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Worthy winners

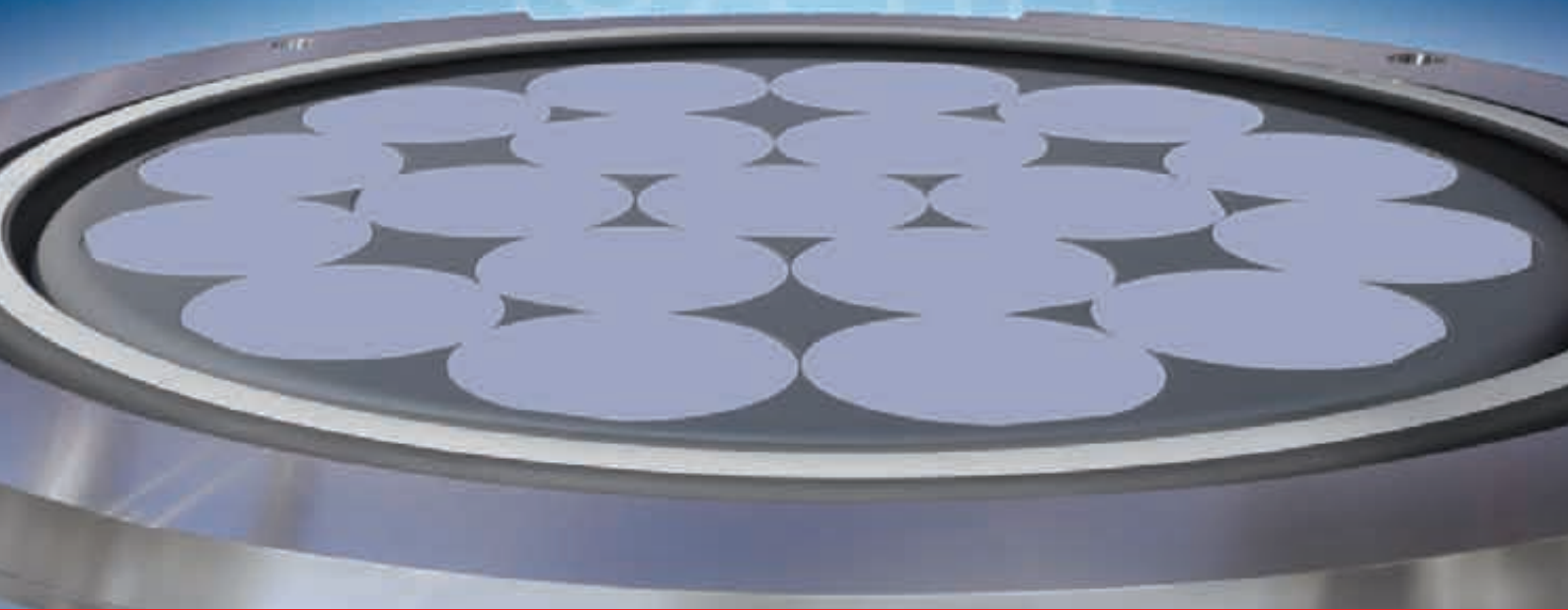
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There may be trouble ahead

The LED industry is a midst of a blood bath as overcapacity drives down prices. For LED manufacturers caught up this, these times are tough and painful. But there is hope ahead in the promise of a rapidly growing lighting market, which should help to swell chip revenues for the next few years.

How quickly this market will grow is a very important question. And according to IMS Research, it's going to be very fast, with shipments in the LED lighting market more than doubling in 2013, and then growing through to 2020 by an average of just over 50 percent a year.

Unfortunately, by then this market will start to stagnate. At that stage the penetration of LED lighting, at least in the developed world, will be very high, and thanks to the very long lifetimes of the chips, changing a bulb will be a rare event.

This may prompt chipmakers with spare capacity to move into new markets. One scenario, discussed at the recent and highly successful CS Europe conference by Philippe Roussel of Yole Développement, is a possible move by LED chipmakers to GaN-on-silicon power electronics.

Such a switch could be tempting, given that the total value of the power electronics market is tipped to top \$35 billion by the end of this decade. However, in Roussel's opinion, making a move from LEDs to high power diodes and transistors is anything but trivial – and I agree.

If LED chipmakers are to make this transformation, they will have to first learn how to grow high-quality epiwafers on large diameter silicon substrates. Stresses and strains cannot be left unchecked, because they would cause the wafer to bow and prevent it from being processed through silicon lines. Once that's mastered, there is still much more to do – to develop the expertise to manufacture high-quality devices.

So it's possible that LED manufacturers operating in ten years' time would enjoy more success by developing new chip technologies that can catapult light bulbs to even higher performance levels. This would threaten to change a habit that goes back many generations: Consumers would no longer replacing a bulb because it is broken, but instead insert a new one because it is far better. If that happens, at least some chipmakers will be generating healthy revenues in the following decade.

Richard Stevenson PhD
Editor



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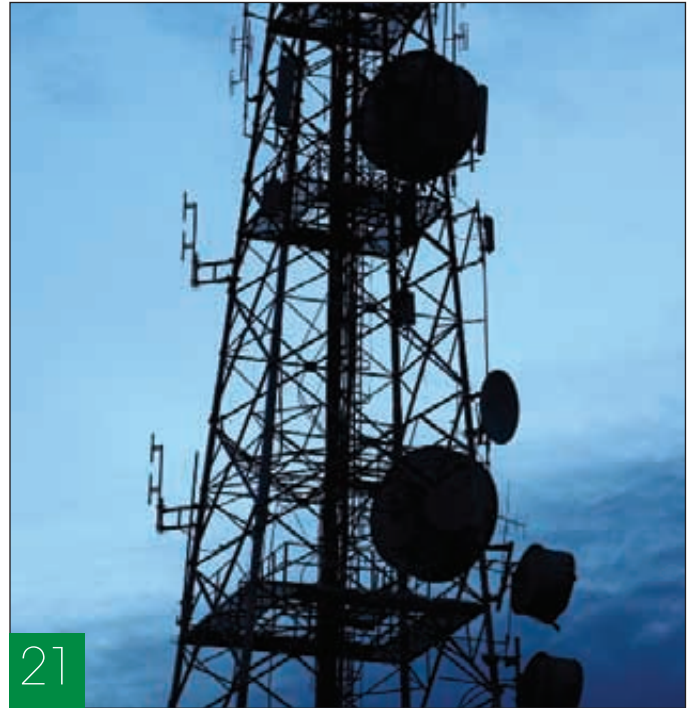
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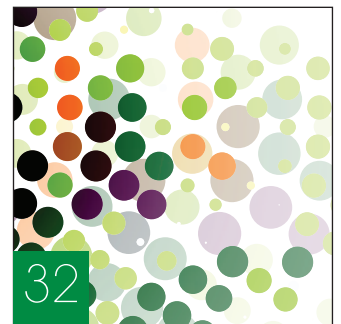
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Optogan and Philips unite to light up LED roads in Russia

A NEW joint venture between Royal Philips Electronics and Optogan is aiming to become a strong player in the fast growing LED road lighting market in Russia. The new company will be 51% owned by Philips and 49% by Optogan. Financial details of the joint venture (JV) have not been disclosed. The JV will combine Philips' LED road lighting solutions with Optogan's LED knowledge and understanding of local market requirements.

Products developed and manufactured by the JV will be sold in the Russian Federation and within its customs union with Kazakhstan and Belarus. The Philips-Optogan partnership will focus on developing a local LED industry, supporting the energy efficiency (EE) initiatives by the Russian government. The firms say switching to LED street and road lighting can reduce energy consumption by up to 80% and lead to significant savings in service and maintenance costs.

The enhanced visibility of the LED lights can also contribute to more secure road safety and put people more at ease.

"Today's announcement of our joint venture with Optogan represents the beginning of a new, ambitious journey to become a key player on the Russian outdoor lighting market," says Arjan de Jongste, CEO Philips Russia and CIS. "We believe it will unlock new potential for us to bring lighting solutions to Russia that save energy, reduce maintenance costs and increase road safety, thereby making a difference in people's lives."

"Optogan is one of the technology leaders in the manufacturing of LEDs. With energy efficient and cost-efficient solutions in the fields of high brightness chips, LED components, LED lamps and LED luminaires. Optogan has a very deep understanding of the local Russian market," adds Maxim Odnoblyudov, CEO Optogan Group.



Exchange of JV agreement between Maxim Odnoblyudov, CEO of Optogan Group (left) and Arjan de Jongste, CEO Philips Russia (right)

"By joining forces with Philips we will be able to serve the Russian customers even better."

Road lighting in Russia is expected to become one of the leading growth segments for LED products.

The Russian road lighting market is expected to double over the next four years to €100 million by 2015. This growth is mainly driven by government energy efficiency programs for modernisation of road lighting. Analysts say this should also increase the share of LEDs in Russia to reach 50% by 2015.

Cree claims its high-voltage LEDs drive performance up and costs down

CREE announced the availability of brighter Cree XLamp XT-E and XM-L High-Voltage LEDs to provide manufacturers with more efficient, cost-effective components.

The new, high-performance LEDs leverage the SC3 Technology Platform, which also powered the previously introduced XLamp XB-D and XT-E LEDs. The SC3 Technology Platform, built on Cree's advanced SiC technology, features advancements in LED chip architecture and phosphor, and



XLamp XM-L High-Voltage White LED

boasts a new package design to deliver the most advanced LED components in the industry. The brighter XT-E and XM-L High-Voltage LEDs deliver up to 22 percent more lumens than their predecessors. These High Voltage LEDs are designed to use lower cost, higher efficiency and smaller size drivers than standard-voltage LEDs.

The brighter high-voltage XLamp XT-E and XM-L LEDs provide comparable performance to their standard-voltage counterparts, eliminating the trade-off of optimising for either LED efficacy or driver efficiency. The new high-voltage XLamp LEDs provide customers with more design options to address a wider spectrum of small indoor and outdoor lighting applications such as accent lights and replacement lamps.

"Relentless innovation, like the SC3Technology Platform, will always be part of Cree's DNA, and applying the innovations to optimise application



Cree XLamp XT-E LED

performance, lower system cost and drive LED lighting adoption is our mission," says Mike Watson, Cree senior marketing director, LED components. "Leveraging the power of the SC3Technology Platform, Cree has fundamentally transformed price-performance with the XB-D LED, set new performance standards with the XT-E LED and with the introduction of the new XT-E and XM-L High-Voltage LEDs, redefined performance limits for LEDs of this size."

The XT-E High-Voltage LEDs can deliver up to 357 lumens at 3W in cool white (6500K) and up to 275 lumens at 3W in warm white (3000K), both at 85°C. The XM-L High-Voltage LEDs can deliver up to 647 lumens at 6W in cool white (6500K) and 555 lumens at 6W in warm white (3000K) both at 85°C.

AkzoNobel broadens its horizons with magnesium-based LED precursor

AKZONOBEL has recently started production of the magnesium-based metalorganic compound Cp_2Mg . Used as a dopant in compound semiconductor epitaxial structures, the product, also known as bis-cyclopentadienyl magnesium, is being manufactured at the company's Deventer site in the Netherlands.

This expands AkzoNobel's technology for the manufacturing of highly pure metal-organic complexes, which are used in a number of markets including electronics, polymer and pharmaceutical applications. "Cp2Mg is a relatively small part of our product range, however, it is a key product

for our customers and used extensively in many CVD applications" says Michiel Floor, Global Business Manager of the HPMO product group.

"We continue to execute our capacity growth plan across all products in our portfolio, to support further growth of the LED and other compound semiconductor industries. While our expansion efforts are focused on growth of our core products Trimethyl Gallium (TMGa), Triethyl Gallium (TEGa), Trimethyl Indium (TMIn) and Trimethyl Aluminium (TMAI), we are very happy to bring the new and large scale Cp2Mg capacity at Deventer on stream, to the benefit of our global

customer base. The newly added capabilities can also be used to produce other advanced metalorganic complexes used in the broader semiconductor industry, so we will pursue further development of this product range," he adds.

The HPMO business is part of AkzoNobel Functional Chemicals, which produces semiconductor grade indium, gallium, aluminium, zinc and magnesium based metalorganics.

These materials are all used as key precursor materials in the production of LEDs, solar cells and other compound semiconductor devices.

Raytheon to develop GaN-on-diamond

RAYTHEON has been awarded an 18-month, \$1.8 million contract by the Defence Advanced Research Projects Agency (DARPA) to develop next-generation GaN devices bonded to diamond substrates. The technology, known as Thermally Enhanced Gallium Nitride (TEGAN), aims to increase the power handling capability of GaN devices by at least three times.

TEGAN enables state-of-the-art transistors and monolithic microwave integrated circuits (MMICs) to achieve their full performance potential by reducing thermal resistance. TEGAN acts as a multiplier for GaN's unique qualities, which may dramatically reduce the cost, size, weight and power of defence systems. Over the course of the 18-month contract,

Raytheon seeks to develop and test TEGAN's capabilities and establish a clear path to technology insertion into military systems. The uniqueness of GaN devices allows radar, electronic warfare and communications systems to be smaller, more affordable and highly efficient.

"Raytheon continues to be at the forefront of GaN technology development," says Joe Biondi, vice president of Advanced Technology for Raytheon's Integrated Defence Systems (IDS) business. "We are pushing the envelope of this proven technology to provide our war fighters with the most advanced sensing, communications and electronic warfare capabilities in the world."

Skyworks diversifies to maintain pole position in GaAs device manufacturing

ALTHOUGH the GaAs device market growth plummeted in the second half of 2011, with overall revenue increasing by only six percent, Skyworks secured its position as the largest GaAs device manufacturer with a 27% growth in revenue.

The Strategy Analytics report, "Skyworks Remains the Largest GaAs Device Manufacturer," explores 2011 GaAs device revenue results and growth trends, as well as revenue performance of leading

device manufacturers. These include the likes of RFMD, Skyworks, TriQuint Semiconductor, Avago Technologies, Renesas Electronics, Hittite and WIN Semiconductors.

"While the 2011 growth rate of the GaAs device market was right around its historical average of 6 percent, Skyworks and WIN Semiconductors did more than significantly better," notes Eric Higham, Director of the Strategy Analytics GaAs and Compound Semiconductor

Technologies Service. "The big increase at Skyworks is a testimonial to their efforts for diversifying smartphone customers, products, technology and market applications."

Asif Anwar, Director, Strategy Analytics Strategic Technologies Practice, adds, "The growth at WIN Semiconductors indicates their commitment to expansion, and also reflects success for outsourcing foundry operations in the GaAs device industry."

SiC and GaN to boost power electronics market to \$15 billion

THANKS to a resurgence in innovation, power electronics revenues are poised to grow to \$15 billion for discrete components in four key industry segments in 2020. It's also moving beyond its historic dependence on silicon, with significant developments in SiC and GaN technology. According to Lux Research's new report, "Beyond Silicon: Plotting GaN and SiC's Path within the \$15 Billion Power Electronics Market," these materials are taking a 22% market share for \$3.3 billion in power electronics sales.

"There's clearly a growing opportunity in power electronics, but the challenge for both current market players and would-be entrants is finding the places where these emerging technologies meet customer needs at the right price points," notes Pallavi Madakasira, Lux Research Analyst and lead author of the report. "While consumer electronics is a 'here and now' opportunity, fast-growing industries such

as renewable energy and industrial power applications are likely to challenge power electronics manufacturers to innovate on form factor and improve efficiency at the lowest cost."

SiC and GaN are vying for a slice of the silicon pie. With silicon-based power electronic devices reaching theoretical limits, other semiconductors, notably SiC and GaN, are making inroads into the power electronics industry.

These materials promise better performance and energy savings, and in SiC will gain a 14% market share and in GaN, an 8% share. SiC, with its better maturity and reliability, has a head start, but GaN catches up thanks to innovators such as Efficient Power Conversion and Transphorm and incumbents like International Rectifier.

SiC gains the most in renewables,

capturing a 32% market share in solar, and is poised to capitalise on the grid storage boom. Its adoption in transportation is less aggressive, leading SiC and GaN to a relatively even share, at 16% and 15%, respectively, in 2020. GaN eclipses SiC in IT & electronics, carving out 14% share in 2020; and flourishes in smaller-scale applications within buildings in a broad \$2.4 billion market.

Over the past five years, investors have funnelled over \$200 million into developers of advanced materials and devices for power electronics. On the venture side, Transphorm, EpiGaN, GaN Systems and Azzurro have closed notable rounds, while corporate investments and acquisitions such as TranSiC (Fairchild), SiCed (Infineon), SiCrystal (Rohm) and Crysband (SKC) have continued apace. This year promises to be a record-setting one for transactions with particular attention on substrate and GaN technology developers.

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LED equipment and substrate market to decline in 2012

After two years of explosive revenue growth, the LED market appears to be slowing down. The Strategy Analytics report, "Compound Semiconductor Industry Review January 2012: Optoelectronics, Materials and Equipment" predicts that equipment spending and epitaxial substrate demand in the LED sector will decline in 2012.

This validates recent announcements from equipment manufacturers, like Aixtron, that substantial funding from Asian governments has been masking inherent softness in LED demand. The report also captures announcements for companies such as Soitec, Sumitomo Electric, AXT, IQE, Oclaro, Cree, Renesas Electronics, GigOptix, Avago Technologies, JDSU, Lumileds and First Solar.

"The LED industry has grown in cycles," observes Eric Higham, Director of the Strategy Analytics GaAs and Compound Semiconductor Technologies Service. "The first phase involved backlighting for small consumer devices, like mobile handsets. These solutions have evolved to meet the needs of laptop, television, electronic sign and automotive applications and the next wave for LED adoption appears to be commercial and residential lighting."

Asif Anwar, Director, Strategy Analytics Strategic Technologies Practice adds, "Despite a slowdown in demand, companies are hard at work developing products that improve the performance and cost of devices in preparation for the next wave of LED adoption."

UV LEDs to account for 28 percent of total UV lamp market by 2016

ACCORDING to Yole Développement's Technology & Market study "UV LED Market", the UV LED market will reach more than \$150 million in 2016.

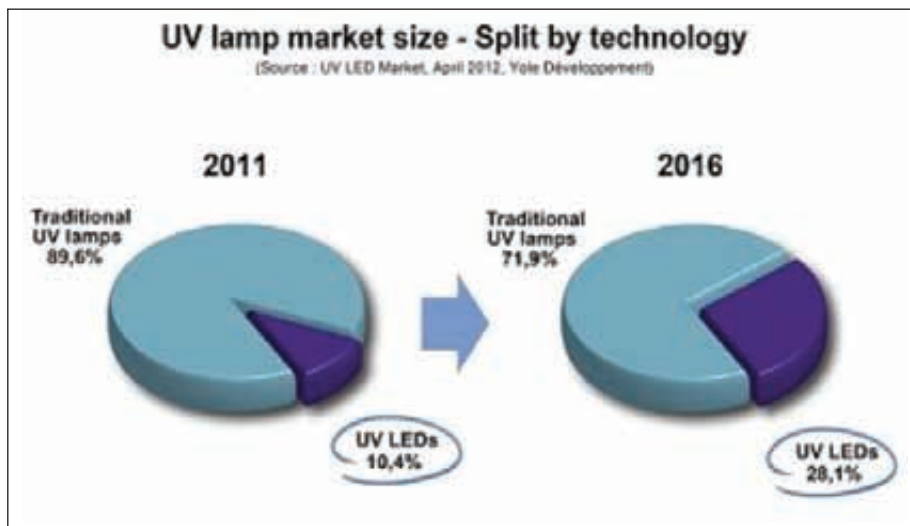
"Thanks to its compactness, lower cost of ownership and environmental friendly composition, UV LEDs continue replacing traditional UV lamps in incumbent applications, but will also create new applications, especially portable ones", explains Pars Mukish, Technology & Market Analyst, LED & Compound Semiconductors at Yole Développement.

The market research firm expects UV LED business to grow from \$32.5 million in 2011 to more than \$150 million in 2016. In this period, the million dollar UV LED market will grow by a factor of 5 whereas the traditional UV lamps market will grow by only a factor of 1.5. In 2011, LEDs were sold mostly in the UVA /B spectrum, especially in upper wavelengths, between 365 and 400 nm. More than 90% of the UV LED market (outside of R&D) was still covered by UV curing, counterfeit detection and medical & instrumentation applications requiring UVA/B sources.

In the same year, UVC LEDs, were still mainly sold for R&D and scientific instrumentation purposes, but 2012 should see the commercialisation of the first UV LED based purification system. UVA business is currently the main UV LED market and will remain so for at least the next 5 years. It accounted for about 90% of the million dollar market in 2010 and is anticipated to take about an 85% market share in 2016.

The booming UV LED market has attracted several new players from different backgrounds over the past few years. These include traditional mercury lamp suppliers, traditional UV curing system suppliers, pure UV LED curing system suppliers, visible LED suppliers and substrate suppliers. Each type of player will adopt a different strategy to capture the maximum value created by this disruptive technology.

"At the device level, Asian companies, especially Japanese and Taiwanese ones, have taken the lead on the UV LED market



but recently, some Chinese companies have also entered the playground," says Mukish. "This should increase competition, reduce prices and enable mass applications at middle/long term".

