents to 51 cents per share, on a revenue of \$415 million to \$420 million. Shares rose 12% following the latest third quarter results.

TriQuint GaN devices promise better RF efficiency

Latest power amplifiers and transistor boast better RF performance while reducing overall cost



GaN-based RF device developer, TriQuint Semiconductor, has released three new power amplifiers and a transistor.

The GaN power amplifiers promise to deliver greater efficiency, wideband coverage and excellent performance for communications, defense and civilian radar.

Three versions have been developed, the TGA2572-FL, 14-16 GHz, the TGA2579-FL, 14-15.5 GHz and the TGA2593-GSG, 13-15 GHz.

Meanwhile, the T1G6003028-FS, a 30W wideband GaN packaged transistor, promises to cut the number of driver circuits in a typical power amplifier design by 50%.

“TriQuint is advancing state-of-the-art high frequency and high power GaN research,” said TriQuint defense products and foundry services vice president James Klein. “Our internal product development programs are creating new commercial and defense lower-voltage devices.”

According to the company, GaN-based integrated circuits outperform silicon, gallium arsenide and other semiconductor technologies.

The devices are considered to be crucial to future ‘green’ RF and DC-DC power solutions, that can reduce network electrical consumption, enable greater range in electric vehicles or extend smartphone battery life.

EpiGaN ramps up production on Aixtron reactors

IMEC spin-off, EpiGaN, kick-starts six inch wafer production and eight inch development on Aixtron systems



Belgium-based GaN epiwafer maker and IMEC spin-off, EpiGaN, has commissioned two new MOCVD systems from Aixtron for the commercial production of 6-inch GaN-on-Silicon wafers.

Producing wafers for power and RF electronics devices, EpiGaN will also use the systems to develop next generation 200mm GaN-on-Silicon wafers. The systems can operate multiple 6” or in 8” configurations. Aixtron installed and commissioned the reactors at EpiGaN’s purpose-built, state-of-the-art facility in Research Campus Hasselt, which opened in May this year. “After several years of efficient collaboration with Aixtron towards GaN-on-Si, it was evident that their Close Coupled Showerhead systems perfectly suit our needs,” explains Dr Marianne Germain, CEO of EpiGaN.

“[We’ve] worked with Aixtron’s CCS MOCVD systems at IMEC and have jointly published numerous papers on GaN-on-Silicon development.”

“There are challenges ahead for high voltage 200mm GaN-on-Si, but we are confident that the combination of our enduring expertise and the leading edge equipment and process technology will deliver all our objectives rapidly and efficiently,” she adds. EpiGaN’s founders have pioneered GaN on Si technology, and were the first to demonstrate GaN HEMT’s on 6” and 8” silicon substrates.

The company is also participating in the EU project HiPoSwitch aiming to develop more compact and powerful energy converters. Activities cover the entire value chain from GaN-on-Si epiwafers over GaN power device development to industrial application.

Lasers

Tiger Optics a roaring success in the U.S.

The innovator in laser-based monitor and gas analysers came 71st in greater Philadelphia and 76th in manufacturing in terms of growth.

For the fourth time, Inc. magazine has named Tiger Optics LLC to its 5000 list of fastest-growing private companies in the United States.

Among manufacturers on the 2012 list, the magazine ranked Tiger as the 76th fastest-growing firm, based on its percentage revenue growth from 2008 to 2011.

In the greater Philadelphia area, the magazine rated Tiger Optics as the 71st fastest-growing private company. Nationwide, Tiger ranks 2,285th on the 2012 Inc. 500|5000.

Founded in 2001, Tiger makes ultra sensitive, laser-based environmental air monitors for continuous emissions and agricultural process control, as well as gas analysers to monitor highly critical processes for semiconductor fabrication plants, High Brightness LEDs and gas manufacturers.

With close to 1,500 robust Tiger units serving these demanding applications, Tiger also supports the metrology institutes of 16 nations.

The company's devices utilise Continuous Wave Cavity Ring-Down Spectroscopy (CW CRDS), a patented technology developed in the early 1990s by Kevin Lehmann, then a chemistry professor at Princeton University.

The company makes all of its products in Pennsylvania, while over 50 percent of its sales occur in foreign markets. Its 2011 revenue of \$10.3 million rose 110 percent from 2008 revenue of \$4.9 million.

Previously, Inc. magazine named Tiger Optics to its 500|5000 lists in 2011, 2009 and 2008.

To qualify for the current list, companies must have been founded and generating revenue by March 31st, 2008. They had to be U.S.-based, privately held, for profit, and independent - not subsidiaries

or divisions of other companies - as of December 31st, 2011.

Stuttgart University orders another Aixtron tool for laser research

The 3x2" MOCVD CCS reactor will be used for the growth of gallium arsenide solid state lasers and III-V materials on silicon

The University of Stuttgart has made a repeat order for Aixtron's CCS (Close Coupled Showerhead) system that is capable of handling three 2-inch (3x2") substrates at a time.

The system will be used by University of Stuttgart's Institute of Semiconductor Optics and Functional Interfaces (Institut für Halbleiteroptik und Funktionelle Grenzflächen, IHFG) research group.

IHFG researchers specialise in semiconductor optics and epitaxy.

The new Aixtron system will be used to expand IHFG's work in GaAs based optoelectronics, in particular, producing material for solid state lasers.

The order was booked in the first quarter of 2012 and the reactor will be delivered in the third quarter of 2012.

Michael Jetter of IHFG comments, "We want to use the CCS 3x2" in two ways: on the one hand we want to produce our GaAs-based laser structures on GaAs, but we also want to transfer them to silicon substrates. As a specialist in semiconductor optics, the Institute's main research areas are semiconductor lasers and low dimensional structures such as quantum wells (QWs) and quantum dots (QDs)."

One focus of the work will be quantum cryptography and single photon emitters. However, the researchers also foresee opportunities arising from their efforts in automotive electronics. In particular, the researchers plan to grow III-V materials on silicon substrates using Aixtron's MOCVD technology.

Jetter adds, “We would like to give silicon electronics an optic touch, which means that we want to monolithically integrate III-V optoelectronic devices (lasers and LEDs, either QW- or QD-based) into CMOS-compatible silicon substrates. These can then be used for the optical data interconnects either on-chip, chip-to-chip or as board-to-board connectors.”

The Aixtron equipment will be also used by the Stuttgart Research Centre of Photonic Engineering (SCoPE), which aims to improve interdisciplinary collaborations between scientists and engineers at the Universität Stuttgart.

IHFG and Aixtron plan to work together in the future on joint research and to co-operate on other scientific programs in the Stuttgart region, focusing on III-V growth on silicon.

InP lasers break spectral bandwidth record

Researchers have developed indium phosphide based long-wavelength VCSELs which have a bandwidth of 100nm

Working in collaboration with their partners under the EU’s “Subtune” project, scientists at the TU Darmstadt have developed semiconductor lasers that emit light over a wavelength range of 100 nm.

The researcher say this is a new world record for a single semiconductor laser.

Such lasers might allow more efficient, lower-cost operation of future fibre optic telecommunications networks and the development of high-responsivity gas sensors.

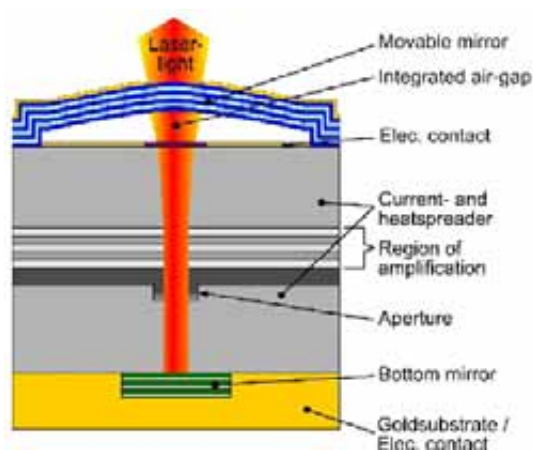
Currently, continuous tuning and mode-hop free tuning over 60 nm is typically achieved at wavelengths around 1.55 μm .

The goal of the Subtune project is to develop InP-based long-wavelength VCSELs ranging from 1.5 μm to 2.0 μm and GaAs-based VCSELs with wavelengths down to 800 nm, to introduce widely tuneable VCSELs in a broad range of the optical spectrum.

The concept is that the active component or so called half-VCSEL, is combined with a bulk-micromachined moveable mirror membrane in a hybrid two-chip assembly. The mirror can be electrothermally actuated to expand the air-gap and shift the cavity resonance towards longer wavelengths.

The eight European partners involved in the Subtune project are:

The Technische Universität Darmstadt (Germany), The Technische Universität München (Germany), Vertilas GmbH (Germany), Chalmers University of Technology (Sweden), Tyndall National Institute (Ireland), IR Microsystems SA (Switzerland), Commissariat à l’Energie Atomique (France) and Consiglio Nazionale Delle Ricerche, IEIT (Italy).



Design of TU Darmstadt’s semiconductor laser. (Picture Credit: Institute for Microwave Technology and Photonics)

Surface-emitting semiconductor lasers emit light at a right angle to the plane of the semiconducting wafer on which they have been fabricated. They don’t need much power to operate and are therefore used as light sources, for example in computer mice and laser printers.

Christian Gierl and Karolina Zogal of the TU Darmstadt’s Institute for Microwave Technology and Photonics have recently significantly extended the tuneabilities of such lasers.

Their approach involves taking advantage of yet another benefit of surface-emitting semiconductor lasers, namely, their very large resonator-length/ emitting-area ratios, which greatly increases the

spacings of their emitted wavelengths.

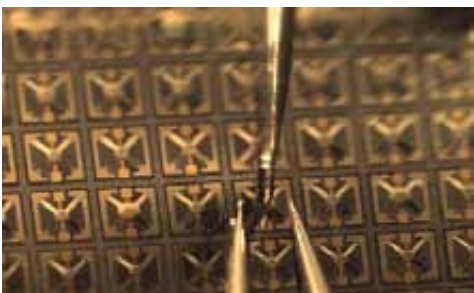
Their broad free spectral range allows tuning the wavelength of their strongest emission line over a broad range. It converts them into transmitters whose output may be set to any wavelength falling within a certain, broad range, just as radio transmitters may be tuned to various frequencies/wavelengths.

Gierl, a physicist, and Zogal, a materials scientist, managed to tune the wavelength of the output beam of a semiconductor laser provided by one of their Subtune partners, the Walter Schottky Institute at the TU München, over a range of more than 100 nm.

This, they claim, is the broadest tuning range so far achieved by any semiconductor laser and that these devices have excellent, emission characteristics, such as high output power and high spectral purity, similar to their conventional counterparts.

In order to obtain this broad tuneability, the scientists applied to its emitting surface a flexible membrane having a reflectance exceeding 99 percent at its lasing wavelengths that served as its output mirror, and whose flexing could be externally controlled.

Every laser is equipped with a pair of facing mirrors that reflect light back and forth in order to amplify the laser's active medium on each pass. The spacing of its mirrors determines which wavelengths from the amplified range will be emitted. The TU Darmstadt duo's new lasers allow accurately varying that spacing at will and smoothly tuning laser output wavelength over a broad range.



Such lasers might allow more efficient, lower-cost operation of future fibre optic telecommunications networks and the development of high-responsivity gas sensors. (Picture Credit: Institute for Microwave Technology and Photonics)

What's more, the TU Darmstadt duo have said that this fundamentally new technology could be easily transferred to practical applications without a hitch. Their lasers are tuneable over a range centred on 1.55 μm , the wavelength utilised by fibre optic telecommunications systems. They also claim to have developed the world's first tuneable laser covering a range centred on 2.0 μm .

Gierl explains, "The telecommunications industry is extremely interested in this technology because in the future it will need to service households via fibre optic networks operating at various wavelengths." If there were no tuneable lasers, a special type of semiconductor laser would have to be fabricated for each wavelength to be involved. He adds, "Tuneable lasers obviate that necessity, since only a single type of laser will have to be fabricated."

The wavelength range centred on 2.0 μm is of particular interest to sensors for detecting the presence of gases, since it falls within the range where the vibrational modes of molecules, such as CO₂, are excited. Gases may be identified and their concentrations determined by means of precision measurements of the wavelengths at which they absorb radiation and the absorption coefficients occurring at those wavelengths.

Gierl also says, "Since that absorption is very strong, gas sensors based on our technology have high responsivities, in addition to being extremely compact and highly energy-efficient."

He also points out that thanks to their tuneability, a single laser would be sufficient for detecting various gases.

The next goal is to close the remaining gaps for utilisation in practical applications.

According to the two researchers, another benefit of its new lasers is that they are easy to fabricate. As Gierl puts it, "Although the method we employ for applying the membrane directly to the laser is new, we utilised methods that have become well-established in the semiconductor industry for that purpose." The method involved is microphotolithography, a sort of engraving technique employed for fabricating microchips that allows generating structures having dimensions of the order of a few micrometres.

Gierl goes on to say that, they are able to fabricate chips having numerous, tuneable, surface emitters that meet all of the requirements for the particular applications involved.

A follow-on project is intended to close the remaining gaps in such chips' readiness for utilisation in practical applications. Closing one of those gaps involves providing that their output may be modulated at high frequencies in order that data may be transmitted at high transfer rates. The researchers also plan to incorporate their chips into modules similar to USB sticks that may be readily integrated into telecommunications systems.

They are already collaborating with the Lawrence Livermore National Laboratory, Livermore, California, and Leister Technologies AG, Kaegiswil, Switzerland, on improving their gas sensors.

The new lasers have already been successfully tested on a communications network at Subtune partner Tyndall.

Chalmers professor nets HP award for VCSEL research

Anders Larsson has been honoured for his research on gallium arsenide based vertical cavity surface emitting lasers

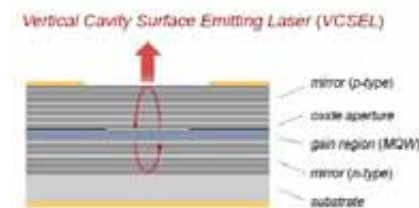
HP Labs Innovation Research has awarded Chalmers professor Anders Larsson for his work on "High Contrast Grating VCSELs for WDM Computer Interconnects."

The project was a collaboration with Michael Tan and his group at the Intelligent Infrastructure Lab at HP Labs.



Chalmers researchers involved in the project: Jörgen Bengtsson, Erik Haglund, Anders Larsson, Johan Gustafsson and Åsa Haglund. (Photography credit: Peter Widing)

The HP Labs' Innovation Research Program is designed to create opportunities at colleges, universities and research institutes around the world for collaborative research with HP. Anders Larsson is one of 61 university professors selected for the HP Labs Innovation Research Awards in 2012.



VCSELs are the primary light source for short-reach optical communication because they are highly efficient, have excellent high speed properties, can be easily coupled to optical fibres and are cheap to manufacture.

VCSELs are mass produced for high capacity optical interconnect cables in storage area networks (data centres) and high performance computing systems such as computer clusters and supercomputers. In the near future, high speed optical cables with VCSEL-based optical transmitters will also make their debut in consumer electronics (Thunderbolt, USB, HDMI and so on.).

For computing applications, the small footprint and high modulation speed of VCSELs enable very high density and very high capacity interconnects. To increase capacity beyond what can be provided by a single channel, space division multiplexing (parallel fibre ribbons or multi-core fibres) or wavelength division multiplexing (WDM) can be used.

WDM, which requires monolithic multi-wavelength VCSEL arrays, enables optical interconnect architectures which offer more complex interconnect topologies and routing schemes. It also enables the interconnect network to adapt to irregular and time varying traffic patterns.

The project aims to develop a VCSEL technology where the wavelength of individual VCSELs can be

set in a post-growth fabrication process. This will enable the realisation of low power consumption, high speed, multi-wavelength VCSEL arrays for future WDM interconnects in computing systems.

Princeton Opto reveals 808nm high power VCSEL Illuminator

The new model, based on gallium arsenide technology, is suited to high speed photography

Princeton Optronics has announced the availability of 808nm high power illuminator model (PR-HPIL-800-W808) with power output of 800W using multiple Vertical Cavity Surface Emitting Laser (VCSEL) arrays.

Higher illumination levels are required for high speed photography as with increase of frame rate (or reduction of frame time), the number of available photons per pixel per frame decrease proportionately. Very high level of illumination is required to image certain fast events such as speeding bullets or blast fragments through the air. VCSEL arrays are preferred illumination devices for such applications because of their low speckle and flattop beam profile.

In the PR-HPIL-800-W808, four VCSEL array chips are mounted in the module and connected in series so that they deliver a power level of 800W from the module. We also supply the power supply which is triggered by the camera for some applications. A diffuser is optionally attached to the VCSEL arrays to increase the beam divergence, if needed. Also offered are illumination modules of various power levels starting from several watts to 800Watts for CW, QCW or pulsed illumination.

In addition to 808nm, Princeton Optronics offers illumination modules at other wavelengths such as 830nm, 976nm, 1064nm and at 680nm (red). The firm is a manufacturer of high power single and multi-mode VCSELs and VCSEL arrays, and has a diverse line of products suitable for many applications including illumination, sensing, and solid state laser pumping.

Below are two pictures of the product from two

angles.



JDSU completes acquisition of GenComm

The innovator of networks and high-powered commercial lasers for a range of applications has purchased the a provider of wireless test and measurement products

JDSU has completed the acquisition of GenComm, a provider of wireless test and measurement solutions based in Seoul, South Korea.

JDSU announced its intent to acquire GenComm on August 14th, 2012.

GenComm's solutions were previously distributed by JDSU under an OEM relationship and are used by tier one service providers, wireless network manufacturers and contractors around the world to quickly provision wireless services that help them create new revenue streams and improve wireless service for millions of users worldwide.

"We welcome the talented employees of GenComm to JDSU and look forward to working with them on new ways to advance wireless networks as part of the world's leading provider of communications network test solutions," says David Heard, president of JDSU's Communications Test and Measurement business segment.

Ferdinand-Braun orders tool for laser diode deposition

Oxford Instruments' ion beam Optofab3000 system will be used to deposit 0.63 μm to 1.12 μm III-V semiconductor layer structures

Research organisation, the Ferdinand-Braun-Institut

(FBH) has ordered an Optofab3000 for laser bar facet coating.

The ion beam deposition tool from Oxford Instruments Plasma Technology, further expands FBH's capability in optoelectronics research & pilot production.



A similar ion beam system to the one that will be delivered to FBH

The Optofab3000 tool will be used to deposit high quality optical thin films for high-power and high-brightness laser diodes at wavelengths in the range from 0.63 μm to 1.12 μm , that are based on III-V semiconductor layer structures.

Götz Erbert, Head of the Optoelectronics Department at FBH, comments, "We have chosen the Optofab3000 ion beam deposition tool because of its capability to deposit high quality optical films as well as its advanced in-situ optical monitor. Another key factor in making our decision was the twin benefits of a tool that can achieve our high-specification requirements with a small footprint. While we are primarily an R&D institute we also undertake pilot production, and consequently need to achieve the highest quality end product possible."

"We are extremely pleased to have the opportunity to work with a prestigious research institution like FBH", adds Mark Vosloo, Director of Sales, Marketing and Customer Support at Oxford Instruments Plasma Technology. "Their decision to order an Optofab3000 for Laser Bar Facet Coating

from Oxford Instruments further establishes our ion beam products in the field of optoelectronics research & production."

The Optofab3000 ion beam tool is scheduled to be delivered by the end of 2012.

IPG supports laser operations in Turkey

The firm's new sales and service office, based in Istanbul, is targeting additional customers in the large expanding Turkish economy

IPG Photonics Corporation, a manufacturer of high-performance fibre lasers for diverse applications, has opened a new office in Istanbul, Turkey to provide local support and service for the Company's fibre lasers in Turkey and surrounding countries.

Office staff will include trained sales, support, technical and administration.

While many economies have been unable to recover from the recent global financial recession, the Turkish economy expanded by 9.2 percent in 2010, and 8.5 percent in 2011, standing out as one of the few growing economies in Europe, and one of the fastest growing economies in the world.

Turkey, which has a population of 80 million, has a diversified economy with a strong manufacturing ethic, particularly in consumer durables and automobiles. Currently, Turkey is the 16th largest economy in the world and the 5th largest economy in the EU, according to GDP figures in 2011.

"Opening an office in Turkey demonstrates IPG's commitment to the region and will enable the Company to provide prompt and direct technical support," says Valentin Gapontsev, IPG's Chief Executive Officer. "In a short time, we developed numerous cutting OEMs in Turkey which use our high performance fibre lasers. Our continued success there merits a local sales and service presence in Turkey. We are excited about the opportunities in the Turkish market and nearby as well as participating in the growth that Turkey is experiencing."

IPG Photonics Eurasia Lazer Ürünleri Satış ve

Servis Hizmetleri Limited Şirketi, the official name of the Turkish office, is registered and is now conducting business.

II-VI reveals record bookings but falling profits

US optoelectronics components maker posts mixed quarterly results

II-VI revenues for the quarter increased 4% to \$136,910,000 from \$131,783,000 in the fourth quarter of last fiscal year, while revenues; year-on-year increased 6% to a record \$534,630,000 from \$502,801,000.

As the company highlights, bookings remain strong, increasing by 8% to \$141,959,000 for this quarter, compared to \$131,177,000 in the fourth quarter of last fiscal year. Bookings were up 3% year-on-year to a record \$534,865,000 compared to \$520,238,000 for last fiscal year.

However, net earnings for the quarter were down to \$14,446,000 from \$22,039,000 in the fourth quarter of last year. Annual earnings came in at \$60,306,000, down from \$82,682,000 for last fiscal year.

“For the quarter, company revenues increased 4% from the year-ago period, while earnings decreased,” says Francis Kramer, president and chief executive officer. “During the fourth quarter – and for the third quarter in a row - PRM both wrote-down inventory and realised depressed margins on product sales due to declines in the index pricing of tellurium; and, for the first time, the same was true for selenium.”

“In the Advanced Products Group, our Marlow business unit realised lower revenues and earnings due to decreased customer demand,” he added.

Oclaro posts rising revenues

Revenues rise, quarter-on-quarter, as the optics supplier reports positive feedback on merger US optics components supplier, Oclaro, reported a sequential increase in revenues for the fourth

quarter of 2012, but an overall year-on-year decline for fiscal 2012. Revenues were \$104.4 million for the fourth quarter of fiscal 2012, compared with revenues of \$88.7 million in the third quarter of fiscal 2012. GAAP gross margin was 21% for the fourth quarter, versus 15% in the third quarter of fiscal 2012. GAAP operating loss for this quarter came in at \$4.0 million, including approximately \$11.7 million of gain on the sale of assets previously held for sale and \$3.4 million of net Thailand flood-related income from insurance advances, net of additional write-offs and expenses.

The figure represents an improvement over the third quarter, which saw a GAAP operating loss of \$15.9 million, which also included \$3.3 million of net flood-related income. “Our results for the fiscal fourth quarter were in line with our previously announced guidance ranges,” said chief executive Alain Couder. “With the close of our merger with Opnext, we are well positioned as the number 2 player in the optical components, modules and subsystems market.

Customer feedback on the merger is very positive.” “Moving forward we are focused on accelerating the synergies of our combined business and capitalizing on the strengths of our customer relationships, comprehensive product portfolio and technologies, which we will discuss in detail during our quarterly conference call later,” he added. Looking ahead to the first quarter of fiscal 2013, and the first quarter of the efforts to integrate the Opnext assets, management forecasted revenues in the range of \$154 million to \$168 million, non-GAAP gross margin in the range of 17% to 21%, and adjusted EBITDA in the range of negative \$17.0 million to negative \$8.0 million. Revenues were \$385.5 million for fiscal 2012, compared with \$466.5 million in fiscal 2011. Oclaro expects to see revenues in the range of \$154 million to \$168 million for the first quarter of fiscal 2013.

IPG Photonics beats economy downturn

US high-power fibre laser developer, IPG Photonics, posts record revenues as worldwide sales rise.

IPG Photonics has posted record revenue and net

income for the second quarter of this year, as sales of laser products soared around the world. Second-quarter earnings rose a healthy 23 percent, with revenue up 13%, year on year. "Sales for materials processing applications grew 16%, driven by demand for high-power, medium-power and pulsed lasers with continued strength in cutting, welding and marking applications," said Valentin Gapontsev, IPG Photonics chief executive. "High-power laser sales increased 13%, primarily for the automotive manufacturing industry and cutting OEMs, while pulsed laser sales were up 10%, benefiting from increased demand in the consumer electronics industry," he added.

According to Gapontsev, sales grew across most geographic regions, with Europe reporting a 'solid quarter', record sales in Russia, and China, Japan and Turkey selling well in Asia. And the business expects sales to continue. "Our near-term outlook is strong," says Gapontsev. "Despite the macroeconomic environment in our various geographic markets, there are several factors counteracting these conditions to drive our growth, including the adoption of fibre lasers over other laser technologies, the use of lasers in an increasing number of applications, and strong demand trends in key industries, including automotive and consumer electronics." IPG Photonics expects revenue in the range of \$145 million to \$155 million for the third quarter of 2012.

Oclaro and Opnext finalise merger

Telecom and datacom businesses hope to create a new leader in the optical industry

Optical communications provider, Oclaro, and optical module designer, Opnext, both of the US, have announced shareholder approval of their merger, which closed July 23, 2012.

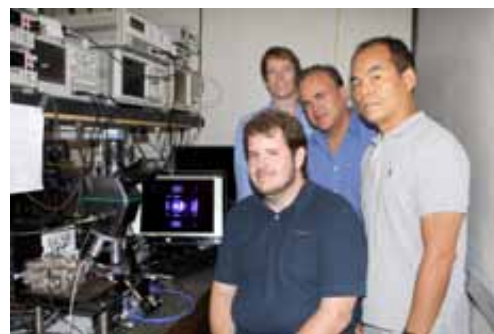
The combined company will continue to operate under the Oclaro name. "The new Oclaro boasts one of the broadest and vertically-integrated product lines in the industry. Our vision is that the power and speed of light will change the way we live and work," said Alain Couder, chairman and CEO, Oclaro. "By transmitting data over fibre at increasing speeds, our customers have made

possible new and fast growing applications such as social networking, video streaming, and cloud computing." "The ability to control the power of lasers as a heat and energy source is transforming healthcare, material processing and consumer electronics.

Through this merger, we have assembled the optical technologies, products and expertise at the heart of this new world of innovation," he adds. Oclaro is now the second largest provider of optical components, modules and subsystems to the optical communications, industrial and consumer laser markets, with approximately \$833 million in combined revenues and around 3,200 employees worldwide. Alain Couder is the named chairman and CEO of the combined company, with Opnext Chairman and CEO Harry Bosco joining the board of directors. Opnext shareholders will receive a fixed ratio of 0.42 shares of Oclaro common stock for every share of Opnext common stock they own.

UCSB researchers unveil world's first violet, non-polar, vertical-cavity lasers

Nakamura-led researchers develop the first m-plane nitride based nonpolar vertical-cavity surface-emitting lasers



In a leap forward for laser technology, a team at University of California, Santa Barbara, has developed the first violet non-polar vertical-cavity surface-emitting lasers (VCSELs) based on m-plane gallium nitride semiconductors. Led by LED pioneer Shuji Nakamura, the researchers' breakthrough paves the way to higher optical efficiency lasers at greatly reduced manufacturing costs for a variety of applications. "This is the first report of a non-

polar VCSEL, which we believe to be one of the biggest breakthroughs in the field of laser diode technology,” explains Nakamura, professor of Materials at UCSB. “The non-polar VCSEL has a lot of advantages in comparison with conventional c-plane devices. One major advantage is that the light polarization is locked to one direction.” “This device could be used for a variety of applications, such as lighting, displays, sensors, and technology that requires energy efficiency and small form-factor,” he adds. VCSELs offer advantages over conventional edge-emitting laser technology for some applications. For example, on-wafer testing of VCSEL arrays during the manufacturing process can save costs compared to edge-emitting lasers that require additional steps before testing. The lasers exhibit low threshold currents, circular and low divergence output beams, and are easily integrated into two-dimensional arrays. The non-polar VCSEL platform also provides high optical gain, which helps to increase optical efficiency of devices. The researchers believes the nonpolar VCSEL could enable new products and applications, such as pico-projectors for smartphones, mobile cinema, and automotive lighting.

Oclaro urges shareholders to vote for Opnext merger

Additional Oclaro votes are needed to close Opnext merger, so voting deadline is extended

US-based Oclaro, manufacturer of laser diodes, is asking its shareholders to approve the proposed merger with fibre optics components manufacturer, Opnext, US, alongside an increase in authorised shares, to deliver sufficient shares to Opnext stockholders.

At their respective meetings, stockholders of Opnext approved the merger of the two companies, this being their final milestone needed to close the merger. Meanwhile, Oclaro received approximately 46% of the greater than 50% majority vote needed to approve this proposal and close the merger. Of the votes, approximately 89% were in favour of the proposal.

“The Oclaro and Opnext teams have been working diligently and our integration plans are

on schedule,” said Alain Couder, chairman and CEO, Oclaro. “We are ready to operate as a single company and look forward to taking our place as the number two global provider of optical components, modules and subsystems.”

Trumpf Photonics to use Aixtron tool for As/P laser growth

The AIX 2800G4 reactor will be used in the production of arsenide and phosphide high power lasers

Aixtron SE has announced that Trumpf Photonics, located in Princeton, New Jersey, USA has taken delivery of an Aixtron AIX 2800G4 MOCVD reactor for high power laser applications.

Carl Miester, Head of Production Semiconductors at Trumpf Photonics states, “Trumpf Photonics has been delivering high quality laser components to the high power laser industry for over 10 years. The recent increase in market demand has required us to upgrade our manufacturing capabilities. We have performed an exhaustive search of the current MOCVD technologies.”

He continues, “The enhancements Aixtron has made in the control of the MOCVD process has made it the ideal platform for the challenging structures required for the high power laser market. Aixtron was the platform of choice from our beginnings and we are pleased they will be working with us as we move into the future.”

Aixtron’s Chief Operating Officer, Bernd Schulte, adds, “We are particularly pleased with our sustained relationship with the Trumpf organisation and to have the unique opportunity of being a vendor to Trumpf Photonics. Aixtron has maintained its investment in the development of MOCVD technology for all compound semiconductor material systems such as As/P materials for the solid state laser markets. Trumpf’s decision to continue to use our platform provides confirmation that these investments have been successful.”

The Trumpf Group has 58 subsidiaries and branch offices in more than 26 countries, employs over

8,500 people, and generates sales in excess of US \$2.76 billion. The company is an innovator in sheet metal fabrication machinery and industrial lasers.

Solar Fabricating ZnSe/CdS nanocrystals to harvest solar energy

According to new research, a novel technique of fabricating zinc selenide / cadmium sulphide photovoltaic films could produce a more stable solar panel than organic versions and reach commercialisation

One reason that solar energy has not been widely adopted is because light absorbing materials are not durable. Materials that harvest solar radiation for energy often overheat or degrade over time. This reduces their viability to compete with other renewable energy sources like wind or hydroelectric generators. A new video protocol addresses these issues by presenting a synthesis of two inorganic nanocrystals, each of which is more durable than their organic counterparts.