As for visible LEDs, for the last few years, the value chain has been expanding with the arrival of pure players at mainly the packaging and system level. This has allowed an increase in performance of UV LEDs with specific package developments and enabled an easier technological transition with traditional UV system manufacturers. Key applications for UVA are UV curing, counterfeit detection and photocatalyst air purifiers. Among these, the most dynamic and important market is the UV curing business where UV LEDs compete with traditional mercury lamps and offer significant advantages in terms of cost of ownership and system miniaturisation.

In 2012, two professional associations dedicated to UV LED curing were formed, showing the robustness and the credibility of UV LED technology. Also, recent improvements greatly increased the power output available at window surface of UV LEDs to 16W/cm² in 2011. Water & Air purification are the potential next high volume applications for UVC LEDs. In 2011, the UVC LED industry achieved a new milestone of saturation. For example, Crystal IS was acquired by Japanese group, Asahi Kasei. The partnership of Dot Metrics, the first pure UV LED, with Aquionics, a water purification company,

announced that it would launch its first commercial product in 2012. Another player is, SETI, which is increasing its production capacity by a factor six with a \$20 million investment. In parallel, numerous research results published in 2011 have demonstrated an impressive improvement in the optical power output of UV LEDs; up to ten times, compared to 2010. Hence, it is expected that UVC LEDs should penetrate those key applications in 2014.

More than 50% performance improvement for bulk AlN based UV LEDs in 2011. Templates (AlN-on-sapphire) are the substrate of choice for UVA/B applications due to their lower cost and sufficient performance. "But for UVC applications, the competition with bulk AlN is increasing as such substrates could offer improvement of lifetime and power output of the UV LEDs", explains Pars Mukish. "For example, in 2011, Crystal IS has improved its bulk AlN based UV LED results by a factor x 20".

Several players are also aiming to commercialise 2" bulk AlN wafers by the end 2012. So, the time to market for UVC applications based on bulk AlN would probably be in the 2013-2015 period. Yole does however point out that up to now, no research has clearly demonstrated the positive effects of bulk AlN substrates on UV LEDs performance, and so the future commercial success of such substrates for UVC purification applications is still under debate.

Aixtron CCS MOCVD reactor to aid Chinese institute in laser research

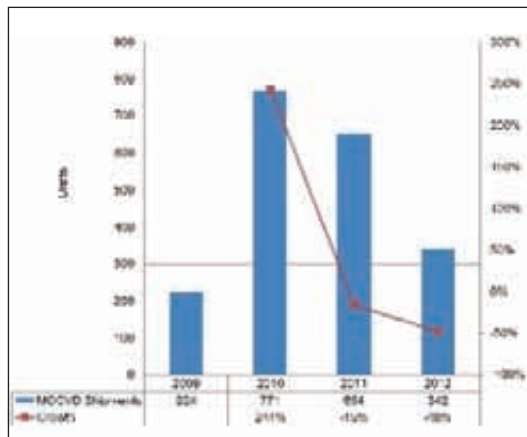
AIXTRON SE's new customer FJIRSM – the Fujian Institute of Research on the Structure of Matter, Chinese Academy of Sciences, has placed an order for one MOCVD system.

The CCS R&D reactor in a 6 x 2-inch wafer configuration is intended for telecommunications diode laser research.

Ordered in the third quarter of 2011, the reactor has been delivered in the first quarter of 2012.

A service support team from Aixtron China has installed the reactor in a new cleanroom at the FJIRSM Laser Laboratory.

"After having evaluated the MOCVD market thoroughly, we established that Aixtron offers worldwide the best currently available equipment for our purposes,"



comments Su, Fab Director of FJIRSM. "Our engineers were very impressed with the ease of operation, run-to-run and wafer-to-wafer uniformity of the CCS system. It is undoubtedly the most suitable platform for the development of the long-wavelength lasers for applications in telecom, data-com, and sensor networks that interest us."

FJIRSM research is focused on laser engineering and technology, promoting the development on the novel key cell technology of solid-state laser and systems integration technology, laser crystals and nonlinear optical crystal material exploration, and engineered growth technology.

FJIRSM was founded in 1960 and today is one of the most influential and comprehensive research bases in China. Specialising in structural chemistry and new crystal materials, FJIRSM comprises eight laboratories equipped with state of the art equipment. Until 2007, FJIRSM was ranked in the Top 10 amongst national research institutions.

Provincial scientific and technological major projects led by FJIRSM have included: "New Materials and Devices", "Optoelectronic Information Materials and Devices", "Solar Energy Electron Materials and Devices."

Mobile devices a shining light in lacklustre semiconductor market

MOBILE device semiconductors were one of the few bright spots in a chipset market that stalled in 2011. This is according to ABI Research's new study, "Mobile Device Semiconductor Markets," which focuses on baseband ICs, applications processors and power amplifiers, in mobile devices. These are used in applications such as smartphones, media tablets and e-book readers and the report offers market sizes, forecasts, and supplier market shares.

Revenue from chipsets designed for mobile devices increased by more than 20% to \$35 billion, while the total semiconductor market limped out of 2011 with just 2% year-on-year growth.

"It's tempting to describe this industry as lacklustre," says Peter Cooney, practice director, semiconductors, ABI Research. "But then, some segments of the semiconductor market are booming and vendors concentrating on the mobile device sector have delivered very healthy growth in 2011."



Shipments of mobile devices are driving growth for a range of semiconductor components including modems, applications processors, wireless connectivity ICs, MEMS sensors, and audio ICs.

Platform ICs (including modems, applications processors, RF components, and PMUs) account for the bulk of overall

revenues, but are becoming an increasingly competitive section of the market. Compound semiconductor competitors include RFMD, TriQuint and Skyworks who manufacture RF components used in mobile devices.

The main players in the market though, are Qualcomm, ST-Ericsson, MediaTek, Intel, Texas Instruments, Broadcom, Marvell, and Renesas Mobile. These firms have positioned themselves as platform solution suppliers and the top 10 suppliers now account for more than 75% of total revenues.

ABI Research says their dominance will continue to build as niche suppliers are acquired or muscled out of the market.

Growth and opportunities will be more prevalent within wireless connectivity ICs (Bluetooth, Wi-Fi, GPS, NFC, etc.) as well as MEMS sensors and audio. Growth across the three segments is expected to top a 30% CAGR from 2011 to 2016.

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Mumbai to rely on Reliance Power and First Solar CdTe project

FIRST SOLAR has announced the commissioning of a 40 MW (AC) ground-mounted solar photovoltaic power plant in the state of Rajasthan, India that will provide clean energy to Mumbai. The recently completed project was built in just five months.

Comprising some 500,000 First Solar thin-film modules, the power plant near the village of Dhursar in Jaisalmer district of Rajasthan in North Western India, is expected to generate more than 60 million kilowatt hours (kwh) of clean solar energy a year. This will make it one of the country's largest photovoltaic power plant in terms of electricity generation. Covering 350 acres, it is 23 times the size of Calcutta's famous Eden Gardens cricket grounds and is expected to satisfy the annual electricity needs of more than 70,000 average Indian households. It will displace nearly 60,000 metric tons of CO₂ emissions per year, the equivalent of taking more than 25,000 cars off the road.

"We are proud to partner with Reliance on this milestone project," says Mike Ahearn, First Solar Chairman and Interim Chief



Executive Officer. "We applaud India on its visionary solar policies and Reliance Power for their leadership in implementing them, and we look forward to helping India realise its solar vision through this and future projects."

"This power plant demonstrates the huge potential of solar energy to help India meet its growing energy needs in the most environmentally friendly manner. It is also a testimony of the quick timeframe in which solar power plants can be built and commissioned," adds Anil D Ambani, Chairman of Reliance Power. The Dhursar project is the first that Reliance plans to build with First Solar modules as part of a 100 MW module order placed last year.

Kopin makes massive moves in GaN HEMT technology

KOPIN has announced that it has obtained record results from GaN-based high electron mobility transistor (HEMT) materials. The advanced GaN-based materials developed at Kopin are important for improving performance of next-generation power amplifiers and power switching converters.

The research, which has recently been published in Applied Physics Letters, describes the use of InGaN as the conducting layer in HEMT structures grown on sapphire and SiC substrates. The use of an InGaN channel layer, instead of GaN has the benefit of providing a back-channel barrier for better electron confinement, which is important for deep sub-micron gate length devices to achieve

ultra-high-frequency operation. However, obtaining good InGaN channel HEMT materials is challenging since InGaN layers can become very rough during growth.

Using proprietary MOCVD growth processes, Kopin scientists showed a high electron mobility of 1290 cm²/V.s and a low sheet resistance of 240 Ω square. Kopin says this is about 30 % lower than the previous best result.

Further details of this work have been published in the paper, "InGaN channel high electron mobility transistor structures grown by metal organic chemical vapor deposition", by O. Laboutin et al, Applied Physics Letters, 100, 121909 (2012), published online on 23 March 2012.

DARPA funds efforts to combine InP with silicon ICs

HIGH-PERFORMANCE microsystems are vital for a wide variety of Department of Defence (DoD) systems that provide US war fighters in communications, sensing and electronic warfare. Current fabrication technology limits the types of materials and devices that can be integrated together, forcing circuit designers to make compromises when selecting devices for an integrated microsystem.

DARPA's Diverse Accessible Heterogeneous Integration (DAHI) program is launching the DAHI Foundry Technology effort to advance novel methods for combining a variety of devices and materials onto a single silicon chip.

Thomas Lee, office director at DARPA Microsystems Technology Office says, "Enabling the ability to 'mix and match' a wide variety of devices and materials on a common silicon substrate would allow circuit designers to select the best device for each function within their designs. This integration would provide DoD systems with the benefits of a variety of devices and materials integrated in close proximity on a single chip, minimising the performance limitations caused by physical separation among devices."

This effort also seeks to enable complex signal-processing and self-correction architectures to be brought to bear. The DAHI Foundry Technology project hopes to establish a foundry capability for the production of chips using a wide range of heterogeneously integrated devices.

"DARPA anticipates bringing the compound semiconductor and silicon integrated circuit (IC) communities together for new ways to integrate components onto a single silicon wafer," adds Sanjay Raman, DARPA program manager. "Such convergence would enable foundry-style production of high-performance microsystems, leveraging today's silicon IC manufacturing base."

Soraa reveals 40W halogen equivalent for outdoor and enclosed fixtures

SORAA, a developer of GaN-on-GaN solid-state lighting technology, is marketing its outdoor LED MR16 lamp.

Matching the performance of a 40W halogen MR16, Soraa's outdoor LED MR16 is claimed to be the first LED lamp in its class appropriate for use in outdoor and enclosed fixtures.

Soraa's outdoor MR16 lamp line is specifically designed and tested to operate in challenging environments. It is suitable for use in outdoor fixtures, or indoors in fully enclosed, recessed, or confined, non-ventilated track fixtures.

Designed to replace standard 40W MR16 halogen lamps, Soraa says its latest addition meets and exceeds the performance of halogen lamps, while saving 75% of the energy.

The outdoor LED MR16 lamp, available in 2700K and 3000K correlated colour temperatures, provides halogen-equivalent brightness and light quality without requiring a mechanical fan.

Soraa's proprietary GaN-on-GaN technology plays a significant role in the performance of the outdoor LED MR16. Soraa says its GaN crystal is up to a thousand times purer than GaN-on-Sapphire or GaN-on-SiC substrates, two of the platforms other LED lighting technologies rely upon today.

The firm says its technology enables the outdoor LED MR16 to overcome common ventilation and thermal design barriers while still producing a reliable, high-performing, eye-pleasing and natural light.

"We proved that GaN-on-GaN is the future of LED lighting with Soraa's premium and essential MR16 products," says Soraa CEO Eric Kim. "Now, with the launch of the Soraa outdoor LED MR16, we're proving GaN-on-GaN's ability to overcome critical barriers and open new frontiers in LED lighting."

Like the entire family of Soraa's LED MR16 lamps, the firm says its outdoor LED MR16 lamp's "perfect" crystal structure delivers a bright, highly-focused, controlled beam. It also has the ability to produce a high

colour rendering index and centre beam candle-power to match a standard halogen lamp. Soraa's outdoor LED MR16 lamp "has a stunning visual impact on my projects and the lamp itself sheds heat elegantly, a rare quality in outdoor LED lighting," adds Jan Moyer, a leading

landscape lighting designer. "I've compared my outdoor lighting projects using a competitor LED replacement lamp and a traditional halogen lamp, and I want all my lighting projects to look the way they do when lit with Soraa's outdoor LED MR16."

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Analysts are tipping tremendous growth for the **compound semiconductor industry**

Speaking at CS Europe 2012, leading market analysts predicted healthy sales growth for GaAs microelectronics, plus rocketing revenues for LEDs and wide bandgap devices. **Richard Stevenson reports.**

In some ways, all our purchasing habits are very similar; but in others ways they are markedly different. Nearly all of us only buy and fit a new light bulb when the existing one fails. But when it comes to mobile devices, some of us upgrade very frequently, others make do with the same model for a couple of years, and there are also those that cart around handsets that they bought in the previous decade.

For the compound semiconductor industry, the implications of these differences in purchasing behaviour are massive. They explain why the LED industry is tipped to grow massively over the next few years, but could go into reverse around 2020, while sales of chips for mobile devices could steadily rise for many, many years.

These insights, along with revenue predictions for LEDs, GaAs ICs and a host of other devices, were provided by some of our industry's leading analysts at the second

CS Europe conference. This two-day gathering – attracting almost 250 delegates to the Hilton in Frankfurt, Germany – kicked-off with an overview of the entire compound semiconductor industry by Asif Anwar of Strategy Analytics.

Greater detail on the LED industry followed in a talk by Philip Smallwood from IMS Research, while very positive predictions for the wide bandgap market came from a presentation from Yole Développement's Philippe Roussel.

Anwar delivered a very promising message, which he summed up in just one sentence: "Compound semiconductors are, and will remain, a key enabling technology across wireless, consumer, automotive and defence sectors."

At the beginning of his talk, he honed in on RF GaAs devices, which are a key component in many handsets, including smartphones. They are also used for amplification in Wi-Fi networks and will soon enable communication between one machine and another. The market for the GaAs chips used in these established and emerging applications is fairly buoyant, having grown by more than 30 percent between 2009 and 2010. Although 2012 will be a 'challenging year', according to Anwar, total device revenue should rise towards \$6 billion by 2015.

Wireless traffic is increasing at a tremendous rate. To accommodate for this, there is a build-out of faster networks involving base-stations, back-haul links, fibre networks and broadband systems. To vastly increase capacity, transmission data rates through fibre are rising




Lumens	Incandescent	Halogen	CFL	LED
				
1500	100 W	up to 72 W	up to 26 W	N/A
1000	75 W	up to 53 W	up to 23 W	17 W
700	60 W	up to 43 W	up to 15 W	7-13 W
430	40 W	up to 29 W	up to 11 W	5-9 W

Table 1. According to IMS, the strengths of LED light bulbs include: The absence of mercury and lead; 40,000 hour lifetimes; great robustness; and no cold-starting issues. Credit: IMS Research

from 10 Gbit/s to 40 Gbit/s and then 100 Gbit/s, generating sales for photodiodes and various forms of laser.

Anwar also touched on cable TV, which can also be used by many homeowners to provide Internet access. Here, compound semiconductor devices are vying with silicon rivals for deployment in amplification systems. “What we’ve seen is a move away from silicon to the III-Vs,” said Anwar, who also spoke briefly about automotive radar systems, which have traditionally been deployed in premium vehicles, but are now starting to penetrate the mid-price car market.

In defense of GaN

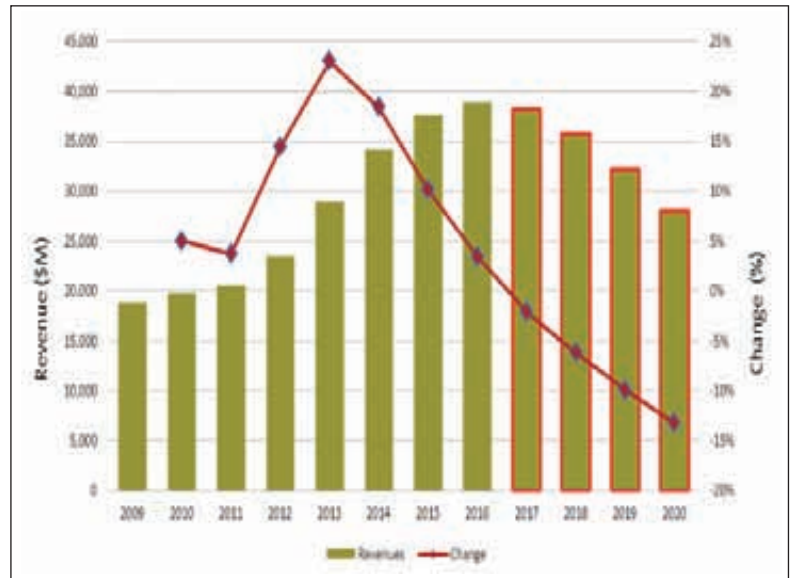
Predictions for wide bandgap electronic components also featured in Anwar’s presentation. According to him, most GaN devices sales are for military applications. Devices built with this material – which combine high operating voltages with high switching frequencies and excellent reliability – are now being deployed in: Electronic warfare systems, which produce broadband, high-power emission to disrupt and jam RF signals used to detonate improvised explosive devices; active electronically scanned radar based on hundreds or thousands of transmit and receive modules, which can be phase shifted to form and steer a beam; and radios that can operate over a frequency range of 30-3000 MHz and an output power of up to 100 W.

In Anwar’s opinion, the main opportunities for the other popular wide bandgap semiconductor, SiC, are in the power electronics market. These devices could be used in the IT and consumer sectors in uninterruptible power supplies and power factor correction power supplies, and they could also find deployment in the automotive sector, enabling DC-to-AC and DC-to-DC conversion in hybrid electric vehicles. In addition, they could find application in electronic systems operating at far higher powers, which are needed in photovoltaic systems and wind turbines.

One area where silicon will continue to reign is in the photovoltaic market. However, Anwar believes that concentrating photovoltaic systems built with multi-junction solar cells can be competitive in climates where the sun beats down very hard and the air is dry.

This technology is already starting to have some success in south-western regions of the US, and Anwar tips installations to hit 2 GW in 2015, equating to 4 percent of the photovoltaic market.

In the illumination market compound semiconductor chips are already generating billions and billions of dollars. Backlighting handset keypads and screens was the first killer application for the LED, and in the last few



years similar revenues have come from backlighting larger screens, such as those found in laptops and TVs. “Ultimately, the aim is to replace the incandescents in your house with an LED technology,” said Anwar.

That topic was covered in far more detail by Philip Smallwood from IMS Research. He explained that the LED lighting industry is only just starting to make an impact in a market dominated by compact fluorescents (CFLs) and incandescents. “In 2011, LEDs had a 1 percent penetration, in terms of units, but a 14 percent penetration in terms of dollars.”

LED lighting is tipped to grow fast (see Table 1 for an overview of its strengths), and by 2016 it is expected to overtake backlighting, in terms of revenue, to become the biggest market for this chip. However, at that stage LED lighting will still only account for about a quarter of all LED shipments. Fast forward another two years to 2018 and sales of light bulbs based on LEDs will have grown to a staggering 6.3 billion units, overtaking incandescents, which will have a unit share of just 14 percent by the end of this decade.

The high price of LED bulbs means that they will bring in more revenue than another other lighting technology in 2013. According to Smallwood, sales in that year could net \$30 billion. This will drive a compound annual growth rate (CAGR) in the lighting market of 85 percent through to 2016.

Between 2009 and 2020 shipments and revenue from LEDs employed for lighting will increase at a CAGR of 53 percent and 26 percent, respectively, but towards the end of this timeframe this market will start to stagnate.

Figure 1. Growth of the LED lamp market will go into decline in 2014 and halt in 2017, according to IMS Research. Credit: IMS Research

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Uptake of LED lamps in the lighting sector will have a profound affect on the lighting business. IMS Research predicts that total units shipments will start declining in 2017, and revenues will go into reverse the year after, due to the very long lifetime of the LED bulb (see Figure 1).

The good news for consumers is that the prices of LED bulbs will tumble over the next few years (see Figure 2). In 2014 their average price should drop below \$10, a major milestone from the perspective of many US consumers. Smallwood says that three years' later, the average price should nudge below \$5, and he predicts it will retail for just \$3.59 in 2020.

During the next few years Japan will account for the greatest deployment of LED lamps and luminaires. This will be fuelled by the very high cost of energy in this country, which has been driven up by the impact of the Fukushima nuclear reactor damage. But by 2018, North America will overtake Japan.

The residential market will be the hardest one to penetrate for LED lighting. "Consumer's don't do return-on-investment calculations," said Smallwood. "They go to the supermarket and pick out the cheapest bulb. They've been doing that for the last hundred years."

But households will start to buy LED bulbs when prices fall. By 2020, LEDs will be found in four-fifths of sockets in developed regions, with incandescents making up just 2 percent. In offices, fluorescents could still be widely used, thanks to their combination of high efficiency, long life time and low cost.

In developing regions a slightly different picture will emerge. Although LEDs will be found in 44 percent of sockets by 2020, for the next few years the CFL will remain the most popular energy efficient lighting product, due to its lower price.

Forecasts for LED lighting have been translated into LED die shipment predictions. According to Smallwood, shipments of packaged LEDs for lighting will hit about 3 billion die this year, and will rocket to more than 30 billion by 2017.

The role of SiC

Analyst Philippe Roussel provided a detailed analysis of the current state of the wide bandgap market, offering some predictions for the coming years. According to him, the wide bandgap market will be worth almost \$100 million in 2012, rising to nearly \$3 billion by the end of this decade.