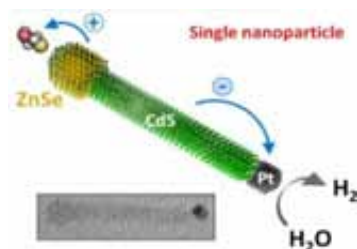
The article, published in *Journal of Visualized Experiments (JoVE)*, focuses on the liquid phase synthesis of two nanocrystals that produce hydrogen gas or an electric charge when exposed to light.

“The main advantage of this technique is that it allows for direct, all inorganic coupling of the light absorber and the catalyst,” says the leading author Mikhail Zamkov of Bowling Green State University.

Zamkov’s nanocrystals are unique for two reasons: they separate charge in different ways due to their architectures, and they are inorganic and durable. The first nanocrystal, is rod-shaped, which allows the charge separation needed to produce hydrogen gas, a reaction known as photocatalysis. The second nanocrystal, is composed of stacked layers and generates electricity, thus being photovoltaic.

The researchers produced the photoactive nanocrystals by first fabricating the ZnSe electron

donor component. The second step was to overgrow the ZnSe with the CdS electron acceptor component. Next, the metal catalyst was deposited onto the grown ZnSe/CdS donor/acceptor nanoparticle. The synthesis of photoactive films of semiconductor nanocrystals comprising PbS nanocrystal arrays embedded into a CdS matrix was then demonstrated.



Schematic of the photocatalytic nanocrystal (Credit: Journal of Visualized Experiments)

Because the nanocrystals are inorganic, they are easier to recharge and less sensitive to heat than their organic counterparts. Zamkov’s inorganic photocatalytic material allows a rechargeable reaction when exposed to cheap organic solvents, whereas in traditional photocatalytic reactions the catalyst is often irreversibly degraded. The photovoltaic nanocrystals can also withstand higher heat than traditional photovoltaic cells that do not dissipate heat well.

“We have established a new method for making photocatalytic and photovoltaic materials. This is important primarily as a new strategy for making photovoltaic films that are 100 percent inorganic, thus producing a more stable solar panel. It is a design that you could reach marketability,” Zamkov says. “It is important to have these steps documented in a video format, as the synthesis of the photocatalytic nanocrystals and the photovoltaic cells are long procedures with detailed steps. It makes our technique more visible and accessible.”

Further details of this research are in the video presentation, “Harvesting Solar Energy by Means of Charge-Separating Nanocrystals and Their Solids,” by Geoffrey Diederich *et al* in the Applied Physics section of *JoVE*, a peer-reviewed journal devoted to publishing scientific research in a video format.

Ascent market value doubles since Apple iPhone announcement

A new report finds that some electronic companies are shifting their focus from high-end solar panels and other such devices to consumer gadgets. One of these is Ascent Solar, who expects its CIGS revenues from consumer electronics will be between 70 and 80 percent of the company's future sales

Ascent Solar is a company best-known to many for its thin, rooftop-ready solar panels--but according to a recent report, the company plans to shift its focus rather dramatically in the years to come.

Bloomberg BusinessWeek reports that, as sales of solar films decrease, the company is moving into consumer electronics, developing an array of environmentally-aware solar products that include smartphone cases and more.

Ascent's CIGS technology is being used to harness sunlight into charging the latest smartphones. The firm released its EnerPlex charger for the Samsung Galaxy S III in August 2012. This was following the successful debut of EnerPlex for the Apple iPhone 4 for which it received an initial 50,000 unit order, announced in June. Ascent started debuting its chargers in Asia earlier this month.



Enerplex charger powered by CIGS technology

The Ascent report says that, according to one company representative, somewhere between 70 and 80 percent of the company's future sales will come from consumer electronics. This change comes on the heels of dramatic reductions in the average price of rooftop solar panels, which have led to Ascent's products becoming less competitive.

Instead of these solar panels, Ascent has announced a new focus on such gadgets as a

solar-charging iPhone case.

Since it announced the development of this case, Ascent's market value has more than doubled. BusinessWeek estimates that it is currently at \$52 million.

The firm's move into consumer electronics, and specifically its iPhone case announcement, has won the attention of Simply Electronics, an e-commerce company that specialises in consumer electronics. Simply Electronics has released a new statement to the press, responding to the Ascent announcement and expressing its own enthusiasm over the prospect of a solar-charging iPhone case.

"We think this is exciting news for environmentally conscientious consumers, with long-term savings for those on a budget," says the Simply Electronics press statement. The company follows its endorsement with a prediction about the future of the market. "We expect many other companies to follow suit in repurposing their technologies in order to increase their bottom line, driven by such consumer demand."

Meanwhile, even as it announces a major shift into consumer electronics, Ascent Solar has made it clear that it has no intention of leaving the rooftop solar market completely, with new developments in the works for new projects in that vertical.

IBM CZTS conversion efficiency breaks world record

The firm's latest solar cell contains abundantly available materials and goes beyond 11 percent efficiency. IBM says CZTS could compete with CIGS and CdTe in the future as the latter two compounds contain rare and expensive elements

Energy from the sun reaching the earth's surface amounts to several thousand times our global consumption of electricity.

But electricity from photovoltaic (PV) solar cells currently contributes a lot less than one percent of worldwide production. And according to photovoltaic scientists Teodor Todorov and David Mitzi at

IBM Research, none of the numerous existing PV technologies have been efficient, cheaply scalable as well as come from abundantly available materials.

Until now. IBM's Materials Science team has partnered with Solar Frontier, Tokyo Ohka Kogyo (TOK) and DeSolar to develop an efficient and affordable PV cell made of abundant natural materials.

The collaboration has manufactured and tested $\text{Cu}_2\text{ZnSn}(\text{S},\text{Se})_4$ (made of 3retcopper, zinc, and tin, and referred to as CZTS) thin-film devices. The researchers say that they achieved a world-record PV solar-to-electric power conversion efficiency of 11.1 percent (10 percent better than any previous reports) for this class of semiconductors.

And the material can be manufactured by simple ink-based techniques such as printing or casting. According to IBM, CZTS offers several advantages over competing technologies such as the most widespread PV semiconductors, made of crystalline silicon, which are abundant and highly efficient. Such silicon panels are used for everything from home electricity to the International Space Station. However, they have extremely high material purity requirements (over 99.9999 percent!), and the wafers are typically cut from large solid ingots and wired in series to form PV modules making them expensive and difficult to upscale.



IBM's CZTS Solar Cell Device

Other thin-film chalcogenide materials used in PV cells, such as $\text{Cu}(\text{In},\text{Ga})(\text{SSe})_2$ (CIGS) and CdTe , have been developed to a performance level close to that of silicon, with inherently more scalable processing. They are directly deposited on large-area, low-cost substrates such as glass, metal or plastic foil.

While CIGS and CdTe are easy to integrate into buildings and consumer products, their compounds

contain rare and expensive elements that increase cost and limit their manufacturing levels to less than 100 GW per year (worldwide continuous electricity consumption is 15 Terawatts - apparently 150 times greater than the level of what these CIGS can produce).

IBM says its CZTS PV cells could potentially yield up to 500 GW/year – coming closer to the Terawatt levels of renewable electricity the planet needs.

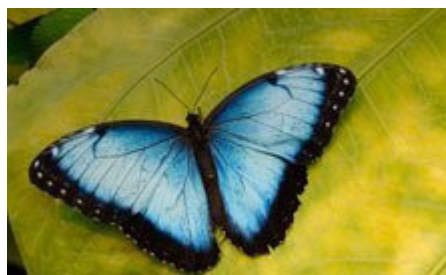
The focus of the joint-development team remains to further increase this device efficiency and transfer the technology to environmentally-friendly, high-throughput industrial manufacturing. The hope is that within several years this new class of photovoltaic materials will begin to contribute to the wider availability of lower-cost solar electricity.

More details of this work have been published in the paper, "Beyond 11% Efficiency: Characteristics of State-of-the-Art $\text{Cu}_2\text{ZnSn}(\text{S},\text{Se})_4$ Solar Cells," by Teodor K. Todorov *et al*, in *Advanced Energy Materials*. DOI: 10.1002/aenm.201200348

Unveiling the secrets of light on glowing materials

A novel technique combines electronic excitation and optical detection, to explore the inside of a photonic crystal and study the confinement of light in a silicon nitride membrane Mainbody:

A collaboration between research institutes ICFO (Barcelona) and AMOLF (Amsterdam) and King's College London have succeeded in mapping how light behaves in complex photonic materials inspired by nature, like iridescent butterfly wings.



The scientists say they have broken the limit of light resolution at the nanoscale and delivered a fundamental insight into how light and matter

interact. This could lead to the development of enhanced bio-sensors for healthcare and more efficient solar cells and displays.

Optical measurements of light waves at the nanoscale have always been limited by the resolution of the optical microscope, but the researchers were able to break this limit using a new technique which combines electronic excitation and optical detection, to explore the inside of a photonic crystal and study the confinement of light.

Working with a spatial resolution of 30 nm, scientists examined structures at a resolution more than ten times smaller than the diffraction limit for light. This revealed a greater understanding of how light interacts with matter to create, for example, the visible iridescence phenomena observed in nature on the wings of butterflies.

Riccardo Sapienza, from the Department of Physics at King's, says, "We were thrilled in the lab to observe the finer details of the photonic crystals that were simply inaccessible before. This is very important as it allows scientists to test optical theories to a new level of accuracy, fully characterise new optical materials and test new optical devices."

The team constructed an artificial two-dimensional photonic crystal by etching a hexagonal pattern of holes in a very thin SiN membrane. Photonic crystals are nanostructures in which two materials with different refractive indices are arranged in a regular pattern, giving rise to exotic optical properties. Natural photonic crystals can be found in certain species of butterflies, birds and beetles as well as in opal gemstones where they give rise to beautiful shimmering colours.

The photonic crystal inhibits light propagation for certain colours of light, which leads to strong reflection of those colours, as observed when such materials 'catch the light'. By leaving out one hole, a very small cavity can be defined where the surrounding crystal acts as a mirror for the light, making it possible to strongly confine it within a so-called 'crystal defect cavity'.

The scientists based their research methods on cathodoluminescence, where a beam of electrons is generated by an electron gun and impacted on a luminescent material, causing the material

to emit visible light. Albert Polman and his group in AMOLF modified this technique to access nanophotonics materials. He says, "In the past few years we have worked hard with several technicians and researchers to develop and refine this new instrument."

Sapienza adds, "Each time a single electron from the electron gun reaches the sample surface it generates a burst of light as if we had placed a fluorescent molecule at the impact location. Scanning the electron beam we can visualise the optical response of the nanostructure revealing features ten times smaller than ever done before."

Niek van Hulst, ICFO, continues, "It is fascinating to finally have an immediate view of the light in all its colours inside a photonic crystal. For years we have been struggling with scanning near-field probes and positioning of nano-light-sources. Now the scanning e-beam provides a local broad-band dipolar light source that readily maps all localised fields inside a photonic crystal cavity."

With major advances in nanofabrication techniques it has become possible to construct artificial photonic crystals with optical properties that can be accurately engineered. These structures can be used to make high-quality nanoscale optical waveguides and cavities, which are important in telecommunication and sensing applications.

Sapienza also points out, "Our research provides a fundamental insight into light at the nanoscale and, in particular, helps in understanding how light and matter interact. This is the key to advance nanophotonic science and it can be useful to design novel optical devices like enhanced bio-sensors for healthcare, more efficient solar cells and displays, or novel quantum optics and information technologies."

This work is described in detail in the paper, "Deep-subwavelength imaging of the modal dispersion of light", by Sapienza *et al* in *Nature Materials*, (2012). DOI:10.1038/nmat3402

Opel to focus on GaAs based multi-junction POET technology

Two special committees have been established to explore the divestiture of the Opel Solar Division to interested parties and to drive the monetisation efforts of the POET platform technology of Opel's ODIS Inc. division

Executives at Opel Technologies announced at its Annual General Meeting, which took place in August, that the core component of the company's strategy going forward is to continue to develop the POET platform.

POET enables monolithic fabrication of integrated circuit GaAs devices containing both electronic and optical elements onto a single wafer.

In support of the strategic direction, the two special committees that have been established by the Opel Technologies Board of Directors are continuing to work diligently on their goals. The first committee is exploring the divestiture of its Opel Solar Division to interested parties now engaged in talks with the Company. The second committee's charter is to drive the monetisation efforts of the POET platform technology of its ODIS Inc. Division.

The decision to hold the AGM at Storrs was made so that a tour of the ODIS facility would be available to further reinforce the stated objective to drive monetisation efforts of the POET platform.

Shareholders in attendance were welcomed by the ODIS Team at the facility and given a showcase of the intricacy of this "breakthrough" technology.

Also, the shareholders approved the election of the following nominees to the Board of Directors: Mark Benadiba, Peter Copetti, Chris Tsiofas, Samuel Peralta, Leon M. Pierhal and John F. O'Donnell.

And following the AGM, at the Board Meeting that followed, the Board reappointed the following executive officers for the Company: Mark Benadiba, Executive Chairman; Leon M. Pierhal, President & Chief Executive Officer; Michael McCoy, Treasurer & Chief Financial Officer; Javier Berrios, Vice President of Engineering; Patricia Venneri Agudow, Vice President of Administration,

Public & Government Relations; Michel Lafrance, Corporate Secretary. Also reappointed was Marcum LLP, Accountants & Advisors, of New Haven, Connecticut, as the auditors of the Company for the ensuing year.

Following the AGM, the directors granted incentive stock options to the newly-elected director of the Company to purchase up to an aggregate of 500,000 common shares, representing 0.5 percent of the outstanding voting shares of the Company. There are currently 15,272,550 options outstanding and 100,461,813 voting shares outstanding. The options will vest and be exercisable on the basis of 25 percent on the date of grant and 25 percent every six months thereafter. These options were granted subject to provisions of the Company's stock option plan which was approved by shareholders at last year's AGM, and are subject to the TSX Venture Exchange policies and the applicable securities laws.

PV solar installations rocket 120% in America

For the first time, global installations exceeded 13 GW in the first half of 2012, with the German and Americas markets leading PV growth

The photovoltaics (PV) market in the Americas more than doubled in the first half of 2012 to reach 1.7 Gigawatts (GW) and is set to reach almost 4.3 GW for the full year according to the Q3 PV Demand Report from IMS Research.

Installations grew by more than 120 percent in the first half of this year and will help drive the global PV market to grow by at least 3 GW in 2012, according to the market research firm.

Materials currently used for photovoltaics include monocrystalline, polycrystalline and amorphous silicon, CdTe, CIGS (where S stands for diselenide or sulphide) and multijunction III-V compound semiconductors.

The latest quarterly report from IMS Research revealed that, for the first time, global installations exceeded 13 GW in the first half of 2012, with the German and Americas markets leading growth. The Americas market was found to have grown by more

than 120 percent to reach 1.7 GW in the first half of 2012, compared to just 750 MW in the same period last year.

“Despite the lacklustre financial performance of the industry’s suppliers, underlying demand was robust in the first six months of this year, with first half installations 35 percent up on 2011”, comments IMS Research PV Research Director Ash Sharma. “The Americas market, led by the USA was unseasonably strong in the first half and did not show any significant slowdown resulting from the anti-dumping duties.”

Apart from China, the report found that the USA would be the largest single contributor to global PV growth in 2012, accounting for 40 percent of new capacity growth. In contrast, the European market is predicted to shrink by almost 3 GW in 2012, despite the strong start to the year in Germany.

“IMS Research remains optimistic about the potential for the US PV market, and we predict it will grow to at least 3.5 GW in 2012 and become the world’s third largest PV market. The longer-term outlook for this market is less certain, although the speed at which it is developing so far in 2012 provides some encouragement,” adds Sharma.

Global demand is predicted to accelerate in the second half of 2012, despite the slowing of key European markets, Germany and Italy. IMS Research predicts installations will hit a new half-yearly record of almost 18 GW in the second half of 2012, driven by markets such as China and Japan, as well as the Americas. China recently approved 1.7 GW of Golden Sun projects which must be completed by the end of the year, whilst Japan’s new FIT became effective on 1st July and will help spark a surge in demand towards the end of 2012.

Ascent Solar back on the Nasdaq map

The developer of flexible thin-film photovoltaic CIGS modules has maintained a closing bid price equal to or above \$1.00 for a minimum of ten consecutive trading days

Ascent Solar Technologies has regained compliance with the Nasdaq Stock Market Listing

Rules that require maintenance of a minimum \$1.00 bid price.

On August 17th, 2012, the Company received notification from The Nasdaq Listing Qualifications department that the Company had regained compliance with the minimum bid price requirement set in Nasdaq Listing Rule 5450(a)(1) after maintaining a closing bid price equal to or in excess of \$1.00 for a minimum of ten consecutive trading days and that the Company’s noncompliance with that rule, as announced on October 13th, 2011, had been rectified.

Ascent Solar’s President and CEO, Victor Lee, comments, “We are extremely pleased to be back in regulatory compliance with the Nasdaq listing rules. This is the first and an important milestone for me to achieve as a new CEO of Ascent as we continue to work towards regaining the trust and confidence from our shareholders, employees and vendors. The launch of our EnerPlex chargers is gaining strong momentum. We shall continue to maximise our potential to unfold the true value of Ascent Solar for all our shareholders.”

Record efficiency quantum dot PbS solar cells

A prototype colloidal QD solar cell comprising lead sulphide has achieved 7 percent efficiency

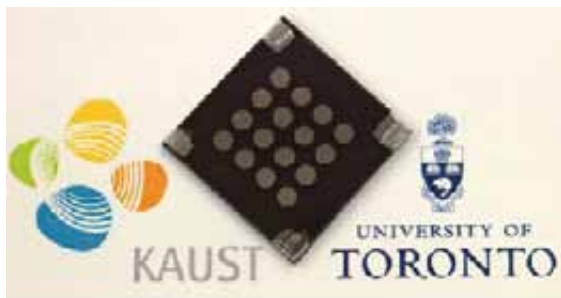
Researchers from the University of Toronto (U of T) and King Abdullah University of Science & Technology (KAUST) have made a breakthrough in the development of colloidal quantum dot (CQD) films.

The scientists say this has led to the most efficient CQD solar cell ever. Their work is featured in a letter published in Nature Nanotechnology.

The researchers, led by Ted Sargent from the U of T have created a solar cell out of inexpensive materials that was certified at a world-record 7 percent efficiency.

“Previously, quantum dot solar cells have been limited by the large internal surface areas of the nanoparticles in the film, which made extracting electricity difficult,” points out Susanna Thon, a co-

author of the paper. "Our breakthrough was to use a combination of organic and inorganic chemistry to completely cover all of the exposed surfaces."



A prototype of the U of T-made colloidal quantum dot solar cell

Quantum dots are semiconductors only a few nanometres in size and can be used to harvest electricity from the entire solar spectrum - including both visible and invisible wavelengths. Unlike current slow and expensive semiconductor growth techniques, CQD films can be created quickly and at low cost, similar to paint or ink. This research paves the way for solar cells that can be fabricated on flexible substrates in the same way newspapers are rapidly printed in mass quantities.

The researchers say the U of T cell represents a 37 percent increase in efficiency over the previous certified record.

In order to improve efficiency, the researchers needed a way to both reduce the number of "traps" for electrons associated with poor surface quality while simultaneously ensuring their films were very dense to absorb as much light as possible. The solution was a so-called "hybrid passivation" scheme.

"By introducing small chlorine atoms immediately after synthesizing the dots, we're able to patch the previously unreachable nooks and crannies that lead to electron traps," explained doctoral student Alex Ip. "We follow that by using short organic linkers to bind quantum dots in the film closer together."

Work led by Aram Amassian of KAUST showed that the organic ligand exchange was necessary to achieve the densest film.

"The KAUST group used state-of-the-art

synchrotron methods with sub-nanometre resolution to discern the structure of the films and prove that the hybrid passivation method led to the densest films with the closest-packed nanoparticles," comments Amassian.

The advance opens up many avenues for further research and improvement of device efficiencies, which could contribute to a bright future with reliable, low cost solar energy.

According to Sargent, "Our world urgently needs innovative, cost-effective ways to convert the sun's abundant energy into usable electricity. This work shows that the abundant materials interfaces inside colloidal quantum dots can be mastered in a robust manner, proving that low cost and steadily-improving efficiencies can be combined."

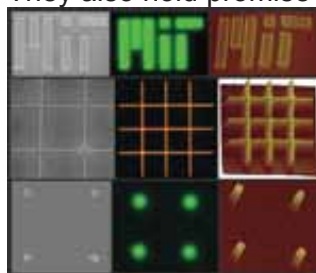
Further details of this work have been published in the paper, "Hybrid passivated colloidal quantum dot solids," by Alexander H. Ip *et al* in *Nature Nanotechnology*, (2012). DOI :10.1038/nnano.2012.127

Defect-free nanocrystal films

A new process developed at MIT could enable better LED displays, solar cells and biosensors - and foster basic physics research with the use of cadmium based compounds

Films made of semiconductor nanocrystals - tiny crystals measuring just a few billionths of a metre across - are seen as a promising new material for a wide range of applications.

Nanocrystals could be used in electronic or photonic circuits, detectors for biomolecules, or the glowing pixels on high-resolution display screens. They also hold promise for more efficient solar cells.



Images of nanopatterned films of nano crystalline

material produced by the MIT research team. Each row shows a different pattern produced on films of either cadmium selenide (top and bottom) or a combination of zinc cadmium selenide and zinc cadmium sulphate (middle row). The three images in each row are made using different kinds of microscopes: left to right, scanning electron microscope, optical (showing real-colour fluorescence), and atomic force microscope. (Images courtesy of Mentzel et al, MIT from *Nano Letters*)

The size of a semiconductor nanocrystal determines its electrical and optical properties. But it's very hard to control the placement of nanocrystals on a surface in order to make structurally uniform films. Typical nanocrystal films also have cracks that limit their usefulness and make it impossible to measure the fundamental properties of these materials.

Now, researchers at MIT say they have found ways of making defect-free patterns of nanocrystal films where the shape and position of the films are controlled with nanoscale resolution, potentially opening up a significant area for research and possible new applications.

"We've been trying to understand how electrons move in arrays of these nanocrystals," which has been difficult with limited control over the formation of the arrays, says physicist Marc Kastner, the Donner Professor of Science, dean of MIT's School of Science and senior author of a paper published online in the journal *Nano Letters*.

The work builds on research by Mounji Bawendi, the Lester Wolfe Professor of Chemistry at MIT and a co-author of this paper, who was one of the first researchers to precisely control nanocrystal production. Such control made it possible, among other things, to produce materials that glow, or fluoresce, in a range of different colours based on their sizes - even though they are all made of the same material.

In the initial phases of the new work, postdoc Tamar Mentzel produced nanoscale patterns that emit invisible infrared light. But working on such systems is tedious, since each fine-tuning has to be checked using time-consuming electron microscopy.

So when Mentzel succeeded in getting semiconductor nanocrystal patterns to glow with

visible light, making them visible through an optical microscope, it meant that the team could greatly speed the development of the new technology. "Even though the nanoscale patterns are below the resolution limit of the optical microscope, the nanocrystals act as a light source, rendering them visible," Mentzel says.

The electrical conductivity of the researchers' defect-free films is roughly 180 times greater than that of the cracked films made by conventional methods. What's more, the process developed by the MIT team has already made it possible to create patterns on a silicon surface that are just 30 nm across - about the size of the finest features possible with present manufacturing techniques.

The process is unique in producing such tiny patterns of defect-free films, Mentzel says. "The trick was to get the film to be uniform, and to stick" to the silicon dioxide substrate, Kastner adds. This was achieved by leaving a thin layer of polymer to coat the surface before depositing the layer of nanocrystals on top of it. The researchers think that maybe the tiny organic molecules on the surface of the nanocrystals help them bind to the polymer layer.

Such nanocrystal patterns could have many applications, Kastner says. Because these nanocrystals can be tuned not only to emit but also to absorb a wide spectrum of colours of light, they could enable a new kind of broad-spectrum solar cell, he says.

But Kastner and Mentzel's personal interest has more to do with basic physics. Since the minuscule crystals behave almost like oversized atoms, the researchers aim to use the arrays to study fundamental processes of solids, Mentzel says. The success of this technique has already enabled new research on how electrons move in the films.

Such materials could also be used to develop sensitive detectors for tiny amounts of certain biological molecules, either as screening systems for toxins or as medical testing devices, propose the researchers.

Douglas Natelson, a professor of physics and astronomy at Rice University who was not involved in this work, says, "The challenge in the past has been achieving thin, uniform films, patterned at

high resolution, with good contact between the nanocrystals and no cracking.” The MIT team’s approach, he says, “while deceptively simple in appearance, accomplishes all of these objectives.”

Natelson adds, “I think this is a very nice achievement. The fluorescence images showing the nanopatterned films are eye-popping, particularly for those who know how tough this is.”

The research was supported by the U.S Army Research Office, the Department of Energy and Samsung.

Further details of this work have been published in the paper, “Nanopatterned Electrically Conductive Films of Semiconductor Nanocrystals” by Tamar S. Mentzel *et al* in *Nano Letters*, 2012, 12 (8), pp 4404–4408. DOI: 10.1021/nl3022863

Emcore restructures to improve efficiency and profitability

With the reorganisation, the company aims to make up for losses of \$15 million in the past year

Emcore Corporation has completed both a business and a management realignment in a company-wide restructuring that changes the Company’s corporate business and management structure.

In May 2012, Emcore closed the sale of its Enterprise product lines to Sumitomo Electric Device Innovations USA. It was announced earlier this week that the company also signed a definitive agreement to consolidate Emcore’s terrestrial Concentrator Photovoltaics (CPV) business into its joint venture, Suncore Photovoltaics.

These two transactions mark the completion of the company’s business realignment and allow Emcore to more effectively focus its portfolio on areas where its technology and product solutions have strong differentiation in the marketplace. The losses from these product lines over the past four quarters were approximately \$15 million.

“In this complex market environment, it is vital to focus our business scope on those areas with the

highest potential for growth and profitability. I am very excited about our current business portfolio: a combination of solid sustaining businesses and the high growth areas with the most-sought-after technology in our industries,” says Reuben Richards Jr., Executive Chairman of the Company. “Emcore is determined to drive its business to achieve profitability.”

As a part of this restructuring effort, Richards proposed to Emcore’s Board of Directors to eliminate the position of Executive Chairman, and subsequently, he will retire from the Executive Chairman position at Emcore, effective September 30th, 2012. Richards will continue as Chairman of the Board where he will provide strategic guidance and governance oversight.

With Richards’ retirement and Company’s focused business scope and operations, Emcore will realign its management responsibilities accordingly.

Reuben Richards joined the Company in 1995 as Chief Operating Officer. He took over as President and Chief Executive Officer in 1996, and led the company to its initial public offering in 1997. In March of 2008, he assumed the role of Executive Chairman and Chairman of the Board to help facilitate the CEO succession and transition plan.

During his 17 year tenure as Emcore’s top executive, Richards has led the transformation of the Emcore from a single-product start-up to a leader in compound semiconductor technology and applications. Throughout his leadership, Emcore pioneered high-throughput production platform equipment - MOCVD, magneto-resistive sensors, multi-junction solar cells, LEDs, epitaxial materials for high-speed electronic devices (HBTs and HEMTs), and semiconductor lasers - VCSELs and distributed feedback lasers (DFBs).

In this time, Emcore has developed leading technologies and product solutions for many compound semiconductor devices and applications. Richards was also instrumental in establishing and then selling the Company’s interest in the solid-state-lighting joint venture with GE, GELcore, defining the growth strategy and operational plans, and raising capital to execute firm’s business plan.

“Reuben has provided exceptional leadership to Emcore over the past 17 years and has helped

navigate the Company through a very dynamic and complex marketplace. I applaud his contributions to the compound semiconductor industry through his leadership of a very innovative company. He is unparalleled in his ability to perceive market opportunities, develop technologies and to lead the industry in those markets.

I would like to personally thank Reuben for his mentorship and leadership during this transition period and look forward to continuing working with him as Chairman of the Board to drive shareholder value," concludes Hong Hou, Emcore's President and CEO. "With this business restructuring and management realignment, I am very optimistic to attain the company's strategic mission and to significantly improve financial performance going forward."

First Solar opens Bangkok office

The cadmium telluride solar panel manufacturer is taking advantage of the strong economic growth in Thailand with a new subsidiary

First Solar has established a Thailand operating subsidiary, First Solar (Thailand) Ltd., and opened an office in Bangkok.

The local subsidiary will help First Solar to execute its strategy to expand the market for utility-scale solar CdTe PV power plants in the local market, and to deliver value to Thai solar power producers.

"The long-term energy fundamentals in Thailand are very favourable for a solar power solution to meet their growing energy needs, and we will continue to invest here as part of our strategy to develop sustainable, utility scale solar markets," says Won Park, Senior Manager, Business Development.

Thailand is expected to remain an important solar market in Southeast Asia due to its strong economic growth, significant energy demand and abundant solar resource. First Solar entered the Thai PV market in 2011, and since then more than 12MW of solar PV projects have already been installed or are under construction using First Solar's advanced CdTe thin-film module technology.

NPD Solarbuzz: Non-residential growth booming in China

Non-residential building mount applications now account for more than 36 percent of PV projects

A sharp increase in non-residential building-mount PV applications indicates a strong growth towards self-sustained power generation in the Chinese PV market, according to a recently released NPD Solarbuzz China Deal Tracker report.

What's more, the number of non-utility commercial projects being planned has surpassed the utility sector, a further indication of the growing trend towards non-utility-driven PV (photovoltaic) adoption.

Materials currently used for photovoltaics include monocrystalline, polycrystalline and amorphous silicon, CdTe, CIGS (where S stands for diselenide or sulphide) and multijunction III-V compound semiconductors.

In May 2012, Premier Jiabao Wen called for an increase in self-sustained solar power within the utility and residential segments. It is estimated that the number of non-residential building-mount applications increased to more than 400 at the end of July 2012, while the number of planned projects within China's PV pipeline exceeded 700.

However, ground-mount applications are forecast to continue as the largest segment in China during 2012 with a 58 percent share, followed by large building-mount applications, which are growing rapidly.

"In the Chinese PV market, utility and corporate segments are expected to dominate in the period from 2012 to 2016," says Steven Han, Analyst for NPD Solarbuzz. "However, the corporate segment is now forecast to exceed the utility segment in 2013."

The Northwest region of China, including Qinghai, Gansu, Ningxia, Xinjiang and Shaanxi, will have 63 percent of the total PV project pipeline for China during 2012-2016. Systems of 1-5 MW will contribute 30 percent of the total project count,

driven by Golden Sun projects expected to be completed.

Currently, the leading PV system developers in the Chinese market include the China Power Investment Corporation (CPI), China Energy Conservation and Environmental Protection Group (CECEP), and China Datang Corporation. These companies alone account for more than 5 GW of PV capacity currently in the project pipeline.

The dominance of the utility segment in the Chinese PV market has made it very difficult for overseas PV companies to compete successfully with domestic PV module and systems providers. However, the growing share of non-utility commercial projects will provide new opportunities for a wider range of module, inverter, and other balance-of-systems component suppliers.

Access to the Chinese PV market by overseas systems integrators is now more viable, which is fortunate at a time when sales pipelines in major European PV markets are at risk from policy uncertainties. However, identifying the most suitable PV projects and partners, and understanding the mechanics of the different bidding processes within China will be key factors for all companies targeting these new opportunities.

Ascent's CIGS charger powers Samsung Galaxy S III

The firm is releasing its EnerPlex for the Galaxy S III following the successful debut of EnerPlex for the Apple iPhone 4

Ascent Solar Technologies has launched a charger for the Samsung Galaxy S III smart phone featuring its ultra light CIGS technology.



Branded under Ascent's EnerPlex line of consumer

products, the charger incorporates the company's solar cells into a sleek, protective Galaxy S III case, along with an ultra thin battery. The charger adds minimal weight and size to the Galaxy S III yet provides significantly improved battery life by harnessing sunlight for electric power.

Following the successful launch of the EnerPlex for iPhone 4S case, Ascent is releasing the EnerPlex for the Galaxy S III as Samsung continues to introduce new products in a competitive market where the number of smart phones in use globally is expected to reach 1 billion in the next 4 years.

144 million smart phones were sold globally in the first quarter of 2012. Ascent is developing the EnerPlex line utilising its CIGS technology to bring solar enabled power to a variety of new consumer products such as the widely anticipated next generation iPhone.

Ascent Solar's President and CEO, Victor Lee, says, "The EnerPlex charger is the only protective case for the Samsung Galaxy S III which leverages the lightweight qualities and superior aesthetics of our CIGS solar technology. It will extend the usage time of the Galaxy S III while preserving the high level of design quality that consumers demand. Samsung customers can now incorporate transformational solar technology into their everyday life, improving the performance of their smartphone without compromising style."

Lee continues, "Ascent's solar powered case designs target the top two market share leaders, Apple, Inc. and Samsung, who together, account for over 70% of the smart phone market. With the launch of this second product in the EnerPlex line, Ascent now has a solar charger for two of the most popular smart phones on the market, the Apple iPhone and the Samsung Galaxy S III."

The EnerPlex case for the Samsung Galaxy S III will debut in South Korea in October with an expected launch in the United States in time for the 2012 holiday shopping season.

Singulus secures €7 million order from CIGS firm

The order is for several systems for vacuum coating, selenisation and wet-chemical processing from South African university spin off PTIP

Singulus Technologies has an additional order in the Solar segment.

A long-time cooperation partner for the development of new, more efficient CIGS thin-film solar modules ordered several machines for more than €7 million for vacuum coating, selenisation as well as wet-chemical processes. With this investment, Photovoltaic Technology Intellectual Property (Pty) Limited (PTIP) extends its activities in the development of efficient CIGS thin-film solar modules.

PTIP is a spin-off from the University of Johannesburg and already successfully operates research machines for the development of CIGS thin-film cells in its newly established research and development facility in Techno Park close to Stellenbosch in South Africa.

Singulus has cooperated successfully with the scientists of the University of Johannesburg in the past, having delivered components in 2011. Various companies are currently using PTIP's R&D results and patents worldwide. The activities as well as the results were already presented by the PTIP in this year's April in the course of the opening of the "German-South Africa Year of Science" in Cape Town.

"Climate Change" is one of the core themes of this Year. PTIP intends to further expand the research facilities in Stellenbosch and to commission a development and laboratory line for CIGS modules in the original commercial size of 1200 x 600 mm. The development efforts are in the limelight of the South African government. The Industrial Development Corporation (IDC) recently supported the further expansion of PTIP's operations in Techno Park and acquired substantial shareholding in PTIP. Additional financial support was obtained from the Technology Innovation Agency (TIA), an initiative of the Department of Science and Technology.

Vivian Alberts, CEO of PTIP, comments, "The support by the IDC and TIA confirms the goal of the South African government to support locally developed IP and to boost alternative and renewable energies, such as photovoltaic. With this support PTIP is now in the position to invest in proven and well engineered equipment and process plants."

"We are now able to industrially and efficiently implement our developed process with the machines of our partner Singulus. The goal is to set up a production line for CIGS thin-film modules in South Africa as soon as possible. The European Investment Bank already announced to support this project with €40 million," continues Alberts.

Stefan Rinck, Chief Executive Officer of the Singulus Technologies AG, adds, "This is a great project and we are pleased to have already supplied four important process steps in a CIGS line, namely vacuum coating, selenisation as well as two process steps in the wet-chemical area. PTIP's trust is based on the excellent R & D results from the start, which were achieved with our equipment. We expect this to also translate to additional expansion stages as well."

Singulus continues to expand its activities in the business segments Solar and Optical Disc. The goal is to attain a leading position in the silicon and thin-film solar technology as a machine supplier as well as a development partner for new cell concepts and to maintain the market leadership in the Optical Disc segment for production equipment for the manufacturing of dual-layer Blu-ray Discs.

The business activities in the division Semiconductor are extensively strengthened in the course of the apparent growing market for MRAM semiconductor technology. In addition, the company reviews other sectors and work areas, where new market segments can be developed on the basis of the present know-how in the area of vacuum coating.

Emcore consolidates CPV business into Suncore

The move will allow Emcore to focus its efforts on its arsenide based multi-junction solar cell technology for both space and terrestrial power applications

Emcore Corporation has entered into a definitive agreement, subject to closing conditions, to consolidate its terrestrial concentrating photovoltaics (CPV) system engineering and development efforts into its joint venture, Suncore Photovoltaics.

Emcore has engaged in research, development, and manufacturing of solar concentrator photovoltaics technology and products since 2005.

The firm uses III-V multi-junction technology in its solar products.

The company has been providing terrestrial CPV solar cells, receiver assemblies, and complete turn-key CPV systems to the market for both grid-tied utility applications and commercial rooftop solar power applications.

In late 2010, Emcore formed its joint venture, Suncore Photovoltaics, with San'an Optoelectronics to engage in high-volume manufacturing and business development in China.



Emcore Soliant 1000 rooftop system

In order to streamline the development and engineering effort for CPV systems, Emcore and Suncore have entered into a definitive agreement to consolidate intellectual property and development efforts for both ground mount and rooftop terrestrial CPV products, including key engineering, and sales and marketing personnel, to a wholly-owned subsidiary of Suncore in the United States.

Suncore's subsidiary will fund all ongoing R&D, marketing, sales and business development related to terrestrial CPV systems. Emcore will continue to own all of its intellectual property related to solar cell technology and maintain investment activities to advance CPV cell performance to serve a broader customer base within the CPV industry.

"This announcement will allow Emcore to focus its efforts on our core competency of multi-junction solar cell technology for both space and terrestrial power applications," comments Christopher Larocca, Emcore's Chief Operating Officer. "Moving forward, Emcore will continue to support Suncore through supply of advanced CPV solar cell products and maintain its presence in the terrestrial CPV Systems market through our ownership in Suncore."

"This transaction provides Suncore with strong research and development capability on top of the existing world-class, low-cost and high-volume manufacturing infrastructure, and allows Suncore to quickly respond to its customers' need in today's fast-changing solar energy market," adds Charlie Wang, General Manager of Suncore Photovoltaics.

"With our strong IP portfolio, solid financial status, and high volume manufacturing capacity, Suncore is now ready to serve the worldwide renewable energy industry with state-of-the-art CPV products and technology."

Emcore employees who are currently engaging in product and business development for terrestrial CPV will be transferred to Suncore. Emcore's Executive Vice President, Charlie Wang, will also be joining Suncore, continuing to serve as its General Manager on a full-time basis upon the closing of the transaction.

MiaSolé cutting staff

The copper indium gallium selenide solar panel manufacturer is reorganising its workforce in order to enable cost reductions and renewed development

CIGS innovator, MiaSolé, is to restructure its manufacturing and operations.

The aim is to allow the company to continue

strategic discussions with potential partners to ensure long-term success.

The California based firm will reorganise its workforce to retain employees in the technology in order to reduce manufacturing and operations. This will enable MiaSolé to focus on critical functions such as commercial and flexible product areas and make cost reductions.

The restructuring will ensure continued CIGS technology development, execution on the firm's sales pipeline and ongoing development of its flexible product, which NREL recently verified at 15.5% efficiency. This, says MiaSolé, is a world record.

"MiaSolé has advanced solar technology by developing the highest efficiency, lowest-cost CIGS modules and executing globally," says John Carrington, CEO of MiaSolé. "However, in the near term we need to conserve costs to enable a strategic partnership. The company is looking forward to aligning with a partner and collectively executing on our technology roadmap, flexible product launch and additional capacity to fulfil our 1GW+ commercial pipeline. I am confident based on current discussions we will finalise a partnership within the next 60-90 days."

MiaSolé says it did not receive any government funding and had access to tax credits but never used them.

EPIC report reveals record PV industry

The dynamics of the market may be changing but the growth of the photovoltaic (PV) industry in 2011 reached record levels according to a new EPIC report

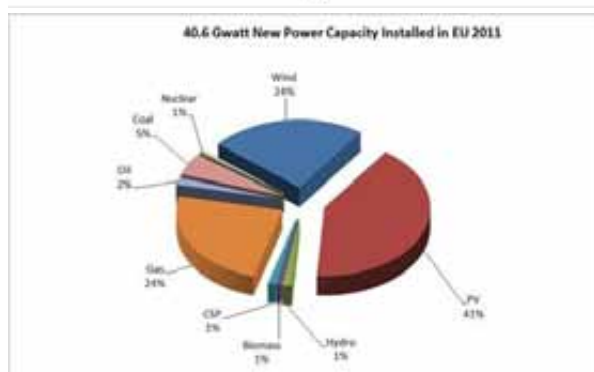
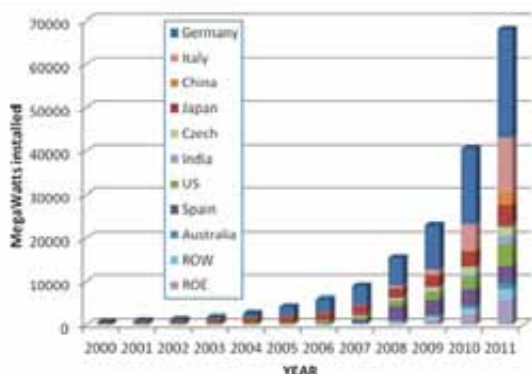
EPIC, the European Photonics Industry Consortium, announced they have released their most recent report on the global PV market which they release to their membership. The report's provides a quick snapshot of the successes of the global industry as a whole. Europe remained the powerhouse of the PV industry but the statistics reveal the distribution of global PV is changing with Asian interests expanding in both production and installation. Germany accounted for almost a third of last years

installed total.

Photovoltaic industry revenues reached a record \$US 93 billion in 2011, a 13.4% increase over \$US 82 billion in 2010, and a 150% increase over revenues in 2009. World-wide, 27.4 Gwatts of PV were installed, bringing cumulative PV electrical generation capacity to 68 Gwatts at the end of 2011. Our data show that installations grew by 56% compared to 2010. Europe remains the leader for deployment, accounting for more than 63% of the PV installations world-wide. About 27% of all the installations world-wide took place in Germany. These percentage figures are lower than those for 2010, and they indicate the growing importance of PV markets outside of Europe, and in particular in China.

In Europe, 41 Gwatts of electrical generation capacity from all sources were installed in 2011. This can be compared to 57.6 Gwatts in 2010. This decrease is due in part to the economic recession which strengthened in Europe throughout the year. For the first time ever, more PV generating power was installed in Europe than any other energy source, surpassing both natural gas and wind turbine generation. New Eu PV at 17.3 Gwatts out-paced natural gas installations by 58%. However on a world-wide basis, wind power remains the dominant new renewable energy source with installations of over 40 Gwatts in 2011. By 2011, the cumulative installed PV generating base reached 68 Gwatts. By comparison, this represents about 28% of the installed wind base of 238 Gwatts.

In terms of production, 7.6% more wattage of PV cells was manufactured than generating capacity installed (29.5 Gwatts compared to 27.4 Gwatts). Inventories at the end of 2011 amounted to less than 1 month. Our figure of merit, (the ratio of total sector revenues to installed PV generation capacity) for 2011 improved significantly to US\$3.53 per watt by 24% compared to US\$4.6 per watt in 2010. PV production volume is now dominated by manufacturing in Asia where China and Taiwan now account for about 74% of the world supply. Production by European companies declined sharply in 2011 to less than 6% of the global total. Because many of the remaining companies manufacture some of their products in Asia, the actual amount of manufacturing activity in Europe is even less significant.



Soitec wins tenders for eight domestic CPV projects

The solar firm, which manufactures III-V multijunction cells, has been acknowledged by the French ministry and been awarded eight projects

The process of selecting the successful participants in the call for tenders for “large solar power plants” confirmed the attractive positioning of Soitec.

The call for tenders is to build and operate power plants harnessing solar energy with an individual capacity of over 250 kWp. The program was launched in September by the French Energy Regulatory Commission (CRE, Commission de régulation de l’énergie).

Soitec’s concentrator photovoltaic (CPV) technology is present in most of the eight projects in the “concentrator solar plants with installed capacity of less than 12 MW” sub-category.

Recently selected by Delphine Bathot, French Minister of Ecology, Sustainable Development and Energy, these eight projects have over 54 MW in total capacity, with CPV solutions accounting for at

least 30% of each project’s installed capacity.

“Without revealing the details of the eight concentrator solar projects, as their go-ahead depends of course on gaining all the requisite permits and their design may yet be tweaked by the various partners, we are very happy that our module- and tracker-based offering has been chosen for the majority of projects,” comments Gaetan Borgers, Executive Vice President of Soitec’s Solar Energy Division.

“This choice reflects not only their confidence in our technology, but also in our manufacturing capabilities. We possess a great deal of experience in large-scale manufacturing, with automated lines and certified processes,” adds Borgers.

Soitec believes it is very well positioned following this selection process. This call for tenders has also afforded the company another opportunity to demonstrate its high efficiency technology. The energy efficiency of its CPV modules stands at close to 30%, double that of standard photovoltaic products.

André-Jacques Auberton-Hervé, Soitec’s Chairman and Chief Executive Officer, adds, “The announcement of the winners of this call for tenders illustrates the determination of our government to foster the emergence of a first-class solar energy industry. Our company is originally from the Grenoble area of south eastern France, but thanks to its innovation and its expertise, it has established itself in global markets.”

“These projects will help to establish the ramp-up in the highest-performance technologies. For example, we are already working on development of a new, very high-performance cell. We are therefore delighted with the Ministry’s announcements concerning the next stages, and we intend to play an active role in driving forward this segment so that it can realise its tremendous potential,” he concludes.

Soitec’s CPV technology uses III-V triple-junction cells mounted on a glass plate. Fresnel lenses (manufactured using silicone on glass) concentrate sunlight 500 times before it reaches these cells, which convert it into electricity. A metal frame holds two glass plates to form highly robust, durable and resilient modules. By combining several modules on

biaxial trackers (based on a proprietary algorithm automatically optimising their position based on the path of the sun), Soitec maximises energy generation throughout the day.

The work that the company is conducting in France on a new type of cell should hopefully eventually enable it to achieve an energy yield of around 50%. In addition to its teams in France, Soitec also has 70 MW in production capacity in Germany (with ISO 9001 and ISO 14001 certification). Looking ahead, this manufacturing base will be boosted by Soitec's new plant in San Diego, California, which is anticipated to ultimately add 200 MW in capacity.

Ascent`s CIGS BIPV modules to power new Foxconn plant

The firm's flexible and lightweight modules can be integrated seamlessly into the building structure in ways traditional glass-back photovoltaic technology can't

CIGS thin-film PV module developer, Ascent Solar, has been selected to provide BIPV solar modules in a pilot application at Foxconn's new factory in Zhenzhou City, Henan Province, China.

Foxconn is one of the world's largest makers of electronic devices and produces many products including the iPad, iPhone, Kindle, Playstation and Xbox.



Foxconn's new plant in Zhenzhou City

The integration of the modules will allow the factory to utilise cost-effective, high-performance solar power using Ascent's CIGS technology to deliver the highest power density available on thin-film plastic substrates.

Ascent Solar's President and CEO, Victor Lee, says, "We are honoured to be selected by Foxconn to provide our lightweight, durable, flexible thin-film solar modules in this new factory. We plan to demonstrate the value of our technology and we hope to build a long term relationship with Foxconn."

CdTe firm First Solar appoints CEO to the board

James Hughes was appointed CEO in May, succeeding Mike Ahearn, First Solar's founder and Chairman, who had been serving as interim CEO since October 2011

Arizona based First Solar has announced the election of its CEO, James Hughes, to its board of directors

Hughes, who joined First Solar in March 2012 as Chief Commercial Officer, has nearly 20 years of experience in the global energy industry. Before joining First Solar, he served as the CEO of AEI, which owned and operated power distribution, conventional and renewable power generation, natural gas transportation and natural gas distribution businesses in 19 countries. Prior to that, he was President and Chief Operating Officer for Prisma Energy.

Hughes earned a juris doctor from the University of Texas at Austin School of Law, a Certificate of Completion in international business law from Queen Mary's College, University of London, and a bachelor's degree in business administration from Southern Methodist University.

First Solar beats market expectations

CdTe photovoltaic manufacturer, First Solar, reports soaring sales for the second quarter, 2012.

US-based thin-film CdTe photovoltaic manufacturer, First Solar, has bounced back from a poor year, beating second-quarter profit expectations and raising revenue guidance for the year.

Net sales came in at \$957 million in the quarter,

an increase of \$460 million from the first quarter of 2012 and \$425 million from the second quarter of 2011.

The company attributes the gains to an increase in the number and size of projects under construction meeting revenue recognition criteria during the quarter, including Antelope Valley Solar Ranch1 in California and Silver State North in Nevada.

The company reported second quarter net income of \$1.27 per fully diluted share, compared to a net loss of \$5.20 per fully diluted share in the first quarter of 2012 and net income of \$0.70 per fully diluted share in the second quarter of 2011.

“Despite market uncertainties, First Solar delivered strong performance in the quarter,” said Jim Hughes, chief executive. “Looking forward... we believe that by executing our strategic roadmaps and completing our restructuring program we can achieve our targets of 2.6 to 3.0GW of sales in sustainable markets, earning a return on invested capital of 13 to 17 percent by 2016.”

Based on reductions in First Solar’s ongoing cost structure primarily related to restructuring initiatives, the company is increasing 2012 guidance; net Sales of \$3.6 - \$3.9 billion, compared to prior guidance of \$3.5-\$3.8 billion, and earnings per fully diluted share to \$4.20-\$4.70, compared to prior guidance of \$4.00-\$4.50.

First Solar shares have plummeted since 2008 after an influx of competitors, many from Asia, flooded the market, forcing down the price of solar panels. First Solar is also developing the 139MW Campo Verde Solar Project, located near El Centro in Imperial County, California. The project is expected to start construction in the third quarter of 2012 and be completed in 2013.

First Solar will construct the project using its advanced thin film PV modules that generate clean, renewable energy with no emissions, waste or water consumption during operation. According to First Solar, the project will generate enough electricity to power approximately 50,000 average California homes, displacing 80,000 metric tons of CO2 per year, the equivalent of taking 15,000 cars off the road.

CIGS firm Centrotherm applies for insolvency protection

The 3 month protective phase means the company is largely protected from creditors’ enforcements and sanctions, and can remain fully operational

Centrotherm photovoltaics AG has submitted an application to the District Court of Ulm to launch insolvency protection proceedings (pursuant to the German Act Relating to the Further Simplification of the Reorganisation of Companies [ESUG], and Section 270b of the German Insolvency Directive [InsO]).

The firm has also applied to open insolvency proceedings under its own administration in connection with the application mentioned above.

With the help of these proceedings, the company aims to consistently pursue the reorganisation path that it has already adopted.

The application includes the subsidiaries centrotherm thermal solutions GmbH & Co. KG and centrotherm SiTec GmbH. The activities of the companies centrotherm management services GmbH & Co. KG and centrotherm cell & module GmbH are to be prospectively bundled within the parent company as part of the reorganisation. All other subsidiaries both in Germany and abroad will continue to operate as previously, and will not participate in the insolvency protection proceedings.

The German Act Relating to ESUG came into force on March 1st 2012, and provides protection to companies in insolvency proceedings. It allows companies to restructure themselves based on a coordinated reorganisation and future concept. During the “protective” phase, which is limited to three months, the company is largely protected from creditors’ enforcements and sanctions, and can remain fully operational.

The Management and Supervisory boards of centrotherm photovoltaics AG are convinced that this step is the best option in the company’s current difficult situation to successfully conclude the Group’s reorganisation (which has already started), in the interests of employees, customers, suppliers,

shareholders and creditors, and to thereby secure the Group as a going concern.

To support these moves, the Supervisory Board of centrotherm photovoltaics AG has appointed reorganisation expert Tobias Hoefer to the Management Board with effect as of July 11th, 2012. Tobias Hoefer, a specialist insolvency lawyer, specialises in highly complex corporate reorganisations. His most notable reorganisations include internationally operating groups AKsys and Robert Sihn (automotive supply companies), ATS (rim manufacturer), and NDT Systems & Services (ultrasound testing systems).

“Given the insolvency protection proceedings, I see my new role as being a moderator of the interests of all parties involved in the proceedings. The joint objective of all these parties must be to maintain centrotherm as a company despite the serious market slump, and to lead it to a successful future. All will benefit if we succeed in this endeavour. The insolvency protection proceedings offer the best opportunities to achieve this, and I believe that my more than 15 years of experience as a corporate reorganiser, and as an insolvency administrator, can be of use in the necessary settlement of interests,” Tobias Hoefer points out.

Business operations at centrotherm photovoltaics AG and the other Group companies are currently continuing as usual. “Our customers continue to receive the same first-class quality engineering and services, technology and products from centrotherm to which they are accustomed,” adds the SIGS firm CEO, Robert M. Hartung.

“The protection provided by the ESUG creates the necessary scope to realise a balanced and sustainable future concept that lies in the interests of all participants in the proceedings. At the same time, centrotherm photovoltaics AG continues to be able to manage its operations itself. Since we remain solvent, we can both process customer orders to schedule, and also pay our suppliers,” adds Hartung.

Liabilities that were originated before the application for the insolvency protection proceedings was filed cannot be satisfied during the protection proceedings, however. They are nevertheless to be satisfied as best as possible as part of the reorganisation concept coordinated with creditors.

Core elements of the reorganisation of the centrotherm photovoltaics Group

Concentration on technological strengths and core business areas, such as mechanical engineering for the energy and high-tech industry areas, are to form the cornerstones of the future concept which is to be elaborated further over the coming weeks. “We were, and are, world market leaders in thermal equipment and related technologies. We must, and will, invest further in this expertise, in order to maintain our technological and competitive league,” Robert M. Hartung makes clear.

He goes on to note that, with its products, centrotherm can be a technology and efficiency motor for the global energy revolution, and realise so-called grid parity, in other words, make photovoltaic electricity competitive with conventional energy sources.

For this reason, centrotherm photovoltaics is experiencing high demand, particularly on new markets such as the MENA region (Middle East and North Africa). He commented that this development offers great potentials for the future. By contrast with its previous approach, the company would nevertheless now contribute only its expertise and products as a technology partner in major projects when tapping such potentials, in order to thereby limit risks, according to Hartung.

Further capacity adjustments and cost reductions are required, however, given the slump in the solar industry over recent months, and the resultant decline in orders and sales. “We require further structural adjustments in order to secure our company’s continued existence in the future. This will allow us to maintain centrotherm’s competitiveness in a difficult market situation,” emphasises Jan von Schuckmann, Management Board member responsible for restructuring. “In parallel, we will continue to invest in research & development, and extend our extraordinary market position.”

Emcore III-V solar cells power 100th satellite

The satellite is powered by Emcore's multijunction arsenide based solar cells and panels and has been launched and deployed

Emcore Corporation has recently achieved the Company's 100th successful satellite launch and deployment with primary power supplied by Emcore solar cells or solar panels.

In June, the 100th on-orbit spacecraft powered by Emcore solar equipment was launched. Built by Space Systems/Loral and powered by solar panels equipped with Emcore's high-efficiency multi-junction solar cells, the satellite will provide C- and Ku-band capacity for a variety of communications services.

"Completing 100 successful satellite launches is a tremendous milestone for Emcore and our space satellite solar business," says Christopher Larocca, Chief Operating Officer for Emcore.

"We are especially proud to have achieved this milestone with zero on-orbit failures. Emcore currently has a total of 120 more satellites under contract to be launched and powered by Emcore solar equipment over the next several years. We look forward to continued success in this segment by delivering innovative, high-performance solar technology to the satellite power market," he continues.

With a beginning-of-life conversion efficiency nearing 30% and the option for a patented, onboard monolithic bypass diode, Emcore's multi-junction solar cells provide one of the highest available powers to interplanetary spacecraft and earth orbiting satellites.

Oxford Instruments unveils new PlasmaPro 100 system

The latest tool offers impressive hardware and process solutions for both Production and R & D customers in HBLED, semiconductor Electronics, and photovoltaics
Oxford Instruments has launched the PlasmaPro

100 system, its latest generation etch and deposition tool.



The NEW PlasmaPro 100 tool has up to 200mm single wafer production capability, offering excellent uniformity and high throughput on a range of applications

The system is ideally suited to many key market applications, including HBLED, Semiconductor Electronics, Failure Analysis and Photovoltaics. The, innovative system that has been developed by Oxford Instruments to address the exacting needs of Production users, who demand the very latest technological innovations.

This latest system offers an evolution of PECVD hardware delivering step changes in deposition rate of high quality SiO₂ and SiN_x, with corresponding reductions in cleaning overhead. It also features the latest generation of Cobra ICP source which delivers improvements in etch rate and feature control capability. With robotic handler and capability and 'Plug and Play' hardware and optimised processes, the enhanced system control infrastructure and software interface delivers improved diagnostics, reliability and serviceability for the customer.

Providing a common platform for all Oxford Instruments Plasma Technology's processes and technologies, the PlasmaPro 100 is a highly configurable system, with process chambers that are available as standalone modules or in cluster configurations. "All our tools boast industry leading technology and automation that are well proven with over 90% uptime", comments Senior Product Manager Ian McKinlay, "This latest product release offers genuine process improvements delivering excellent uniformity and high throughput processes on a range of applications. With access to our exclusive library of over 6,000 process recipes, built up over 25 years as a leading plasma tool manufacturer, our customers are guaranteed an excellent product with comprehensive, market

leading backup.”

SoloPower’s CIGS SoloPanels certified by UL and IEC

The firm’s flexible thin-film solar cells and modules are optimised for twelve-inch and sixteen-inch standing-seam metal roof integration

SoloPower has received certification of its next-generation SF1, SP1, and SP3L SoloPanels to both Underwriters Laboratories (UL) and the International Electrotechnical Commission (IEC) standards.

“Certification to UL and IEC standards for our SoloPanels is a testament to the outstanding work of our technology team, which has a proven track record of industry firsts for flexible CIGS modules,” says Tim Harris, CEO, SoloPower. “It represents another step towards our goal of making solar the main source of energy for commercial and industrial buildings worldwide.”

SoloPower’s remaining next generation module, the SP3S SoloPanel, has been certified to UL standards, and the company anticipates certification to IEC standards in the near term. The SF1 and SP1 SoloPanels are optimised for twelve-inch and sixteen-inch standing-seam metal roof integration. The SP3L and SP3S SoloPanels are optimised for commercial and industrial low-slope building applications.

The firm’s new suite of solar solutions feature three first-of-their-kind, easy, non-penetrating installation kits: the SoloSaddle, SoloEdge, and the SoloBridge, which increase application versatility while maximising module performance across rooftops and geographies.

The SoloSaddle integrates the SP3S into membrane-based roofing systems, while a low-slope curve provides self-cleaning and high performance in hot climates. The SoloEdge easily integrates the SP3L into membrane based roofing systems. A five-degree slope provides self-cleaning and high performance in cold climates. The SoloBridge integrates the SP3L into metal roofing

systems.

“Being certified to both UL and IEC standards is a significant milestone on the road to full scale commercialisation,” adds Bruce Khouri, President & Chief Commercial Officer and a building integrated photovoltaics (BIPV) pioneer.

“In addition to bringing to the market world-class, high efficiency, flexible modules, our first-of-their-kind rooftop installation kits are designed to rapidly expand the versatility for commercial and industrial rooftop solar applications. With BIPV as one of the fastest growing segments of the solar industry, we are thrilled to be able to share our unique solutions at Intersolar.”

The certifications come at an exciting time for SoloPower. In June, the company announced an expansion of its senior leadership team to incorporate two veterans of the solar energy space, appointing Paolo Pietrogrande, Chairman of Element Power Solar, as a member of its Board of Directors and Bart Van Ouytsel to lead sales in Europe, the Middle East, and Africa.

SoloPower is also preparing to open its state-of-the-art, high-volume manufacturing facility in Portland, Oregon, which will begin commercial production later this year. Operations in Portland are ultimately expected to have a capacity of 400MW and employ 450 people.

SoloPower’s proprietary approach embodies critical technology, manufacturing, and cost advantages that enable large-scale “fab-style” production of high-efficiency CIGS-based photovoltaic cells. The CIGS cells are packaged into unique, flexible, lightweight solar modules that require less balance-of-system hardware and are easier to install than traditional solar panels.

Intermolecular and KAUST unite to develop CIGS technology

The two organisations aim to contribute to the renewable energy strategy in the Kingdom of Saudi Arabia

Intermolecular has announced an ongoing project with King Abdullah University of Science and Technology (KAUST) for the enhancement of CIGS thin film photovoltaic (PV) manufacturing technology.

The advanced metrology capabilities of the Solar and Photovoltaics Engineering Research Centre (SPERC) at KAUST in Thuwal, Kingdom of Saudi Arabia, are used along with Intermolecular's High Productivity Combinatorial (HPC) platform in San Jose to rapidly learn about high efficiency CIGS solar cell materials and process interdependencies.

"Working with Intermolecular's team and HPC platform allows us to accelerate our mission of developing sustainable solar power," comments Ghassan Jabbour, Director of SPERC at KAUST. "The Kingdom of Saudi Arabia is focusing enormous resources on developing renewable energy technologies as part of the strategy to transform its fossil fuel-based economy in the coming decades. KAUST is at the forefront of this effort and sees CIGS technology as extremely promising in terms of its potential to deliver the lowest cost solar electricity in the Kingdom." The joint IMI-KAUST project is led by Research Scientist Jessica Eid, a member of Jabbour's team, hosted at Intermolecular's facility in San Jose, California.

Sandeep Nijhawan, Intermolecular's vice president of its Clean Energy Group, adds, "We are fully committed to accelerating various PV technologies using our HPC platform. We recently reported progress on our patent pending sulphur-free, two-step sputtered CIGS approach with fundamental manufacturing benefits at the IEEE PV Specialists Conference (IEEE-PVSC)."

"The breakthrough result of 17.7% active-area CIGS efficiency at an open-circuit voltage of 692mV --which we developed internally in less than one year - reaffirms the broad applicability of our HPC platform to rapidly advance CIGS PV. We are very excited to work with KAUST to further enhance CIGS technology and showcase our capabilities in this important region," concludes Nijhawan.