This rapid rise in sales will occur because of two highly valued characteristics found in all wide bandgap

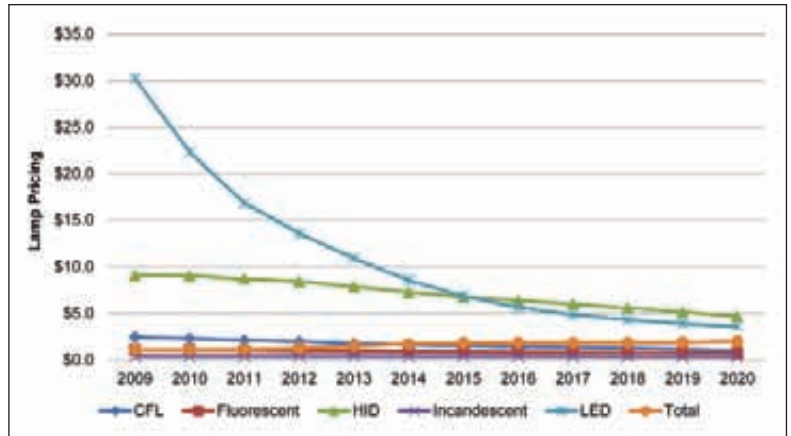


Figure 2. The average selling price of LED lamps will tumble during the next few years. Credit: IMS Research

devices: A high junction temperature and a high electron mobility. Thanks to these twin strengths, devices have no recovery time during switching, leading to low losses and high switching frequencies. And at the system level that means lower cooling demands, fewer filters and ultimately a unit that can be lighter and smaller.

Efficiency gains also result from replacing silicon devices with those made from wide bandgap materials. According to Roussel, switching from the incumbent technology to GaN or SiC can increase the efficiency in DC-to-DC conversion from 85 percent to 95 percent; boost the efficiency of AC-to-DC conversion from 85 percent to 90 percent; and propel the efficiency of DC-to-AC conversion from 96 percent to 99 percent.

Thanks in part to these efficiency gains, Roussel believes that we are starting to enter a new era for

Country	2010	2011	2012	2013	2014
United States			100W	75W	40 & 60W
Canada			100W	75W	40 & 60W
China			100W		75 & 60W
Mexico			100W	75W	40 & 60W
Russia					Banned
Cuba	Banned				
Argentina	Banned				
European Union	100 & 75W	60W	15-40W	Banned	
United Kingdom	100 & 75W	60W	15-40W	Banned	
South Korea	Banned				
Japan	Banned				
Philippines	Banned				
Malaysia	100W	75W	60W	40W	
Australia	Banned				

Table 2: Many countries are using legislation to phase out the purchasing of incandescents. Credit: IMS Research

power electronics devices. Thyristors and MOSFETs reigned supreme from the 1970s to the 1990s, IGBTs have been the dominant technology for the past two decades, but SiC and GaN devices are an ever-increasing threat to their ascendancy (see Figure 3 for details of product releases).

The silicon-dominated power electronics market is currently valued at \$17.7 billion, and is predicted to increase at a CAGR of almost 100 percent throughout this decade, to hit \$35.7 billion in 2020. Today, more

than half of these devices are produced on 6-inch silicon, but by the end of the decade the 200 mm platform will be the most popular one for manufacturing.

Two-thirds of the power electronics market is associated with devices operating at up to 900 V, and Rousset believes that in this sector GaN is the most attractive alternative to silicon. At voltages beyond 1.2 kV, however, he believes that SiC can be more competitive than GaN.

Commercial interest in wide bandgap devices has recently stepped up a gear. Funding for the likes of Transphorm, CamGaN, EpiGaN and Azzurro, plus the acquisition of Velox by Power Integration, has led to a \$100 million injection of funds into GaN development through merges, acquisitions, investments and fund raising.

What's more, nearly all of the top twenty power semiconductor manufacturers are involved in developing either GaN or SiC – and the top two, Infineon and Toshiba, are pursuing both. All this effort will spur the GaN market from \$13 million in 2012 to \$1.9 billion in 2020, according to Rousset.

This analyst also considered the possible impact of overcapacity in the LED market on the wide bandgap electronic sector. He considered the situation where companies with MOCVD tools for GaN LEDs and a

		Power Electronics
R&D	Duration	5 to 10 years
	# 6" wafer / year	< 1,000
Prototyping <i>(very small lot-size)</i>	Duration	2 to 3 years
	# 6" wafer / year	1,000 – 2,000
Qualification <i>(first volume sales)</i>	Duration	3 to 5 years
	# 6" wafer / year	3,000 – 5,000
Ramp-up	Duration	1 year
	# 6" wafer / year	> 10,000
Mass production	# 6" wafer / year	> 50,000
Total time from prototype to mass production		6 to 9 years

Table 3: It can take many years to develop a new GaN device and ramp its production to high levels. Credit: Yole Développement

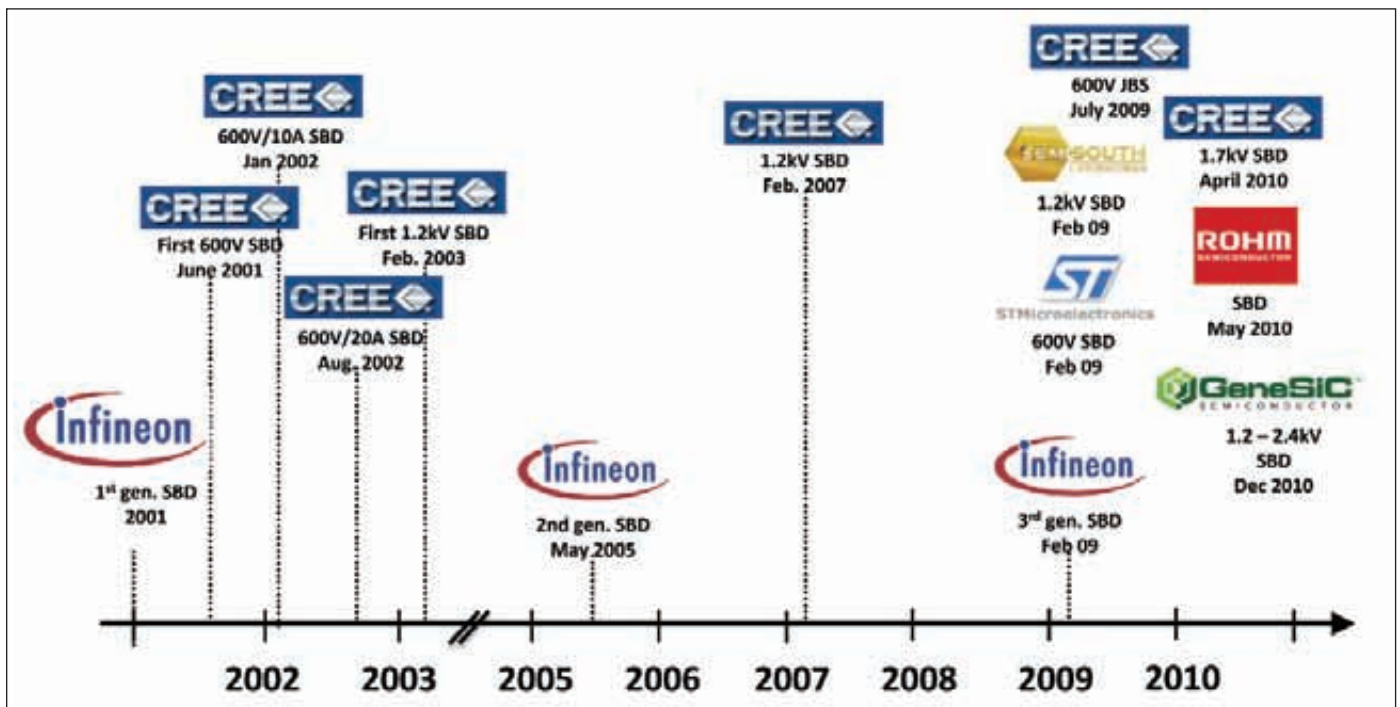


Figure 3. SiC diodes appeared on the market before any form of transistor, with Infineon and Cree leading the charge. Credit: Yole Développement

weak order book could consider diversifying into power electronics. This would not be easy, warned Roussel: “It’s certainly not as simple as copying and pasting”. He believes that – depending on access to intellectual property and patents - it could take up to two years to master the production of GaN-on-silicon epiwafers, and a further two-to-three years to develop good device designs.

Meanwhile, SiC device revenues will grow, although not at quite the same pace as their wide bandgap rival. Roussel estimates that the SiC market for this year will be worth \$70.6 million, rising to almost \$950 million by 2020.

This means that by the end of this decade, the compound semiconductor industry could have multiple billion dollar markets, including those for GaN power devices and SiC power devices. That doesn’t mean that there will not be painful times ahead – overcapacity in the LED market is likely to lead to some tough times over the next few years – but the long-term future for the compound semiconductor industry is a bright one.


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Company	GaN epiwafers	GaN device
ACELERO (FR)	X	
BerMOS (US)		FL
Comtek (US)	X	
Dow Electronics Materials (E)	X	
GPC (US)		X
Epistar (E)	X	
Farakawa (E)	OO	X
GaN Systems (CA)		FL
International Rectifier (US)	OO	X
MicroGaN (US)		X
Nishin Inc. (US)	X	FL
NTT (E)	X	
Panasonic (E)	OO	X
Powertrix (E)	X	
Sankor (E)	OO	X
Sonitomo SDS (E)	OO	X
Yashiba (E)	OO	X
Transphorm Inc. (US)	OO	X

FL: Fabless business model; Design only
OO: For internal purpose only; no merchant business

Source: GaN power players

Table 4: The nascent GaN power electronics industry features some epiwafers providers, some fabless companies, and some players that produce their devices in-house. Yole Développement



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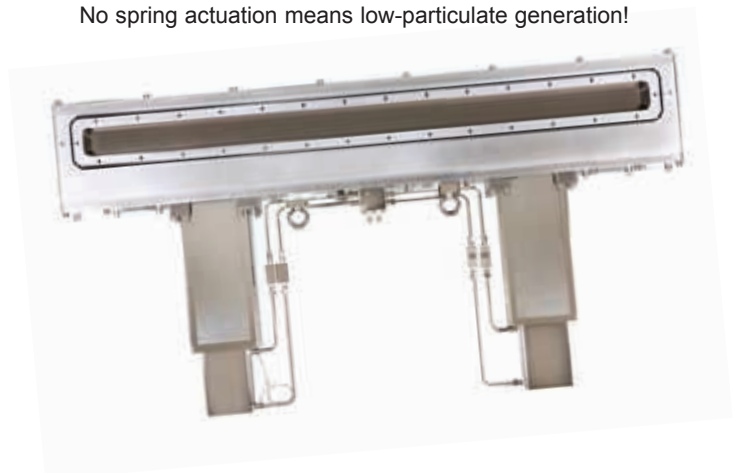


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Carving out a niche in the RF market

If a small start-up is to succeed in the GaAs industry, it must identify niche markets and focus on them. BeRex has done just that, and it is now winning substantial sales in the mobile infrastructure and microwave sectors. **Richard Stevenson reports.**

In every walk of life the big players go after the big bucks. This means that in the GaAs industry, the likes of RFMD and Skyworks concentrate their efforts on winning sales to the leading handset makers. Although these massive chipmakers will also go after smaller markets, these secondary targets will never be a top priority for them, and completely satisfying customers operating in these areas is not a chief concern.

Consequently, these smaller markets offer an opportunity for start-ups, who have virtually no chance of success in the cutthroat handset business. Competition is far less fierce in these lower revenue markets, which are served by fewer firms, and by fully focusing on a niche a start-up can give a level of customer care that would be difficult to match in a big outfit that has to fight wars on many fronts.

One start-up that's identified lucrative niche markets within the GaAs sector and is now winning significant sales is BeRex. This fabless firm, which was founded in 2004 in Korea as BeRex Corporation, initially targeted a mobile infrastructure market with GaAs HBTs. And a few years' later – after the leaders of the company identified a second opportunity, this time for GaAs pHEMT products in various military and commercial applications – it set-up a subsidiary, BeRex Inc., in San Jose, CA.

The driving force behind both these successful ventures is the company's CEO Nahm-Wook Lee. After graduating in economics, he worked at Samsung's offices for many years, where he rose through the ranks to become president of Samsung Information Systems in the US. He then embarked on a new career, working as a consultant to local start-up companies. During that time a friend of his suggested that the infrastructure

market offered a great opportunity to makers of GaAs chips. Back then, wireless communication was migrating from CDMA to W-CDMA.

"Where there is change, there is opportunity," reasons Lee. "I carried out a market survey, looked at the business opportunity, and asked a friend: Could you find me a semiconductor engineer who could design a



BeRex pHEMT chips are primarily used in military and commercial microwave amplifiers

product?” In late 2003, his friend introduced Lee to Alex Yoo, an electrical engineer with a PhD from Oregon State University.

This duo teamed up with Young Moon Kim, who has a friendship with Lee that dates back to the 1960s, and the three of them started developing a gain block amplifier for the wireless infrastructure market. This self-funded venture initially made rapid progress – but then the team came across a stumbling block. When they started talking to potential customers prior to production of their device, they discovered that many of these firms were starting to focus their efforts towards Korea.

Although Lee’s early years were spent in Korea – he went to Seoul National University – by then he had put down roots in California. Yoo, too, had a family in Silicon Valley, so relocating would involve some hardship. But moving to Korea made a lot of sense from a business perspective, so the founders decided to head to Seoul, forming BeRex Corporation in 2004.

A year later the company started delivering its first product, and thanks to rapidly increasing sales, it reached profitability in 2007. Since then, the company has always been in the black, with revenue growing every year. What’s more, it has no debt.

The company’s success can be put down to a variety of factors: It launched a strong product in a receptive market at the right time; its rivals were complacent and failing to focus on the needs of the customer; and it adopted a fables approach, working with local foundries.

Arguably, it is the latter factor that has contributed most to the success. On paper, outsourcing growth is more expensive than carrying it out in-house (with the benefits greatest in high-volume markets, such as the production of HBT power amplifiers for mobile phones). But in practice, in the low-volume markets that BeRex serves, the fab is a not an asset – it’s a burden. Not everyone appreciated that back in 2004, but more and more people are coming round to that way of thinking.

An outsourcing model

One of the biggest benefits of the fables approach, according to David Snook, Sales and marketing Manager for BeRex Inc., is that it allows a company to tap into the capacity of a foundry, without having to incur its maintenance costs. What’s more, he says that a fables firm does not have to worry about ensuring a sufficient wafer throughput to maintain product quality and reliability. “To do that, you have to have a lot of product coming out of the fab.”



The left side of the page features a vertical image showing the silhouettes of several communication towers against a clear blue sky. The towers are made of metal lattice and have various antennas and satellite dishes attached to them. The sky is a gradient of light blue, suggesting a clear day.

In Snook's opinion, BeRex's fabless approach also allows it to focus on putting together and maintaining a strong team that excels in designing chips, ensuring their quality, and fostering great customer relationships. In contrast, if a fab is on-site, its running can take precedent over everything, while keeping its technology competitive can require further investment.

A big concern facing any start-up operating in a niche market is that its orders are too small for fabs to be interested in its business. "Each fab has its own minimum order requirements," says Snook, who reveals that this could be several wafers, or it could be a dozen of them. "These are not seriously limiting factors, but they are certainly factors that we take into account as we make business decisions."

Although individual orders may be low, these mount up. And this means that fabs are willing to deal with smaller, loyal customers, if both sides establish a good working relationship. "Are you honest? Do they like to deal with you? Qualities like that don't appear on any spreadsheet, but they are very critical to that relationship," says Snook, "Our relationships with our fabs are very, very good – they know who they are dealing with personally. They are dealing with the same people all the time."

This strong relationship helps BeRex's to offer rapid turnaround times. While some firms quote six weeks, eight weeks, or even 16 weeks, BeRex promises to ship a production product within just two weeks. "I don't think we've broken that promise to our customers in almost eight years of operation," says Snook, who reveals that the money saved from fabless operations is re-deployed on engineering resources and building up an inventory.

Back in the US

Today BeRex generates most of its income from sales of infrastructure products, with revenue from devices built for microwave applications not coming far behind. Lee became aware the microwave market through a business friend in the US, who suggested that he should take a look at the RF and microwave amplifier market. "When I looked at the potential of that market, I thought we could do better than any of the current vendors."

To sell products to the US military, BeRex Corporation founded an independent company in Silicon Valley, BeRex Inc.. By taking this step, the organization avoids issues related to imports, exports and the sharing of information. "We need to keep a firewall between an off-shore company and a US company," explains Snook.

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The pHEMTs that BeRex Inc. has been producing, which can be used in military and commercial microwave applications, operate at up to 40 GHz and have a gate width of 0.2 mm to 2.4 mm, enabling output powers of 0.25 W to 3 W. Transistors with a smaller gate deliver less power, but produce more gain

“We can operate as a subsidiary, as long as we have that firewall – but we can’t have that firewall and be the same company.”

This west-coast outfit focuses on supplying the military and commercial markets with pHEMTs, which are designed in the US and built in native fabs. In addition, it acts as a distributor for products made by BeRex Corporation, such as GaAs HBTs, SiGe gain blocks, switches, dividers and amplifiers.

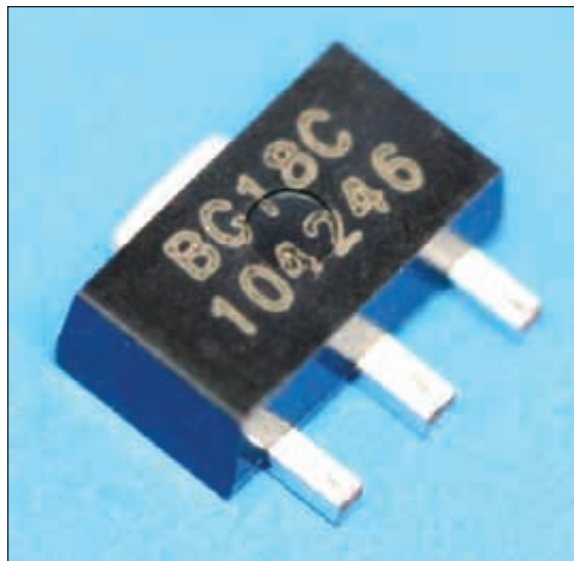
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BeRex Inc. started business in 2008, the nadir of the current economic storm. However, it has not struggled in this climate, due to significant sales to the military. “The military never disappoints,” says Snook, “and seems to fill the void in those years.” Although the last few months he has seen a slight ‘softening’ of this market, commercial markets are on the way up, particularly in the US. “We’ve not seen the same level of expansion in Europe, but I expect it to be there.”

The US outfit has several products in the pipeline, including some GaN devices and a line of GaAs



BeRex, Inc. is headquartered in San Jose, CA, at the heart of the Silicon Valley



BeRex GaAs HBT parts, such as the BG18C, target wireless infrastructure like base stations and repeaters

MESFET chips. The latter products have been developed for microwave customers in search of a level of linearity that is not possible with a pHEMT process.

“Some people need the better OIP3 that the MESFET provides over the pHEMT process,” says Snook. “We can select the process. We can go out and pick the best. Not many people are doing MESFETs anymore, but this niche market still needs it.”

Launching MESFETs forms part of the strategy for BeRex Inc.: To be a ‘one-stop-shop’ for high-quality pHEMT, MESFET and HBT bare-die for military and commercial applications. If it executes on this front – while its parent company continues to enjoy success in the infrastructure markets in Korea, and more recently China – it will provide further proof that it is possible for start-ups carve out a profitable niche in the GaAs chip industry.

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Nahm-Wook Lee the founder and president of BeRex, Inc. and BeRex Corporation, understands the power of the fabless semiconductor business model





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The photodiode has been serving mankind for many years. Since its invention in the 1950s, it has been used to read data off countless optical discs and bar code scanners, sense the onset of twilight for numerous streetlights around the globe and detect billions and billions of pulses of light that underpin optical communication.

In recent times there has been a rapid build-out of Internet capacity. This has propelled a hike in the performance of photodiodes, which have made major strides in power-handling and detection speeds. In turn, this improved photodiode performance has helped engineers to fully exploit many opportunities in the burgeoning field of photonics.

Working in the photonic domain, rather than its electronic counterpart, is tremendously beneficial to engineers: Bandwidth is higher, losses are smaller, cabling is lighter, and there is greater resistance to

electromagnetic interference. As a result, photodiodes can find application in areas traditionally dominated by electronics, such as data transmission links and oscillators. What's more, these diodes can play a role in terahertz signal generation, arbitrary waveform synthesis, photonic analogue-to-digital conversion and high-speed wireless links.

Although the majority of fibre-optic links deployed around the world are digital, a growing number of applications are using analogue optical links, which convey electrical signals over an optical carrier in analogue form (see Figure 1). Examples include cable TV, local oscillator (LO) distribution for radio telescopes, beam-forming networks for phased array antennas and 'antenna remoting' for military radar. In addition, the Atacama large millimetre/sub-millimetre array in Chile – one of the largest radio telescopes in the world – uses analogue optic links to distribute the photonic LO over 100 GHz (see image below).