IQE & Solar Junction aim to boost cell efficiency to over 50%

IQE has received a \$1.95 million order for III-V solar wafers from the current world record cell efficiency holder, Solar Junction. The cash will be used for two purposes ; \$1 million for first production wafers, and the remainder for the optimisation of Solar Junction's triple-junction indium gallium arsenide cells

IQE has received its first major orders for Concentrating PhotoVoltaic (CPV) wafers from CPV cell developer and manufacturer Solar Junction.

The orders are worth a total of \$1.95 million, relating to \$1 million for first production wafers and \$950,000 for development wafers for improving yet further the efficiency of Solar Junction's CPV products. IQE signed a seven-year exclusive wafer supply agreement with Solar Junction in February 2012.

The CPV wafer production order follows Solar Junction's recent announcement of its first 5MW order from SolFocus, which has been chosen as the system supplier for the 450MW project in Baja, Mexico, the largest CPV project announced to date, funded by Grupo Musa and Synergy Technologies LLC. CPV project announcements during 2012 are exceeding industry projections, with more than 650MW project announcements thus far.

Solar Junction currently holds the world record for CPV cell efficiency at 43.5% and, in conjunction with IQE's proprietary internal wafer technology, aims to develop cell architectures with efficiencies of more than 50%. The cost of generating electricity using CPV in hot sunny areas such as California is already at cost parity with all other forms of power generation (source: GTM) and increasing cell efficiency will further lower the cost of CPV power generation substantially.

Drew Nelson, IQE President and CEO, says, "This order from Solar Junction is clear indication that CPV technology is gaining significant traction in large scale power generation projects in sunny areas. Our long term, exclusive wafer supply agreement with the world record holders

in cell efficiency, coupled with the large scale manufacturing capacity now in place following our deal to acquire RFMD's in-house MBE production capacity, position IQE to be a major wafer supplier to the rapidly emerging CPV industry, by far the most efficient of any solar technology."

New Board and Sales executives appointed by CIGS firm SoloPower

The firm has appointed two veterans of solar energy and renewables space to aid SoloPower's mission to make rooftop solar the main energy source for world's commercial and industrial buildings. San Jose-based SoloPower has appointed Paolo Pietrogrande as a member of its Board of Directors and Bart Van Ouytsel to lead sales in Europe, the Middle East, and Africa (EMEA). Pietrogrande was approved on June 13th, and Van Ouytsel started in his role on June 1st.

Veterans of the solar energy and renewables space, Pietrogrande and Van Ouytsel add expertise and experience to SoloPower's mission to make rooftop solar the main energy source for the world's commercial and industrial buildings.

The new additions come after SoloPower launched its next-generation of integrated solar solutions at Intersolar Europe in Munich, Germany. SoloPower's first-of-their-kind easy installation systems are designed to make the firm's SoloPanels perform optimally and to be integrated into a variety of roof systems across geographies.

SoloPower's integrated solar solutions address rooftops that cannot bear the weight of heavier, traditional panels while expanding the global solar rooftop market. "It's a really exciting time for SoloPower, with Paolo and Bart joining our team, the recent introduction of our next generation of solar solutions, and hiring for the high volume manufacturing facility we're preparing to open in Portland, Oregon," says Tim Harris, CEO, SoloPower.

"Paolo's extensive experience in utilities, in renewable power generation, and in managing international manufacturing companies will help

us make solar energy possible for any rooftop in the world. And Bart's global expertise in the solar energy and building materials industries are just what we need to continue our customer growth," he continues.

Pietrogrande is Chairman of Element Power Solar, a developer that put 77MW in operation and has 2800MW of pipeline in North America, Latin America, Europe, and other emerging markets. In his past positions, he supervised the development and operation of over 4000MW of renewable energy projects around the world, including 200MW of solar power plants.

He has 31 years of experience in alternative energy and corporate management, is a founding partner of Netplan Management Consulting, and has held leadership and executive positions in companies such as Enel, Gamesa Solar, General Electric, Bain, and KTI. He joins the SoloPower Board of Directors just three months after General Wesley K. Clark (USA, Retired), former NATO Supreme Allied Commander, Europe and a former U.S. Presidential candidate, was appointed to SoloPower's Board of Directors as an independent director.

"SoloPower has developed the most compelling approach, technology, and manufacturing capability to address a unique solar market need," says Pietrogrande, who currently sits on the boards and advisory committees of other public companies. "I'm honoured to be working closely with the SoloPower team and its dedicated board that provides critical leadership and support to the company. Together, we're on a path to make solar the primary source of energy for the world's commercial and industrial buildings."

SoloPower's proprietary approach embodies critical technology, manufacturing, and cost advantages that enable large-scale "fab-style" production of high-efficiency CIGS-based photovoltaic cells. The CIGS cells are then packaged into unique, flexible, lightweight solar modules that require less balance-of-system hardware and are easier to install than traditional solar panels. A seasoned professional in alternative energy management, Van Ouytsel most recently served as Vice President of European Sales and Marketing for EMEA at Solar Integrated, an Energy Conversion Devices company.

Over a seven-year period, Van Ouytsel had profit

and loss and sales responsibility for \$40 million in annual revenue. "SoloPower is paving the way for the future of solar energy around the globe, and I'm looking forward to being a part of the company's continued growth as we expand the possibilities of solar integration," concludes Van Ouytsel, who is fluent in Dutch, German, English, and French. "We see great opportunity in Italy, Japan, the U.S., and around the world."

Power Electronics

Advantech Wireless releases GaN whitepaper

The company's paper discusses gallium nitride based solid state power amplifiers for satellite communication

Advantech Wireless, a Canadian-based manufacturer of broadcast-quality Satellite, RF Equipment and Microwave Systems has released a new whitepaper titled, "A new generation of Gallium Nitride (GaN) based Solid State Power Amplifiers for Satellite Communication".

The paper explores the technology and benefits of incorporating GaN into a line of high power amplifiers.

Energy efficiency and going "Green" is very important throughout the world. The Advantech Wireless whitepaper identifies and explains how it is possible to achieve significant reductions in energy consumption, space and weight while maintaining linearity and significant output power.

The introduction of GaN High Electron Mobility Transistors (HEMT) in early 2000 has left an undeniable mark on the entire satellite communication landscape.

"It is now possible for the first time since the introduction of the Solid State Microwave Technology to design and manufacture Power

Amplifiers that exceed by several orders of magnitude the reliability, linearity, power density and energy efficiency of all existing technologies, being GaAs, LDMOS, or TWT" states Cristi Damian, VP Product Line Management and Business Development at Advantech Wireless.

Over the past 6 years, Advantech Wireless has developed a full line of GaN based SSPAs and BUCs/SSPBs (Block Up Converter integrated with SSPA). The product line was launched at Satellite 2010 in Washington, included up to 200W Ku-band offering, the first product line worldwide.

Since then, major deployments in both the commercial and military markets have been taken place with thousands of devices now operating in the field. GaN is a mature, stable and high reliability technology with low OPEX.

By using patent pending technologies and in close cooperation with key technology suppliers, Advantech Wireless says it has managed to perfect the design, and raise the performance of GaN based SSPA/SSPB above all existing technologies.

SiC-based devices show aggressive penetration

Demand for lighter, smaller, cheaper and more efficient systems jump starts an evolution of new semiconductor technologies using silicon carbide

Conversion and motion amidst the power electronics industry has increased demand for lighter, smaller, cheaper and more efficient systems.

Beginning at the semiconductor level, four technologies are best suited to handle new system requirements; silicon IGBT, Super Junction (SJ) MOSFETs, GaN and SiC -based devices.

IGBTs are expected to account for \$1.6 billion in the medium to high voltage sector, while SJ MOSFETs are estimated to reach \$567 million by the end of 2012.

While global market revenue for SiC-based semiconductor devices will only account for 1 percent of the total market for semiconductor devices, the SiC sector is forecasted to grow 37

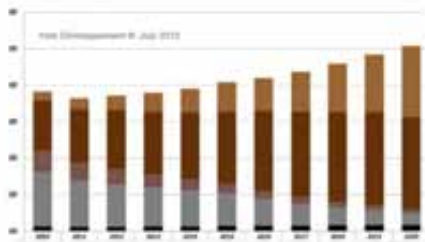
percent per year to reach \$5.34 billion by the end of the next decade through aggressive market penetration.

Yole Développement, in partnership with Global Information has released two new reports on the global market for semiconductors and power devices.

The first report, "Status of the Power Electronics Industry", highlights the trends of the disruptive power semiconductors technology and market. The second report, "Power Fabs Database 2012", presents a global picture of today's power electronics manufacturing industry.

POWER ELECTRONICS: A \$20 BILLION DEVICES MARKET WITH 4 MAIN SEMICONDUCTOR TECHNOLOGIES

Market volume for Si, SiC and SiC substrates in Power Electronics



Overall power electronics wafers market estimation: 2010-2020

In 2012, the market for semiconductor devices (discrete, modules and ICs) dedicated to the power electronics industry will reach \$20 billion. With applications as diversified as hybrid cars, PV inverters, lighting, energy, and voltage ranging from a few volts to a few thousands volts, power electronics is and will remain one of the most attractive branches of the semiconductor industry over the next decade.

While SJ MOSFETs see new players and foundry service suppliers, the IGBT dies' industry is being consolidated by the presence of large players involved in many applications. These include Infineon, Mitsubishi Electric and Fuji. However, the IGBT (and SJ MOSFET) modules business is increasing and new players are expected to provide solutions for cooling, interconnections, substrates, packaging, and gel.

On the other hand, the SiC industry, in which Cree is a major player, is now an interesting playground for new players. With access to lower cost material, the SiC industry now has the possibility to ramp up and organise itself. However, apart from the PFC business, technological capabilities of SiC show that it will surely be dedicated to high power/voltage

applications.

Last but not least, SiC companies have appeared in China, which will definitely provide competition and tougher access to local markets according to Yole.

EPC demos GaN wireless powering system

The superior switching speeds of EPC's gallium nitride FETs increases the efficiency of power electronics for highly resonant wireless power transfer

Efficient Power Conversion Corporation (EPC) is offering a high efficiency wireless power demonstration system utilising the high frequency switching capability of gallium nitride transistors.

The firm's eGaN FETs are an ideal solution for these systems because of their ability to operate efficiently at high frequency, voltage, and power.

Highly resonant wireless power transfer was invented by the founders of WiTricity. WiTricity licenses its intellectual property to companies seeking to build products based on this new technology.

Capable of transferring power over long distances, WiTricity technology enables a wide range of consumer, medical, industrial and automotive applications. Products using highly resonant wireless power transfer can meet stringent regulatory guidelines, and are safe for people and animals.

Many wireless charging products now in the market use traditional magnetic induction coils with operating frequencies between 100-300 kHz, and Class E, F and S amplifier converter topologies. Recently, organisations such as the Consumer Electronics Association and A4WP (Alliance for Wireless Power) have called for a higher frequency standard (6.78 MHz) for wireless charging systems.

At higher frequencies, traditional silicon-based power transistors (MOSFETs) approach the limit of their switching capability. EPC's eGaN FETs offer higher efficiency compared to MOSFETs at these higher frequencies.

This wireless power demonstration system, jointly developed by EPC and WiTricity, is a class-D power system operating at 6.78 MHz, and capable of delivering up to 15 W to a load.

The demonstration system simplifies the evaluation process of the wireless power technology. The system includes all the critical components in a single system that can be easily connected to demonstrate the powering of a device with wireless energy transfer.

M/A COM's HEMT targets radar applications

The firm's depletion mode HEMT microwave pulsed power transistor features broadband operation at +50 V. The gallium nitride device is suited to civilian and military pulsed radar applications

M/A-COM Technology Solutions, a supplier of analogue semiconductor solutions, has revealed a new highly efficient 40 W pulsed power transistor.

The GaN based MAGX-002735-040L00 is optimised for civilian and military pulsed radar applications between 2.7 and 3.5 GHz.



MAGX-002735-040L00

The device is a gold metalized, internally matched, GaN on SiC RF power transistor. It exhibits excellent performance when operated at +50 V, class AB operation, 40 W peak output, using a 300 μ s pulse and 10% percent duty cycle pulsed signal.

The transistor provides high gain, efficiency, bandwidth, and ruggedness over a wide bandwidth for today's demanding needs.

Based on extensive HTOL RF accelerated life testing, quantifiable test results demonstrate this product is designed to provide an MTTF of 600

years or better.

"The 800 MHz of instantaneous bandwidth and rugged performance makes this versatile device an excellent choice as a driver stage or output stage for any s-band radar power amplifier application," said Gary Lopes, Senior Director for RF Power Technologies.

Manufactured in a thermally enhanced, Cu/Mo/Cu, flanged ceramic package, the MAGX-002735-040L00 boasts excellent thermal performance as well as high breakdown voltages that allow for reliable and stable operation in extreme mismatched load conditions. Operating at +50 V, class AB, the pulsed power transistor provides 40 W of peak power at 55 percent drain efficiency with a minimum gain of 10.5 dB across the full 2.7 to 3.5 GHz frequency band.

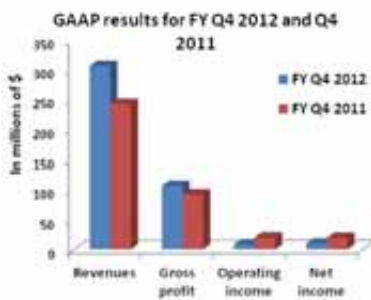
Production quantities and samples of MAGX-002735-040L00 are available from

Cree revenues on the up

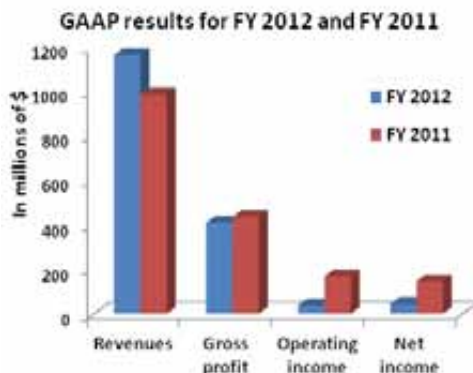
Although LED lighting adoption continues to increase, the firm has found that the macroeconomic environment is impacting its growth outlook in the near future

Durham based LED and power device manufacturer Cree has announced revenue of \$306.8 million for its fourth quarter of fiscal 2012, ended June 24, 2012.

This represents a 26% increase compared to revenue of \$243.0 million reported for the fourth quarter of fiscal 2011 and an 8% increase compared to the third quarter of fiscal 2012. GAAP net income for the fourth quarter was \$10.0 million, or \$0.09 per diluted share, a decrease of 49% year-over-year compared to GAAP net income of \$19.8 million, or \$0.18 per diluted share, for the fourth quarter of fiscal 2011.



For fiscal year 2012, Cree reported revenue of \$1.16 billion, an 18% increase compared to revenue of \$988 million for fiscal 2011. GAAP net income was \$44 million, or \$0.39 per diluted share, a decrease of 70% compared to \$147 million, or \$1.33 per diluted share for fiscal 2011. Cree generated \$242 million of operating cash flow and \$130 million of free cash flow (cash flow from operations less capital expenditures) during fiscal 2012.



“We finished the year strong in our fiscal fourth quarter with record revenue and non-GAAP earnings per share on the high end of our target range,” noted Chuck Swoboda, Cree Chairman and CEO.

“Overall, LED lighting adoption continues to increase and we remain focused on being the leader in innovation to grow our business by enabling our customers to realise the tremendous benefits of LED technology. While we are encouraged by our progress, the macroeconomic environment is impacting our growth outlook in the near term,” he added.

Gross margin decreased 10 basis points from Q3 of fiscal 2012 to 34.8% while cash and investments increased \$34 million from Q3 of fiscal 2012 to \$745

million. Accounts receivable (net) decreased \$16 million from Q3 of fiscal 2012 to \$152 million, with days sales outstanding of 45. Inventory decreased \$8 million from Q3 of fiscal 2012 to \$189 million and represents 85 days of inventory.

Business Outlook:

For its first quarter of fiscal 2013 ending September 23, 2012, Cree targets revenue in a range of \$305 million to \$325 million with GAAP gross margin targeted to be around 36%. The GAAP gross margin targets include stock-based compensation expense of approximately \$2.1 million. Operating expenses are targeted to increase by approximately \$2 million on a GAAP basis. The tax rate is targeted at 19.0% for fiscal Q1. GAAP net income is targeted at \$10 million to \$16 million, or \$0.09 to \$0.14 per diluted share. The GAAP net income target is based on an estimated 116.0 million diluted weighted average shares.

Hittite unveils GaAs power amplifiers

Latest GaAs amplifiers are said to be ideal for high linearity microwave radio, EW/ECM, radar and test instrumentation.

US-based Hittite Microwave has launched two new power amplifier products which are said to be ideal for microwave radio, EW, ECM and radar applications to 28GHz. Also released is a unique wideband LNA which operates from 300MHz to 20GHz and is ideal for wideband multi-chip-module and subsystem applications. The HMC994LP5E is a GaAs MMIC pHEMT Distributed Power Amplifier which operates between DC and 28GHz. The amplifier provides 13dB of gain, +29dBm of saturated output power, and 23% PAE from a +10V supply.

With up to +38dBm Output IP3, the power amplifier is suited to high linearity applications in military and space as well as point-to-point and point-to-multi-point radios. The HMC998LP5E is a GaAs pHEMT MMIC Distributed Power Amplifier which operates between 100MHz and 20GHz. The amplifier provides 11dB of gain, +41 dBm output IP3, and +31 dBm of output power at 1 dB gain compression while requiring only 500mA from a +15V supply. Both devices exhibit very flat gain, which Hittite

says makes them ideal for EW, ECM, radar and test equipment applications. Each is supplied in leadless QFN 5 x 5mm surface mount packages and feature I/Os that are internally matched to 50Ohms. The HMC1049 is a GaAs MMIC pHEMT low noise amplifier die which operates between 300MHz and 20GHz and employs a novel topology which maintains an excellent low noise figure of 1.7dB at low frequencies.

The amplifier also delivers 16dB of small signal gain and output IP3 of +27dBm, while requiring only 70 mA from a +7V supply. The P1dB output power of +16 dBm enables the LNA to function as a LO driver for balanced, I/Q or image reject mixers. The HMC1049 is internally matched to 50Ohms for ease of integration into multichip-modules (MCMs). Hittite has also released the HMC1048LC3B, a GaAs MMIC, general purpose, double-balanced mixer that can be used as a downconverter with DC to 4GHz at the IF port and 2 to 18GHz at the RF port.

Anadigics posts losses, leaders remain buoyant

As revenues drop for the fourth quarter in a row, Anadigics bosses assert growing wireless data markets will fuel power amplifier demand. Semiconductor company Anadigics has reported a second-quarter net loss of \$20.9 million or \$0.30 per share, compared to \$13.1 million or \$0.19 per share last year. Revenue has dropped for the fourth quarter in a row, with second quarter revenues down 29.5% to \$25.1 million from the year-earlier quarter.

This falls short of analysts' revenue estimates of \$28.6 million. Industry reports already suggest analysts are pessimistic about the company's next quarter performance, but Anadigics leaders remain buoyant. "We believe revenues have stabilised and are pleased with the traction we continue to see in the development of our new products," said Terry Gallagher, vice president and chief finance officer. "In continuing our focus on streamlining our cost structure, we recently took actions that will further reduce annualized expenses by over \$1 million." As president and chief executive, Ron Michels, highlights, his company's growth relies on three drivers; the transition from 3G to 4G communications, deployment of small cell networks

and rising use of high performance wi-fi. Each is fuelled by the increasing demand for wireless data consumption, which he is confident is rising.

"We've secured several design wins since starting production shipments of our single-band ProEfficient [power amplifier] to tier one OEMs... and we're preparing our next-generation dual band power amplifiers based on ProEfficient technology as well," he says. "Furthermore, our dual-band power amplifier has continued to be recognised by manufacturers... Samsung is using these power amplifiers for the new Galaxy S3, available on both the Verizon and Sprint networks."

Michels also asserts that his company's small cell power amplifier represents a significant growth opportunity. Recent market forecasts indicate that unit shipments for the entire small cell market will grow by a factor of five next year. And as Michels also points out, Anadigics's parts will be on all reference designs currently under development by the likes of Mindspeed and Qualcomm, in the small cell market.

"Some of these boxes have as many as six, seven of our power amplifiers in them," he says. "So when they start to ramp, we get a good multiplication factor." Michels admits his business isn't seeing significant growth right now from GaN development, but reckons cable TV revenues will pick up in the fourth quarter of this year while revenues from high power infrastructure products will rise come the second half of 2013. Both sectors require GaN components, which are currently being sampled. "In the CATV market, we continue to anticipate stable, long term growth... and we're working closely with key customers as we build traction for our next generation gallium nitride line of amplifiers," he says. "We also anticipate a growing need for high-performance RF front end components to enable full scale deployment of 802.11ac wi-fi in mobile devices," he adds. "Our wafer process technology enables a unique combination of industry leading linearity, outstanding efficiency, and ultra-small form factor."

Rohm develops SiC power MOSFET with internal Schottky barrier diode

The device promises to significantly reduce power loss in inverters and requires fewer components. Rohm Semiconductor has unveiled a 1200V SiC power mosfet designed for inverters and converters in power conditioners for industrial devices and photovoltaic power generation.

The SCH2080KE integrates an SiC MOSFET and Schottky barrier diode into a single package, to minimise forward voltage that was problematic in previous SiC power MOSFET body diodes.

According to the company, the SCH2080KE reduces operating power losses by at least 70% compared to Si IGBTs used in general inverters. This not only provides lower switching losses, but also enables compatibility with smaller peripheral components by supporting frequencies above 50kHz.

Current Si IGBTs commonly used in 1200Vclass inverters and converters cause power switching loss due to tail current or recovery of the external FRD, bringing a need for SiC power MOSFETs capable of operating with low switching loss at high frequencies.

However, conventional SiC power MOSFETs were plagued with numerous reliability problems, including characteristic degradation due to body diode conduction and failures of the gate oxide film, making full-scale integration impossible.

Rohm says it has succeeded in overcoming these problems by improving processes related to crystal defects and device structure, and reducing ON resistance per unit area by approximately 30% compared to conventional products, leading to increased miniaturisation.

There is also the SCT2080KE, an SiC power MOSFET with no internal SiC Schottky barrier diode. Both the SCH20801KE and SCT2080KE can be configured based on customer requirements.

Azzurro receives millions of Euros for 200mm GaN-on-Si process

Local government awards Euro 2.6 million to

Azzurro for large wafer development
Azzurro Semiconductors, Germany-based developer of GaN-on-Si wafers, has bagged Euro 2.6 million in government funds from the European Regional Development Fund and the Free State of Saxony. The company will use the funds to drive its GaN on 200mm silicon wafer technology forward and strengthen its competitive position. With GaN-on-Si technology, Azzurro addresses two huge growth markets, LEDs and power semiconductors. The company asserts that its large diameter wafers allow the industry to fabricate power semiconductors and LEDs using existing, standard semiconductor production sites, thereby cutting costs. According to the company, its performance data on 150mm wafers is “already unique” and it will now extend its lead to 200mm substrates. “Based on the technology grant, we can execute the strategic development of our 200mm technology platform for power semiconductors and LEDs and quickly attend to the strong customer demand,” said Stephan Lutgen, Vice President Technology at Azzurro.

GaN Systems and Converter Technology partner to drive power semiconductors forward

GaN Systems and Converter Technology plan to deliver application support for advanced power control and conversion GaN applications
Canada-based developer of gallium nitride power switching semiconductors, GaN Systems, and UK design consultancy, Converter Technology, have joined forces to advance the adoption of new GaN applications.

Under the terms of the agreement, the companies will work directly to develop application notes, reference designs, training material and cutting-edge technology demonstrators to accelerate the commercialisation of GaN Systems’ technology.

The partners plan to develop new applications where the performance of GaN Systems’ switches and solutions will deliver maximum impact. To support the adoption of the new applications, GaN Systems and Converter Technology will promote

industry engagement, and demonstrate key benefits to GaN Systems' customers.

The team hopes this engagement will further accelerate the adoption of GaN System's technology into the next generation of power conversion systems in a power devices market worth \$14 billion.

"The remarkable performance level available from GaN Systems' technology presents an ideal opportunity to push the limits in power conversion and we look forward to demonstrating what can be achieved in real world customer designs," said Iain Mosely, technical director of Converter Technology. GaN Systems' patented power switch technology promises new levels of performance with unparalleled advantages of size, weight, cost and efficiency.

At the same time, Converter Technology, claims to be leading facilitator of pushing ground-breaking technology into high volume production across a wide range of end user applications.

GaN Systems last week closed its Series B financing round with existing investors and cleantech venture capital firms Chrysalix Energy Venture Capital and RockPort Capital, only six months after closing its Series A round. Initial development milestones were achieved months ahead of schedule.

Semiconductors jostle for places in power electronics industry

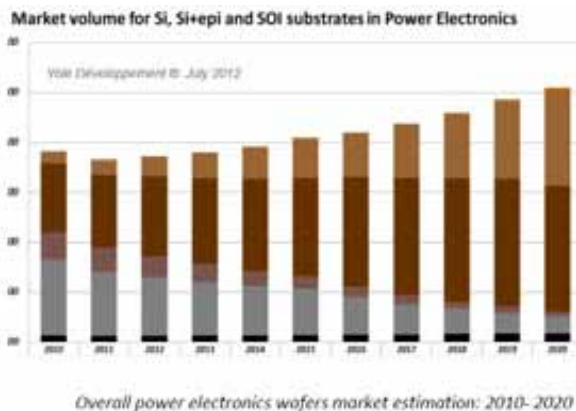
Yole Développement reports on how compound semiconductors are crucial to the rapidly growing power electronics market

In 2012, all semiconductor devices - discrete, modules and ICs - dedicated to the power electronics industry will reach \$20 billion in market size, reports France-based analyst business, Yole Développement. With applications as diverse as hybrid cars, PV inverters, lighting, energy, and voltage ranges as wide as a few volts to a few thousands volts, power electronics is and will remain one of the most attractive branches of the semiconductor industry for the next decade. According to the analyst, the power electronics

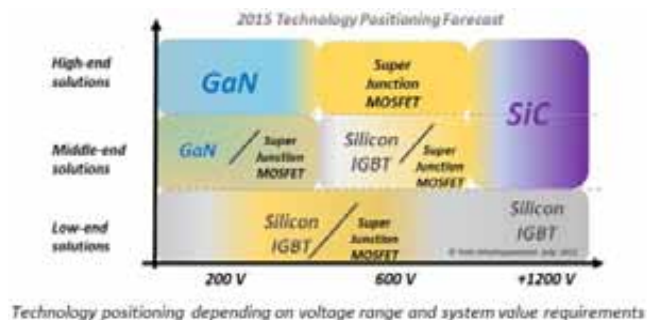
industry now deals with conversion and motion and needs lighter/smaller, cheaper and more efficient systems.

The four technologies, best suited to handling new system requirements are silicon IGBT, Super Junction (SJ) MOSFETs, GaN and SiC based devices. As Yole points out, the well-established IGBTs already account for \$1.6 billion in the medium to high voltage market while the SJ MOSFET market will reach \$567 million by the end of the year. GaN and SiC promise to surpass silicon performance and enhance inverter capabilities, although the materials are still expensive and the technology is not ready yet, reports Yole.

GaN requires technological enhancement of the manufacturing process, especially for the epitaxy thickness, and SiC is expensive, prohibiting implementation in consumer markets. But, as Yole highlights, both materials are well developed in the LED industry, and plenty of LED players are looking at opportunities in the power electronics sector.



Technology positioning will also take place. Yole expects to see a segmentation between technology and the power/voltage range, with some segments only accepting a single, "best" technology.



Industry differences

The industry varies from technology to technology. While SJ MOSFETs see new players and foundry service suppliers, the IGBT dies' industry is consolidating based on a number of large players, such as Infineon, Mitsubishi Electric and Fuji, involved in many applications. However, the IGBT (and SJ MOSFET) modules business is increasing and Yole has noted new players entering to provide solutions for cooling, interconnections, substrates, packaging, and gel. Meanwhile, the SiC industry, which has been led by CREE, is now an interesting playground for new players.

With access to lower cost material, the SiC industry now has the possibility to ramp up and get organised, asserts Yole. However, apart from the PFC business, technological capabilities of SiC show that it will surely be dedicated to high power/voltage applications. Last but not least, SiC companies have appeared in China, which will definitely provide competition and tougher access to local markets. At this point in time, the GaN industry is mostly a US business.

International Rectifier, EPC, Transphorm, Microsemi or GaN Systems now propose fully off-the-shelf or customised products. Some pioneers, such as MicroGaN, NEC and Powdec, are showing a trend towards globalising the GaN manufacturing industry. However, the market is still soft and LED players are considering using their technological platform to enter this power electronics market, which will be very much low power/voltage oriented.

As Yole also highlights, while the power electronics industry has great growth potential, technological and cost requirements imposed to power semiconductors are driven by the inverter industry. Power semiconductors are "just a piece" of the power electronics industry, and the power semiconductor industry has to answer requirements from a bigger system; the inverter. Indeed, power devices ameliorations will be useful only if they fit with passive and connective devices, defined by inverter needs. And as Yole concludes, geographical positioning is also critical in the power electronics area, especially with the boom in China and other emerging countries, but also because several applications (PV, wind, electric vehicles) are supported by local governments.



EpiGaN ramps up production on Aixtron reactors

IMEC spin-off, EpiGaN, kick-starts six inch wafer production and eight inch development on Aixtron systems



Belgium-based GaN epiwafer maker and IMEC spin-off, EpiGaN, has commissioned two new MOCVD systems from Aixtron for the commercial production of 6-inch GaN-on-Silicon wafers. Producing wafers for power and RF electronics devices, EpiGaN will also use the systems to develop next generation 200mm GaN-on-Silicon wafers. The systems can operate multiple 6" or in 8" configurations. Aixtron installed and commissioned the reactors at EpiGaN's purpose-built, state-of-the-art facility in Research Campus Hasselt, which opened in May this year. "After several years of efficient collaboration with Aixtron towards GaN-on-Si, it was evident that their Close Coupled Showerhead systems perfectly suit our needs," explains Dr Marianne Germain, CEO of EpiGaN. "[We've] worked with Aixtron's CCS MOCVD systems at IMEC and have jointly published numerous papers on GaN-on-Silicon development." "There are challenges ahead for high voltage 200mm GaN-on-Si, but we are confident that the combination of our enduring expertise and the

leading edge equipment and process technology will deliver all our objectives rapidly and efficiently,” she adds. EpiGaN’s founders have pioneered GaN on Si technology, and were the first to demonstrate GaN HEMT’s on 6” and 8” silicon substrates. The company is also participating in the EU project HiPoSwitch aiming to develop more compact and powerful energy converters. Activities cover the entire value chain from GaN-on-Si epiwafers over GaN power device development to industrial application.

Australia funds silicon carbide chip production

Griffith University researchers win Aus\$1million from government and work with UK equipment maker, SPTS Technologies, to commercialise SiC-on-silicon production.