Building better photodiodes

Faster, more responsive photodiodes with greater linearity result from modifying the well-established uni-traveling carrier structure. These higher performance photodiodes that result can improve the performance of analogue optical links, which are used for radio over fibre, distributing high-purity radio frequency (RF) signals and military radar, say Yang Fu, Huapu Pan, Andreas Beling and Joe Campbell from the University of Virginia.



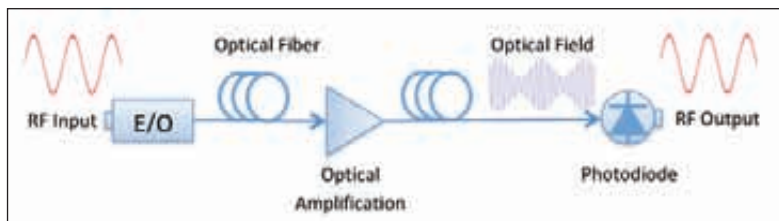


Figure 1. A simplified diagram of analogue optic link

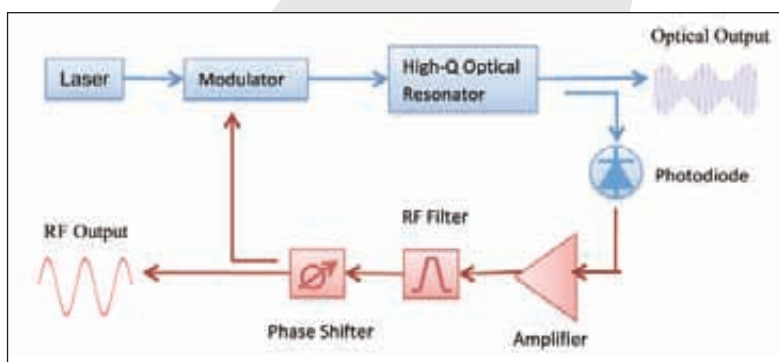
These analogue links can be viewed as replacements for conventional electrical cables or waveguides, which are often impractical, due to their high loss and limited bandwidth. One reason why analogue optical links can realise very high speeds is that they are able to overcome the limitations of analogue-to-digital and digital-to-analogue conversion, which are found in digital transmission. With analogue optical links it is possible to transmit signals over vast distances by using a substantial amount of RF power between a centre station and remote locations, such as antenna feeds. This reduces the complexity of the instruments held at remote locations, and cuts their maintenance requirements.

The performance of these links depends on the capability of the photodiode in providing optical-to-electrical conversion. A high gain, large bandwidth link demands a diode with high-power-handling capacity and high-speed operation. High linearity of the photodiode is valued too, because this minimises the signal distortion in the link and enables it to maintain a large, spurious-free dynamic range.

High-performance photodiodes can also be deployed in oscillators, an indispensable component in virtually all modern electronic systems. Most of these oscillators are electronic, and they tend to rely on 'high-Q' quartz crystal resonators to achieve high spectral purity. But as frequency increases their performance drops off, due to either a weakening of the resonance or an introduction of phase noise, which results from frequency multiplication.

It is possible to address these weaknesses with an optoelectronic oscillator (OEO) (see Figure 2 for an example of this approach). This class of oscillator produces an ultra-stable microwave signal at

Figure 2. Schematic diagram of an OEO based on a transposed gain approach



frequencies of up to tens of gigahertz by exploiting the low-loss properties of optical resonators. Approaches can involve long fibre delay lines, Fabry-Pérot cavities and whispering gallery mode resonators. Many OEOs are based on a transposed gain oscillator, while others use a dual-mode laser or an optical frequency division technique. One of the strengths of these OEOs is that they generate microwave signals in both the electrical and optical domains, a trait that makes them specifically suitable for integration with other photonic systems.

Ideally, high-RF-power-output photodiodes are used in OEOs, because this increases the signal-to-noise ratio and lowers the system phase noise. Further enhancements in performance are possible when the RF power output from the photodiode is large enough to eliminate the electronic amplifier and its corresponding noise from the loop. The introduction of extra phase noise during the photo-detection process can be addressed with low distortion photodiodes.

Device design

PIN photodiodes are widely used to meet the requirements for high optoelectronic conversion efficiency and large bandwidth. These devices contain an intrinsic absorber sandwiched between heavily doped n-type and p-type layers that give rise to a space charge region. When photons hit the device, they spawn electron-hole pairs, which are pulled apart by an applied bias voltage acting in partnership with an internal electric field established by ionized dopants. Electrons and holes flow in opposite directions, creating a photocurrent in the external circuit.

Many PINs operate at 1.55 μm , the wavelength for long-distance optical communication. Producing this class of device involves epitaxial growth of a lattice-matched InGaAs layer on an InP substrate. A key decision is to select the optimal thickness for the depleted, ternary absorbing layer: Get it too thick and the diode is too slow, due to excessive transit times; but get it too thin and the device does not absorb enough incident light, leading to a signal that is too weak.

Another key characteristic for the photodiode is its power handling capability. This is strongly influenced by the space-charge effect, and can be traced back to the spatial distribution of photo-generated carriers as they pass through the depletion layer. In the photodiode, the electric field generated by the free carriers – the space-charge field – opposes that established by ionized dopants and the applied bias voltage. This leads to a total electric field in the depletion region that drops to almost zero at high current densities. When this happens, carrier transit time increases and RF power output falls, due to a combination of compression and saturation. Making matters worse, the voltage drop across the load resistor reduces the effective bias voltage, pushing the diode toward saturation (see Figure 3 for a summary of the major factors limiting

high-power photodiode performance). In an ideal world the electrical output of the photodiode follows its optical input in a linear fashion. But in practice this is never the case – nearly every physical mechanism has some degree of nonlinearity. This is present in optical transmission, carrier generation and transport, and compounding this issue, the non-linear mechanism that dominates varies, depending on the power level, frequency range and bias voltage of the photodiode. So to produce a diode with good performance, an engineer has to weave a well-chosen path that trades conflicting requirements for high-linearity with the need for certain levels of performance in key areas.

While addressing these issues, the photodiode designer must not neglect thermal management. Multiplying the photocurrent by the bias voltage reveals that a high-power photodiode needs to dissipate nearly 1 Watt from an active area of less than 10^{-4} cm². The junction temperature of the diode – which is governed by factors such as heat conductance of semiconductor layers, the photodiode geometry and heat sink design – can exceed 200 °C (see Figure 4). Even higher diode temperatures are possible when the bias voltage is cranked up to improve photodiode saturation. This further increases the importance of good thermal management.

New variants

During the last decade engineers have increased the performance of the photodiode by modifying its design. Variants introduced include the uni-traveling carrier (UTC) photodiode, the partially-depleted-absorber photodiode, and the dual-depletion region photodiode.

Our group at the Department of Electrical and Computer Engineering at the University of Virginia believes that the UTC photodiode merits special attention: It delivers superb performance and has potential for further improvements. This class of photodiode features a quasi-neutral absorber and a transparent depletion region. When incident photons create electron-hole pairs in the un-depleted absorption layer, electrons behave as minority carriers and holes as majority carriers. Via a combination of diffusion and drift, electrons are transported to the depleted, high-field collection layer, where they then drift toward the *n*-contact at their high saturation velocity. In contrast, holes, thanks to the quasi-neutrality of the absorption layer, respond very fast – within the dielectric relaxation time that is determined by their collective motion. This means that there is a fundamental difference between a UTC photodiode and its PIN counterpart: In the former structure, electrons and holes contribute to the response current, with the low-velocity hole transport dictating the device's speed. An additional strength of the UTC design is that it alleviates the space-charge effect, thanks to a more balanced electron and hole distribution profile. Electrons are able to maintain their high velocity at relatively low electric fields, enabling the

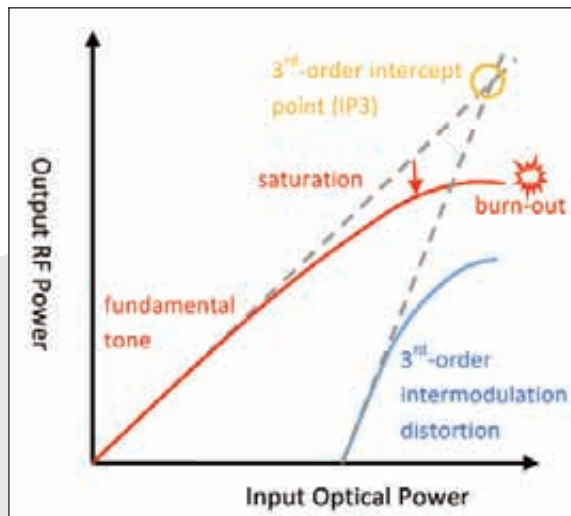


Figure 3. Factors that limit the performance of high-power photodiodes

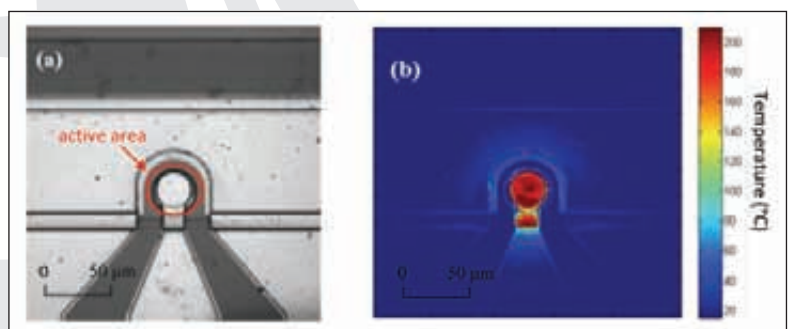
UTC photodiode to achieve high speed and high saturation output photocurrent, even at a low bias.

Through modifications to the UTC structure, we have taken the device to a new level of performance in certain areas, such as output power. Our modified UTC (MUTC) features several elements that contribute to the device's outstanding performance (see Figure 5). This includes an intrinsic InGaAs layer inserted between the p-type InGaAs absorber and the InP drift layer. Additional design flexibility follows from this – the device can then be optimized for both high responsivity and high speed.

Our quasi-neutral InGaAs absorber consists of four step-graded p-type layers. Grading creates a quasi-electric field that drives electron transport in the absorber region. To increase the saturation current, we use charge compensation. To this end, we slightly dope the depletion region to pre-distort the electric field in such a way that it is initially higher where the space-charge effect is most severe at high current.

Another feature that pre-distorts the electric field is the cliff layer – a very thin layer of n-type InP sandwiched between the InGaAs absorber and the InP drift layer. The cliff layer increases the electric field in the intrinsic InGaAs absorber and speeds the passage of electrons through the InGaAs/InP hetero-junction interface.

Figure 4 (a). The layout image and (b) thermal image of 34- μ m backside-illuminated MUTC photodiode obtained by thermal reflectance imaging



Demonstrated superiority

Measurements on our 40- μm diameter MUTC photodiode, using back-illumination and a 5 V reverse bias, show that this diode has a 3-dB bandwidth of 24 GHz and 0.69 A/W responsivity at 1.55 μm . At the 3-dB bandwidth frequency, the 1-dB saturation current was 146 mA.

One option for further increasing RF power is to divide the optical signal between a parallel array of photodiodes, before combining their outputs in a coherent manner. This approach delivers an RF power improvement of 5-6 dB over a single photodiode, according to our measurements of home-built photodiode arrays based on a traveling-wave and Wilkinson power combiner. Further improvements to MUTC photodiode performance are possible with better thermal management of the device. To realise this, we have flip-chip bonded our diode to an AlN substrate, which has much higher thermal conductivity than InP. The optical path remains in InP, while electrical and

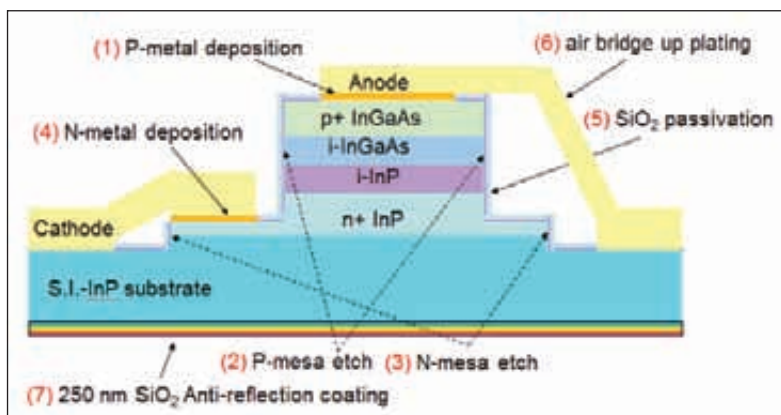


Figure 5. Cross section of the MUTC photodiode. The numbers in brackets indicate the order of fabrication steps

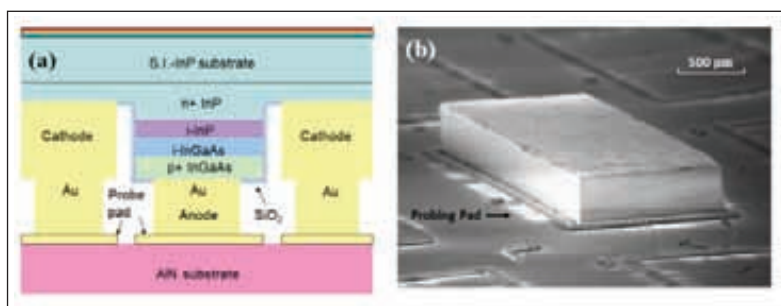


Figure 6. (a) Cross-sectional view of the flip-chip bonded photodiode. (b) SEM picture of the bonded chip on probe pads

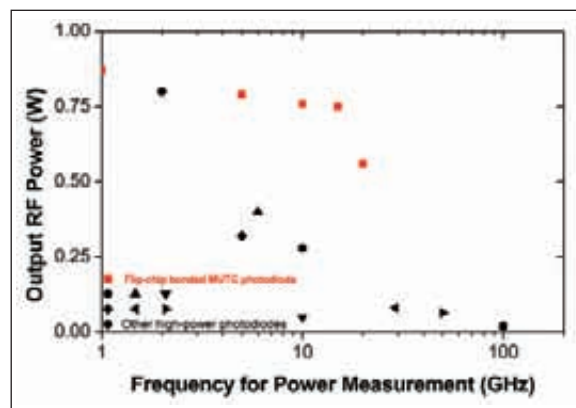


Figure 7. Summary of recent results: Output RF power of a single photodiode versus measurement frequency

thermal accesses to the photodiode are provided on the AlN substrate (see Figure 6). Using the same-sized photodiode as before, the flip-chip technology enabled a hike in the 1-dB saturation current to more than 180 mA at 11 V reverse bias. The corresponding RF output power reached a record-high of 28.8 dBm (0.75 W) at 15 GHz (see Figure 7 to compare the performance of our MUTC photodiode to that of other high-power photodiodes detailed in recent publications.)

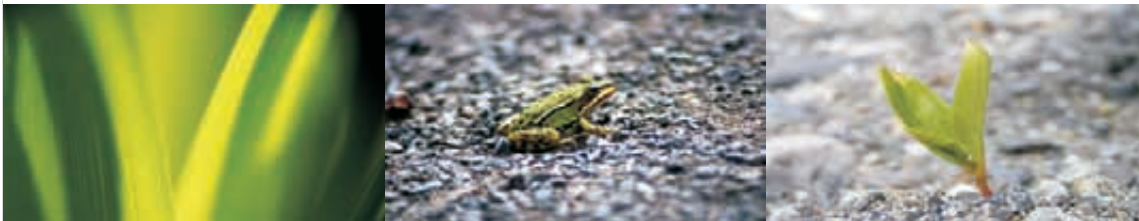
Many researchers are also focusing efforts on improving device linearity. Our approach is to incorporate a heavily doped p-type absorber in the UTC photodiode design (HD-MUTC). This modification improves linearity by reducing the influence of voltage on photodiode capacitance and responsivity. We were able to realise a third-order intercept point (OIP3) of 55 dBm for our HD-MUTC at low frequencies; at 20 GHz it retained a high value of 47.5 dBm.

Our efforts highlight the rapid development of photodiode technology, which continues to contribute to the advancement of photonics. Improvements are being made in many different areas, including optimisation of device geometry and epitaxial structure, attempts to enable more effective optical/electrical coupling, better heat management, and integration with a silicon platform. It is clear that in future more and more applications will utilise high performance photodiodes while taking advantage of the benefits of photonics technology.

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Further reading

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Dots deliver efficient, phosphor-free white lighting

White LEDs have two major weaknesses: Droop, the decline in device efficiency as the drive current is cranked up; and phosphors, which drag down efficiency and add to production costs. The solution to both these issues, according **Zetian Mi from McGill University**, is to turn to phosphor-free dot-in-a-wire white LEDs.

LED light bulbs have many great attributes. Their efficiency trounces that of the incumbent source, the incandescent bulb, and unlike their energy-efficient rival, the compact fluorescent, they are not ridden with mercury and reach full brightness in an instant. However, sales are poor, because retail prices are very high – on average an LED bulb sells for \$28, according to the UK-based market analyst IMS Research.

To slash LED bulb prices, manufacturers must trim every major contribution to the overall cost. The packaged LED is the obvious place to start, since it accounts for almost 60 percent of the total bill of materials, according to a recent report from the US Department of Energy. If the efficiency of these chips can be increased, that will not only trim the price of the light bulb, thanks to a reduction in the number of LEDs needed to produce a given power; it will also reduce running costs, and in turn make the purchase more attractive.

White LED prices are very high, because the production process involves coating red, yellow or green phosphors on blue-emitting chips to produce white emission via colour mixing. This combination of chips and phosphors limits device efficiency, yield and reliability. But it is possible to tackle these issues by building novel, phosphor-free GaN-based dot-in-a-wire white LED. This technology promises to unlock the door to very-high-efficiency, more affordable light bulbs, according to our team at McGill University, Montreal, Canada.

Broadband emission

If solid-state lighting products are to be competitive, they must deliver high-performance in the blue, green and red spectral range. Today, blue LEDs built from GaN-based quantum wells are a relatively mature, high-performance technology, but their longer wavelength green, yellow and red cousins produce relatively low quantum efficiencies. What's more, the device efficiency plummets at increasing current densities, a weakness that is commonly referred to as 'efficiency droop'.

The low quantum efficiency of these green, yellow and red LEDs – and their severe efficiency droop – stems from material characteristics associated with III-nitride planar heterostructures, such as polarization fields and high densities of defects and dislocations. These traits

are behind the unique carrier dynamics found in conventional III-nitride quantum-well LEDs, and have been claimed to be the root cause for electron leakage or overflow, Auger recombination, and poor hole transport in this type of device.

In contrast, our one-dimensional nanowire heterostructure LEDs do not suffer from many of these issues, which plague their planar counterparts. They can be built with drastically reduced dislocations and polarization fields, and they can enhance light extraction efficiency, thanks to far larger surface-to-volume ratios.

Conventional wisdom indicates that the way to realise green and red emission with nitride devices is to embed the InGaN quantum wells or ternary wires in GaN nanowire structures. But this approach is flawed: Only a small proportion of injected carriers transfer to the lateral surfaces of the wire, due to relatively poor carrier confinement in the nanoscale heterostructures; and the non-radiative carrier recombination on the wire surfaces significantly degrades the quantum efficiency of the device.

Our unique InGaN/GaN dot-in-a-wire heterostructures address this critical issue. In our case, InGaN quantum dots are incorporated in defect-free GaN nanowires that provide three-dimensional carrier confinement, a prerequisite for ultra-high-efficiency emission (see figure 1(a)). On top of this, our novel nanostructures offer unprecedented colour tunability. The size and the composition of the dots govern the emission wavelengths, and it is possible to create intrinsic white-light sources from single GaN nanowires by varying the structural properties of the dots during a single epitaxial growth process.

We have employed a scanning electron microscope to acquire images of our InGaN/GaN dot-in-a-wire arrays that are grown directly on silicon (111) substrates by radio-frequency plasma-assisted MBE (see Figure 1 b). Catalyst-free nanowires, which are vertically aligned to the substrate and exhibit excellent size uniformity, form spontaneously under nitrogen-rich conditions.