Australia-based Queensland Micro- and Nanotechnology Centre, Griffith University, has won Aus\$1million in funding from the Queensland State Government to develop production processes for silicon carbide microchips. The research centre has been developing SiC-on-silicon substrates for a wide variety of applications including LEDs, micro-electro-mechanical systems (MEMS) and power integrated electronics. According to Professor Sima Dimitrijevic, lead researcher at the University’s Micro- and Nanotechnology Centre, research breakthroughs include low temperature epitaxy of cubic SiC on Si as well as the development of MOS purity oxides for SiC MOS devices.

“The superior properties of silicon carbide enable smaller, more efficient, sensitive and robust devices that can operate in harsh chemical and temperature environments,” he adds. Researchers at the Centre have also been working alongside UK-based semiconductor equipment manufacturer, SPTS Technologies, to commercialise SiC-on-silicon technology. Having demonstrated low temperature epitaxial growth of SiC films directly onto low-cost silicon wafers, the partners intend to develop thermal processing equipment to commercialise the technology.

“Our industry partner will help us take the next critical step of making our SiC production processes ready for industry to adopt,” adds Centre operation

director, Alan Iacopi. “There is a potentially enormous global market and our breakthroughs have far reaching implications in terms of engaging with international industry and bringing frontier technologies to Queensland.”

ANADIGICS amplifiers to boost smartphone efficiencies

New power amplifier family will “set the standard for 4G battery life”

ANADIGICS has unveiled its latest power amplifier family for WCDMA and LTE networks. According to the company, the ProEfficient power amplifiers have been optimised for the next generation of 4G devices, by delivering world-class efficiency across all power levels. These products are said to combine greater talk time in low-power mode with longer data application use in high-power mode. As Jerry Miller, vice president of business development and marketing at ANADIGICS, explains the devices will extend battery life across all operating conditions of modern smartphone and tablet devices, as well as lower overall system cost. “4G devices enable users to tap into ultra-fast broadband speeds, resulting in greater data use,” explains Miller.

“This change in use drives the power amplifier to operate more frequently in high power mode. By delivering outstanding efficiency in both high and low power modes, the new power amplifiers will help manufacturers set the standard for 4G battery-life.”

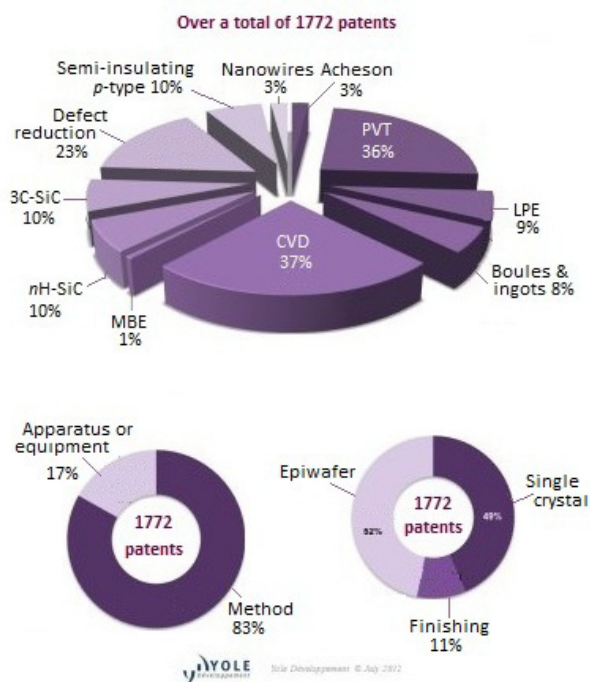
The latest power amplifiers are manufactured on InGaP HBT MMIC technology to achieve efficiency at high and low power modes. The devices are optimised for use with average power tracking operation to reduce current consumption at medium and low operating powers. In addition, the power amplifiers are said to provide exceptional linearity to ensure a stable connection for clear voice and high-speed data. The devices target the most widely used 3G/4G frequency bands, such as bands 1, 2, 3/4/9/10, 5, and 8.

Number of SiC patents don't tally with revenues

Although Japan holds 72% of patents related to silicon carbide wafer growth, the US holds a larger proportion in terms of revenue

Despite a cumulative raw wafer and epi wafer market that won't exceed \$80 million in 2012, the corpus of related patents of SiC growth comprises over 1772 patent families and more than 350 companies since 1928. Eighty-three percent of patents relate to a method while 17% of them claim an apparatus.

This is according to Yole Développement's latest report, "SiC Patent Analysis single crystal, wafer and epiwafer manufacturing".



Since 1978, the main technique used to grow bulk single-crystals of SiC is PVT (Physical Vapour Transport). The seeded sublimation method represents 36% of published patents. The PVT technique mostly deals with the hexagonal polytype nH-SiC (n=2,4,6).

An alternative route to growing SiC is Liquid Phase Epitaxy (LPE), with early efforts dating back to 1961. This technique enables the grow of crystals with low dislocation densities at relatively low temperatures, which is particularly attractive for

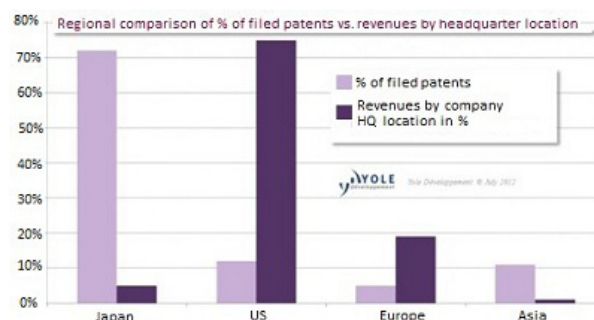
cubic polytype 3C-SiC.

About 37% of patents relate to a Chemical Vapour Deposition technique (CVD) which is almost exclusively used today to manufacture SiC epiwafers. Molecular Beam Epitaxy (MBE) is only mentioned in 1% of patents. The polytype (hexagonal or cubic) is explicitly claimed in 15% of patents. Numerous strategies to reduce crystal defects (micropipes, carrots ...) and make semi-insulating material are proposed in 23% and 10% of patents respectively.

Roughly 350 applicants are involved in SiC crystal/epiwafer technology. They are mainly located in Japan, which holds 72% of patents and the US, which possesses 12% of patents. The five major applicants based on their patents number are Denso, Sumitomo, Nippon Steel, Bridgestone and Toyota. They represent about 35% of studied patents.

US firm Cree occupies 6th position. This balance is totally uncorrelated from the reality of the market where 75% of the SiC wafer business is generated by US-based companies, namely Cree, II-VI or Dow Corning.

Japan is only responsible for 5% of the revenues (at least before Rohm acquired SiCrystal). Similar observations are seen in Europe and Asia (not including Japan) where the number of patents/revenues ratio is very weak at the moment.



Although Japan is currently leading the IP in SiC technology, Korea and China are catching up.

Japan has become increasingly involved in SiC technology since the 1980's. The United States was the earliest player and is still active. In contrast, only 3 Japanese companies are commercially active in SiC material. These are Showa Denko (epiwafer),

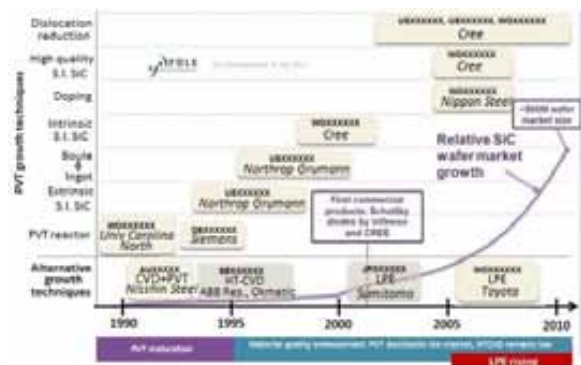
Bridgestone (wafer) and Nippon Steel (wafer and epiwafer).

During the last five years, with the establishment of some new companies, China and Korea have emerged as new players. Chinese firms include Epiworld, TianYue, TYSTC and Tankeblue. Korean firm SKC is also another contender. However, the market share held by these companies is currently very low.

It may seem obvious that IP considerations do not create a differentiating factor for success in the SiC substrate business.

Cree is leading this industry with about half the global market share, and has an excellent reputation in terms of quality, diameter and reproducibility. However, Cree does not own the widest patent portfolio. Thus, know-how and patent numbers do not seem to correlate.

The only field where number of patents and business size appears to be more balanced is in Semi-Insulating (S.I.) SiC technology where both Cree (Vanadium-free) and II-VI (Vanadium-doped) have extensively patented their respective developments.



The barriers to the entry in the SiC substrate world are very high. Today, state-of-the-art technology deals with 6" diameter wafers with very low dislocation densities. According to Yole, only Cree seems able to offer such a product today.

But why is this the case?

Firstly, Cree has been widely funded by DoD, DoE, DARPA and Navy contracts during the last 20 years, meaning the US firm has had a large advantage over its competitors. Cree has been able to invest a lot of time and money in R&D and improve the

technology for both LED and Power Electronics.

So mastering SiC growth is a combination of money and development time, that cannot be compressed. Also, cross-fertilisation between its LED and Power businesses have allowed Cree to benefit from LED mass manufacturing, which is probably less stringent than power at wafer level, to fuel the power electronics side.

Apart from receiving funding to develop the technology, the only options to enter quickly in the SiC substrate battlefield appears to be through M&A (Merger & Acquisition) of an existing activity or to buy a license and related know-how, paying royalties in return.

But who is for sale?

Virtually nobody is at this current time. Beyond the top five SiC substrate leaders, Yole doesn't see a clear positioning of companies who may want to participate in a sale or merger of their business.

Ultimately, new developments based on LPE (Liquid Phase Epitaxy), made by Toyota, Denso or Sumitomo, as well as 3C-SiC (Cubic) which may disrupt the current PVT domination, could be the deciding factor.

Mitsubishi Electric's SiC modules reduce power loss in diode and MOSFETs

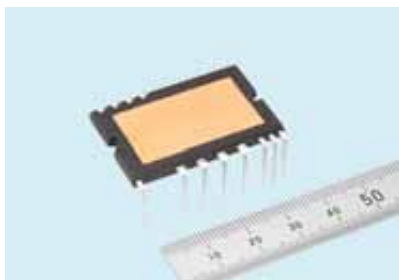
Three types of the silicon carbon power module are for home appliances, while two are for industrial devices such as inverters and servos

Mitsubishi Electric Corporation will begin shipping samples of five kinds of power modules for home appliances and industrial equipment from July 31st, 2012.

The modules use SiC, a next generation semiconductor material expected to significantly reduce power loss in diode and metal oxide semiconductor field effect transistor (MOSFET) chips.

The modules were showcased at POWER SYSTEM

JAPAN 2012 in TECHNO-FRONTIER 2012, an exhibition on electro-mechanical parts and devices at Tokyo Big Sight in Japan.



SiC module for home appliances



Industrial hybrid SiC-IPM



Industrial full SiC module

Inverters are widely used in home appliances like air conditioners and refrigerators, as well as in industrial devices, to increase energy efficiency. Mitsubishi Electric says its SiC modules offer significant reductions in power loss and improvements in high speed switching, achieving even higher efficiency and downsizing.

Of the five new types of SiC power module samples, three types are for home appliances, while two are for industrial devices such as inverters and servos.

Equipment and Materials

Matheson becomes majority shareholder of RASIRC

The provider of gas handling and purification systems used in MOCVD growth has increased its investment in purification

Matheson has acquired a majority share of RASIRC Corporation, which develops products that purify and deliver ultra-pure liquids and gases with a primary focus on water vapour.

Matheson provides industrial, medical, specialty and electronic gases, gas handling equipment, high performance purification systems, engineering and gas management services, and on-site gas generation with a mission to deliver innovative solutions for global customer requirements. Its products are used in the growth of III-V semiconductors.

William J. Kroll, Chairman & CEO of Matheson states, "This acquisition is consistent with our overall electronics & solar strategy to enhance our suite of value-added purification technologies and provide for continued innovation in our related product lines. RASIRC, using membrane technology, offers significant synergy not only to our existing line of purification products, but also to our high purity material business; this is because more liquid chemicals and precursors are being used in advanced technology nodes of semiconductor manufacturing."

"RASIRC will continue to develop new and innovative products focused on in-situ chemical generation of ultra-high purity vapours from liquid chemical sources," adds Jeffrey Spiegelman, RASIRC founder and president. "Having global infrastructure, logistics, and R&D, the Matheson presence will assure customers that we have the size and stability to support them through a complete product adoption cycle - from bench top testing, to pilot line, and high volume."

IPG Photonics adds 4th Veeco MBE reactor for laser diodes

tool will be used to manufacture gallium arsenide based devices

Veeco Instruments has recently completed installation of a GEN2000 Edge MBE system at IPG Photonics Corporation.



GEN2000 *Edge*

The system was delivered to further expand their production of high-quality GaAs-based lasers. This order follows IPG's prior purchases of three Veeco GEN200 Systems.

Alex Ovtchinnikov, Vice President-Components for IPG, states, "We have been very pleased with the cost of ownership advantages and the unsurpassed performance of our previously purchased GEN200 Systems. Thus, it made sense to scale-up to a higher capacity GEN2000 System to accommodate our needs for increased throughput today. Veeco is a valued IPG partner, offering us timely delivery, professional installation, and unmatched service and support."

"Repeat orders such as this from IPG attest to the leading performance of Veeco's cluster-based systems for production applications, as well as the continuing, comprehensive support Veeco offers," adds Jim Northup, Vice President and General Manager of Veeco's MBE Operations. "We are pleased to continue to support IPG in their capacity expansion."

The GEN2000 Edge MBE System is claimed to deliver exceptional wafer quality in high-capacity production applications. Its cluster tool design provides the industry's most cost effective 7x6"

epiwafer growth of devices such as pump lasers, VCSELs and HBTs. Its cluster tool architecture minimises clean-room space and downtime attributed to maintenance, increased throughput; and allows for growth of different materials in connected modules.

IPG Photonics Corporation is the world leader in high-power fibre lasers and amplifiers. Founded in 1990, IPG pioneered the development and commercialisation of optical fibre-based lasers for use in diverse applications, primarily materials processing. Fibre lasers have revolutionized the industry by delivering superior performance, reliability and usability at a lower total cost of ownership compared with conventional lasers, allowing end users to increase productivity and decrease operating costs. IPG has its headquarters in Oxford, Massachusetts, and has additional plants and offices throughout the world.

Tiger Optics a roaring success in the U.S.

The innovator in laser-based monitor and gas analysers came 71st in greater Philadelphia and 76th in manufacturing in terms of growth.

For the fourth time, Inc. magazine has named Tiger Optics LLC to its 5000 list of fastest-growing private companies in the United States.

Among manufacturers on the 2012 list, the magazine ranked Tiger as the 76th fastest-growing firm, based on its percentage revenue growth from 2008 to 2011.

In the greater Philadelphia area, the magazine rated Tiger Optics as the 71st fastest-growing private company. Nationwide, Tiger ranks 2,285th on the 2012 Inc. 500|5000.

Founded in 2001, Tiger makes ultra sensitive, laser-based environmental air monitors for continuous emissions and agricultural process control, as well as gas analysers to monitor highly critical processes for semiconductor fabrication plants, High Brightness LEDs and gas manufacturers.

With close to 1,500 robust Tiger units serving these demanding applications, Tiger also supports the

metrology institutes of 16 nations.

The company's devices utilise Continuous Wave Cavity Ring-Down Spectroscopy (CW CRDS), a patented technology developed in the early 1990s by Kevin Lehmann, then a chemistry professor at Princeton University.

The company makes all of its products in Pennsylvania, while over 50 percent of its sales occur in foreign markets. Its 2011 revenue of \$10.3 million rose 110 percent from 2008 revenue of \$4.9 million.

Previously, Inc. magazine named Tiger Optics to its 500|5000 lists in 2011, 2009 and 2008.

To qualify for the current list, companies must have been founded and generating revenue by March 31st, 2008. They had to be U.S.-based, privately held, for profit, and independent - not subsidiaries or divisions of other companies - as of December 31st, 2011.

Stuttgart University orders another Aixtron tool for laser research

The 3x2" MOCVD CCS reactor will be used for the growth of gallium arsenide solid state lasers and III-V materials on silicon

The University of Stuttgart has made a repeat order for Aixtron's CCS (Close Coupled Showerhead) system that is capable of handling three 2-inch (3x2") substrates at a time.

The system will be used by University of Stuttgart's Institute of Semiconductor Optics and Functional Interfaces (Institut für Halbleiteroptik und Funktionelle Grenzflächen, IHFG) research group.

IHFG researchers specialise in semiconductor optics and epitaxy.

The new Aixtron system will be used to expand IHFG's work in GaAs based optoelectronics, in particular, producing material for solid state lasers.

The order was booked in the first quarter of 2012

and the reactor will be delivered in the third quarter of 2012.

Michael Jetter of IHFG comments, "We want to use the CCS 3x2" in two ways: on the one hand we want to produce our GaAs-based laser structures on GaAs, but we also want to transfer them to silicon substrates. As a specialist in semiconductor optics, the Institute's main research areas are semiconductor lasers and low dimensional structures such as quantum wells (QWs) and quantum dots (QDs)."

One focus of the work will be quantum cryptography and single photon emitters. However, the researchers also foresee opportunities arising from their efforts in automotive electronics. In particular, the researchers plan to grow III-V materials on silicon substrates using Aixtron's MOCVD technology.

Jetter adds, "We would like to give silicon electronics an optic touch, which means that we want to monolithically integrate III-V optoelectronic devices (lasers and LEDs, either QW- or QD-based) into CMOS-compatible silicon substrates. These can then be used for the optical data interconnects either on-chip, chip-to-chip or as board-to-board connectors."

The Aixtron equipment will be also used by the Stuttgart Research Centre of Photonic Engineering (SCoPE), which aims to improve interdisciplinary collaborations between scientists and engineers at the Universität Stuttgart.

IHFG and Aixtron plan to work together in the future on joint research and to co-operate on other scientific programs in the Stuttgart region, focusing on III-V growth on silicon.

Tektronix reveals advanced RF monitoring tool

The firm's Sentry Edge II system is a scalable solution for post-QAM monitoring in the dynamic video environment, where quick problem isolation and resolution are essential

Tektronix has unveiled the Sentry Edge II, another product in its Sentry Video Quality Monitor line.

Sentry Edge II detects RF modulation and transport stream errors generated by equipment errors or failures.

With Sentry Edge II, video service providers (VSPs) now have access to the information needed to proactively monitor RF, before issues affect subscribers.



The Tektronix Sentry Edge II

The tool is a high-performance, scalable solution for post-QAM monitoring in the dynamic video environment, where quick problem isolation and resolution are essential. VSPs can use Sentry Edge II at the hub, headend or wherever QAM is used.

Comprehensive high-quality RF measurements make it easier and faster to pinpoint issues. For example, high quality MER measurements up to 41dB allow providers to detect signal quality degradation sooner, so they can take action before this issue impacts the subscriber's viewing experience.

Providers' business requirements were also taken into account in designing the product.

Sentry Edge II offers more tuners per unit than competing products, lowering the cost of edge monitoring. Providers can choose from two high-density models - 4 or 8 tuners - both designed to minimise rack space and power costs. RF signals up to 1GHz can be monitored, allowing monitoring of the additional services that providers have added to grow their business. QAM A, B, and C support meets providers' requirements worldwide.

"The video and audio errors that can ruin subscribers' QoE can originate anywhere in today's increasingly complex networks, so monitoring network-wide is vital for resolving these errors

before they impact subscribers," says Eben Jenkins, general manager, Video Product Line at Tektronix. "The advanced monitoring capabilities of our new Sentry Edge II ideally complement the other members of the Sentry family, enabling video service providers to comprehensively monitor video content from the 'source to the edge' of their networks."

Monitoring the edge of your network is important for catching modulation errors that could impact the quality of service you provide to your subscribers. Tektronix Sentry Edge products detect transport stream and RF modulation errors generated from equipment errors or failures.

Additional service monitoring capabilities are available for QAM channels in the clear, including audio/video QoE, perceptual video quality (PVQ), and Ad Verification as well as EBIF, tru2way, MHP and DSM-CC carousel analysis.

Sentry Edge II is available now.

Non destructive analysis tool promises a new wave of technologies

A tool created by scientists at the University of Sheffield has enabled researchers to analyse nanometre-sized devices without destroying them for the first time. The tool could be used in harvesting solar energy, computing and communication

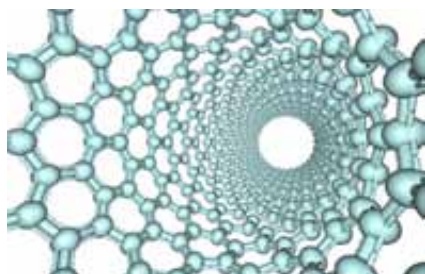
A nuclear magnetic resonance (NMR) system, developed by the Sheffield University's Department of Physics and Astronomy, will allow for further developments and new applications for nanotechnology.

Developments in this field are being increasingly used in harvesting solar energy, computing, communication developments and also in the medical field.

NMR is a physical phenomenon in which magnetic nuclei in a magnetic field absorb and re-emit electromagnetic radiation. This energy is at a specific resonance frequency which depends on

the strength of the magnetic field and the magnetic properties of the isotope of the atoms.

The technique allows the observation of specific quantum mechanical magnetic properties of the atomic nucleus. Many scientific techniques exploit NMR phenomena to study molecular physics, crystals, and non-crystalline materials through NMR spectroscopy.



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Scientists can now analyse nanostructures at an unprecedented level of detail without destroying the materials in the process, a limitation researchers across the world faced before the Sheffield experts' breakthrough.

Alexander Tartakovskii, who led a team of researchers, says, "We have developed a new important tool for microscopy analysis of nanostructures. In the very tiny quantities of matter used in nanostructures the behaviour of electrons and photons is governed by new quantum effects, quite different from what happens in bulk materials. This makes them attractive for various new technologies.»

"Development requires careful structural analysis, in order to understand how the nanostructures are formed, and how we can build them to enhance and control their useful properties. Existing structural analysis methods, key for the research and development of new materials, are invasive: a nanostructure would be irreversibly destroyed in the process of the experiment, and, as a result, the important link between the structural and electronic or photonic properties would usually be lost. This limitation is now overcome by our new techniques, which rely on inherently non-invasive nuclear magnetic resonance (NMR) probing," he continues.

The results open a new way of nano-engineering, a full characterisation of a new material and new

semiconductor nano-device without destroying them meaning more research and development and device fabrication processes.

Tarakovskii adds, "We have developed new techniques which allowed unprecedented sensitivity and enhancement of the NMR signal in nanostructures. Particular nanostructures of interest in our research are semiconductor quantum dots, which are researched widely for their promising photonic applications, and potential for the use in a new type of computer hardware employing quantum logic.»

"The result of our experiments was quite unexpected and changed our understanding of the architecture of these nanomaterials: we learned new information about the chemical composition of quantum dots, and also how atom alignment inside the dots deviates from that of a perfect crystal. Importantly, many more measurements of optical and magnetic properties can be done on the same quantum dots which have undergone the NMR probing."

The development of the new techniques and all experimental work was carried out by Evgeny Chekhovich in the group of Alexander Tartakovskii at the Department of Physics and Astronomy in Sheffield. Quantum dot samples used in this work have also been fabricated in Sheffield, in the EPSRC National Facility for III-V Semiconductor Technology.

More details of this research have been published in the paper, "*Structural analysis of strained quantum dots using nuclear magnetic resonance*", by E. A. Chekhovich *et al* in *Nature Nanotechnology*, (2012). DOI:10.1038/nnano.2012.142

Aerotech galvo & controller together offer infinite field of view

The combination of Aerotech's galvanometer and positioning stage offers 24 bit resolution. The combined instrument can be used to perform characterisation of compound semiconductors such as photoluminescence mapping as it can incorporate 1064nm, 532nm and 355nm lasers

Aerotech's Nmark AGV-HP advanced galvanometers use innovative optical feedback technology to increase resolution to greater than 24 bits.

Both the standard AGV and higher performance AGV-HP series scanners may be directly driven by Aerotech's Nmark CLS galvo controller, which offers a full suite of advanced application tools that include Position Synchronized Output (PSO) and Infinite Field of View (IFOV).



(Left) Aerotech's Nmark AGV-HP advanced galvanometers ; (Right) Aerotech's Nmark CLS galvo controller

The AGV is available with 10, 14, and 20 mm apertures with standard F-Theta lens interfaces to provide maximum application flexibility. The AGV can be configured to accommodate 1064, 532, and 355 nm wavelengths, with other wavelengths available upon request. A variety of focal lengths are standard, with correction files provided to remove lens distortion effects.

The ability to accurately place a laser spot as a function of X/Y axis position is a key feature of Aerotech's linear positioning tables for laser processing applications. With the release of the Nmark CLS, this functionality is now available for scanner applications.

The Nmark CLS offers Position Synchronised Output (PSO) that ties laser pulses directly to galvo position. While other scanner controllers use time-based pulses to shutter laser light, Aerotech says the Nmark CLS PSO allows true position-based triggering.

The ability to accurately trigger the laser as a function of position removes the need to program mark, jump, and polygon delays, resulting in reduced programming complexity. By using the

PSO functionality, scanner-based processes can now be programmed in the same fashion as traditional X/Y stage-based applications.

The IFOV feature seamlessly synchronises servo and scanner motion under one controller environment to allow fast scanner positioning over the entire servo travel, eliminating galvo field of view constraints. The Nmark CLS has two high-power drive circuits, one for each axis in the scanner, that are optimized to get the peak performance from the AGV product family.

Both the AGV and AGV-HP have thermally stable feedback transducers with virtually no gain or offset drift. The Nmark CLS uses advanced interpolation electronics to provide greater than 24-bits of effective resolution. Onboard real-time 2D calibration ensures accurate beam placement over the entire field of view.

Most competitive scanners have the power devices integrated directly into the head, along with the galvos and feedback devices. These power devices can inject considerable thermal energy into the scanner head causing drift in the feedback positions and changing offsets between the mirrors, all of which detract from marking accuracy. Some systems use PWM power stages to minimise heat input.

However, this approach results in reduced tracking accuracy due to nonlinear effects that are present when the galvo motors and control currents reverse polarity. By moving the power stage out of the head, it is possible to use higher performing transistors to drive the galvos and the heat source is effectively removed from the scanner resulting in improved system accuracy.

5N Plus restructures management team

The provider of group III materials such as indium and gallium, used in the manufacture of III-V and solar cells, has made the changes to optimise sustainable growth and maximise long term shareholder value

Canadian based firm, 5N Plus, a producer of specialty metal and chemical products, has

appointed three new executives to its management team.

Jean Mayer is now Director, Legal Affairs and Corporate Secretary. Sean Fuller is Vice President, Strategic Supply. and Zhang Wen is Vice President, Commercial Activities China.

Mayer brings 15 years of business and legal experience. He has served as general counsel, has held senior executive positions and has served as director with various public companies in the mining and technology sectors.

Fuller has served at MCP/5N Plus for 12 years as he initially acted as General Manager in the United Kingdom for 7 years and then acted as Director in Hong Kong for the last 5 years. He holds a degree in Production Engineering from the University of Aston, UK and brings more than 20 years of experience in metal sourcing and significant international experience.

Wen has served as General Manager, CIR since the acquisition of MCP by the Company in April 2011 and is based in Shenzhen. He has been intensely involved in metal sourcing and commercial activities in China over the last decade.

The company also announced that Laurent Raskin and Frank Fache will no longer act as managers of the 5N Plus but will remain on the Board of Director of the Cfirm.

“The new appointments and changes made to our senior management team are in line with our vision of sustainable growth aimed at maximising long term shareholder value. We are excited about the energy and skill set that Jean, Sean and Zhang bring to the team and are confident on their ability to help us realise our vision. We would also like to thank Laurent and Frank for their contribution to our success and expect them to continue providing valuable insight and guidance as active members of our Board of Directors,” says Jacques L’Écuyer, President and Chief Executive Officer of 5N Plus.

Yole: Sapphire supply and demand back on track

Although potential oversupply for sapphire substrates used in the LED industry is looming, the market should self correct as many new entrants scale or pull back projects

Following the massive material shortage in 2010, sapphire material and finished wafer prices remained high throughout early 2011.

This is according to Yole Développement’s latest report, “Sapphire Market, Technology & Market report - November 2011”

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.

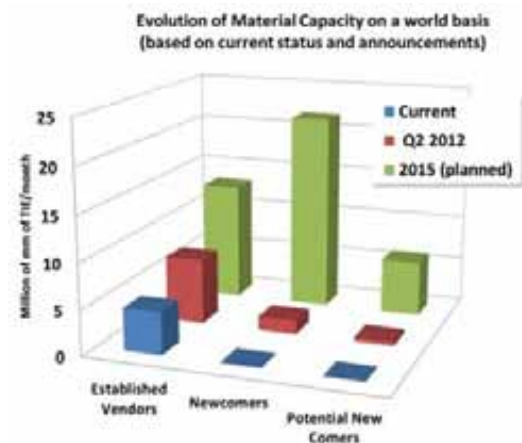
This has triggered a fast drop in wafer prices that have now returned to their pre-shortage levels.

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.



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 three times 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.

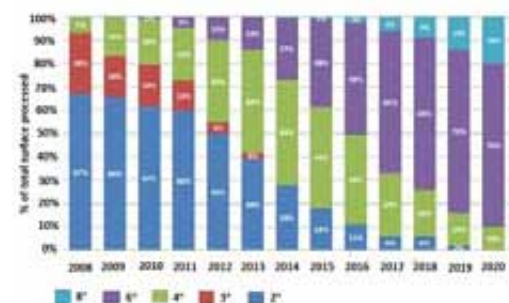
The 2010 pricing environment was very forgiving and allowed some new entrants to achieve comfortable margins despite low yields and subpar technology. Yole calculated that many of those new companies have production cost in the \$6-\$10 / mm of 2” core and will therefore lose money at the current market 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 of less than \$5 that will

allow them to maintain positive margins and weather the storm. Midterm, we expect that this situation will weed out the weakest players and trigger the withdrawal of many potential new entrants.

The transition to large diameter wafers is well underway and past and predicted data is shown in the graph below.

Sapphire Substrates for LEDs: Diameter trends to 2012



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.

But 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 we believe 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.

Yole Développement’s report samples over 170 companies.

Sapphire makers include Almeccs, Alpha Crystal Technology , BIEMT, Blue Optical, Changzhi Hongyuan Technology Crystal Co, Ltd, Crystal Applied Technology, DC Wafers, DJ laser, ECEC (Zhejiang East Crystal Electronic Co), GCL,

GT Solar, Haotian Optoelectronics Technology Co, Harbin Gongda (Aurora Sapphire), Heifei Crystalbridge, Optoelectronic Materials, Iljin Display, Jiaozuo City Crystal Photoelectric, KCC, Kyocera, Lan Yu, Monocrystal, Namiki, NCB Network, Neosemitech, NGC China Transmission, OCI, Darewin Opto, Rubicon, Rybinsk Crystals, Saint-Gobain, San Chih Semiconductor, Sapphire Materials, Sapphire Tech, SAS, Shinkosha, Silian, Siltron / LG, Sumitomo Metal Mining, Swiss Wafers AG, Tera Xtal, Union Light technology, USI Opto (Acme Corporation), Wafer Works, Zhenjiang Huantai Silicon Science and Technology.