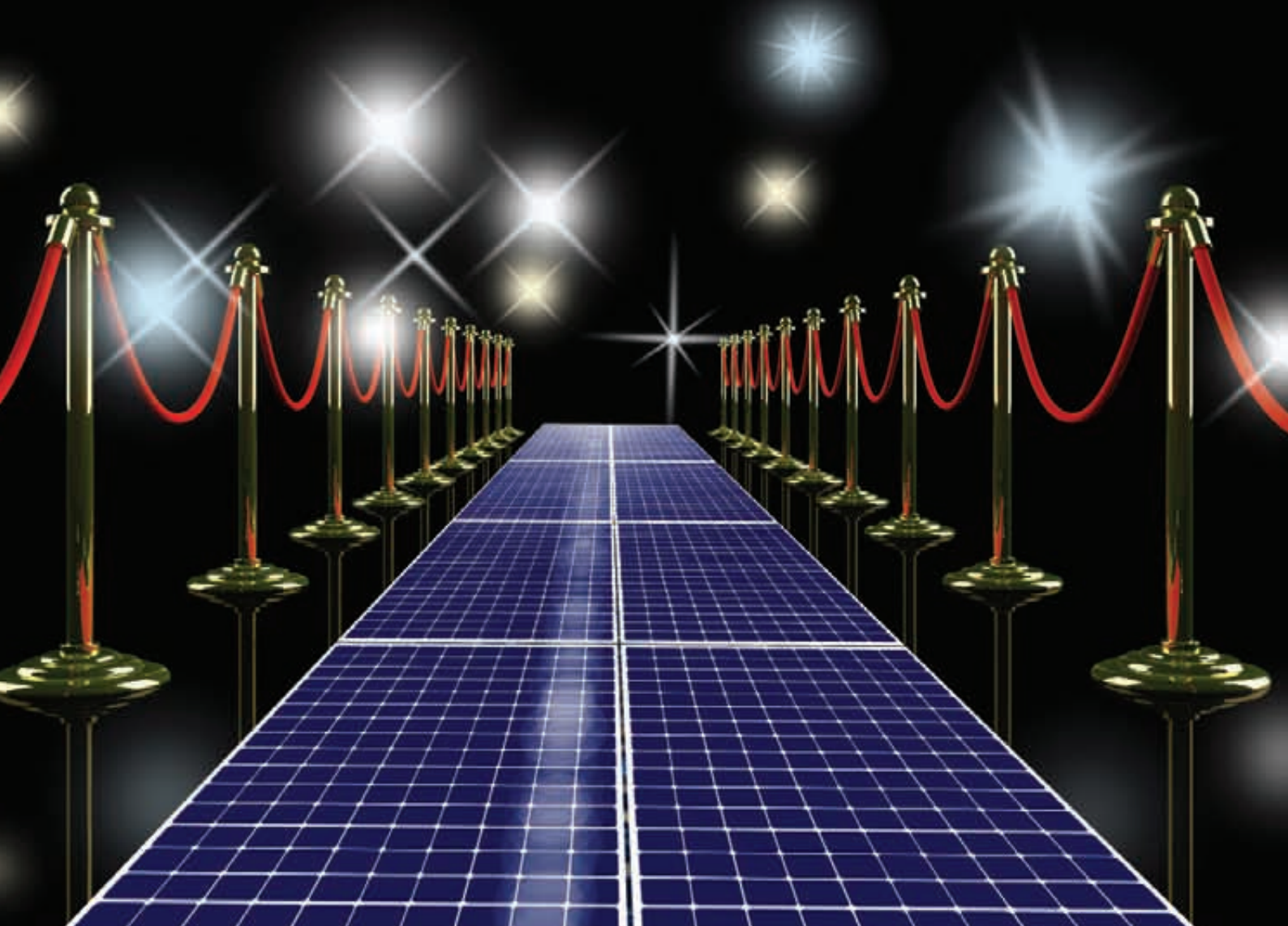
A scanning transmission electron microscope can uncover more detailed images of our devices (see Figure 1 c). This tool reveals multiple InGaN quantum dots near the wire centre, due to strain-induced self-organization. The composition of these dots can be

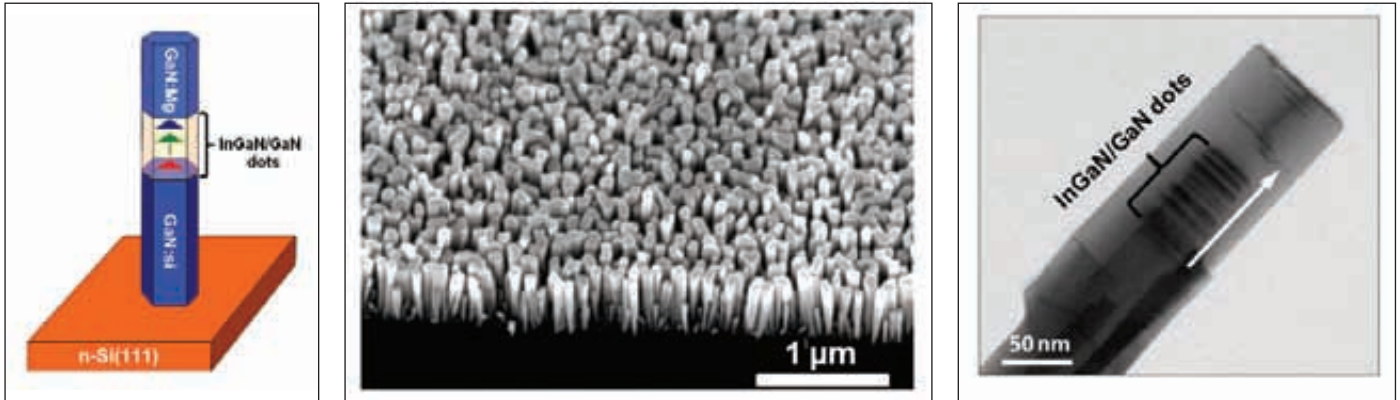
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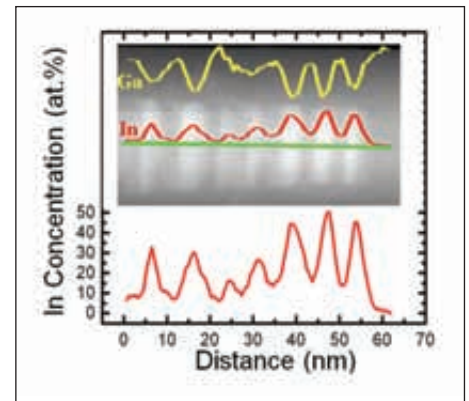
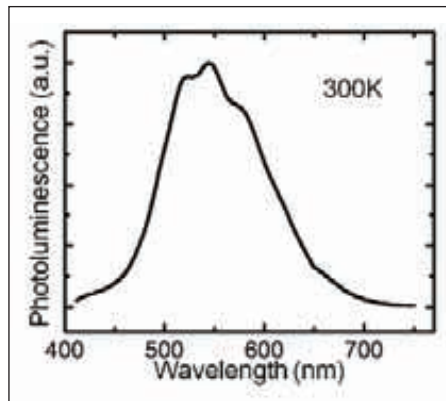
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Clockwise from top left:

Figure 1 (a) An illustration of InGaN/GaN dot-in-a-wire nanoscale heterostructures on a silicon (111) substrate. (b) A 45° tilted scanning electron microscopy image of the InGaN/GaN dot-in-a-wire LED heterostructures grown on silicon (111). (c) A low-magnification, bright-field scanning transmission electron microscopy image clearly showing that InGaN quantum dots are well positioned in the center of a GaN nanowire. (d) An energy-dispersive, X-ray spectrometry spectrum image showing the quantitative variation of indium and gallium along the InGaN dots. The inset shows the line along which the electron energy loss spectrometry spectrum image is taken. (e) Room-temperature photoluminescence spectrum of white-emitting dot-in-a-wire LED heterostructures



revealed with energy dispersive X-ray spectrometry, a technique that exposes variations in indium content from 10 percent to 50 percent (see Figure 1 d). These structures produce strong photoluminescence emission across almost the entire visible range (see Figure 1 e).

To realize the full potential of our nanowire LEDs, we have significantly enhanced hole injection into the active region, while drastically reducing electron overflow out of it. Left unchecked, injected holes tend to reside in the small region close to the p-GaN, due to their heavy effective mass and low mobility. Meanwhile, the likelihood of electrons leaking out of or over the active region can be high, due to surface states and defects. The resulting hot carrier effect can suppress the

likelihood of radiative recombination and diminish LED efficiency under high injection conditions. In our opinion, these efficiency-limiting processes have not been well recognized and addressed in emerging nanowire devices – until now.

We combat these issues with a two-pronged approach to improve the recombination efficiency in this class of LED. We enhance hole transport by doping GaN barriers with magnesium to produce p-type modulation of the quantum dot active region. And by inserting a p-doped AlGaIn electron-blocking layer between the quantum dot active region and p-GaN, we temper electron leakage and overflow from the light-generating zone.

To realize the full potential of our nanowire LEDs, we have significantly enhanced hole injection into the active region, while drastically reducing electron overflow out of it. Left unchecked, injected holes tend to reside in the small region close to the p-GaN, due to their heavy effective mass and low mobility

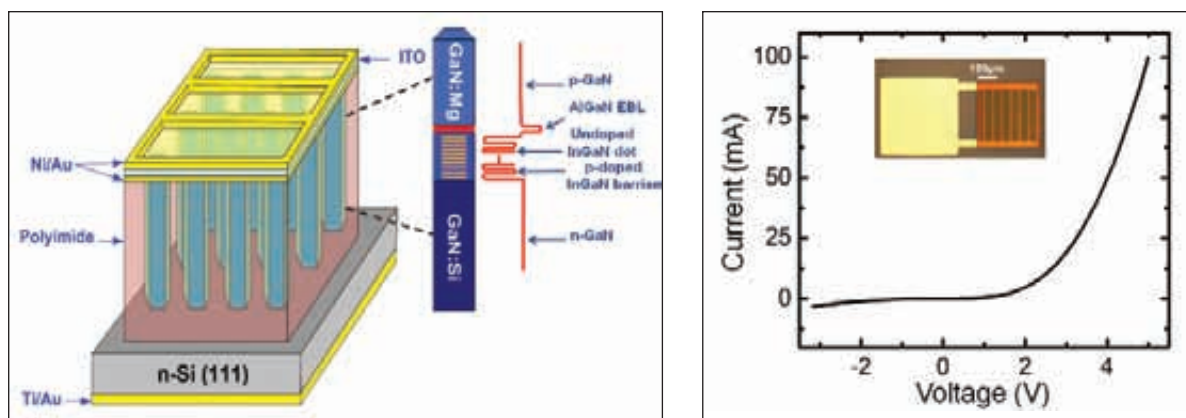


Figure 2: (a) Schematic illustration of InGaN/GaN dot-in-a-wire LEDs fabricated on an n-silicon (111) substrate. A single dot-in-a-wire LED structure with the incorporation of p-type modulation doping and an AlGaIn electron-blocking layer (EBL) is shown in the inset. The flat energy band diagram is also illustrated. (b) Current-voltage characteristic of an InGaN/GaN dot-in-a-wire LED and the optical microscopy image of the device (inset). The series resistance is in the range of 20 - 50 Ω

Commercial promise

The processes that we use to create highly uniform, densely packed InGaN/GaN dot-in-a-wire arrays on silicon substrates are well suited to the fabrication of large-area LEDs (see Figure 2 a). Fabrication involves ‘planarization’ of the nanowire arrays using a polyimide resist, before a p-type Ni/Au/indium-tin-oxide contact is deposited on the top of the nanowire surface and an

n-metal Ti/Au contact is attached to the backside of the silicon substrate. This set of processes yields devices with excellent diode characteristics and negligible leakage current (see Figure 2 b).

By carefully selecting the height of the dots and their composition, we are able to fabricate InGaN/GaN dot-in-a-wire LEDs on silicon substrates with strong green,

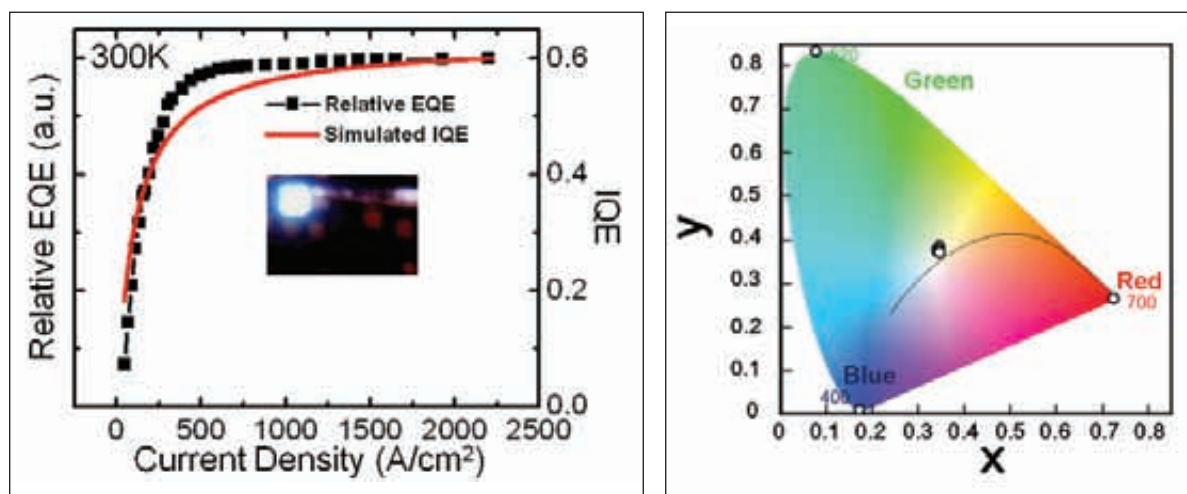
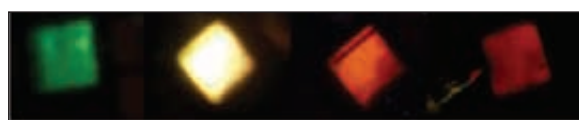


Figure 3 (a)(Top) Optical images of the green, yellow, orange, and red-emitting dot-in-a-wire LEDs. (b) (left) Room-temperature relative external quantum efficiency (EQE) of the InGaN/GaN dot-in-a-wire LED device with the use of p-type modulation doping and an AlGaIn electron-blocking layer. The simulated internal quantum efficiency (IQE) using the ABC model is shown for comparison. The optical image of the white LED is also shown in the inset. (c) (right) The Commission Internationale de l'Éclairage chromaticity diagram showing highly stable emission characteristics, with x and y in the ranges of ~ 0.33 - 0.35, and 0.36 - 0.38, respectively

yellow, orange and red emission (see Figure 3 a). And by combining dots of different colours in nanowires, we have formed high-performance, phosphor-free white LEDs on a silicon platform. These devices combine a strong white-light output with highly stable emission. This high level of performance over a wide range of operating conditions is seen in pulsed bias measurements of relative external quantum efficiency with injection current (see Figure 3b). There is no degradation in room-temperature device efficiency up to injection current densities of 2.2 kA cm^{-2} .

We estimate that our internal quantum efficiency is about 60 percent, using an approach that is essentially based on the well-known 'ABC' model (the basis of this model is that carriers in an LED undergo one of three processes: Shockley-Reed Hall recombination, a non-radiative process that is proportional to the carrier density; radiative recombination, which is proportional to the square of the carrier density; or other higher order carrier loss processes, such as Auger recombination that depends on the cube of the carrier density). Values of the internal quantum efficiency extracted from our model agree with those obtained from optical pumping and electrical injection measurements.

Our dot-based devices set a new benchmark for internal quantum efficiency for any class of LED operating in the green, red, and entire visible spectral range. What's more, the light emission characteristics are incredibly stable over a wide current range (from 333 A cm^{-2} to 1100 A cm^{-2}) (see Figure 3 c)

Another great attribute of our novel LEDs is their absence of droop over a very wide operating range (see Figure 4). Simulations of the internal quantum efficiency, using what is essentially an ABC model, reveal that the third-order non-radiative carrier recombination coefficient is of the order of $10^{-34} \text{ cm}^6 \text{ s}^{-1}$ – nearly four decades smaller than the commonly reported Auger coefficients in GaN-based quantum-well LEDs.

This extremely small value should not raise any eyebrows, given the absence of efficiency droop. What's more, it provides unambiguous evidence that Auger recombination plays a negligible role on the performance of InGaN/GaN dot-in-a-wire LEDs operating in the entire visible spectral range.

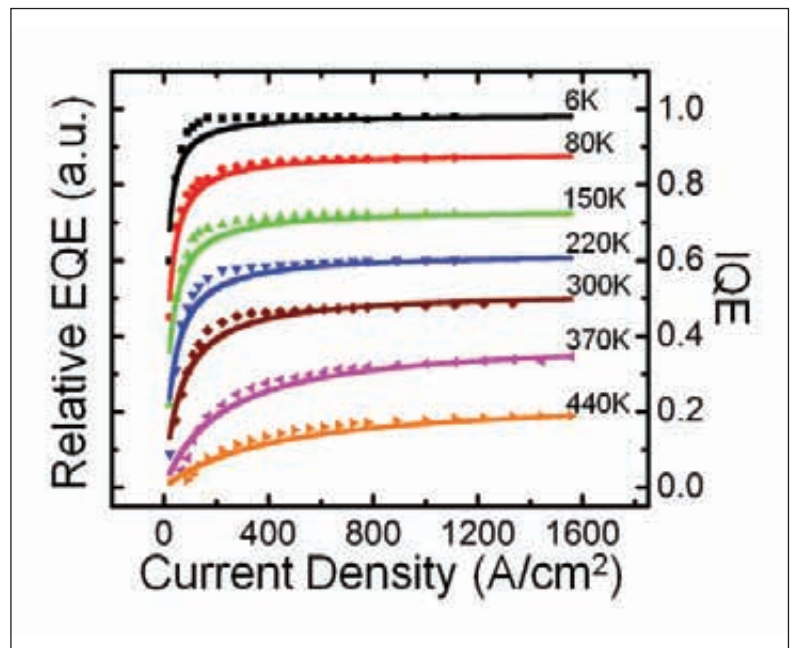


Figure 4 Relative external quantum efficiency (EQE) of a dot-in-a-wire white LED measured at different injection currents in the temperature range of 6 K to 440 K. The simulated internal quantum efficiency (IQE) (solid curve) using the ABC model is also shown for comparison.

Our technology fundamentally addresses some of the major bottlenecks for the growth of phosphor-free solid-state lighting, such as low quantum efficiency and efficiency droop. Though still in its infancy, this remarkable dot-in-a-wire LED technology is already showing enormous potential for applications in future lighting and full-color displays.

What's more, it provides an extremely powerful, unprecedented approach for controlling the LED emission properties at the wafer level, which can significantly reduce manufacturing cost and improve device yield.

To advance the promise of these LEDs, we are now focusing on methods to transfer nanowire devices to transparent substrates, a step that will lead to high external quantum efficiency and effective thermal management. In addition, we are undertaking a detailed investigation of device reliability.

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Further reading

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Substrates & Materials Award

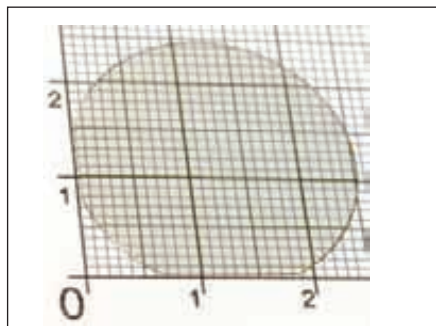


High-transparency n-type substrates

Today's LED industry is at a very important turning point where the market imposes new product segmentation leading to new technological requirements in the production process.

Up till now within the main LED market segment - residential lighting, the challenge was to bring down the cost of a single lumen of light. This cost was the main barrier to entry while competing with other light sources. Today, new market segments related to the ultra- high brightness have LEDs appeared. The first one is street lighting where LEDs have the advantage of a much higher reliability than existing solutions. LEDs for automotive head-lights is another application. The added value is lower power consumption / light output ratio than in the case of standard head lights. Additionally LEDs for the backlight in outdoor infotainment displays where a perfect display readability in daylight conditions are needed. For those applications the cost of a lumen is still important, however much higher light output and good heat dissipation are of ultimate importance. The CS award winning High Transparency n-type gallium nitride substrate introduced by Ammono is the result of a clear market need for high quality GaN substrates aiming at ultra-high brightness LEDs.

Ammono's substrate brings together two key features. The most important one is the inherent low dislocation density of the ammonothermal GaN. In AMMONO-GaN this parameter is at the level of 10^4 cm^{-2} , which is an order of magnitude, or in some cases even two orders of magnitude lower than for other technologies used to manufacture gallium nitride. It provides two direct benefits. The reduction of the droop effect which means better efficiency in the case of high light output and a



better heat dissipation which influences the working conditions of the LED and increases its life-time. The second differentiator is the substrate's high transparency which improves the light output of the LED. For years ammonothermal gallium nitride production method was considered as the one where it was impossible to obtain highly transparent GaN crystals. Breakthroughs by Ammono during the last few years allowed for the engineering of a new class of substrates with high transparency.

As a result the LED industry has a substrate paving the way towards three important breakthroughs. Those are: the decrease of the cost of a single lumen, the increase of the LED life-time and a much higher light output.

"Our product defines a new class of gallium nitride substrates"- explains Piotr Wilinski, the sales and marketing director of Ammono. "Today, we are the only ones to provide gallium nitride mono-crystal substrates with homogeneous parameters over the whole wafer. As the result the crystal lattice in our wafers is much more flat than in the case of wafers obtained by using other manufacturing technologies. It enables a higher manufacturing yield which is very attractive for the mass production. If we add to it the advantages

of the High Transparency n-type substrates the customer obtains a perfect solution to address new market segments. We are conscious that this is just a beginning of a road aiming at introducing AMMONO-GaN substrates to new LED market segments. Working closely together with leading LED manufacturers world-wide we are actively improving further the characteristics of our substrates. Our competitor's HVPE-GaN which was tested by many of our customers have made the LED industry very careful in considering GaN as a substrate. The opinions that we get is that the cost-performance benefit of HVPE-GaN based LEDs is not obvious. The answer to it is the High Transparency AMMONO-GaN which boosts the LED performance and allows new market segments to be addressed."

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**Richard Stevenson,
Editor, comments:**

"Ammono's growth technique is a wonderfully elegant way to address the challenging problem of how to form GaN substrates. The tremendously flat, ultra-high-quality substrates that result should help to spur further improvements in laser and LED performance."

**CSindustry
awards2012**
WINNER

Device Design and Packaging Award



Cree XLamp MT-G EasyWhite LEDs

Cree X-Lamp MT-G LEDs are designed for high-output, small form-factor directional lighting applications, such as accent, track and down lighting.