Crystal Growth Equipment Makers include Apeks, Arc energy, Crystal Tech, Dai Ichi Giken, GT Solar, Omega, Pryroda Engineering and Thermal Technology amongst others.

Raw Material suppliers include Haemaroo, KC Corporation, Sasol/Ceralox, EMT, RSA Le Rubis, Spolchemis, Baikowski, Comadur, Nippon Light Metal, Sumitomo, Taimei Chemical, Zibo Xinmeiyu, Heibe Pengda Advanced Material and Suzhou Crystal.

Indium Corporation elevates Mackie to senior product manager

The provider of indium, gallium, germanium and high purity metals has promoted the expert in electronics manufacturing, including wafer fabrication, electronics assembly, and semiconductor packaging

Indium Corporation has promoted Andy C. Mackie to senior product manager, semiconductor and advanced assembly materials.



Andy C. Mackie

Mackie leads the product development and marketing of Indium Corporation's advanced materials for their semiconductor customers' most demanding applications. Through his partnerships with sales, and research and development teams, he has opened up new business opportunities in Asia and the Americas.

Andy Mackie earned a Ph.D. in physical chemistry from The University of Nottingham, UK, and an M.Sc. in surface and colloid chemistry from the University of Bristol, UK. He has over twenty years of experience in new product and process development and materials marketing in all areas of electronics manufacturing, including wafer fabrication, electronics assembly, and semiconductor packaging.

He is an electronics industry expert in physical chemistry, surface chemistry, rheology, solder materials properties and processes (including solder paste printing), and reflow processes. Mackie has written papers and lectured internationally on subjects ranging from sub-ppb metals analysis in supercritical carbon dioxide to pin-probe testing of flux residues. He also holds patents in novel polymers, gas analysis, and solder paste formulation, and is trained in Six Sigma - Design of Experiments.

Founded in 1934, Indium Corporation is a materials supplier to the global electronics, semiconductor, solar, thin-film, and thermal management markets.

GaAs bulk substrate revenues bounce back

Demand for gallium arsenide substrates is expected to increase in 2012

Slow growth in the GaAs device market in 2011, coupled with a shift away from GaAs technology for handset switches dropped demand for semi-insulating GaAs bulk substrates by 4 percent.

However, the 2011 earthquake and tsunami in Japan disrupted the supply chain resulting in increased substrate pricing and higher overall revenue.

Strategy Analytics' latest "Semi-insulating GaAs

Substrate Markets: 2011-2016”, forecasts that total demand for semi-insulating (SI) GaAs bulk substrates from manufacturers such as Freiberger Compound Materials (FCM), Hitachi Cable, AXT, Sumitomo and Dowa reached slightly more than 32100 kilo square inches (ksi) in 2011.

The report estimates that this demand resulted in nearly \$230 million in revenues in 2011. The forecast indicates demand and revenues will return to slow growth with demand reaching nearly 39000 ksi and revenues growing to slightly more than \$240 million by 2016.

“Growth in the GaAs device market slowed noticeably in the second half of 2011 and this slowdown was one of several factors causing GaAs bulk substrate demand to decline”, notes Eric Higham, Director of the Strategy Analytics GaAs and Compound Semiconductor Technologies Service (GaAs). “The other notable trend that has slowed growth in GaAs substrate demand is the rapid conversion of handset switches to technologies other than GaAs.”

Asif Anwar, Director in the Strategy Analytics Strategic Technologies Practice (STP) adds, “The earthquake and tsunami in Japan disrupted the entire GaAs bulk substrate supply chain. These disruptions have increased substrate prices in the short-term but as they diminish, we expect modest market growth and substrate price declines will return.”

JDSU completes acquisition of GenComm

The innovator of networks and high-powered commercial lasers for a range of applications has purchased the a provider of wireless test and measurement products

JDSU has completed the acquisition of GenComm, a provider of wireless test and measurement solutions based in Seoul, South Korea.

JDSU announced its intent to acquire GenComm on August 14th, 2012.

GenComm’s solutions were previously distributed by JDSU under an OEM relationship and are used

by tier one service providers, wireless network manufacturers and contractors around the world to quickly provision wireless services that help them create new revenue streams and improve wireless service for millions of users worldwide.

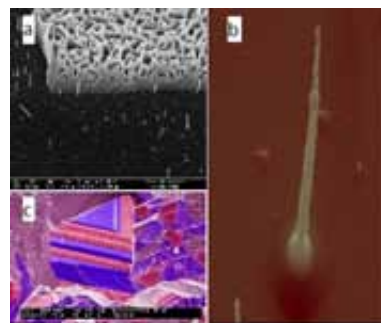
“We welcome the talented employees of GenComm to JDSU and look forward to working with them on new ways to advance wireless networks as part of the world’s leading provider of communications network test solutions,” says David Heard, president of JDSU’s Communications Test and Measurement business segment.

Hitachi High-Tech & FEI make peace

The firms have buried the hatchet over FIB patents

FEI has reached a mutually acceptable agreement with Hitachi High-Technologies Corporation (HHT) to settle an ongoing dispute regarding certain HHT patents relating to Focused Ion Beam (FIB) systems.

FIB is a technique used in a number of industries including the semiconductor manufacturing. In an FIB instrument, a focused beam of ions is used to image samples in a chamber. The technique can be used to perform failure analysis in semiconductors, to look at layer quality, and to prepare samples for transmission electron microscopy (TEM). TEM is an important technique used to analyse dislocation density and type in compound semiconductors.



*FIB images showing:
(a) GaN nanowires ; (b) InAs nanowire ; (c)
Different crystals of In₂S₃ with tetragonal structure
and pyramidal shapes. In₂S₃ is a semiconductor*

used primarily as a buffer layer in CIGS thin film based solar cells, replacing toxic cadmium sulphide, (all courtesy of FEI)

In exchange for HHT's agreement to dismiss all currently pending claims and to grant future license rights to FEI for the FIB patents, FEI will make a one-time payment of \$15 million to HHT. Both parties have issued a cross license on various elements of intellectual property, the specifics of which are confidential.

Brad Thies, senior vice president and general counsel of FEI, commented, "We are pleased to have come to agreement with Hitachi on these patent issues and bring to a close these various long-standing disputes. The licensing of the patents from Hitachi allows FEI to continue to enrich and improve the capability of our products for our customers."

FEI has previously recorded charges of \$5.4 million related to pending claims pursuant to this patent dispute. The remaining \$9.6 million of the most recent payment will be recorded as prepaid royalties and amortised over a period estimated at approximately seven years.

Elisabeth Steimetz announced as guest speaker at CS International Conference, Frankfurt

CS International are pleased to announce Elisabeth Steimetz, Director Marketing and Sales at LayTec AG has been confirmed as a guest speaker for the Compound Semiconductor industry's premier international event, CS International, which will held in Frankfurt, Germany on 4th & 5th March 2013, her presentation will focus on Process control and yield improvement of compound semiconductors through in-situ monitoring.

Elisabeth has almost 20 years background in compound semiconductor manufacturing and metrology. She received her diploma in Physics from RWTH Aachen for her work on alternative group V sources for GaAs MOCVD. Her PhD research topic at Technical University Berlin was

in-situ monitoring of quantum dot formation in MOCVD.

In 2000 she joined LayTec, which was a start-up company at that time. As part of the team of founders she made a significant contribution to LayTec's development into the leading provider of in-situ metrology for the compound semiconductor market.

Elisabeth will join the two day event with speakers coming from a wide range of organisations including leaders from Intel Corporation, Epistar Corporation, RF Micro Devices (RFMD), TriQuint Semiconductor and over 25 other leading chipmakers giving their perspective on the latest developments in device technology.

Professionals from around the world will attend this two-day event to hear key insights and opportunities, from a range of leading analysts, and learn of the latest chip developments in LEDs, solar cells, lasers and power and RF electronics.

Delegates will have the opportunity to network with leading industry professionals of the III-V chip making industry and interact with suppliers.

Further information is available on the CS International website at: www.cs-international.net or calling 44 (0) 24 7671 8970.



Rudolph enlists Michael Jost to head inspection unit

The provider of process characterisation equipment and software used in LED and solar manufacturing has taken on board a new veteran of spectroscopy

New Jersey based Rudolph Technologies has appointed Michael Jost as vice president and general manager of the Company's Inspection Business Unit.

Jost has over 20 years of experience with scientific products, initially in development, and most recently as vice president and general manager of the Molecular Spectroscopy Business Unit at Thermo Fisher Scientific.

He joined Rudolph in April 2012 as supply chain vice president and will assume general manager responsibilities immediately. Jost replaces Nathan Little who will remain with Rudolph working on special corporate-wide growth initiatives at the Company's headquarters in New Jersey.

"The inspection business continues to exceed expectations and now accounts for 60 percent of our total revenue," points out Paul McLaughlin, chairman and chief executive officer. "In addition to managing a broad product portfolio for both front- and back-end semiconductor manufacturing, Mike will lead the research and development of Rudolph's next-generation inspection solutions -a critical, ongoing effort that is required to address today's diverse and emerging process requirements. In addition, he will oversee the Company's centralised manufacturing operations located in Bloomington, Minnesota."

Jost holds a B.S. in physics/mathematics from St. John's University and a PhD in materials science/chemical engineering from the University of Minnesota.

Rudolph Technologies designs, develops and manufactures defect inspection, process control metrology, and data analysis systems and software used by semiconductor device manufacturers worldwide. The company's yield management solutions are used in both the wafer processing and final manufacturing of ICs, as well as in emerging markets such as FPD, LED and solar.

Jilin university orders Aixtron reactor for LED research

The Chinese university will use the 3 x 2-inch wafer CCS reactor to grow gallium nitride materials for UV and white LEDs

Aixtron SE has a new MOCVD system order from existing customer Jilin University China.

The contract is for one CCS reactor in a 3 x 2-inch wafer configuration, which will be dedicated to the growth of GaN materials for UV and white LEDs.

One of Aixtron's local support teams has installed and commissioned the new reactor in a state-of-the-art clean-room facility at Jilin University in Changchun, China.

Zhang of the Jilin University, State Key Laboratory on Integrated Optoelectronics, comments, "We already have experience and a very good understanding of Aixtron systems, and we were particularly impressed with the reactor's ergonomics and security. The system has set the standard amongst the world's best laboratories, thus we intend to join those ranks."

Zhang continues, "Our intention is to develop exciting new material structures that will lead to greater understanding and to production of gallium nitride materials for UV and white LEDs. This is a challenging task, but we are confident that the combination of the process technology capabilities of the CCS reactor and strong backing from the local Aixtron support team will enable us to achieve our aims quickly and efficiently."

Thomas Uhrmann announced as guest speaker at CS International Conference, Frankfurt

CS International are pleased to announce Thomas Uhrmann, Business Development Manager - EV Group(EVG) has been confirmed as a guest speaker for the Compound Semiconductor industry's premier international event, CS International, which will held in Frankfurt, Germany on 4th & 5th March 2013, his presentation will focus on Wafer-level Packaging of Compound Semiconductor Devices.

Thomas Uhrmann is a business development manager for Compound Semiconductors, Power Devices and Engineered Substrates at EV Group (EVG).

In his current role, Thomas is responsible for

introducing and managing technological innovations for the fabrication of high-brightness light emitting diodes (HB-LEDs) and compound semiconductor devices at EVG.

Thomas holds an engineering degree in mechatronics and a PhD in semiconductor physics from Vienna University of Technology.

Thomas will join the two day event with speakers coming from a wide range of organisations including leaders from Intel Corporation, Epistar Corporation, RF Micro Devices (RFMD), TriQuint Semiconductor and over 25 other leading chipmakers giving their perspective on the latest developments in device technology.

Professionals from around the world will attend this two-day event to hear key insights and opportunities, from a range of leading analysts, and learn of the latest chip developments in LEDs, solar cells, lasers and power and RF electronics.

Delegates will have the opportunity to network with leading industry professionals of the III-V chip making industry and interact with suppliers.

Further information is available on the CS International website at: www.cs-international.net or calling 44 (0) 24 7671 8970



Emcore restructures to improve efficiency and profitability

With the reorganisation, the company aims to make up for losses of \$15 million in the past year

Emcore Corporation has completed both a business and a management realignment in a company-wide restructuring that changes the Company's corporate business and management structure.

In May 2012, Emcore closed the sale of its Enterprise product lines to Sumitomo Electric Device Innovations USA. It was announced earlier this week that the company also signed a definitive agreement to consolidate Emcore's terrestrial Concentrator Photovoltaics (CPV) business into its joint venture, Suncore Photovoltaics.

These two transactions mark the completion of the company's business realignment and allow Emcore to more effectively focus its portfolio on areas where its technology and product solutions have strong differentiation in the marketplace. The losses from these product lines over the past four quarters were approximately \$15 million.

"In this complex market environment, it is vital to focus our business scope on those areas with the highest potential for growth and profitability. I am very excited about our current business portfolio: a combination of solid sustaining businesses and the high growth areas with the most-sought-after technology in our industries," says Reuben Richards Jr., Executive Chairman of the Company. "Emcore is determined to drive its business to achieve profitability."

As a part of this restructuring effort, Richards proposed to Emcore's Board of Directors to eliminate the position of Executive Chairman, and subsequently, he will retire from the Executive Chairman position at Emcore, effective September 30th, 2012. Richards will continue as Chairman of the Board where he will provide strategic guidance and governance oversight.

With Richards' retirement and Company's focused business scope and operations, Emcore will realign its management responsibilities accordingly.

Reuben Richards joined the Company in 1995 as Chief Operating Officer. He took over as President and Chief Executive Officer in 1996, and led the company to its initial public offering in 1997. In March of 2008, he assumed the role of Executive Chairman and Chairman of the Board to help facilitate the CEO succession and transition plan.

During his 17 year tenure as Emcore's top executive, Richards has led the transformation of the Emcore from a single-product start-up to a leader in compound semiconductor technology and applications. Throughout his leadership, Emcore

pioneered high-throughput production platform equipment - MOCVD, magneto-resistive sensors, multi-junction solar cells, LEDs, epitaxial materials for high-speed electronic devices (HBTs and HEMTs), and semiconductor lasers - VCSELs and distributed feedback lasers (DFBs).

In this time, Emcore has developed leading technologies and product solutions for many compound semiconductor devices and applications. Richards was also instrumental in establishing and then selling the Company's interest in the solid-state-lighting joint venture with GE, GELcore, defining the growth strategy and operational plans, and raising capital to execute firm's business plan.

"Reuben has provided exceptional leadership to Emcore over the past 17 years and has helped navigate the Company through a very dynamic and complex marketplace. I applaud his contributions to the compound semiconductor industry through his leadership of a very innovative company. He is unparalleled in his ability to perceive market opportunities, develop technologies and to lead the industry in those markets.

I would like to personally thank Reuben for his mentorship and leadership during this transition period and look forward to continuing working with him as Chairman of the Board to drive shareholder value," concludes Hong Hou, Emcore's President and CEO. "With this business restructuring and management realignment, I am very optimistic to attain the company's strategic mission and to significantly improve financial performance going forward."

EV Group sponsor CS International Conference in Frankfurt

EV Group (EVG) have confirmed they will be platinum sponsors at the Compound Semiconductor industry's premier international event, CS International, which will held in Frankfurt, Germany on 4th & 5th March 2013.

EV Group targets advanced packaging, compound semiconductor and silicon-based power devices, MEMS, nanotechnology and SOI markets with

its industry-leading wafer-bonding, lithography/nanoimprint lithography(NIL), metrology, photoresist coating, cleaning and inspection equipment.

The must attend event for 2013 is the third CS International conference in Frankfurt, Germany, where delegates will gain a comprehensive overview of the entire compound semiconductor industry.

Professionals from around the world will attend this two-day event to hear key insights and opportunities, from a range of leading analysts, and learn of the latest chip developments in LEDs, solar cells, lasers and power and RF electronics.

Delegates will get the opportunity to network with leading industry professionals of the III-V chip making industry and interact with suppliers.

Industry leaders from Intel, Cree, Epistar, RFMD, TriQuint and over 25 other leading chipmakers will also be present and to share their perspective on the latest developments in device technology.

A Networking Conference Dinner will be held on the evening of the 4th March where the industry will recognise the success and development along the entire value chain of the Compound Semiconductor industry from research to completed device, focusing on the people, processes and products that drive the industry forward through The CS Industry Awards 2013.

Further information on the conference and the awards is available on the CS International website at: www.cs-international.net

Registration is now open for 2013 event. Delegates who book before October 31st 2012 can take advantage of our early bird rate, saving of €57.



Temescal sponsor CS International Conference in Frankfurt

Temescal have confirmed they will be platinum sponsors at the Compound Semiconductor industry's premier international event, CS International, which will held in Frankfurt, Germany on 4h & 5th March 2013.

For over forty years, Temescal has been at the forefront of electron beam coating and the design and manufacture of systems and components for precision deposition. Today, their industry leading evaporation systems are recognized as the premier solution for the most demanding metalization applications.

Today the world's most sophisticated HB-LED lighting, wireless, ophthalmic lens, triple junction PV solar, precision optic and telecom sub-systems rely on millions of devices that are made using Temescal deposition systems and components.

The must attend event for 2013 is the third CS International conference in Frankfurt, Germany, where delegates will gain a comprehensive overview of the entire compound semiconductor industry.

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Veeco quarterly revenues plummet 48%

Although revenues for MOCVD remained flat sequentially, orders were severely affected in the LED and solar sectors due to the weak macro-economic market

Veeco Instruments has announced its financial results for the second quarter ended June 30, 2012.

John R. Peeler, Veeco's Chairman and Chief Executive Officer, commented, "Veeco continues to deliver solid results in a soft market. Second quarter revenue was \$137 million, and adjusted EBITA and non-GAAP earnings per share were \$20 million and \$0.37, respectively, with gross margins of 45%. Veeco generated about \$19 million in cash flow from operations, ending the quarter with \$540 million in cash and short term investments." Second quarter LED & Solar revenues were \$87 million, including \$75 million in MOCVD and \$12 million in MBE. Data Storage revenues were \$50 million.



"As anticipated, we experienced a challenging bookings environment in Q2, with total orders of approximately \$103 million," continued Peeler. "Across our markets, macro-economic concerns and weakness in TV, PC and consumer electronics sales are delaying customers' capex purchases." Veeco's LED & Solar orders totalled \$77 million, with MOCVD flat sequentially at \$70 million and

MBE declining 50% to \$7 million. Data Storage bookings remained weak at \$25 million. Veeco's book-to-bill ratio was 0.75 to 1 and quarter-end backlog, after a \$30 million adjustment, was \$241 million.



Third Quarter 2012 Guidance & Outlook

Veeco's third quarter 2012 revenue is currently forecasted to be between \$120 million and \$140 million. Earnings per share are currently forecasted to be between \$0.12 to \$0.29 on a GAAP basis, and \$0.22 to \$0.38 on a non-GAAP basis.

Peeler commented, "We are executing on our plan to deliver solid profitability in a down revenue year while investing for future growth. At the mid-point of the year, we are tightening our 2012 revenue guidance to between \$520 and \$560 million. Assuming macro-economic conditions do not worsen, we currently anticipate a gradual order recovery in the second half of 2012."

He continued, "MOCVD orders appear to be bumping along the bottom and we have not yet seen a meaningful inflection in customer buying. However, utilisation rates are up at key customer facilities in China, Taiwan and Korea, and we have seen a pick-up in quoting activity as customers plan future capacity expansions to ensure their position in LED lighting for 2013 and beyond. We continue to win in the market due to our low cost of ownership solutions that drive customers' yield and productivity, most recently through our new TurboDisc 'M' and 'HP' product suite

Albemarle to expand metal organics manufacturing plant

The expansion will enable the production of high purity trimethyl gallium and trimethyl aluminium

used in the MOCVD manufacture of compound semiconductor wafers

Albemarle Corporation's board of directors has authorised the expansion of its facility in Yeosu, Korea.

The Yeosu facility, which is currently in the final stages of construction, will produce commercial quantities of finished catalysts and components used in the polymer industry.

The additional manufacturing capacity that has been authorised by the board will be dedicated to producing Albemarle's PureGrowth products. These include high purity trimethyl gallium (TMG), triethyl gallium (TEG) and trimethyl aluminium (TMA). These materials are used in the MOCVD process to manufacture compound semiconductor chips such as LEDs, III-V multi-junction solar cells, PINS, lasers and APDs.

The Korean expansion will complement Albemarle's existing capacity for these products, as well as trimethyl indium (TMI), at its facility in Baton Rouge, Louisiana.

"This expansion further strengthens Albemarle's position as the global leader in metal organic chemistry," says Amy H. Motto, Vice President of Albemarle's Catalysts global business unit. "More specifically, these new assets will enable us to meet both existing and future demand in the rapidly expanding electronic chemicals market."

"Over 80% of the global demand for LED products is in Asia," adds Jenny S. Hebert, Global Product Manager for Electronic Materials. "Expansion of our Korea facility will ensure security of supply in this high-growth region while reducing transportation risks. These state-of-the-art facilities will also allow us to consistently maintain the high purity standards required of electronic-grade metal organics."

Property for the expansion has been acquired and infrastructure plans have already been finalised and approved. The project is planned for completion in 2013.

Rubicon orders multiple profilers for sapphire production

The cost-effective, precision optical profilers for micron-scale surface analysis, will be used in the precision manufacturing of sapphire substrates used for HBLED growth

Rubicon Technology has ordered multiple units of the Zeta 300 series optical profiler for its sapphire substrate and wafer production from San Jose based Zeta Instruments.

Rubicon's sapphire substrates and products to the LED, semiconductor, and optical industries, are claimed to be sensitive to the LED manufacturer's costs of wafer failure late in the production cycle. The firm will use the Zeta-300 series optical profilers for inspection and metrology of sapphire substrates to help improve wafer yield and lower costs for their LED customers.



Zeta 300 optical profiler

Known for cost-effective advanced functionality, Zeta's novel high-precision metrology systems have gained strong traction across the LED industry. The latest in the innovative suite of optical profilers, the Zeta-300 series was specifically designed to address the stringent specifications of the Patterned Sapphire Substrate (PSS) market. It combines PSS metrology and defect review in a system that is unique in the sapphire industry, enabling detailed measurement of PSS structure dimensions as well as wafer defect inspection on the same system.

"We have evaluated many tools for the production environment and the Zeta 300™ series, delivers the best combination of speed and accuracy for precision metrology applications," says Raja M. Parvez, president and CEO of Rubicon Technology.

"Zeta's systems are integral to assuring our products meet and surpass our own internal quality specifications and those of our customers."

The Zeta-300 series leverages Zeta's patented Z-Dot technology to deliver high repeatability and accuracy for the measurement of LED-patterned/etched substrates, photo-resist and stacked structures on transparent surfaces. Regarded as having one of the best optics and algorithm combinations, these profilers provide rapid and reliable data acquisition and analysis. In side-to-side comparisons with competitive offerings the Zeta-300 series is claimed to consistently deliver the highest repeatability and accuracy for PSS measurements in the LED industry. Coupled with application-specific software and a companion automated wafer handler, the Zeta-380 provides imaging and measurement capabilities superior to those of laser confocal microscopes. The Zeta-380 measures and detects defects falling outside the industry certification levels that may not be detected by competing offerings. Zeta's intuitive and innovative system design also offers a greater ease of use while lowering overall cost of ownership.

Rusmin Kudinar, president of Zeta Instruments, adds, "Having one of the world's largest and most esteemed PSS wafer suppliers select the Zeta-300 series as integral to its manufacturing process is powerful validation of our product strategy and development efforts. We look forward to an ongoing trusted partnership with Rubicon as they continuously pave the way advancing sapphire technology."

Rubicon allowed fabrication patent

Latest US patent granted for in-situ crystal orientation

US-based sapphire substrate developer, Rubicon Technology, reveals the US Patent and Trademark Office has allowed its patent application entitled, "Intelligent Machines and Process for Production of Monocrystalline Products with Goniometer Continual Feedback."

The patent covers Rubicon's equipment and

process developed to perform in-situ orientation of its sapphire crystals within the various fabrication tools used by the company. As the company explains, manufacturers have different requirements for the crystal planar orientation of the sapphire products used in various applications. However, the new patented orientation technology provides greater precision in sapphire planar orientation and eliminates time-consuming steps by performing the orientation at the fabrication tool. "Rubicon is known by many for its expertise in crystal growth technology, but our technological leadership extends from raw material through finished sapphire wafers," said Raja Parvez, president and chief executive of Rubicon Technology. "This patent reflects one of many technological innovations we've put in place to meet our customers' exacting and evolving requirements."

Michelle Bourke announced as guest speaker at CS International Conference, Frankfurt

CS International are pleased to announce Michelle Bourke, Senior Product Manager, Oxford Instruments Plasma Technology has been confirmed as a guest speaker for the Compound Semiconductor industry's premier international event, CS International, which will held in Frankfurt, Germany on 4th & 5th March 2013, her presentation will focus on plasma etch and deposition processes for leading compound semiconductor device technologies.

Michelle will join the two day event with speakers coming from a wide range of organisations including leaders from Intel Corporation, Aixtron, Epistar Corporation, RF Micro Devices (RFMD), TriQuint Semiconductor and over 25 other leading chipmakers giving their perspective on the latest developments in device technology.

Professionals from around the world will attend this two day event to hear key insights and opportunities, from a range of leading analysts, and learn of the latest chip developments in LEDs, solar cells, lasers and power and RF electronics.

Delegates will have the opportunity to network with leading industry professionals of the III-V chip making industry and interact with suppliers.

Michelle M. Bourke received a BSc degree in Optoelectronics and Laser Engineering from Heriot-Watt University, Edinburgh, Scotland, UK. Initially beginning her career in the UK Government labs working on advanced optoelectronic and electronic devices she migrated to the equipment vendor environment where she developed a broad range of etch processes relating to silicon and compound semiconductor devices. Prior to joining Oxford she worked with other equipment vendors in Business Development and Product Marketing roles.

Michelle is a Senior Product Manager at Oxford Instruments.

Further information is available on the CS International website at: www.cs-international.net or calling 44 (0) 24 7671 8970.



AXT profits dip amid growing GaAs revenues

The US compound semiconductor wafer maker sees growth in GaAs business but InP and Ge substrate sectors wane

AXT revenue for the second quarter of 2012 was \$25.2 million, up 7 percent from \$23.5 million in the first quarter of 2012. This quarter's revenue was down, however, by 16.3% year-on-year. Second quarter profits were down to \$1.3 million, compared to \$1.6 million in the previous quarter. GaAs substrate revenue came in the strongest, at \$14.9 million for the second quarter of 2012, compared with \$12.2 million in the first quarter of 2012. Meanwhile both InP and Ge substrate revenues were down, quarter-on-quarter. InP revenue was \$1.3 million for the second quarter of 2012, compared with \$1.5 million in the first quarter of 2012, while Ge revenue was \$2.4 million for the second quarter of 2012 compared with \$2.6 million in the first quarter of 2012. Raw materials sales

were also down, standing at \$6.5 million for the second quarter of 2012, compared with \$7.2 million in the first quarter of 2012. Gross margin was down from 34.9% to 29.8% of revenue quarter-on-quarter, with AXT attributing the drop to a new People's Republic of China VAT levied on foreign enterprises that import materials which do not form part of the final product.

"The second quarter was a positive quarter for our gallium arsenide business, which grew more than 20 percent sequentially," said Morris Young, chief executive officer. "Further, we continued to make good progress with new customer qualifications, and are hopeful that we will begin to layer on additional revenues from new qualifications later this year and into 2013." As we move into Q3, the demand environment appears to be more challenging, particularly in certain geographies... and expect to see weaker than normal seasonal performance as a result," he adds. "However... we view improving market conditions, new customer qualifications and a bottoming of raw material pricing as key catalysts for our growth later this year and beyond."

Carl Zeiss leads EUV lithography project

Germany-based collaboration - ETIK - promises to take extreme ultraviolet lithography "to the next level"



Germany-based optics supplier, Carl Zeiss, is collaborating with Germany-based organisations on extreme ultraviolet lithography. Carl Zeiss, Germany, has joined forces with six other German companies and research institutes to form a joint project, ETIK or "EUV projection optics for 14 nm resolution", which aims to drive extreme ultraviolet

(EUV) lithography forward. The team aims to boost EUV lithography resolutions to at least 14nm, and intend to have a first technology platform ready by the end of the year that will enable the manufacture of structures as small as 20nm.

The German Ministry of Education and Research (BMBF) has awarded Euros 7 million to the project. To improve the resolutions, consortium partners are currently researching new manufacturing technologies for the key modules of EUV systems; the illumination system and the projection optics. For example, a highly flexible optical switching unit has been designed to enhance system performance while researchers have also developed a novel design for the surfaces of the reflection mirrors in the projection lens. Additional research in optical measuring technology, precision engineering and micro-cooling technology is also planned. Andreas Dorsel, management board member at Carl Zeiss, says: "We see EUV technology as the key to the microelectronics of tomorrow.

The project unites proven experts who will now take EUV to the next level." "As a result, we are not only strengthening Germany's leading position in the field of complex optics for lithography systems, but also enabling even more people around the world to acquire state-of-the-art electronic devices by lowering the price of microchips through our research work," he adds. For this joint project, Bestec, Berlin, is developing machine concepts for a new generation of reflectometers to measure the EUV reflectivity of large mirror surfaces while the Institute for Technical Optics, University of Stuttgart, is testing the concept of flexible setting measuring technology for mirrors with a new type of surface geometry.

IMS CHIPS, Stuttgart, is to provide optical components to ensure the quality of the projection lens. At the same time, the Fraunhofer Institutes for Electron Beam and Plasma Technology, Dresden, Applied Optics and Precision Engineering, Jena and Material and Beam Technology, Dresden, are providing scientific-technical services to improve the surface quality of reflective optical components.

Finisar places repeat order for Aixtron reactor

The AIX 2800G4-TM automated reactor will be used in the production of indium phosphide lasers and detectors

Aixtron has taken a new MOCVD system order from US optical communications supplier, Finisar, for an AIX 2800G4-TM automated reactor.

The reactor is dedicated to the growth of indium phosphide materials for lasers and detectors.

The new order was placed after the first AIX 2800G4-TM system had been successfully installed and qualified at Finisar's facility in Allen, Texas.

As Aixtron says, its local support team will install and commission the new reactor in a state-of-the-art clean-room at Finisar's California plant, targeting later this year.

"The AIX 2800G4-TM reactor provides the best means to create high-performance optical device products that fulfil the necessary requirements of our customers," says Charles Roxlo, vice president and general manager of Active Devices for Finisar. "The backing of the excellent AIXTRON local support team gives us much confidence and security."

Bernd Schulte, executive vice president and chief operating officer at Aixtron added: "The AIX 2800G4-TM reactor has a strong reputation within the industry for performance, ergonomics and efficiency, all features that effectively meet the challenges of opto device production."

LayTec sponsor CS International Conference in Frankfurt

LayTec have confirmed they will be platinum sponsors at the Compound Semiconductor industry's premier international event, CS International, which will be held in Frankfurt, Germany on 4th & 5th March 2013.