The world's first MR16 application-optimized LED, the multi-die XLamp MT-G LEDs features Cree EasyWhite technology to deliver consistent color in a highly efficient package that can enable true halogen performance in small, thermally constrained designs. MT-G LEDs are ideal for retail, residential settings, museums, art galleries, hospitality, and landscape applications and are the first commercial LEDs to deliver sufficient light output for these applications.

Until now, LED-based MR16 lamps have been a tremendous challenge for the lighting design community in terms of both light output and color consistency due to their small size and limited capacity for thermal management. Cree developed this LED from the ground-up with applications like these in mind.

Generating more than 50,000 hours of consistent light, Cree MT-G LEDs are designed for the high-lumen, small-footprint requirements of 35- and 50-watt halogen retrofit lamps. The XLamp MT-G LED was the first in the industry binned and tested at 85 degrees C, which can simplify luminaire design calculations and speed time-to-market.

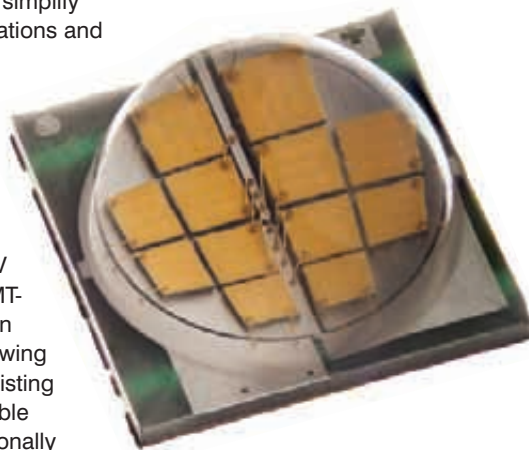
The industry's first LED to be binned for luminous flux and chromaticity at 85°C, the MT-G LED can be driven to much higher currents in less constrained designs, achieving up to 1670 lumens at 25W at 85°C in warm-white (3000-K) colour

temperatures. This can simplify luminaire design calculations and speed time-to-market.

XLamp MT-G LEDs are now available in brighter bins, high CRI and new colour temperatures both in 6V and 36V options. The MT-G LED is now more than 10 percent brighter allowing customers to extend existing MT-G designs, and enable new applications traditionally supported by halogen light sources.

The new higher-CRI MT-G LEDs enable customers to address applications such as retail and restaurant lighting where high CRI and lighting uniformity is required.

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Richard Stevenson,
Editor, comments:

"Cree is playing a major role in driving the LED lighting revolution with its incredibly impressive portfolio of XLamp products."

CSindustry
awards2012
WINNER

Metrology, Test and Measurement Award



Candela 8620 substrate and epitaxy (epi) wafer inspection system

Introduced to the market in January 2011, the Candela 8620 substrate and epitaxy (epi) wafer inspection system is designed for the inspection needs of the light-emitting diode (LED) industry to capture a wide variety of mission-critical substrate and epitaxial defects. For LED device manufacturers the Candela offers automated defect inspection for LED materials such as gallium nitride, sapphire, and silicon carbide—enabling enhanced quality control of both opaque and transparent substrates, faster time-to-root cause, and improved Metal Organic Chemical Vapor Deposition (MOCVD) reactor uptime and yield.

With its proprietary optical design and detection technology, the Candela 8620 LED substrate and epi wafer inspection system detects and classifies sub-micron defects that are not consistently identified by current inspection methods—thereby enabling for the first time a production line monitor for these yield-limiting defects. As LED manufacturers transition production to larger wafer sizes and introduce new patterned sapphire substrate (PSS) processes, there is significant economic impact of resulting process-induced defects.

The 8620 can detect a wide variety of yield impacting defects such as substrate scratches and polishing residues, PSS etch pattern defects, GaN crescents,

hexagon defects, showerhead droplets, micropits and micro cracks. The automated defect classification capability allows customers to filter out nuisance defects and quickly zero in on mission-critical defects of interest. As a result, LED manufacturers are equipped to conduct rapid root cause analysis to speed process development, quickly fine-tune production processes to optimize yields and minimize process excursions, and achieve higher revenues per wafer.

Core to KLA-Tencor's Candela series is providing critical analysis capabilities. Using an innovative proprietary design of optical technology, the Candela systems can detect and classify a wide range of user-defined defects of interest known to impact LED device performance and yield.

One of the most widespread and problematic yield-impacting defects plaguing the LED industry today is GaN-epi micropits. As LEDs make their way into higher-end applications such as LCD backlighting, automotive, and general lighting, field reliability and LED performance longevity are of critical importance. GaN epi microcracks can be extremely problematic to LED makers as these defects cannot be screened at final wafer test or final probe test and only later result in field failures and expensive recalls. Micropits typically range in diameter from 0.1 μm to 2 μm and can occur in extremely high densities. Micropit excursions are frequent, difficult to detect, and result in significant yield

impacts. It is estimated that minor excursions of micropits result in an additional 5-8 percent yield loss while major excursions cause yield losses in excess of 20-30 percent. Conventional methodologies employ AFM or SEM inspection to monitor for micropits but such techniques sample only a tiny fraction of the surface and are not production-worthy process control solutions. Candela 8620 technology has closed the gap on detection and classification of micropit defects and allows for full wafer inspection coverage at production-grade throughputs.

In use at a number of customer sites serving the emerging HBLEED markets, the Candela system is a product of more than three decades of KLA-Tencor's expertise in semiconductor process control.

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Richard Stevenson, Editor, comments:

"For years and years, LED chipmakers have had to use wafer inspection tools designed for silicon wafers. But thankfully these days are now over, due to Candela's introduction of tools focused on scrutinizing LED wafers, such as the 8620 inspection system"



**CSindustry
awards2012**
WINNER

Most Innovative Device Award



Solar Junction

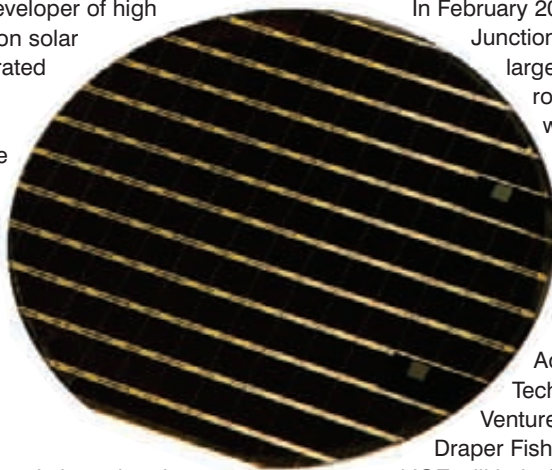
High efficiency SJ3 Product

Solar Junction is a developer of high efficiency multi-junction solar cells for the Concentrated Photovoltaic (CPV) market. Using its proprietary Adjustable Spectrum Lattice Matched (A-SLAM) technology, Solar Junction continues to make technological strides to help reduce CPV module costs.

The A-SLAM technology is based on its dilute nitride material innovation, which provides a platform for bandgap tunability over the solar spectrum to maximize the absorbed sunlight within CPV modules. This technology enables Solar Junction to reach solar cell efficiencies beyond 50 percent within a lattice-matched material. This will also lead to higher reliability for its cells.

Solar Junction's proprietary technology enables the company to reach the highest efficiencies. In April 2011, it became the world record holder for cell efficiency with a 43.5 percent verified by the U.S. Department of Energy (DOE) and the Fraunhofer Institute of Solar Energy. Solar Junction is ramping its multi-junction solar cell technology, with a production median efficiency of 42 percent, to high-volume to fulfill customer orders.

Recent fundraising and partnerships are enabling Solar Junction to meet manufacturing needs, as well as continue technology advances enabling a reduction in CPV module costs down to \$1/W.



In February 2012, Solar Junction closed its largest financing round to date with \$19.2 million.

Investments from New Enterprise Associated (NEA), Advanced Technology Ventures (ATV), Draper Fisher Jurvetson and IQE will help Solar Junction scale its manufacturing.

Additionally, an exclusive manufacturing contract agreement was made with IQE to scale up to 50 Megawatts of multi-junction solar cells by the end of the year. Both parties will require additional process equipment to be secured and qualified at each party's site, IQE in Bethlehem, Pennsylvania and Solar Junction at its headquarters in San Jose, California.

Also, Solar Junction is a recipient of a SUNPATH, Scaling Up Nascent PV at Home, award from the DOE as part of a \$21.5 million program. SUNPATH is part of the SunShot program and aims to increase PV manufacturing in the U.S. Solar Junction is targeting a median cell efficiency of 42 percent on 150mm substrates with the \$5.4 million it will receive from this program. All SunShot investments are designed to help achieve \$1/W by 2020 in the U.S. by investing in technologies that are sustainable with competitive cost and high performance. Founded in 2007, Solar Junction is

dedicated to providing the industry's highest efficiency solar cells to enable CPV as a cost effective energy solution. In a two month span last year, Solar Junction began hitting high efficiencies and secured the world record efficiency on a production size cell of 43.5 percent.

The company continues technical advancements with its proprietary A-SLAM technology and is on a path to exceed 50 percent within the decade with its sustainable efficiency roadmap.

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Richard Stevenson, Editor, comments:

"Dilute nitrides have always held promise. Until now massive commercial success has failed to followed, but that will change with Solar Junction's revolutionary multi-junction solar cells."

**CSindustry
awards2012**

WINNER

Metrology, Test and Measurement Award



Gallium Nitride Microscale Power Conversion Research & Development

TriQuint Semiconductor is an established gallium nitride (GaN) high frequency / high power research, development and product leader with an expanding (DC-18 GHz) packaged MMIC, FET, switch and integrated assembly portfolio.

TriQuint's award-winning research and development activities are now supporting the creation of ultra-fast (1 nanosecond slew rate), high power (up to 500V) DC-DC switch modulators. This initiative is being undertaken as part of the Microscale Power Conversion (MPC) program funded by the US government through its Defense Advanced Research Projects Agency (DARPA). The ultimate goal is to create an integrated amplifier with 75% power added efficiency (PAE). TriQuint's GaN switch plays an essential role since its ability to deliver highly-efficient, modulated power to the amplifier will be key to achieving performance required by the most demanding and rigorous conditions. MPC researchers are utilizing TriQuint's E/D (enhancement-depletion)-mode GaN process as a foundation for their innovative development activities.

This 2012 CS Industry Award follows TriQuint's ground-breaking work in mixed-signal (digital and analog RF) devices,

high power RF switching, and a wide range of GaN-based IC product innovations including multi-chip modules (MCM) and integrated GaN assemblies.

TriQuint's Defense Products and Foundry Services VP and General Manager, James L. Klein, said recognition from the industry and customers supports the company's goals of

continuing its GaN R&D program leadership while growing TriQuint's commercial gallium nitride portfolio. "TriQuint's GaN programs continue to gain recognition and I am pleased that the industry has once again honored our discoveries.

Government-funded contracts not only support future defense applications, but should lead to new commercial products that can substantially advance the capabilities of communications and radar systems," he said.

TriQuint's expertise with gallium nitride circuits continues to stimulate interest from other areas of the international semiconductor community including those at the US Army Research Laboratory (ARL). TriQuint recently announced a Cooperative Research and Development Agreement with the ARL to create

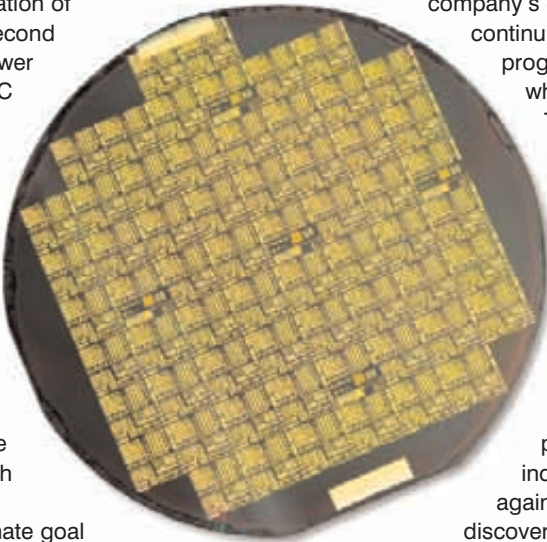
advanced circuits based on its E/D-mode GaN technology.

TriQuint Semiconductor is proud of its defense and commercial products / foundry services heritage. The company's continuing development of innovative product solutions and renowned foundry services supports the RF / microwave / millimeter wave needs of global business. TriQuint's success is based on trust, value, unrivaled support and an in-depth understanding of high-power, high-frequency active devices using gallium nitride (GaN) and gallium arsenide (GaAs) technology.

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Richard Stevenson, Editor, comments:

"GaN is widely touted as the most promising material since silicon. This wide bandgap semiconductor has already spawned a multi-billion dollar LED market, and with TriQuint's help, it is going to make a big splash in the switching arena."



**CSindustry
awards2012**
WINNER

Compound Semiconductor Manufacturing Award



The TurboDisc MaxBright GaN MOCVD Multi-Reactor System

The TurboDisc MaxBright GaN MOCVD Multi-Reactor System is the most productive and lowest cost of ownership MOCVD system for HB LED manufacturing on the market. Its architecture enables single chamber or multi-chamber layer growth capability, increasing process flexibility for demanding LED structures. MaxBright is enabling the industry to accelerate its transition to LED lighting.

Part of Veeco’s multi-generational roadmap for improving MOCVD process capability and capital efficiency, the MaxBright system leverages Veeco’s production-proven Uniform FlowFlange technology and automation expertise by combining multiple high throughput MOCVD reactors in a modular 2- or 4-reactor cluster architecture. These reactors



achieve 25% higher throughput than the standard TurboDisc K465i MOCVD system, while extending proven performance advantages - uniformity, repeatability and material quality.

Low maintenance TurboDisc technology enables highest system availability and throughput. Uniform laminar flow provides for clean reactor during all growths with no daily in-situ bakes needed and no daily or weekly cleaning required. Requiring minimal maintenance while providing highest throughput

MaxBright’s compact architecture also provides a footprint efficiency gain of up to 2.5 times standalone MOCVD systems. Overall, MaxBright delivers a 500% productivity gain compared to the K465i in a flexible and compact package.

The MaxBright MOCVD system offers industry-leading wafer capacity of up to 216 x 2”, 56 x 4”, 24 x 6” or 12 x 8” wafers.



**Richard Stevenson,
Editor, comments:**

“Higher throughput and a lower cost-of-ownership are top priorities for LED manufacturers worldwide. Full marks to VEECO for a tool excels in both these areas.”

**CSindustry
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WINNER**



LED

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The key to your success

European efforts propel nitride devices to a new level

The first GaN HEMTs grown on free-standing diamond, GaN pressure sensors with various designs, robust chemical sensors and power amplifiers delivering hundreds of watts are some of the many highlights of the European project entitled **MORGaN**. The programme's leader, **Sylvain Delage from III-V Lab**, details the many accomplishments.

A tried and tested route for improving device performance involves the introduction of new, superior material combinations. This can pay dividends with nitride electronics, which are traditionally based on the pairing of GaN and AlGaIn. The introduction of InAlN in place of AlGaIn reduces stress, leading to enhanced output powers and superior high temperature capability. What's more, thanks to far stronger spontaneous polarization, the InAlN/GaN heterojunction produces twice the charge density of its $\text{Al}_{0.25}\text{Ga}_{0.75}\text{N}/\text{GaN}$ cousin, enabling devices with higher frequency capabilities. And on top of this, it is possible to wring out further improvements by switching to diamond substrates, a step that aids thermal management of the device.

Advances such as these have just been realized in a three-year project entitled Materials for Robust GaN (MORGaN). This effort, which kicked-off in November 2008 and was backed by €9.2 million (about \$13 million) of funding from the European Commission, involves 23 industrial and academic partners from 11 nations (see Figure 1 for details).

The great promise of the GaN/InAlN heterostructure came to light in a forerunner of MORGaN, a project known as UltraGaN, which started in 2005. Thanks to the success of both these projects, the InAlN/GaN heterostructure is now under close investigation by major research laboratories worldwide for its specific advantages in optoelectronic and microelectronic applications.

Another goal of the MORGaN project is to exploit the thermal and physicochemical robustness of diamond. The former target has involved the development of new silicon/polydiamond composite substrates, along with the deposition of a nanocrystalline diamond coating on top of the wafer to enhance heat removal. Diamond coatings can also protect GaN, which is a major asset when this wide bandgap material is used to make sensors operating in aggressive electrochemical solutions.



Figure 1. The European Commission funded project MORGaN – Materials for Robust GaN – involved 23 industrial and academic partners from 11 nations

One of the hallmarks of the MORGaN project has been its focus on materials. More than half of all resources have been devoted to substrate development, strain management, heterogeneous semiconductor growth, refractory metals, three-dimensional metal manufacturing and ceramic packaging. This approach has born much fruit: Europe's first 2-inch silicon-polydiamond composite substrates, the world's first GaN HEMT grown on single crystal diamond operating in the microwave region, and InAlN/GaN devices operating in continuous wave at 3.5 GHz with an output of 6.6 W/mm and a power added efficiency of 70 percent (see the box "MORGaN's milestones for more details").

Many applications are set to benefit from the successes of the MORGaN project. High-power, high-efficiency amplifiers based on InAlN HEMTs promise to cut the carbon footprint of mobile communication base-stations and various forms of power electronics used in consumer applications. In addition, first version pressure sensors capable of operating at temperatures up to 700 °C under pressures of several tens of bar have been fabricated, which should aid oil exploration and space missions, and also permit measurements in automobile and jet engines. And last but by no means least, MORGaN has spawned incredibly robust chemical sensors offering pH measurements over a large dynamic range.

MORGaN's milestones

- The first European demonstration of 2-inch silicon/poly-crystalline diamond composite substrates
- The first HEMT operating in the microwave region that was formed by direct growth of a GaN heterostructure on a piece of single crystal diamond
- Free-standing epitaxial overgrowth GaN beams and cantilevers
- The first InAlN/ GaN HEMT coated by nanocrystalline diamond with current gain cut-off frequencies in the 20 GHz range
- A top nanocrystalline diamond heat spreader with a thermal conductivity of $500 \text{ W m}^{-1} \text{ K}^{-1}$, indicating that it is possible to preserve the electrical properties of the device while decreasing its thermal resistance.
- The first InAlN/GaN active devices operating in continuous wave with an output of 6.6 W/mm at 3.5 GHz and a power added efficiency of 70 percent
- A medium-size amplifier delivering up to 320 W output power, a figure in line with non-linear circuit design expectations
- Development of novel, high-temperature (800 °C) diffusion barriers and metallisation technology
- Construction of harsh-environment drumskin and cantilever sensors housed in a package.

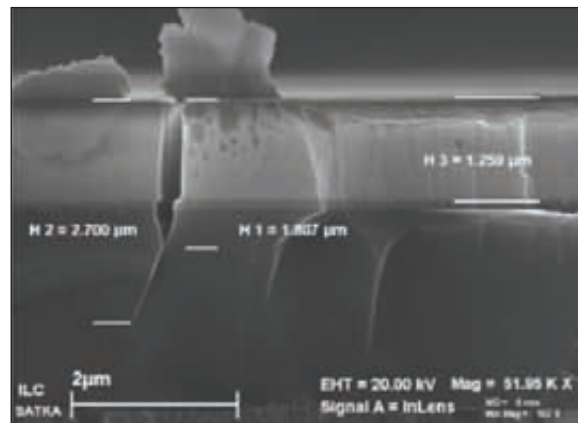


Figure 2. A scanning electron microscopy image of a crack induced by tensile strain that terminates inside the silicon (111) layer

Building on diamond

Leading the development of ultra-high-conductivity platforms is the firm Element Six, which has optimised monocrystalline diamond substrates for the direct growth of GaN on diamond. Although the size of the substrates is relatively small – just 4 mm by 4 mm – electrical performance is promising. Larger sizes are possible by depositing diamond layers on silicon, and this approach has enabled Element Six to produce 2-inch free-standing wafers featuring a 2 μm-thick (111) silicon surface on a 70 μm polycrystalline diamond layer. Scaling to larger substrate sizes, such as 100 mm, will require additional work. One great attribute of the 2-inch polycrystalline composites is a thermal conductivity that reaches $1000 \text{ W m}^{-1} \text{ K}^{-1}$.

Researchers at the University of Bath, UK, have deposited nitride layers on these complex silicon (111)/ polycrystalline diamond composite substrates. Highlights include the formation of high-quality, crack-free AlN and GaN layers, the latter of which is 350 nm thick (see Figure 2).

MBE growth, using either ammonia or RF sources, has been used by engineers at EPFL, CH and FORTH to deposit nitride epi-structures directly onto single crystal diamond. A low-temperature AlN buffer layer was deposited first, followed by strain-engineered interlayers that allowed the subsequent GaN layer to be formed under compressive strain, prior to the growth of an 800 nm-thick GaN layer. On top of this went a HEMT structure, composed of a 24 nm-thick $\text{Al}_{0.28}\text{Ga}_{0.72}\text{N}$ layer followed by a 2 nm-thick GaN cap (see Figure 3).

Hall Effect measurements revealed room-temperature electron mobility of $731 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ ($1740 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$) and a

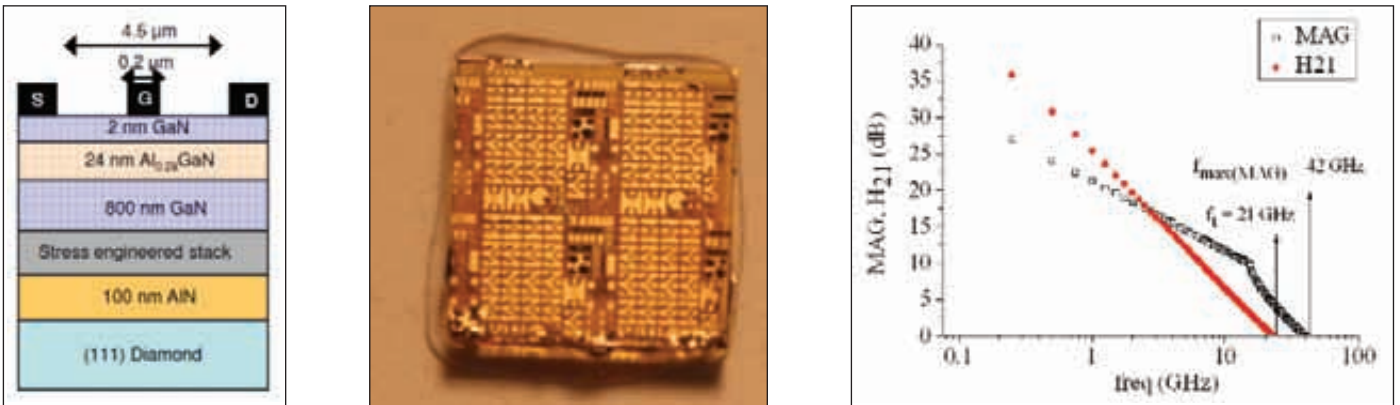


Figure 3. (a)(left) The design of the HEMT structure grown on single-crystal diamond (b) (middle) An optical image shows the processed HEMT on single crystal diamond (c)(right) Measurements of current gain (h_{21}) and power gain (MSG/MAG) as a function of frequency for a $2 \times 0.2 \times 75 \times \mu\text{m}^3$ HEMT with $1\mu\text{m}$ thick nanocrystalline diamond heat spreader. The bias conditions were fixed at $V_{ds}=10\text{V}$ and $V_{gs}=-2.5\text{V}$

sheet carrier density of $1.3 \times 10^{13} \text{ cm}^{-2}$. Cooled to 77K, electron mobility and sheet carrier density in the structure increased to $1740 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ and $1.4 \times 10^{13} \text{ cm}^{-2}$. Thermal characterization shows a thermal resistance, R_{th} , of 3.5 K mm W^{-1} . This is twice as high as that for a HEMT grown on more conventional 4H SiC substrate.

Engineers at Technical University of Ulm have fabricated transistors with a $0.2 \mu\text{m}$ gate length from these wafers (see Figure 3(b)). Small signal measurements show a current gain cut-off frequency, f_t , of 21 GHz and a power cut-off frequency, f_{max} , of 42 GHz (see Figure 3(c)). Although these values are slightly inferior to those obtained for AlGaIn/GaN devices built on SiC, this is a very impressive result for a first trial. Additional work could be carried out to optimise the heterostructure and device processing. However, once this feasibility study was complete, the MORGaN consortium did not want to pursue this direction due to the limited current size of single crystal diamond as planned in the project.

Handling pressure

Pressure sensors were also developed during the MORGaN project. Some of these involve GaN cantilevers, which are self-supporting beams based on high-quality extended lateral overgrowth (ELOG) GaN, selectively etched from a silicon substrate. Other pressure sensors are 'drumskin' devices, combining a membrane made from a sapphire substrate with a HEMT sensor. All forms of sensor are housed in sophisticated packages made by FCubic, Swerea IVF, and Gooch & Housego. Advanced housing enables these sensors to operate at up to $1000 \text{ }^\circ\text{C}$ and 100 bar.

The ELOG-based cantilevers, which are made at the University of Bath, produce deflections of several

microns: Beams $5 \mu\text{m}$ wide and $500 \mu\text{m}$ long deflect $6 \mu\text{m}$, and double-clamped variants that are $15 \mu\text{m}$ long deflect by $9 \mu\text{m}$ (The cantilevers are deflected by a piezo-controlled nano-positioner, and their deflection is determined from an interference fringe shift).

Fabrication of these structures involves lateral overgrowth, which is based on a lithographic process. A thin sacrificial SiN layer is structured, before it is removed by buffered oxide etch after overgrowth to release the beams. It is possible to use a 'double

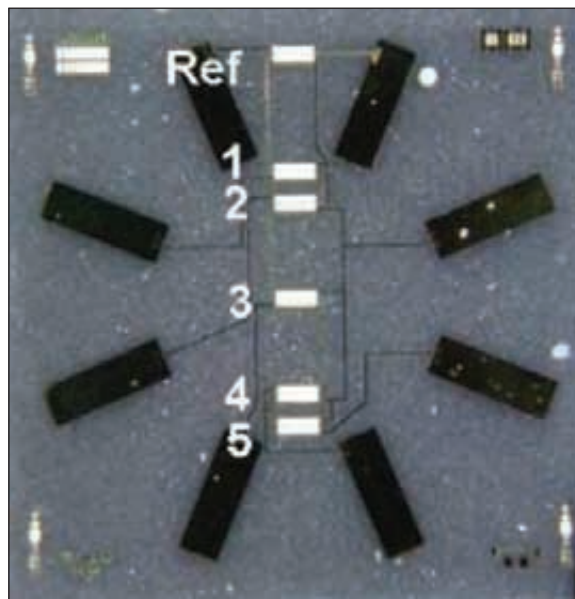
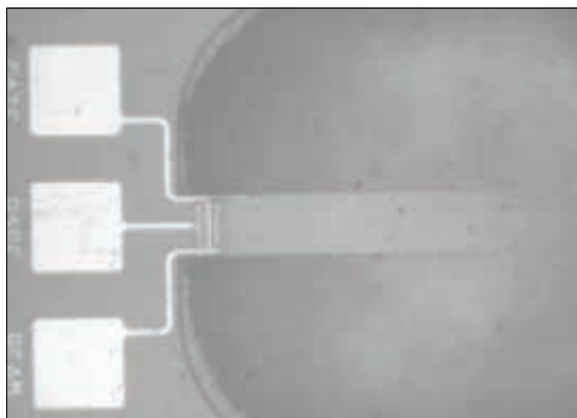


Figure 4. Drumskin pressure sensors use several HEMTs as sensing elements. The sensors are capable of measuring pressures of 80 bar and above

Figure 5. Optical microscopy image of a GaN-based cantilever



dogleg' growth window with this lithographic process that enables ELOG growth along optimum crystallographic directions.

Simulations to optimise the design of the drumskin sensor have been performed by the University of Bath and the University Joseph Fourier. These universities have developed mechanical models for the sensor, which has six sensing elements (see Figure 4). Modelling enables fine-tuning of the thickness of the sapphire substrate for a particular pressure range.

Another contributor to this effort is the IEE Slovak Academy of Sciences, which has developed a high-temperature compatible fabrication process for this sensor. Conductive metal oxides are formed on the gate interface through thermal oxidation of evaporated and patterned thin nickel and iridium interfacial layers. Conductance is increased with this novel gate metallization process, and the device's impressive transport characteristics are maintained after device annealing at 800 °C.

Testing of these sensors in an environment capable of producing pressures up to 60 bar revealed that the drain-source voltage decreases in a linear fashion with increased voltage, diminishing by 0.02 percent per bar. This agrees with finite element models developed in the MORGaN project, which reveal that any deviations from linearity result from piezoelectric relaxation and imperfect clamping. When the sensor is placed in a bespoke package, it can operate at up to 80 bars and at 400 °C.

AlGaIn/GaN cantilevers have also been fabricated on silicon substrates, thanks to efforts at MicroGaN. In this process cantilevers are defined, before dry etching selectively removes the silicon substrate from underneath. The chip design includes a temperature sensor and two cantilevers in a Wheatstone bridge configuration. The sensor operates by measuring the deflection of one cantilever – the other one serves as a reference in order to compensate for temperature effects (see Figure 5). Measurements have been made on this sensor at temperatures up to 300 °C and a range of deflections.

Acid or base?

Another aspect of the MORGaN project is the development by the Technical University of Ulm of ion-sensitive FETs that feature diamond electrodes on AlInN/GaN HEMTs. These chemical sensors can be built by either monolithic integration on one chip or by hybrid integration. With both designs the nano-crystalline diamond electrode is exposed to the electrolyte, and when hybrid integration is used this electrode is also connected to an external AlInN/GaN HEMT. This heterostructure must have resistance to the nano-crystalline diamond thermal deposition budget, which is a temperature of 800 °C for many hours.

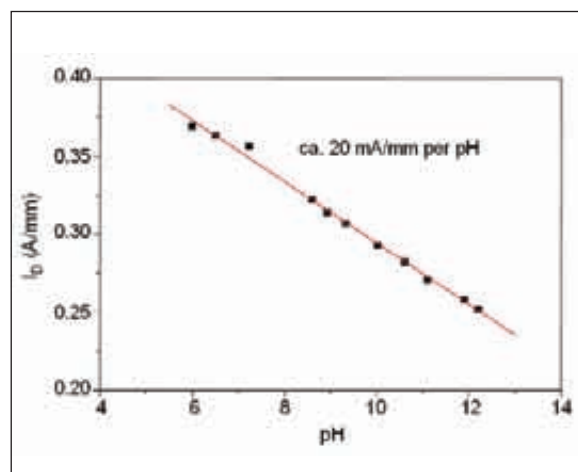
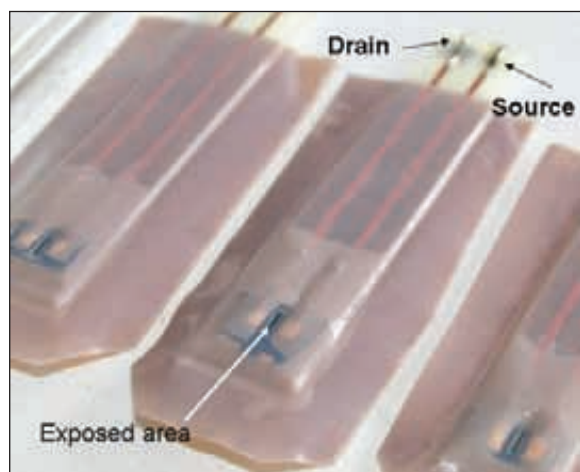


Figure 6. (a) A packaged InAlN/diamond ion-sensitive FET (b) Steady-state values of the drain current of InAlN/nano-crystalline diamond electrochemical sensor as a function of the pH value

Constructing these chemical sensors involves the mounting of FET chips in the centre of a PCB board with Cu/Au-based conductive pathways. Gwent Electronic Materials gave support to that task. These transistors are adhered to 48 pads on a PCB board by ultrasonic wedge bonding, a process that enables fast connection of the nano-crystalline diamond electrode to transistors with different geometries. Covering this sensor with synthesis glass allows observation of the device with an optical microscopic while it is being used (see Figure 6 (a)).

Measurements reveal that the sensor has a reproducible pH sensitivity of 55 mV/pH, a sensitivity in the range of 20 mA/mm per pH (see Figure 6(b)) and a resolution as high as about 0.05 pH. One of the great strengths of the sensor is its fast response, which is limited by the seconds required to realise complete intermixing of the electrolyte.

Dissipating the heat

The potential benefits of coating GaN-based HEMTs with diamond have been recognized for many years: This yields a corrosion-resistant protection layer in harsh environments and forms an ideal heat-spreading layer for dealing with forced cooling from above. Converting the promise into a reality requires deposition at 700 °C or more of nano- or poly-crystalline diamond films in an atmosphere rich in hydrogen radicals at temperatures in excess of 700 °C. This requires an extremely stable semiconductor heterostructure, device contacts and passivation, which may also act as nucleation layer.

The Technical University of Ulm fabricated the first submicron HEMTs overgrown with a 1 µm-thick nanocrystalline diamond heat spreader by bias

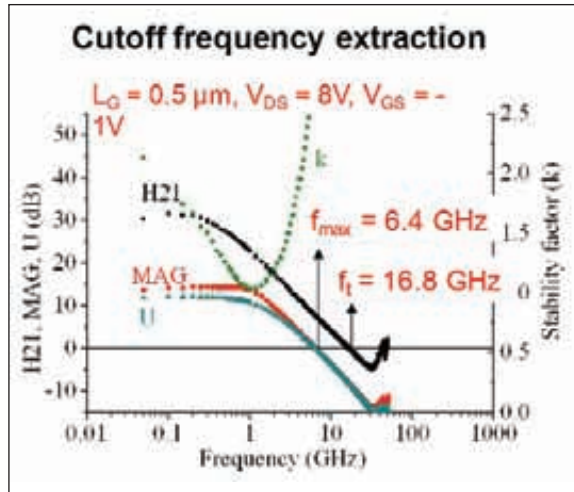


Figure 7. Current gain (h_{21}) and power gain (MSG/MAG) as a function of frequency for a $2 \times 0.5 \times 75 \mu\text{m}^2$ HEMT with 1 µm thick nanocrystalline diamond heat spreader. The bias conditions were fixed at $V_{ds}=8\text{V}$ and $V_{gs}=-1\text{V}$

enhanced nucleation. The small signal performances of the components are satisfactory, with an f_t of 16.8 GHz and an f_{max} 6.4 GHz (see Figure 7). This result constituted a world first for the MORGaN project.

Ultra-powerful HEMTs

Constructing 1 kW transistor technology was another goal of the MORGaN programme. To try and hit this output power, researchers at III-V Lab fabricated HEMTs with a 36 mm periphery and a 0.7 µm gate length on semi-insulating SiC substrates (see Figure 8). These transistors featured a 2 µm-thick GaN layer grown on SiC and a 10 nm-thick InAlN layer. Optimising device topology preserved microwave power gain and addressed thermal constraints. Due to the operating frequency, these devices tend to dissipate more power than they emit. When driven by 10 µs pulses, the basic cell 2 mm device delivers 13.2 Wmm^{-1} with a Power Added Efficiency (PAE) of 70 percent. Switch operation

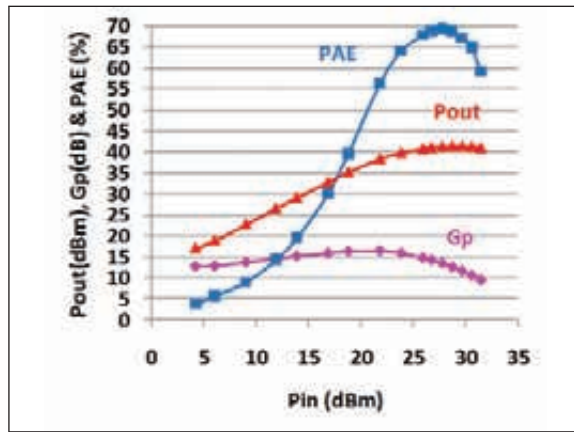
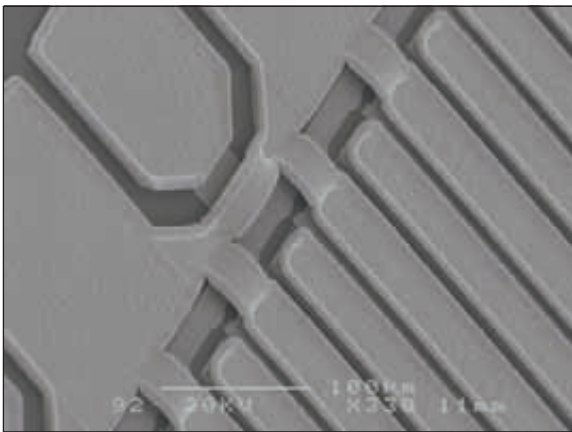


Figure 8. (a) Scanning electron microscopy image of a 36 mm periphery, 0.7 µm gate-length HEMT power bar for L to S-Band operation. (b) $P_{out} = 41.2 \text{ dBm}$ (13.2 W – 6.6 W/mm) with PAE of 70 percent and G_p of 13.4 dB measured on wafer at 3.5 GHz and $V_{ds} = 35 \text{ V}$ (2 mm device & short pulse setup)

to continuous wave mode, and PAE drops to about 55 percent due to thermal self-heating. To improve the thermal environment for these power bars, they were mounted on polycrystalline diamond tabs supplied by Element Six (see Figure 9 for an example).

Prior to mounting, the SiC substrates were thinned to 100 μm to improve thermal management: Thermal conductivity of SiC is 450 $\text{W m}^{-1}\text{K}^{-1}$, which is four times lower than that of high-quality polycrystalline diamond.

The benefit of a high conductivity platform is revealed with thermal infrared imaging. When a 36 mm bar was mounted on a diamond heat spreader and dissipated 3.5 W mm^{-1} on a jig kept at 62 °C, its maximum channel temperature was 173 °C (see Figure 9 b). This increased to 214 °C for a similar 400 μm -thick power bar, not mounted on a diamond heat spreader.

It is possible to further improve the thermal management of the device with active heat exchangers, which can operate by pushing water into a cavity with a large surface area for heat exchange. Such systems have been designed by III-V Lab and Swerea IVF and produced by FCubic using their three-dimensions machining capabilities (see Figure 10). One of the latter firm's contributions to the MORGaN project has been the development of a new process to make high precision copper parts using layer manufacturing. This has enabled the construction of heat exchangers with a thermal resistance, estimated by experiment, of 0.16 °C W^{-1} . This incredibly low figure helps to dissipate hundreds of watts of heat from the HEMT.

Armed with this heat exchanger, researchers have constructed a 2 GHz amplifier that includes two power bars of 36 mm periphery and produces 200 W. Switch to pulsed-mode operation, and a 250 W output is possible, which is a record for devices with an InAlN/GaN heterostructure.

The limit of operation is 320 W, and PAE can hit 35

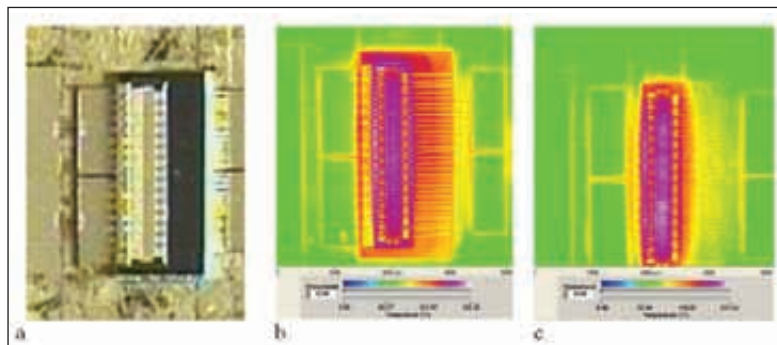


Figure 9. (a) Optical photograph of a 36 mm InAlN/GaN HEMT thinned down to 100 μm thick SiC, mounted on diamond tab TM180 (appear black in image); The power bar was set to dissipate 3.5 W mm^{-1} in CW – the assembly is mounted on a jig at a temperature fixed at 62°C (b) Thermal infrared microscopy of the power bar shown in (a). (c) Infrared imaging of a similar dice but without a heatspreader and with a SiC substrate 400 μm -thick

percent, which equates to 55 percent at the device level, according to reversed analysis. These incredibly impressive results are just one of the highlights of the MORGaN project, which has also led to improvements in materials, sensors, microwave devices and packaging.

This article has only touched on some of the breakthroughs, and anyone seeking more details should take a look at the MORGaN public website: <http://www.morganproject.eu/>

Further reading

Europe turns to AlInN to push the limits of transistor and sensor performance, Compound Semiconductor Nov&Dec 2009, p.27

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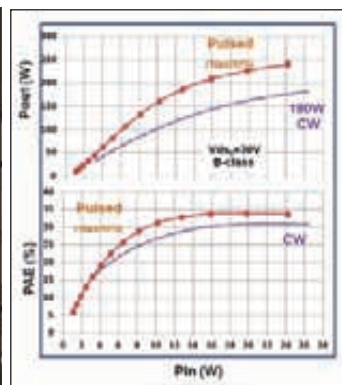
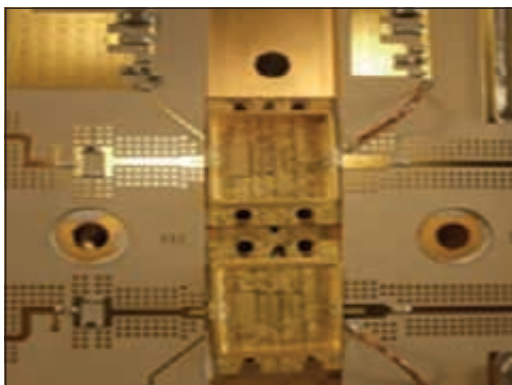


Figure 10. (a) Copper heat exchanger made by three-dimensional machining (b) Partial view of 200 W L-Band using InAlN/GaN HEMT devices (c) Output power and PAE of amplifier including 2 devices of 36 mm at 2 GHz. Duty cycle measurements with 10 μs pulses were used as well as CW operation. Top: Output power; bottom: PAE

Suppressing leakage in nitride diodes

Leakage currents in Schottky barrier diodes plummet by seven orders of magnitude when the barrier composition is shifted from $\text{Al}_{0.21}\text{Ga}_{0.79}\text{N}$ to $\text{Al}_{0.11}\text{Ga}_{0.89}\text{N}$.

ENGINEERS from Central Research Lab, Hitachi, have shown that reverse leakage currents in AlGaN/GaN Schottky barrier diodes can plummet through reductions in sheet carrier density.