LayTec is a major provider of in-situ and in-line

optical metrology systems for thin-film processes. Their products are used in a broad range of thin-film applications such as compound semiconductors, photovoltaics, oxides and organics deposition. LayTec's measurement systems provide access to key thin-film parameters in real-time – either in-situ, during the deposition process, or in-line.

The must attend event for 2013 is the third CS International conference in Frankfurt, Germany, where delegates will gain a comprehensive overview of the entire compound semiconductor industry. Professionals from around the world will attend this two-day event to hear key insights and opportunities, from a range of leading analysts, and learn of the latest chip developments in LEDs, solar cells, lasers and power and RF electronics.

Delegates will get the opportunity to network with leading industry professionals of the III-V chip making industry and interact with suppliers. Industry leaders from Intel, Cree, Epistar, RFMD, TriQuint and over 25 other leading chipmakers will also be present and to share their perspective on the latest developments in device technology.

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Emcore replaces legacy systems with Camstar Semiconductor Suite

The manufacturing software promises to simplify the system complexities inherent in running sophisticated wafer and cell processing.

Manufacturing software developer, Camstar Systems, US, reveals that compound semiconductor supplier, Emcore, US, is to replace several of its legacy manufacturing systems with the Camstar Enterprise Platform for semiconductor manufacturing.

The so-called Semiconductor Suite includes Manufacturing Execution (MES) software to ensure efficient manufacturing and Quality Management software for monitoring fabrication.

According to Camstar, the platform will simplify system complexities inherent in running Emcore's wafer and cell processing, and assembly, test and panel manufacturing.

"With Camstar we can replace a multitude of disparate applications with a single, flexible platform," said Mike Brown, vice president of Information Technology for EMCORE. "We will simplify the IT architecture and reduce support efforts, while improving our flexibility and responsiveness to change."

"Camstar's Enterprise Manufacturing platform provides [the] industry [with] more agility, enabling rapid product builds based on specific customer requirements while insuring rigorous quality standards are met," said Rob Rudder, executive vice president for Camstar. "We look forward to helping Emcore deploy a modern and flexible manufacturing infrastructure that better meets the needs of their expanding business."

The Enterprise platform promises to rapidly implement a manufacturing execution and quality system for maximum return-on-investment, increasing yields by building quality into processes. According to Camstar, the system easily integrates with business systems and shop floor equipment and eliminates the cost and risk of ageing systems.

Plessey takes delivery of Aixtron reactor

The semiconductor manufacturer plans to reach full production of high brightness LEDs by the second quarter of next year.

UK-based Plessey Semiconductors has taken delivery of a CRIUS II-XL reactor in a 7x6-inch wafer configuration from Aixtron, Germany. The delivery forms the first part of Plessey's multi-million pound investment to create a production line for its new high brightness LED (HBLED) products. According to Plessey, the HBLEDs will be based on GaN on 6-inch silicon substrates, with manufacturing taking place at the company's Plymouth facility.

"We use a much thinner GaN layer at only 2.5µm compared to 6-8µm in other GaN on Si technologies," explains Neil Harper, Plessey's HBLED product line director. "This means less deposition time so that we can do multiple production cycles in the reactor in 24 hours to achieve higher throughputs and lower costs." "We completed the acquisition of the University of Cambridge spin-off company CamGaN in February 2012 and are now installing the capability for the full commercial exploitation of GaN-on-Si technology, added Barry Dennington, Plessey's chief operating officer. "Furthermore, we will be in early prototype production before the end of Q3 2012 and in full production by Q2 2013."

Plessey claims to be one of the first companies to make working GaN on Si LEDs with the first samples producing the correct wavelength output from its six inch production line. The company is using standard, readily available 6 inch silicon substrates which promise to offer 80% cost reductions compared to the current technologies using SiC or sapphire that are expensive and hard to scale up. Plessey intends to move to 8-inch substrates in the future for even greater cost savings.

Efficiencies in the new technology will enable outputs in excess of 150 lumens per watt to be achieved, which is significantly brighter than anything commercially available, says the company. Typical HBLED yields come in at 95% providing over 14 000, 1mm², 1W MAGIC (MAnufactured on

Gan ICs) HB LEDs per six inch wafer. Dennington added, "MaGIC and EPIC are two unique, disruptive technologies that are instrumental in our plan to rapidly grow Plessey into a major electronics company producing smart lighting solutions."

Oxford Instruments sponsor CS International Conference in Frankfurt

Oxford Instruments have confirmed they will be Platinum sponsors at the Compound Semiconductor industry's premier international event, CS International, which will be held in Frankfurt, Germany on 4th & 5th March 2013.

A leading provider of high technology tools and systems for research and industry, Oxford Instruments Plasma Technology manufactures etch, deposition and growth systems that provide process solutions for the micro- and nanometre engineering of materials for semiconductor, optoelectronics, HBLED, Photovoltaics, MEMS & microfluidics, high quality optical coating and many other applications in micro- and nanotechnology.

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TriQuint posts losses as mobile demand wanes

US chipmaker blames weak results on slow mobile device demand

US chipmaker TriQuint Semiconductor has posted quarterly losses, blaming its weak results on low demand for mobile devices. Revenues for the second quarter of 2012 were \$178 million, down 22% from the same time last year, and down 18% sequentially. Net losses came in at \$16.5 million this quarter, compared with a profit of \$16.6 million, in the previous year.

"TriQuint's second quarter performance was in line with expectations," said Ralph Quinsey, TriQuint president and chief executive. "Mobile devices demand was soft in the second quarter as the smartphone industry prepares for a seasonally strong second half." "However, our Defense and Networks revenue was slightly up year-to-date with a healthy outlook for the remainder of the year," he added. "We believe TriQuint is well positioned for revenue growth and improved financial performance in the second half of 2012."

TriQuint recently announced a \$12.3 million GaN DARPA contract to develop ultra-fast power switch technology and has introduced the industry's first 802.11ac Wi-Fi RF module for next-generation smartphones and tablets.

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Frank Schulte announced as guest speaker at CS International Conference, Frankfurt

CS International are pleased to announce Frank Schulte, Vice President, Aixtron Europe has been confirmed as a guest speaker for the Compound Semiconductor industry's premier international event, CS International, which will be held in Frankfurt, Germany on 4th & 5th March 2013.



Professionals from around the world will attend this two-day event to hear key insights and opportunities, from a range of leading analysts, and learn of the latest chip developments in LEDs, solar cells, lasers and power and RF electronics.

Mr Schulte will join the two day event with speakers coming from a wide range of organisations including leaders from Intel Corporation, Epistar Corporation, RF Micro Devices (RFMD), TriQuint Semiconductor and over 20 other leading chipmakers giving their perspective on the latest developments in device technology.

Mr Schulte is responsible for all product lines of the Aixtron SE, he joined Aixtron in early 1991, and he was the founder and Director of Aixtron K.K., Aixtron's subsidiary in Japan. Staying three years in Tokyo he built up and managed this organization for the Japanese market.

He gained a PhD for the work he did on integrated circuits on Compound Semiconductors and Si devices in co-operation with Aixtron. Mr Schulte received his Master in Physics at the Technical University, RWTH Aachen, Germany. Delegates will have the opportunity to network with leading industry professionals of the III-V chip making industry and interact with suppliers.

Further information is available on the CS International website at: www.cs-international.net or

calling 024 7671 8970.

Azzurro receives millions of Euros for 200mm GaN-on-Si process

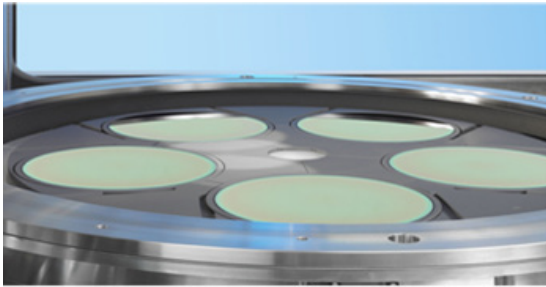
Local government awards Euro 2.6 million to Azzurro for large wafer development

Azzurro Semiconductors, Germany-based developer of GaN-on-Si wafers, has bagged Euro 2.6 million in government funds from the European Regional Development Fund and the Free State of Saxony. The company will use the funds to drive its GaN on 200mm silicon wafer technology forward and strengthen its competitive position. With GaN-on-Si technology, Azzurro addresses two huge growth markets, LEDs and power semiconductors.

The company asserts that its large diameter wafers allow the industry to fabricate power semiconductors and LEDs using existing, standard semiconductor production sites, thereby cutting costs. According to the company, its performance data on 150mm wafers is "already unique" and it will now extend its lead to 200mm substrates. "Based on the technology grant, we can execute the strategic development of our 200mm technology platform for power semiconductors and LEDs and quickly attend to the strong customer demand," said Stephan Lutgen, Vice President Technology at Azzurro.

Aixtron unveils 5x200mm GaN-on-Si technology

Semiconductor equipment manufacturer, Aixtron, develops gallium nitride on silicon technology for its AIX G5 platform



Aixtron, Germany, has introduced a 5x200mm GaN-on-Si technology package for its AIX G5 Planetary Reactor platform. The AIX G5+ was designed and created in the semiconductor equipment maker's R&D laboratory and consists of specially designed reactor hardware and process capabilities. Now available as a part of the AIXG5 product family, any existing G5 system can be upgraded to this latest version, says Aixtron. "GaN-on-Si technology is a hot topic for MOCVD users and manufacturers today," says Rainer Beccard, vice president of marketing at Aixtron. "It is the technology of choice for the emerging power electronics market segment, and also a very promising candidate for future high performance and low cost high brightness LED manufacturing."

"The wafer size and material plays a crucial role when it comes to cost effective manufacturing processes, and thus the transition to 200mm standard silicon wafers is a logical next step on the manufacturing road maps, as it offers unique economies of scale," he adds. As Frank Wischmeyer, vice president and program manager of power electronics at Aixtron explains, company researchers developed the new technology by conducting a simulation program, that enabled them to design fundamentally new hardware components that provide unique process performance in the company's 5x200mm processes. "The hardware is still compatible with the well-proven AIX G5 reactor platform and the results are extremely stable processes, providing much better uniformity of material properties and enabling higher device yield than any other MOCVD platform, whilst offering a reactor capacity of 5x200mm," he adds. According to the company, initial feedback from customers confirms the success of the technological development.

Many have noted the fully rotationally symmetrical uniformity pattern on all five 200mm wafers and the use of standard thickness silicon substrates.

What's more, the controlled wafer bow behaviour is said to be exactly what they require for silicon-style manufacturing. "This uniformity pattern has been an inherent feature of Aixtron's Planetary Reactor technology, which we can now successfully obtain on 200mm GaN-on-Si wafers," underlines Wischmeyer.

Veeco system readies for optical filter volume production

Ocean Thin Films qualifies Veeco's Spector-HT IBD system for high volume production
Veeco Instruments has announced that precision optical coatings company, Ocean Thin Films, has recently qualified the Spector-HT Ion Beam Deposition (IBD) System for high-volume production of optical filters.

These filters could be used in a broad range of applications, including biophotonics, defense, display, aerospace and lighting.

Randel Mercer, vice president of business development at Ocean Thin Films said: "Veeco's system allows us to deliver high quality optical filters to the market faster by achieving ion beam quality films at superior deposition rates."

"After comparing Veeco's deposition technology to other coating platforms, we are confident that Spector-HT will give Ocean Thin Films a distinct production advantage," he added.

According to Veeco, the Spector platform has been the industry-leading optical coating platform for 14 years with over 200 systems shipped around the world.

Compared to previous Spector systems, the Spector-HT provides up to a 400% increase in system throughput through improved deposition rates and increased lot sizes, claims Veeco.

The system also promises up to 300% increase in target material utilisation for reduced maintenance and lower cost of ownership and 50% better material uniformity.

Plasma Etch unveils smallest plasma cleaner

The PE-25-jw plasma cleaning system promises consistent and repeatable results



US-based Plasma Etch has just released the PE-25-jw, the latest addition to its range of plasma systems. Touting “an incredibly low” starting price, the company says the system is the smallest in its line of plasma cleaners, promising to be durable, reliable, and giving consistent, repeatable results. Equipped with PLC control, the system comes with a single gas channel, and has the option of a second channel.

It is fully automated with an aluminium chamber. As the company highlights, plasma can be used to modify a variety of surfaces under precisely controlled conditions, without the safety hazards and liquid waste associated with wet cleaning and etching. This surface treatment is typically used to remove organic and inorganic contamination, increase wettability, increase bond strength, and remove residue. Plasma cleaning systems are now being used for the cleaning or etching of hybrids, PCBs, SMTs, BGAs, lead frames, and flat panel displays, and will remove organic contaminants and prepare surfaces for adhesive bonding, wire bonding, soldering, and marking. For example, plasma cleaning of hybrids can dramatically improve wirebond strengths and reduce the likelihood of circuit failure.

The company claims, epoxy bleed out, residual photoresist, solvent residues and other organic contaminants are safely removed with a short exposure to plasma. As Plasma Etch points out, a consistent temperature is maintained throughout the system’s entire plasma sequence and is controlled independently of the plasma process. Any temperature within the system’s control range

can be selected and will then be automatically maintained. The company claims the etch rates of its plasma systems are 2-3X times faster than competing, comparable plasma systems, as concluded through customer tests.

Global economy takes toll on semiconductors, says equity analyst

Five Star Equities, US, provides bleak stock outlook for Skyworks Solutions and other semiconductor heavyweights

The global economic slowdown has begun to take its toll on the semiconductor industry as recent reports have provided a bearish outlook for the industry, reports US equity analyst, Five Star Equities. The Philadelphia Semiconductor Index – a price-weighted index tracking 18 US semiconductor companies involved in the design, distribution, manufacture, and sale of semiconductors - has fallen roughly 20 percent since the end of March.

“We were seeing signs of a return to growth. But the macro-economic environment is proving very challenging,” said analyst Doug Freedman of RBC Dominion Securities. Five Star Equities has examined the outlook for companies in the Semiconductor Industry focusing on Skyworks Solutions and TriQuint Semiconductor. As the company reports, an analyst at Avian Securities, US, Blaine Carroll, recently stated that these semiconductor suppliers may fall short of their quarterly estimates. Carroll also lowered his production estimates of the much anticipated iPhone to between 5 and 20 million from his previous expectations of 25 million iPhones in the second quarter. “Our original iPhone builds of 25M are too aggressive due to macro headwinds from Europe and the lull in front of iPhone 5,” he explained. According to Five Star Equities, Skyworks Solutions shares have fallen more than 9 percent in the last month, but are still up over 50 percent for the year.

Emcore flood recovery operations on schedule

Emcore expects to fully recover from the Thailand floods and achieve pre-flood production levels by October 2012

Reconstruction of Emcore's Thailand-based primary contract manufacturing operations is running to plan, reports the US-based semiconductor components developer, with some lines operating at pre-flood run-rates.

In October 2011, Emcore announced that flood waters had severely impacted the inventory and production operations of its Thailand manufacturing, damaging product lines from its Telecom and Cable Television (CATV) market segments. The Photovoltaics segment remained unaffected.

Emcore has since shifted manufacturing to alternative locations, including an alternate facility of its contract manufacturer in Thailand as well as its own manufacturing facilities in China and the US.

The production line for integrable tunable laser assemblies for 40 and 100 Gb/s coherent telecom applications has been up and running since March in Thailand, while production line qualification has been completed and most customers successfully completed full-line audits and started taking shipments in April.

As of this quarter, the integrable tunable laser line is operating at pre-flood capacity run-rates while the CATV laser module and transmitter production lines in China reached pre-flood capacity levels in mid-July.

Emcore expects the Tunable XFP transceiver line at its contract manufacturer in Thailand to reach volume production levels by October 2012. In the meantime, this manufacturing is continuing in the company's own Newark, California facility.

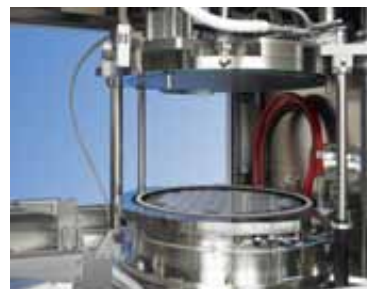
"We are very appreciative of our customers' understanding, cooperation, and support during the rebuild of impacted production lines the past 9 months," said Jaime Relej, vice president of business development, Emcore. "Based on the strong demand for certain product lines, such

as integrable tunable laser assemblies, we are increasing production capacity to exceed pre-flood levels to support orders for 40 and 100 Gb/s coherent applications."

Emcore now expects increased shipments for its fiber optics segment in the coming quarters as manufacturing volume ramps to normal levels.

EpiGaN ramps up production on Aixtron reactors

IMEC spin-off, EpiGaN, kick-starts six inch wafer production and eight inch development on Aixtron systems



Belgium-based GaN epiwafer maker and IMEC spin-off, EpiGaN, has commissioned two new MOCVD systems from Aixtron for the commercial production of 6-inch GaN-on-Silicon wafers.

Producing wafers for power and RF electronics devices, EpiGaN will also use the systems to develop next generation 200mm GaN-on-Silicon wafers. The systems can operate multiple 6" or in 8" configurations. Aixtron installed and commissioned the reactors at EpiGaN's purpose-built, state-of-the-art facility in Research Campus Hasselt, which opened in May this year.

"After several years of efficient collaboration with Aixtron towards GaN-on-Si, it was evident that their Close Coupled Showerhead systems perfectly suit our needs," explains Dr Marianne Germain, CEO of EpiGaN. "[We've] worked with Aixtron's CCS MOCVD systems at IMEC and have jointly published numerous papers on GaN-on-Silicon development."

"There are challenges ahead for high voltage 200mm GaN-on-Si, but we are confident that the

combination of our enduring expertise and the leading edge equipment and process technology will deliver all our objectives rapidly and efficiently," she adds. EpiGaN's founders have pioneered GaN on Si technology, and were the first to demonstrate GaN HEMT's on 6" and 8" silicon substrates. The company is also participating in the EU project HiPoSwitch aiming to develop more compact and powerful energy converters. Activities cover the entire value chain from GaN-on-Si epiwafers over GaN power device development to industrial application.

Riber revenues down, but orders up

Second quarter revenues for Riber are less than half compared to same time last year, but order book has grown by 19%

Molecular beam epitaxy manufacturer, Riber, has recorded Euro 9.4 million in revenues for the first half of 2012.

Revenues for the second quarter of 2012 were down at Euro 3.2 million, compared to Euro 7.2 million for the second quarter of 2011.

However, the company states its order book has grown by 19% to Euro 21.5 million, at the end of June 2012

As Riber spokesperson, Oliver Handschumacher says, in a difficult economic climate affecting the semiconductor industry, revenue for the first half of 2012 shows a change in product mix in favour of MBE systems sales unmatched since 2002.

During the first half of 2012, the company invoiced six machines compared with three machines for the first half of 2011, and has consolidated its market positions, especially in the research sector.

In contrast, the services and accessories business is down by 15% in relation to the previous year, due, stated Riber, to a slowdown in demand in Europe and USA.

Sales of evaporation sources and cells are down compared with the first half of 2011, which included the delivery of a major investment order for OLED production equipments.

At June 30th, 2012, the breakdown of RIBER's

sales was Asia (39%), Europe (37%) and North America (24%).

During the second quarter of 2012, RIBER booked four MBE system orders for research laboratories in Germany, China, France and Japan, compared with two research systems booked in the second quarter of 2011. At June 30th, 2012, the order book came to Euro 21.5 million with 16 systems to be delivered in 2012 and 2013.

The first half results and the outlook for the full year will be announced on September 19th, 2012.

Australia funds silicon carbide chip production

Griffith University researchers win Aus\$1million from government and work with UK equipment maker, SPTS Technologies, to commercialise SiC-on-silicon production.

Australia-based Queensland Micro- and Nanotechnology Centre, Griffith University, has won Aus\$1million in funding from the Queensland State Government to develop production processes for silicon carbide microchips. The research centre has been developing SiC-on-silicon substrates for a wide variety of applications including LEDs, micro-electro-mechanical systems (MEMS) and power integrated electronics. According to Professor Sima Dimitrijević, lead researcher at the University's Micro- and Nanotechnology Centre, research breakthroughs include low temperature epitaxy of cubic SiC on Si as well as the development of MOS purity oxides for SiC MOS devices.

"The superior properties of silicon carbide enable smaller, more efficient, sensitive and robust devices that can operate in harsh chemical and temperature environments," he adds. Researchers at the Centre have also been working alongside UK-based semiconductor equipment manufacturer, SPTS Technologies, to commercialise SiC-on-silicon technology. Having demonstrated low temperature epitaxial growth of SiC films directly onto low-cost silicon wafers, the partners intend to develop thermal processing equipment to commercialise the technology.

"Our industry partner will help us take the next

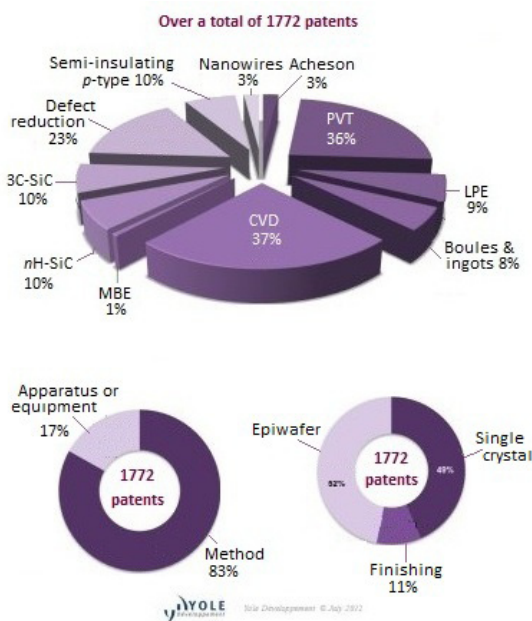
critical step of making our SiC production processes ready for industry to adopt,” adds Centre operation director, Alan Iacopi. “There is a potentially enormous global market and our breakthroughs have far reaching implications in terms of engaging with international industry and bringing frontier technologies to Queensland.”

Number of SiC patents don't tally with revenues

Although Japan holds 72% of patents related to silicon carbide wafer growth, the US holds a larger proportion in terms of revenue

Despite a cumulative raw wafer and epi wafer market that won't exceed \$80 million in 2012, the corpus of related patents of SiC growth comprises over 1772 patent families and more than 350 companies since 1928. Eighty-three percent of patents relate to a method while 17% of them claim an apparatus.

This is according to Yole Développement's latest report, "SiC Patent Analysis single crystal, wafer and epiwafer manufacturing".



Since 1978, the main technique used to grow bulk single-crystals of SiC is PVT (Physical Vapour Transport). The seeded sublimation method represents 36% of published patents. The PVT

technique mostly deals with the hexagonal polytype nH-SiC (n=2,4,6).

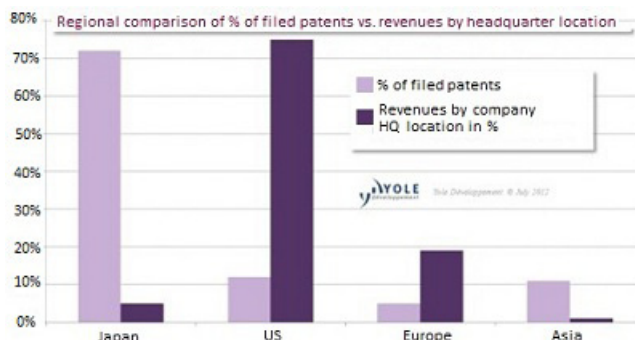
An alternative route to growing SiC is Liquid Phase Epitaxy (LPE), with early efforts dating back to 1961. This technique enables the grow of crystals with low dislocation densities at relatively low temperatures, which is particularly attractive for cubic polytype 3C-SiC.

About 37% of patents relate to a Chemical Vapour Deposition technique (CVD) which is almost exclusively used today to manufacture SiC epiwafers. Molecular Beam Epitaxy (MBE) is only mentioned in 1% of patents. The polytype (hexagonal or cubic) is explicitly claimed in 15% of patents. Numerous strategies to reduce crystal defects (micropipes, carrots ...) and make semi-insulating material are proposed in 23% and 10% of patents respectively.

Roughly 350 applicants are involved in SiC crystal/epiwafer technology. They are mainly located in Japan, which holds 72% of patents and the US, which possesses 12% of patents. The five major applicants based on their patents number are Denso, Sumitomo, Nippon Steel, Bridgestone and Toyota. They represent about 35% of studied patents.

US firm Cree occupies 6th position. This balance is totally uncorrelated from the reality of the market where 75% of the SiC wafer business is generated by US-based companies, namely Cree, II-VI or Dow Corning.

Japan is only responsible for 5% of the revenues (at least before Rohm acquired SiCrystal). Similar observations are seen in Europe and Asia (not including Japan) where the number of patents/revenues ratio is very weak at the moment.



Although Japan is currently leading the IP in SiC

technology, Korea and China are catching up.

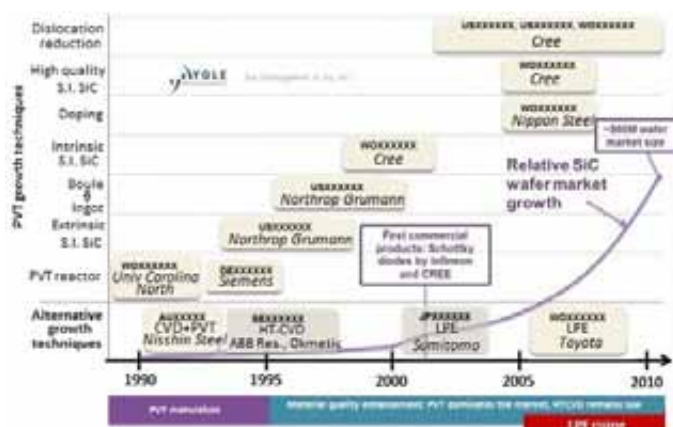
Japan has become increasingly involved in SiC technology since the 1980's. The United States was the earliest player and is still active. In contrast, only 3 Japanese companies are commercially active in SiC material: These are Showa Denko (epiwafer), Bridgestone (wafer) and Nippon Steel (wafer and epiwafer).

During the last five years, with the establishment of some new companies, China and Korea have emerged as new players. Chinese firms include Epiworld, TianYue, TYSTC and Tankeblue. Korean firm SKC is also another contender. However, the market share held by these companies is currently very low.

It may seem obvious that IP considerations do not create a differentiating factor for success in the SiC substrate business.

Cree is leading this industry with about half the global market share, and has an excellent reputation in terms of quality, diameter and reproducibility. However, Cree does not own the widest patent portfolio. Thus, know-how and patent numbers do not seem to correlate.

The only field where number of patents and business size appears to be more balanced is in Semi-Insulating (S.I.) SiC technology where both Cree (Vanadium-free) and II-VI (Vanadium-doped) have extensively patented their respective developments.



The barriers to the entry in the SiC substrate world are very high. Today, state-of-the-art technology deals with 6" diameter wafers with very low dislocation densities. According to Yole, only Cree

seems able to offer such a product today.

But why is this the case?

Firstly, Cree has been widely funded by DoD, DoE, DARPA and Navy contracts during the last 20 years, meaning the US firm has had a large advantage over its competitors. Cree has been able to invest a lot of time and money in R&D and improve the technology for both LED and Power Electronics.

So mastering SiC growth is a combination of money and development time, that cannot be compressed. Also, cross-fertilisation between its LED and Power businesses have allowed Cree to benefit from LED mass manufacturing, which is probably less stringent than power at wafer level, to fuel the power electronics side.

Apart from receiving funding to develop the technology, the only options to enter quickly in the SiC substrate battlefield appears to be through M&A (Merger & Acquisition) of an existing activity or to buy a license and related know-how, paying royalties in return.

But who is for sale?

Virtually nobody is at this current time. Beyond the top five SiC substrate leaders, Yole doesn't see a clear positioning of companies who may want to participate in a sale or merger of their business.

Ultimately, new developments based on LPE (Liquid Phase Epitaxy), made by Toyota, Denso or Sumitomo, as well as 3C-SiC (Cubic) which may disrupt the current PVT domination, could be the deciding factor.

Two inch free-standing Si GaN substrates on the market

PAM-Xiamen, a Chinese supplier of ultra-high purity crystalline gallium nitride and aluminium gallium nitride materials is marketing its semi-insulating substrates for LED growth

Xiamen Powerway Advanced Material (PAM-Xiamen) has announced the availability of 2" size

native semi-insulating GaN (SI GaN) substrates. This new product represents a natural addition to PAM-Xiamen's native SI GaN substrate product line, which also includes 10mm x 10mm, 25mm x 25mm and 38mm x 38mm substrates.

Dr. Shaka, a spokesperson for the company, said, "We are pleased to offer larger native SI GaN to our customers including many who are developing better and more reliable high frequency high power GaN transistors. Our 50mm dia. native SI GaN product has excellent resistivity properties just like our smaller SI GaN substrates, as corroborated by recent electrical resistivity mapping measurements carried out. The larger size and availability improve our native SI GaN boule growth and wafering processes."

"Our customers can now benefit from the increased device yield expected when developing advanced transistors on a larger square substrate. Our larger square SI GaN substrates are natural by products of our ongoing efforts, currently we are devoted to continuously develop round three-inch and four-inch native SI GaN substrates," continued Shaka. Pam-Xiamen's improved SI GaN product line has benefited from strong technical support from Native University and Laboratory Centre. Founded in 1990, PAM-Xiamen is a manufacturer of compound semiconductor materials in China. Pam-Xiamen develops advanced crystal growth and epitaxy technologies, manufacturing processes, engineered substrates and semiconductor devices and wafers. Pam-Xiamen has been involved in GaN research since 2001.

In 2009, the firm began mass production of GaN-on-sapphire and freestanding GaN single crystal wafer substrates which are used in UHB-LED and laser diode manufacturing. Grown by hydride vapour phase epitaxy (HVPE), Pam-Xiamen's native (free-standing) GaN can be grown in customer-defined orientations. These include polar (*c*-plane Ga-face or N-face) and non-polar (*a*-plane and *m*-plane), GaN and AlN templates grown on sapphire and silicon or SiC substrates, and ultra-high purity polycrystalline GaN.

New type of SWIR InGaAs multi-spectral camera revealed

FluxData's new camera incorporates three indium gallium arsenide sensors to simultaneously capture sub-pixel aligned video through a single aperture lens

FluxData is touting what it says is the first commercially available common aperture three sensor multispectral SWIR camera.

The FluxData FD-3SWIR camera offers three InGaAs sensors fitted with customer specified optical filters to simultaneously capture sub-pixel aligned video through a single aperture lens.



FluxData FD-3SWIR SWIR Multispectral Camera

FluxData has chosen Goodrich's Sensors Unlimited as a partner in this product. The Goodrich SUI C-Platform camera features 640 x 512 pixel resolution with a 15µm pitch. The Camera Link digital output offers plug-and-play connectivity, 12-bit imagery for viewing, digital processing and/or transmission. The uncooled SWIR detector images in real-time video (30Hz).

It operates without temperature stabilisation using non-uniformity corrections (NUC) parameterised over temperatures. It also provides on-board automatic gain control (AGC). Goodrich's SWIR C-platform model operates from 0.9 to 1.7 µm spectral range; the optional near infra-red (NIR) camera model extends the spectral response to include the range from 0.7 to 1.7 µm. The camera operates in a wide temperature range from -350 C to +710 C. The FD-3SWIR has a total power consumption of 4.5W.

The flexibility of FluxData's multi-sensor system

along with the small size of the C-platform allows for a multitude of new spectral and polarimetric configurations for various applications, con-ops and payloads.

Examples include:

3xSWIR (FD-3SWIR): Single lens, simultaneous synchronized video capture of any three discrete spectral wavelength bands between 700-1700nm using three InGaAs sensors.

Visible+NIR+SWIR (FD-VNS): Single lens, simultaneous synchronized video capture of mono or RGB Visible (400-700nm), Near Infrared (700-1000nm) and Short Wave Infrared (900-1700nm) using two CCDs and one InGaAs sensor.

Visible+2xSWIR (FD-V2SWIR): Single lens, simultaneous synchronized video capture of mono or RGB Visible, and any two SWIR wavelengths (700-1700nm).

Polar-SWIR (FD-PolSWIR): Single lens, simultaneous synchronized video at 0/45/90 or 0/60/120 degree linear polarization configurations.

Custom: Any combination of CCD or InGaAs sensors, with any spectral wavelength filter or linear polariser.

Pano Spiliotis, CEO of FluxData, states, "We are extremely excited about the release of the FD-3 SWIR, three sensor InGaAs camera system. For the first time users will be able to capture parallax free synchronized video at three discrete wavelength ranges from 700-1700nm. The small size, weight and power (SWaP) will provide for smaller payloads that combine multiple detection modalities into a single system and allow real-time image fusion with minimal processing, ideal for many ISR and DoD applications."

"Goodrich's industry-leading SWIR cameras continue to advance the capability and set the standard for performance and SWaP. Goodrich's new uncooled C-Platform cameras offer breakthrough form factor and power levels that enable con-ops which, until now, were unachievable," adds John Trezza, Vice President of Goodrich's ISR Systems, Force Protection Business.

FluxData will work with customers to design a

purpose-built configuration that meets their specific requirements. Standard configuration systems can be made to order for delivery in 4-6 weeks.

LayTec secures new orders and boosts sales & training force

The firm has received orders from Germany, India, Taiwan and Japan and added numbers to its sales team to be able to cope with increased demand. LayTec has received a number of orders for its *in situ* monitoring systems. The firm has a repeat order from Jenoptik in Berlin. The firm's EpiTT sensors have been installed on Aixtron G3 systems for monitoring the MOCVD growth of AlGaAs-based laser structures. Martin Zorn, senior scientist at Jenoptik's Lasers & Material Processing division, said that with EpiTT he was able to optimise the laser emission wavelength and growth rate homogeneity. LayTec's EpiTT sensors enable *in situ* determination of wafer temperature and growth rate of each individual layer on each wafer in a growth. LayTec has also successfully installed its first metrology system in India.

The EpiCurve TT SP (Small Port) is now being used on an Aixtron 3x2" CCS MOCVD system at Tata Institute of Fundamental Research (TIFR) in Mumbai, India. As previously announced in June, LED chip manufacturer Lextar has qualified LayTec's Pyro 400 and is the firm's first customer in Taiwan. To support its activities in Taiwan, a training centre has been opened at Challentech International Corp. in Hsinchu. Demonstration tools such as the EpiCurve TT AR Blue and the first PreCurve, LayTec's new product for *ex-situ* measurement of wafer-bow before and after epitaxial growth, will be used for training purposes. The University of Tokyo and University of Meijo, both based in Japan, chose LayTec's EpiCurve TT *in situ* sensor for the AIX200/4 RF-S and Taiyo Nissan SR-4000 reactors, respectively.

Both groups aim to accelerate their research progress in GaN growth. Due to expansion of market in power device with GaN/Silicon and SiC, strong demand for *in-situ* curvature measurement is seen in Japan. GaN and silicon have a large mismatch in thermal expansion coefficient and

therefore strain engineering during growth is necessary. As wafer sizes are increasing to 6" and 8", strain engineering is becoming increasingly important. LayTec has also boosted its sales force. The firm has taken on Stephanie Fritze, experienced in GaN-on-silicon for LEDs on large diameter substrates. She will support the firm's activities in Taiwan and China. Another new sales team member is Emilie Quillet, who will support business in Europe, has previously worked on III-nitride growth and sales. The final new sales member is physicist Volker Blank, who will predominantly focus on activities in South Korea. He is experienced in tetrahertz spectroscopy and radiation in organic semiconductors.

GCS selects Eyelit's advanced software for III-V growth at California site

Eyelit's Integrated Manufacturing Execution (MES) Software will replace the Legacy System to improve operations in the growth of gallium arsenide, indium phosphide and gallium nitride wafers

Global Communication Semiconductors (GCS), a provider of III-V compound semiconductor wafer foundry services, has selected Eyelit's Manufacturing software to replace its FactoryWorks MES at its wafer fab in Torrance, California.

Eyelit is a manufacturing software provider for visibility, control, and coordination of manufacturing operations for the aerospace & defence, discrete electronics, semiconductor, and solar industries,

With its increasing spectrum of fabrication technologies, GCS decided it was necessary to change systems and implement a next-generation MES to handle its complex manufacturing operations.

Eyelit's solution will help GCS to rapidly introduce and manage dynamic process technologies, improve quality, and reduce costs. GCS recognised Eyelit's success in easily migrating legacy MES systems in wafer fabrication facilities, and looks forward to seeing significant improvements in operations by implementing Eyelit MES, Eyelit Asset Management, Eyelit Reporting, and Eyelit

Automated Data Services.

"GCS is very excited to implement Eyelit's MES in our clean room. We run high-mix process flows on GaAs, GaN, and InP wafers, and Eyelit's combination of flexibility and power will be a huge step up in capability from our current system," comments Franklin Monzon, Vice-President of Operations, GCS.

"We expect that improvements, especially in configurability and traceability, will lead to reductions in scrap and cycle time, and to increases in productivity. We also intend to take advantage of Eyelit's capability to streamline our lot-tracking system, which right now relies on detailed paper travellers alongside our MES, into an electronic system that will reduce errors and facilitate corrective actions."

"Eyelit is firmly established as the premier, next-generation solution for companies that retire their legacy systems to obtain leading-edge MES capabilities, and to reduce costs and risks. With this implementation at GCS, Eyelit builds further on its tradition of replacing MES systems from other vendors, including Applied Materials' WorkStream, PROMIS, and FactoryWorks products," adds Dan Estrada, Eyelit's Vice-President of Sales and Marketing. "We are extremely pleased to help GCS move to Eyelit's advanced, award-winning software, and also enable the reduction of infrastructure costs and long-term cost of ownership."

Veeco to present at nitrides growth symposium

The firm will describe its results on reactant injector temperature effects on III-nitride materials deposited in an MOCVD reactor

The symposium is part of a biannual series focusing on the growth of III-Nitride materials, nanostructures and device structures.

Alex Gurary, Ph.D., Veeco's Senior Director, MOCVD Hardware Test, will present "Reactants injector temperature effect on III-Nitrides materials deposition in the high speed vertical rotating disc MOCVD reactor." Gurary has a Ph.D. in Material Science and over 20 years of experience with

MOCVD equipment.

Veeco's MOCVD equipment for high brightness LED production deliver excellent wavelength uniformity, high footprint efficiency and a range of single and multi-reactor platforms that offer the best cost of ownership solutions in the industry.

The ISGN4 symposium is organised by the Ioffe Physical-Technical Institute of Russian Academy of Sciences. Launched in Sweden in 2006, then Japan in 2008, France in 2010 and now Russia, it is the fourth symposium in a biannual series focusing specifically on growth of III-Nitride materials, nanostructures and device structures.

Oxford Instruments unveils new PlasmaPro 100 system

The latest tool offers impressive hardware and process solutions for both Production and R & D customers in HBLEED, semiconductor Electronics, and photovoltaics

Oxford Instruments has launched the PlasmaPro 100 system, its latest generation etch and deposition tool.



The NEW PlasmaPro 100 tool has up to 200mm single wafer production capability, offering excellent uniformity and high throughput on a range of applications

The system is ideally suited to many key market applications, including HBLEED, Semiconductor Electronics, Failure Analysis and Photovoltaics. The, innovative system that has been developed by Oxford Instruments to address the exacting needs of Production users, who demand the very latest technological innovations. This latest system offers an evolution of PECVD hardware delivering step changes in deposition rate of high quality SiO₂ and SiN_x, with corresponding reductions in cleaning

overhead. It also features the latest generation of Cobra ICP source which delivers improvements in etch rate and feature control capability.

With robotic handler and capability and 'Plug and Play' hardware and optimised processes, the enhanced system control infrastructure and software interface delivers improved diagnostics, reliability and serviceability for the customer. Providing a common platform for all Oxford Instruments Plasma Technology's processes and technologies, the PlasmaPro 100 is a highly configurable system, with process chambers that are available as standalone modules or in cluster configurations. "All our tools boast industry leading technology and automation that are well proven with over 90% uptime", comments Senior Product Manager Ian McKinlay, "This latest product release offers genuine process improvements delivering excellent uniformity and high throughput processes on a range of applications. With access to our exclusive library of over 6,000 process recipes, built up over 25 years as a leading plasma tool manufacturer, our customers are guaranteed an excellent product with comprehensive, market leading backup."

Riber receives order for Compact 21 research system in Germany

The MBE reactor will be used in the development of III-V epitaxial nanostructures for applications in nanoelectronics and photonics

At the end of June, Riber completed the sale of a Compact21 MBE system to a research institute in Germany.

The MBE reactor will be devoted to the growth of III-V epitaxial nanostructures for applications in nanoelectronics and photonics. This order will significantly increase the institute's applied technology research and development capabilities.

Riber says its Compact 21 MBE research system has sold the most units in the world. It is highly flexible and offers great adaptability to meet the most demanding specifications of applied research on compound semiconductor materials.

Evatec sponsor CS International Conference in Frankfurt

Evatec have confirmed they will be platinum sponsors at the Compound Semiconductor industry's premier international event, CS International, which will be held in Frankfurt, Germany on 4th & 5th March 2013.

Delegates will gain a comprehensive overview of the entire compound semiconductor industry, the must attend event for 2013 is the third CS International conference in Frankfurt, Germany.

Professionals from around the world will attend this two-day event to hear key insights and opportunities, from a range of leading analysts, and learn of the latest chip developments in LEDs, solar cells, lasers and power and RF electronics.

Delegates will get the opportunity to network with leading industry professionals of the III-V chip making industry and interact with suppliers. Industry leaders from Intel, Cree, Epistar, RFMD, TriQuint and over 20 other leading chipmakers will also be present and to share their perspective on the latest developments in device technology.

A Networking Conference Dinner will be held on the evening of the 4th March where the industry will recognise the success and development along the entire value chain of the Compound Semiconductor industry from research to completed device, focusing on the people, processes and products that drive the industry forward through The CS Industry Awards 2013.

Further information on the conference and the awards is available on the CS International website at: www.cs-international.net Registration is now open for 2013 event.

Delegates who book before October 31st 2012 can take advantage of our early bird rate, saving €57.



Novel Devices Non destructive analysis tool promises a new wave of technologies

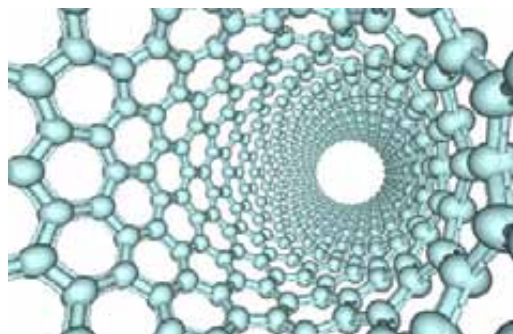
A tool created by scientists at the University of Sheffield has enabled researchers to analyse nanometre-sized devices without destroying them for the first time. The tool could be used in harvesting solar energy, computing and communication

A nuclear magnetic resonance (NMR) system, developed by the Sheffield University's Department of Physics and Astronomy, will allow for further developments and new applications for nanotechnology.

Developments in this field are being increasingly used in harvesting solar energy, computing, communication developments and also in the medical field.

NMR is a physical phenomenon in which magnetic nuclei in a magnetic field absorb and re-emit electromagnetic radiation. This energy is at a specific resonance frequency which depends on the strength of the magnetic field and the magnetic properties of the isotope of the atoms.

The technique allows the observation of specific quantum mechanical magnetic properties of the atomic nucleus. Many scientific techniques exploit NMR phenomena to study molecular physics, crystals, and non-crystalline materials through NMR spectroscopy.



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Scientists can now analyse nanostructures at an unprecedented level of detail without destroying the materials in the process, a limitation researchers across the world faced before the Sheffield experts' breakthrough.

Alexander Tartakovskii, who led a team of researchers, says, "We have developed a new important tool for microscopy analysis of nanostructures. In the very tiny quantities of matter used in nanostructures the behaviour of electrons and photons is governed by new quantum effects, quite different from what happens in bulk materials. This makes them attractive for various new technologies.»

"Development requires careful structural analysis, in order to understand how the nanostructures are formed, and how we can build them to enhance and control their useful properties. Existing structural analysis methods, key for the research and development of new materials, are invasive: a nanostructure would be irreversibly destroyed in the process of the experiment, and, as a result, the important link between the structural and electronic or photonic properties would usually be lost. This limitation is now overcome by our new techniques, which rely on inherently non-invasive nuclear magnetic resonance (NMR) probing," he continues.

The results open a new way of nano-engineering, a full characterisation of a new material and new semiconductor nano-device without destroying them meaning more research and development and device fabrication processes.

Tarakovskii adds, "We have developed new techniques which allowed unprecedented sensitivity and enhancement of the NMR signal in nanostructures. Particular nanostructures of interest in our research are semiconductor quantum dots, which are researched widely for their promising photonic applications, and potential for the use in a new type of computer hardware employing quantum logic.»

"The result of our experiments was quite unexpected and changed our understanding of the architecture of these nanomaterials: we learned new information about the chemical composition of quantum dots, and also how atom alignment inside the dots deviates from that of a perfect crystal. Importantly, many more measurements of optical

and magnetic properties can be done on the same quantum dots which have undergone the NMR probing."

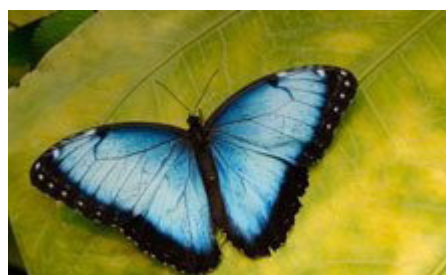
The development of the new techniques and all experimental work was carried out by Evgeny Chekhovich in the group of Alexander Tartakovskii at the Department of Physics and Astronomy in Sheffield. Quantum dot samples used in this work have also been fabricated in Sheffield, in the EPSRC National Facility for III-V Semiconductor Technology.

More details of this research have been published in the paper, "*Structural analysis of strained quantum dots using nuclear magnetic resonance*", by E. A. Chekhovich *et al* in *Nature Nanotechnology*, (2012). DOI:10.1038/nnano.2012.142

Unveiling the secrets of light on glowing materials

A novel technique combines electronic excitation and optical detection, to explore the inside of a photonic crystal and study the confinement of light in a silicon nitride membrane Mainbody:

A collaboration between research institutes ICFO (Barcelona) and AMOLF (Amsterdam) and King's College London have succeeded in mapping how light behaves in complex photonic materials inspired by nature, like iridescent butterfly wings.



The scientists say they have broken the limit of light resolution at the nanoscale and delivered a fundamental insight into how light and matter interact. This could lead to the development of enhanced bio-sensors for healthcare and more efficient solar cells and displays.

Optical measurements of light waves at the nanoscale have always been limited by the

resolution of the optical microscope, but the researchers were able to break this limit using a new technique which combines electronic excitation and optical detection, to explore the inside of a photonic crystal and study the confinement of light.

Working with a spatial resolution of 30 nm, scientists examined structures at a resolution more than ten times smaller than the diffraction limit for light. This revealed a greater understanding of how light interacts with matter to create, for example, the visible iridescence phenomena observed in nature on the wings of butterflies.

Riccardo Sapienza, from the Department of Physics at King's, says, "We were thrilled in the lab to observe the finer details of the photonic crystals that were simply inaccessible before. This is very important as it allows scientists to test optical theories to a new level of accuracy, fully characterise new optical materials and test new optical devices."

The team constructed an artificial two-dimensional photonic crystal by etching a hexagonal pattern of holes in a very thin SiN membrane. Photonic crystals are nanostructures in which two materials with different refractive indices are arranged in a regular pattern, giving rise to exotic optical properties. Natural photonic crystals can be found in certain species of butterflies, birds and beetles as well as in opal gemstones where they give rise to beautiful shimmering colours.

The photonic crystal inhibits light propagation for certain colours of light, which leads to strong reflection of those colours, as observed when such materials 'catch the light'. By leaving out one hole, a very small cavity can be defined where the surrounding crystal acts as a mirror for the light, making it possible to strongly confine it within a so-called 'crystal defect cavity'.

The scientists based their research methods on cathodoluminescence, where a beam of electrons is generated by an electron gun and impacted on a luminescent material, causing the material to emit visible light. Albert Polman and his group in AMOLF modified this technique to access nanophotonics materials. He says, "In the past few years we have worked hard with several technicians and researchers to develop and refine this new instrument."

Sapienza adds, "Each time a single electron from the electron gun reaches the sample surface it generates a burst of light as if we had placed a fluorescent molecule at the impact location. Scanning the electron beam we can visualise the optical response of the nanostructure revealing features ten times smaller than ever done before."

Niek van Hulst, ICFO, continues, "It is fascinating to finally have an immediate view of the light in all its colours inside a photonic crystal. For years we have been struggling with scanning near-field probes and positioning of nano-light-sources. Now the scanning e-beam provides a local broad-band dipolar light source that readily maps all localised fields inside a photonic crystal cavity."

With major advances in nanofabrication techniques it has become possible to construct artificial photonic crystals with optical properties that can be accurately engineered. These structures can be used to make high-quality nanoscale optical waveguides and cavities, which are important in telecommunication and sensing applications.

Sapienza also points out, "Our research provides a fundamental insight into light at the nanoscale and, in particular, helps in understanding how light and matter interact. This is the key to advance nanophotonic science and it can be useful to design novel optical devices like enhanced bio-sensors for healthcare, more efficient solar cells and displays, or novel quantum optics and information technologies."

This work is described in detail in the paper, "Deep-subwavelength imaging of the modal dispersion of light", by Sapienza *et al* in *Nature Materials*, (2012). DOI:10.1038/nmat3402

Topological insulators for dissipationless electronics

A new type of material based on manganese doped Bi₂Te₃-ySey opens the door to electronics based on topologically non-trivial materials

A team of researchers at Riken and the University of Tokyo has demonstrated a new material that promises to eliminate loss in electrical power transmission.

The surprise is that their methodology for solving this classic energy problem is based upon what the team says is the first realisation of a highly exotic type of magnetic semiconductor first theorised less than a decade ago - a magnetic topological insulator.

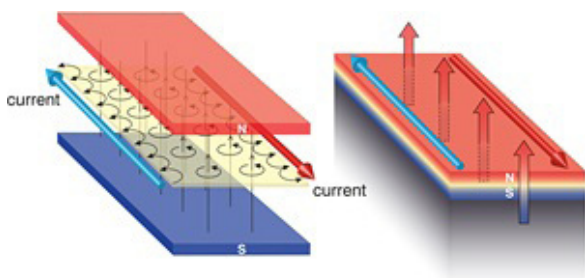
Development of energy saving technologies is one of the central pursuits of modern science. From advancing alternative energy resources like wind and solar power to improving the infrastructure of the electrical power grid, this pursuit by scientists and engineers takes on a variety of forms.

One focus in recent years has been eliminating energy loss in the transmission of power itself, which by some estimates consumes more than 10 percent of all energy being produced. The research team has demonstrated a new material - a magnetic topological insulator - that can eliminate this loss.

The work by the Riken/UT collaboration is closely related to a landmark discovery from the 1980s, the so-called quantum Hall effect. That effect is known to produce dissipationless electricity channels, but it requires large, cumbersome magnets to produce fields 100,000 larger than the earth's magnetic field for its operation.

The Riken/UT collaboration circumvented this difficulty by using an exotic type of semiconductor predicted to exhibit a similar effect. The material used was manganese doped $\text{Bi}_2\text{Te}_3-y\text{Sey}$.

In contrast to the quantum Hall effect, this effect, known as the quantum anomalous Hall effect, stems from the semiconductor's own magnetisation rather than from an external one. At the heart of this new phenomenon is the interaction between magnetic ions and the topological insulator's current carrying particles (known as Dirac fermions), the latter of which are unique because they behave as if they have zero mass.



Depiction of quantum Hall effect (left) and quantum anomalous Hall effect (right)

The devices produced by the Riken/UT team are a robust "proof of principle", demonstrating that this new type of dissipationless transport can be harnessed in prototype transistors. While currently requiring cryogenic conditions, improvements in materials design promises to improve the stability of the magnets, making it possible to operate them at higher temperatures.

By doing away with external stimuli such as magnetic fields and, in the future, cryogenic cooling, these new magnetic topological insulators may represent the most efficient path to modernising the power grid by eliminating loss in energy transfer.

More details of this work has been published in the paper, "Dirac-fermion-mediated ferromagnetism in a topological insulator," by J. G. Checkelsky *et al* in *Nature Physics*, 2012. DOI: 10.1038/nphys2388

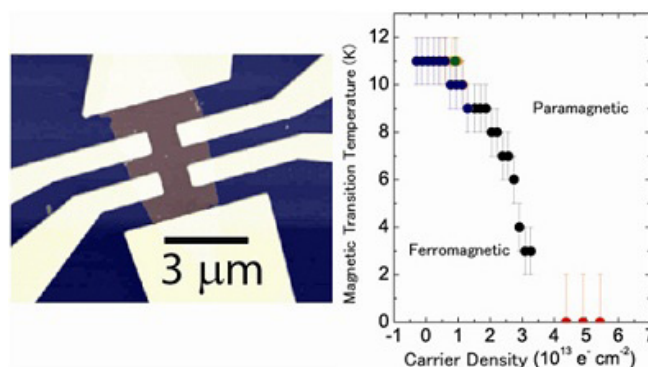


Figure 1. (Left) The active area of magnetic topological insulator (dark gray) is $3 \mu\text{m}$ across and only 70 atoms thick. The blue background is an insulating gate dielectric and the yellow regions are metallic electrodes. (Right) The internal magnet favours the "off" state of the transistor on the left. This is evidence for a new type of magnetic semiconductor

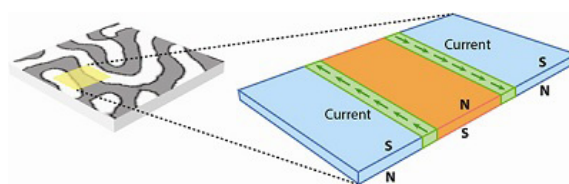


Figure 2. Depiction of realisation of edge modes on

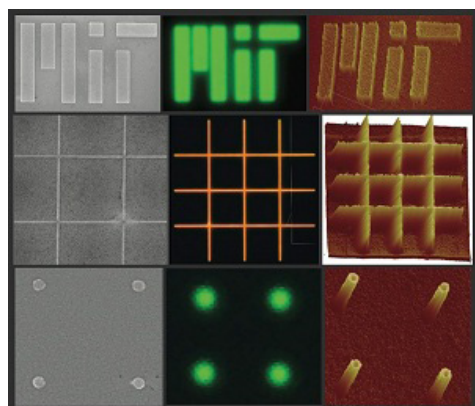
sample surface. (Left) A schematic representation of magnetic structure is shown, dark and light representing down and up polarisation, respectively. (Right) The corresponding edge mode structure is shown, with the green arrows representing chiral modes at magnetic reversal. The electrical current flows in the same manner as in the quantum Hall and anomalous quantum, Hall states

Defect-free nanocrystal films

A new process developed at MIT could enable better LED displays, solar cells and biosensors - and foster basic physics research with the use of cadmium based compounds

Films made of semiconductor nanocrystals - tiny crystals measuring just a few billionths of a metre across - are seen as a promising new material for a wide range of applications.

Nanocrystals could be used in electronic or photonic circuits, detectors for biomolecules, or the glowing pixels on high-resolution display screens. They also hold promise for more efficient solar cells.



Images of nanopatterned films of nano crystalline material produced by the MIT research team. Each row shows a different pattern produced on films of either cadmium selenide (top and bottom) or a combination of zinc cadmium selenide and zinc cadmium sulphate (middle row). The three images in each row are made using different kinds of microscopes: left to right, scanning electron microscope, optical (showing real-colour fluorescence), and atomic force microscope. (Images courtesy of Mentzel et al, MIT from Nano Letters)

The size of a semiconductor nanocrystal determines its electrical and optical properties. But it's very

hard to control the placement of nanocrystals on a surface in order to make structurally uniform films. Typical nanocrystal films also have cracks that limit their usefulness and make it impossible to measure the fundamental properties of these materials.

Now, researchers at MIT say they have found ways of making defect-free patterns of nanocrystal films where the shape and position of the films are controlled with nanoscale resolution, potentially opening up a significant area for research and possible new applications.

"We've been trying to understand how electrons move in arrays of these nanocrystals," which has been difficult with limited control over the formation of the arrays, says physicist Marc Kastner, the Donner Professor of Science, dean of MIT's School of Science and senior author of a paper published online in the journal *Nano Letters*.

The work builds on research by Mounji Bawendi, the Lester Wolfe Professor of Chemistry at MIT and a co-author of this paper, who was one of the first researchers to precisely control nanocrystal production. Such control made it possible, among other things, to produce materials that glow, or fluoresce, in a range of different colours based on their sizes - even though they are all made of the same material.

In the initial phases of the new work, postdoc Tamar Mentzel produced nanoscale patterns that emit invisible infrared light. But working on such systems is tedious, since each fine-tuning has to be checked using time-consuming electron microscopy.

So when Mentzel succeeded in getting semiconductor nanocrystal patterns to glow with visible light, making them visible through an optical microscope, it meant that the team could greatly speed the development of the new technology. "Even though the nanoscale patterns are below the resolution limit of the optical microscope, the nanocrystals act as a light source, rendering them visible," Mentzel says.

The electrical conductivity of the researchers' defect-free films is roughly 180 times greater than that of the cracked films made by conventional methods. What's more, the process developed by the MIT team has already made it possible to create patterns on a silicon surface that are just 30

nm across - about the size of the finest features possible with present manufacturing techniques.

The process is unique in producing such tiny patterns of defect-free films, Mentzel says. "The trick was to get the film to be uniform, and to stick" to the silicon dioxide substrate, Kastner adds. This was achieved by leaving a thin layer of polymer to coat the surface before depositing the layer of nanocrystals on top of it. The researchers think that maybe the tiny organic molecules on the surface of the nanocrystals help them bind to the polymer layer.

Such nanocrystal patterns could have many applications, Kastner says. Because these nanocrystals can be tuned not only to emit but also to absorb a wide spectrum of colours of light, they could enable a new kind of broad-spectrum solar cell, he says.

But Kastner and Mentzel's personal interest has more to do with basic physics. Since the minuscule crystals behave almost like oversized atoms, the researchers aim to use the arrays to study fundamental processes of solids, Mentzel says. The success of this technique has already enabled new research on how electrons move in the films.

Such materials could also be used to develop sensitive detectors for tiny amounts of certain biological molecules, either as screening systems for toxins or as medical testing devices, propose the researchers.

Douglas Natelson, a professor of physics and astronomy at Rice University who was not involved in this work, says, "The challenge in the past has been achieving thin, uniform films, patterned at high resolution, with good contact between the nanocrystals and no cracking." The MIT team's approach, he says, "while deceptively simple in appearance, accomplishes all of these objectives."

Natelson adds, "I think this is a very nice achievement. The fluorescence images showing the nanopatterned films are eye-popping, particularly for those who know how tough this is."

The research was supported by the U.S Army Research Office, the Department of Energy and Samsung.

Further details of this work have been published in the paper, "Nanopatterned Electrically Conductive Films of Semiconductor Nanocrystals" by Tamar S. Mentzel *et al* in *Nano Letters*, 2012, 12 (8), pp 4404–4408. DOI: 10.1021/nl3022863

II-VI reveals record bookings but falling profits

US optoelectronics components maker posts mixed quarterly results

II-VI revenues for the quarter increased 4% to \$136,910,000 from \$131,783,000 in the fourth quarter of last fiscal year, while revenues, year-on-year increased 6% to a record \$534,630,000 from \$502,801,000.

As the company highlights, bookings remain strong, increasing by 8% to \$141,959,000 for this quarter, compared to \$131,177,000 in the fourth quarter of last fiscal year. Bookings were up 3% year-on-year to a record \$534,865,000 compared to \$520,238,000 for last fiscal year.

However, net earnings for the quarter were down to \$14,446,000 from \$22,039,000 in the fourth quarter of last year. Annual earnings came in at \$60,306,000, down from \$82,682,000 for last fiscal year.

"For the quarter, company revenues increased 4% from the year-ago period, while earnings decreased," says Francis Kramer, president and chief executive officer. "During the fourth quarter – and for the third quarter in a row - PRM both wrote-down inventory and realised depressed margins on product sales due to declines in the index pricing of tellurium; and, for the first time, the same was true for selenium."

"In the Advanced Products Group, our Marlow business unit realised lower revenues and earnings due to decreased customer demand," he added.

Australia funds silicon carbide chip production

Griffith University researchers win Aus\$1million from government and work with UK equipment maker, SPTS Technologies, to commercialise SiC-on-silicon production.

Australia-based Queensland Micro- and Nanotechnology Centre, Griffith University, has won Aus\$1million in funding from the Queensland State Government to develop production processes for silicon carbide microchips. The research centre has been developing SiC-on-silicon substrates for a wide variety of applications including LEDs, micro-electro-mechanical systems (MEMS) and power integrated electronics. According to Professor Sima Dimitrijevic, lead researcher at the University's Micro- and Nanotechnology Centre, research breakthroughs include low temperature epitaxy of cubic SiC on Si as well as the development of MOS purity oxides for SiC MOS devices.

"The superior properties of silicon carbide enable smaller, more efficient, sensitive and robust devices that can operate in harsh chemical and temperature environments," he adds. Researchers at the Centre have also been working alongside UK-based semiconductor equipment manufacturer, SPTS Technologies, to commercialise SiC-on-silicon technology. Having demonstrated low temperature epitaxial growth of SiC films directly onto low-cost silicon wafers, the partners intend to develop thermal processing equipment to commercialise the technology. "Our industry partner will help us take the next critical step of making our SiC production processes ready for industry to adopt," adds Centre operation director, Alan Iacopi.

"There is a potentially enormous global market and our breakthroughs have far reaching implications in terms of engaging with international industry and bringing frontier technologies to Queensland."