High leakage currents are an Achilles heel for today's GaN diodes, which hold much commercial promise thanks to their combination of high temperature, high frequency and high power.

It is widely believed that the dominant cause of leakage is structural defects, especially dislocations, which can result from strain in the AlGaN layer.

However, initial studies by the Hitachi researchers indicated that sheet carrier density also influences leakage current.

This finding motivated these engineers to carry out further work involving three AlGaN/GaN heterostructures that shared a $3.6\ \mu\text{m}$, highly-resistive GaN buffer layer and a 5 nm GaN cap.

In these samples, barrier compositions were $\text{Al}_{0.11}\text{Ga}_{0.89}\text{N}$, $\text{Al}_{0.16}\text{Ga}_{0.84}\text{N}$ and $\text{Al}_{0.21}\text{Ga}_{0.79}\text{N}$, and corresponding room-temperature two-dimensional electron gas densities determined by Hall measurements were $3.6 \times 10^{12}\ \text{cm}^{-2}$, $6.6 \times 10^{12}\ \text{cm}^{-2}$ and $1.0 \times 10^{13}\ \text{cm}^{-2}$, respectively.

"We prepared those three samples with our own MOCVD [tool] under precisely controlled conditions," says lead author Akihisa Terano. "We think that the material quality of our three samples is almost the same."

All three epiwafers were processed into planar Schottky barrier diodes with contacts formed by electron beam evaporation (see Figure 1).

Measurements on the devices revealed that a three-fold fall in the density of the two-dimensional electron gas results in a reduction in leakage current by seven

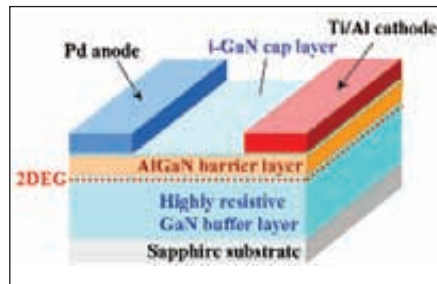


Figure 1. Schottky diodes built by Hitachi feature $1000\ \mu\text{m}$ by $200\ \mu\text{m}$ cathodes and anodes, separated by $200\ \mu\text{m}$

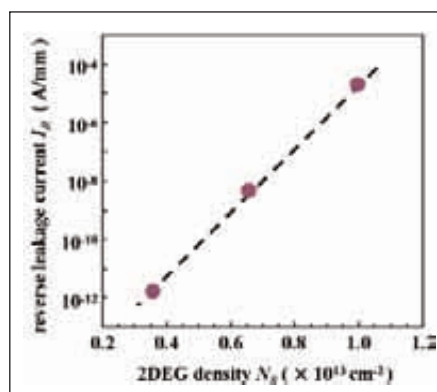


Figure 2. Massive changes in leakage current result from relatively small changes in the density of the two-dimensional electron gas

orders of magnitude (see Figure 2).

Unfortunately, slashing leakage current with this approach has its downsides.

"A reduction in the sheet density is thought to lead to some increase in the resistance of the drift layer, resulting in some decrease of the forward current," explains Terano.

He and his co-workers are now planning to tackle this issue head-on, developing devices that combine a sufficiently high forward current with a low leakage.

A. Terano *et al.* *Electron. Lett.* **48** 274 (2012)

Multi-million-atom QD metrology

Researchers have used a simulation of InAs quantum dots to accurately reproduce experimentally measured optical spectra

GROWTH DYNAMICS in real quantum dot devices has been modelled by an international team from Tyndall National Institute, Ireland, the National Nanotechnology Laboratory-CNR, Italy, and Purdue University, Indiana. The researchers used multi-million atom simulations that are claimed to deliver unprecedented precision.

The semiconductor device simulation tool, called NEMO 3D, was developed at NASA and Purdue. This tool can model structures containing up to 50 million atoms through parallelised computation on high performance supercomputing clusters.

By accurately mimicking indium-gallium intermixing and indium-segregation effects with an innovative two-layer composition model for quantum dots (QDs), the researchers can reproduce polarisation-dependent optical emission spectra of an MBE-grown InAs QD.

Tyndall has proposed an innovative two-composition model for the InAs QDs, comprised of an indium-rich central core surrounded by an indium-poor region close to the edges of the QD. This model allowed the researchers to reproduce the experimentally measured optical spectra.

Modelling of growth dynamics is a challenging computational task as it requires simulation of realistic QD sizes with atomistic resolution.

By performing a systematic set of multi-million atom atomistic simulations, the researchers in Ireland found a correlation between their calculations and the experimentally measured data.

The results quantitatively show the influence of indium-gallium intermixing and indium segregation effects on the polarisation properties of the QDs.

M. Usmanet *et al.* *Nanotechnology* **23** 165202 (2012)

Powerful, simple ultraviolet LEDs

UV LED performance soars with the addition of a little indium incorporation in the active region and optimized metallic contacts.

A GERMAN COLLABORATION has produced 355 nm AlGaIn-based LEDs with state-of-the-art efficiency using a relatively small number of processes.

“As far as we know, our [device] has a slightly higher EQE than the best values published so far for AlGaIn-based LEDs,” says Thorsten Passow from Fraunhofer Institute for Applied Solid State Physics.

The high performance of these UV LEDs, which can produce up to 22.7 mW at a 100 mA drive current, will help the development of solid-state sources for several applications including optical sensing, fluorescence spectroscopy, UV curing, water purification, and disinfection of surfaces.

The team from the University of Ulm and Fraunhofer Institute for Applied Solid State Physics IAF have fabricated LEDs on home-built, 2-inch Al_{0.2}Ga_{0.8}N/sapphire templates prepared with a proprietary *in-situ* SiN_x technology.

MOCVD growth formed three different types of LED epistructure. The first of these features a 700 nm-thick, silicon-doped Al_{0.15}Ga_{0.85}N *n*-contact; a 3 nm-thick GaN quantum well sandwiched between Al_{0.15}Ga_{0.85}N barriers; a magnesium-doped 20 nm-thick Al_{0.3}Ga_{0.7}N electron-blocking layer; plus a 50 nm-thick layer of Al_{0.15}Ga_{0.85}N and a 20 nm-thick GaN cap, both doped with magnesium.

The second variant contains a small amount of indium in the well and barriers.



The 365 nm LED built by engineers at Fraunhofer Institute for Applied Solid State Physics IAF and the University of Ulm can deliver more than 20 mW at a 100 mA drive current.

This is less than one percent, according to secondary ion mass spectrometry.

The third design shares the active region of the second variant, but differs from this structure in two ways.

Its GaN cap is just 10 nm thick; and the thickness of the layer stack grown above the quantum well is optimised, so that this trench is positioned at an anti-node, thereby boosting emission from the chip.

All three types of epiwafers were processed into square LEDs with sides of 240 μm that featured *p*-contacts and *n*-contacts made with Ni/Ag/Ni and V/Al/V/Au, respectively. Devices were then flip-chip mounted onto AlN sub-mounts.

“We did not apply any further measures, such as surface roughening or backside

texturing, to improve the extraction efficiency,” says Passow.

Driven at 40 mA, the standard LED produced an output power of 2 mW at an external quantum efficiency (EQE) of 1.4 percent. Under an identical drive current, the second structure with a modified active region produced 5.4 mW with an EQE of 5.8 percent.

The researchers claim that this hike in performance results from effective screening of non-radiative defects in the quantum-well active region.

The third type of device, which featured a thinner cap, was the brightest and most efficient of all. It produced 9.8 mW at 40 mA, rising to 22.7 mW at 100 mA, and at the lower drive currents its EQE was 7 percent. The researchers attribute this superior performance to lower absorption losses in the cap.

One attractive feature of the most efficient LED is its low operating voltage – just 3.8 V, which is only 0.3 V above the energy of the emitted photon. According to the team, this impressive figure stems from the optimised contact layer.

Further improvements in LED performance should be possible by increasing the light extraction efficiency of the chip through measures such as surface roughening.

R. Gutt *et al.* *Appl. Phys. Express* **5** 032101 (2012)

Electron irradiation exposes laser degradation mechanism

In-grown gallium vacancies are responsible for point defects in GaN lasers

A TEAM FROM Aalto University, Finland, suggests that current-induced point-defect activation is a possible cause for the degradation of GaN-based laser diodes.

The researchers performed experiments on MOCVD-grown nitride device and GaN samples. They used a tightly focused low energy electron beam irradiation to

generate local current densities up to 130 kA cm⁻² on the sample surface, about one order of magnitude higher than in GaN-based laser diodes during operation.

The team discovered that irradiation by 5–20 keV electron beam reduced the integrated band-to-band luminescence of the nitride samples by as much as 75 percent.

The findings were unexpected, since the threshold energies for vacancy generation in GaN, for example, are much higher, about 150 keV for nitrogen and 500 keV for gallium vacancies. Further experiments, are necessary to shed light on the issue.

H. Nykänen *et al.*, *Applied Physics Letters* **100** 122105 (2012)

Carrier manipulation combats droop

Grading quantum barriers cuts LED droop

CALCULATIONS by engineers from National Chiao Tung University, Taiwan, have shown that alterations to the composition of barriers can improve GaN LED performance. By modifying hole transport, it is possible to design devices that are more efficient and less prone to droop, the decline in LED efficiency as current is cranked up.

The team looked at three different LED structures with APSYS software developed by Crosslight of Burnaby, Canada. All these LED designs are formed on 100 μm -thick sapphire and have: A 4 μm -thick *n*-type GaN layer: an active region comprising six 2.5 nm-thick $\text{In}_{0.15}\text{Ga}_{0.85}\text{N}$ quantum wells interspersed with 10 nm-thick GaN barriers; a 20 nm-thick, *p*-doped $\text{Al}_{0.15}\text{Ga}_{0.85}\text{N}$ electron-blocking layer; and a 200 nm-thick, *p*-doped cap.

Differences between the structures relate to variations in barrier design. One device has all its barriers graded in indium composition from 5 to 0 percent along the growth direction; another has just the fifth barrier graded; and the third structure has grading in the fourth and fifth barriers. It is

possible to realise these doping profiles in real devices. "We've demonstrated similar structure experimentally," says corresponding author Hao-Chung Kuo, who has reported the results in a paper in the journal *Applied Physics Letters* (Appl. Phys. Lett. **99** 171106).

LED modelling – employing a Shockley-Read-Hall recombination time of 1 ns, an Auger recombination coefficient in the quantum wells of $10^{31} \text{ cm}^6 \text{ s}^{-1}$ and device dimensions of 300 μm by 300 μm – revealed that doping of just the fifth barrier wrought the greatest improvements.

Efforts involved modelling electron and hole distributions at current densities of 40 mA cm^{-2} and 200 mA cm^{-2} . In conventional LEDs, holes accumulate in the well nearest the *p*-region. This is not the case in any of the three types of device with graded barriers, where holes were distributed slightly more uniformly, with significant populations in the fourth, fifth and sixth wells. Electron distributions were modified by the presence of holes, with most negative carriers found in the well nearest the *p*-type region.

Calculations included those for light output power and external quantum efficiency (EQE) for all three types of LED with graded barriers. Those with two or more graded barriers are best at combatting droop – the efficiency at 200 mA cm^{-2} is only down by 6 percent or less compared to the peak efficiency.

However, these designs have a fatal flaw: Their EQEs are inferior to that of a conventional LED, because excessive improvements in hole doping don't translate to higher device efficiency. In comparison, although grading just the fifth barrier leads to a small improvement in hole transport, it delivers a 42 percent hike in EQE over the standard LED at 200 mA cm^{-2} (droop, measured by the same criteria as before, is 10 percent).

The team is now hoping to demonstrate the benefits and pitfalls of graded barriers in real devices. "We have been cooperating with Epistar for a while," says Kuo. "We'll work together on this project."

C. -H. Wang *et al.* *Appl. Phys. Express* **5** 042101 (2012)

Optogenetics for GaN LEDs and CMOS sensors

Imaging the brain of a mouse with arrays of 470 nm LEDs and silicon pixels.

RESEARCHERS at Nara Institute of Science and Technology, Japan, claim that they have built the first integrated optical neural stimulation and observation device incorporating an LED and a CMOS image sensor. This device could aid researchers in the field of optogenetics, which involves the use of light to alter the behaviour of cells.

It is possible to build a similar system with an avalanche photodiode array rather than a CMOS sensor, which is an approach that has been adopted by engineers at the University of Strathclyde, UK. According to lead-author Takashi Tokuda from Nara Institute of Science and Technology, one of the advantages of the avalanche photodiode array is that it can deliver high-speed detection, which is essential for time-resolved fluorescence measurements. But he adds that this type of detector is unsuitable for on-chip imaging of biological cells and

tissues, because each of the photodiodes has dimensions of the order of 10 μm .

"The resolution of a conventional CMOS image sensor can be as small as 1-2 μm ," says Tokuda, who admits that he and his co-workers are still to shrink their pixels to such small dimensions.

The team builds its neural interface device by flip-chip bonding an LED-on-sapphire array to a CMOS image sensor. Thanks to very low levels of absorption of visible light in the sapphire and nitride layers of the LED, it is possible to place samples, such as a slice of brain, on the backside of the substrate. The neural interface device is formed by combining an array of 470 nm LEDs with a 128 by 268 array of detector pixels, each 15 μm by 7.5 μm . This has been used to image a slice of brain taken from a mouse.

This work is still in its infancy, and Tokuda admits that there is much to do before he and his co-workers will start to acquire high-quality images. In order to realise such images, an on-chip filter is needed to distinguish between emission resulting from fluorescence and light originating from scattering of the excitation source. In addition, detector sensitivity must be improved so that it is possible to measure very small changes in intensity, and the instrument needs to provide a higher spatial resolution, which will require reductions to pixel sizes and the distance between cell and target.

Tokuda and his co-workers will try to tackle many of these issues. Their goals for the future include shrinking the size of their LEDs and improving image performance.

T. Tokuda *et al.* *Electronics Lett.* **48** 312 (2012)

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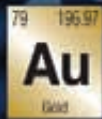
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LEDs

SETi & Cascade to develop UV LEDs for water purification

SETi's germicidal UV LEDs, comprising aluminium gallium nitride, will be used to provide potable water to small groups from any source of fresh water.

Sensor Electronic Technology, Inc. (SETi) and Cascade Designs, Inc. of Seattle, have signed a Joint Development Agreement to develop the next generation of portable water purification systems for commercial, military and disaster relief/humanitarian applications.

The water purification systems will use SETi's germicidal UV LEDs to provide potable water to small groups from any source of fresh water anywhere.

Germicidal UV LEDs are a new technology that offer an alternative to mercury lamps or chemical treatment and enables a compact, lightweight and mechanically robust disinfection solution that can stand up to the rigors of military and humanitarian use and, when powered with an alternative energy source, can offer a sustainable source of drinking water for many months.

Through a development program funded by the National Science Foundation (NSF), SETi has already successfully demonstrated the use of its germicidal UV LEDs in a bench top disinfection chamber. The collaborative effort with Cascade Designs will further this work and lead to the development of the first multi-stage UV LED-based water purification system.

Cascade Designs has forty years of experience developing and manufacturing innovative products for the outdoor and military markets. Under the MSR (Mountain Safety Research) and Platypus brand names, the company has a significant share of the portable, point-of-use water treatment market.

Cascade Designs is the standard issue supplier of sleep pads, snowshoes, camp stoves, and on the move water treatment systems for the U.S. Army and Marine Corps.

Together, the companies believe that UV LEDs, combined with proprietary filtration and absorption technologies, will have breakthrough potential for the military and humanitarian relief efforts.

"We see great potential in partnering with SETi," says Joe McSwiney, president of Cascade Designs, Inc. "With SETi's UV LED technology and our experience in designing and manufacturing a broad range of water treatment products, we believe we can develop revolutionary new water treatment systems that will advance the work we're already doing to supply the U.S. military and bring sustainable relief to people around the world who lack potable water."

Remis Gaska, president and CEO of SETi agrees. "With a

strong track record of taking new technologies to market, Cascade Designs is the obvious choice for SETi to partner with," Gaska says. "This collaborative effort will demonstrate the effectiveness in UV LEDs for Sensor Electronic Technology, Inc. disinfection and will not only address the need of the public sector markets, but will also pave the way for the development of UV LED based disinfection products in the private sector."

Cree's latest LED linear luminaire sets records

The module, suited to retail and industrial applications, integrates high efficacy, advanced optics and architectural design and is claimed to far outperform antiquated linear fluorescent technology

Building on the success of the CR Series LED Troffer, Cree, has revealed the CS Series LED Linear Luminaire, which delivers fast payback to low bay lighting applications.

Cree says the new high-efficacy suspended linear luminaire uses 40-50 percent less energy than comparable linear fluorescents and delivers an unmatched performance combination of up to 120 lumens per watt, 90 CRI and 75,000 hour lifetime.

Featuring Cree MicroMixing Optics, the CS Series brings a combination of performance, aesthetics, optimal light distribution and affordability to grocery stores, retail, showrooms, schools, offices, warehouses and light industrial environments.



Cree LED Linear Luminaire

"The CS Series LED Linear Luminaire is poised to revolutionize low and mid bay lighting applications just like the CR Series did for Troffers," says David Elien, vice president, Cree lighting.

"The Cree CS Series luminaire is unlike any other suspended linear lighting on the market today," adds Jason D. Curtis, principal, Cardinal Gibbons High School. "We researched the LED market extensively and only Cree offered a solution that delivered high-quality lighting and easy payback. Since the new CS Series is designed for 75,000 hours of life, Cardinal Gibbons High School can benefit from ongoing operational

savings due to decreased maintenance and lower energy consumption compared to the linear fluorescents we replaced.”

The CS Series is designed for low maintenance and long life – lasting up to three to four times longer than standard fluorescents and enhancing the appearance of any space. The new luminaire introduces a deceptively simple yet highly efficient optical design approach that integrates an upward-facing LED light strip with Cree TrueWhite Technology and an ultra-lightweight upper reflector, featuring all-new Cree MicroMixing Optics for precise optic control. The CS Series comes standard with 0-10V dimming control to five percent and features a seven year warranty.

“Everything we do at Cree is focused on accelerating LED acceptance and the latest CS Series innovation delivers on our promise and truly provides a no-compromise alternative to fluorescent lighting,” Elien continues. “Businesses no longer have to choose between colour quality and savings and no longer have to suffer the poor performance, toxic mercury and hazardous disposal expense inherent with fluorescent lighting. The colour quality and visual impact offered by Cree CS Series makes it the ideal solution for large retailers and industrial users.”

New, innovative Cree MicroMixing Optics are formed from thousands of tiny impressions imprinted on the state-of-the-art highly reflective polymer material. Unlike direct-view LED solutions, this multi-faceted pattern blends and softens the intense light and redirects it with precise control and colour mixing. The result is beautifully balanced white light with optimal distribution within the desired area.

The Cree CS Series LED Linear Luminaires are made in the United States and sold through Cree lighting sales channels with sample quantities targeted for availability in May 2012

Carsem focusing on LED manufacturing

The firm has successfully assembled and qualified high brightness silicon substrate LED arrays and will begin offering high-volume, full turn-key manufacturing services. These include electrical testing, laser mark and tape-and-reel production

Carsem is now entering a partnership with a key customer to assemble and further develop LED packaging technologies.

The manufacturing process fully utilises the advantage of standard mass production process of assembly and test including matrix substrate design; auto die attach, wire bond and high reflection coating dispense; compression moulding through automould system; mapping of units on substrate and bin sort per test mapping.

This silicon substrate LED array offers higher white light brightness with much less energy required (over 50 lumens/watt). The life expectancy of the product is estimated to be 10 years. General applications can be home use, cars and special lighting effects.

Albert Law, Carsem's V.P. of World Wide Sales and Marketing says, “Because of our extensive experience in providing turnkey solutions, we are able to share our expertise with our LED customers and assist them in getting their products to market faster with turnkey solution on high density and high volume packaging, Carsem is expanding the company's portfolio to include LED packaging solutions for the high brightness LED applications.”

Carsem's Chief Technology Officer, L.W. Yong adds, “By capitalising on our extensive semiconductor experience in materials, process & equipment we have successfully advanced into the LED arena and thereby enhancing the manufacturability and efficiency of high brightness LED.”

Hangzhou Silan Azure impressed with Veeco MOCVD systems

The firm has placed a multi-tool order to expand Silan's manufacturing capacity for blue and green nitride based high brightness LEDs

Hangzhou Silan Azure Co. Ltd., an LED manufacturer in China, has placed a multi-tool order for Veeco's TurboDisc K465i MOCVD systems.

Zhongyong Jiang, President of Silan Azure, comments, “The growth we are experiencing supplying LEDs for general illumination, backlighting and outdoor display applications required us to add manufacturing capacity at our Hangzhou facility. After evaluating various suppliers, we chose to purchase additional systems from Veeco because of our satisfaction with the production-worthiness and reliability of existing K465i MOCVD tools at our fab. The excellent field support we have received from Veeco was also a major factor in our decision.”

William Miller, Executive Vice President of Veeco Process Equipment adds, “We are pleased Silan Azure has chosen the K465i for their manufacturing expansion, and look forward to continuing to build upon our relationship with one of China's top LED manufacturers.”

Is Cree the best in LED luminaire test?

Maybe so. The Cree Technology Centre has achieved NVLAP accreditation with its comprehensive test for LED testing parameters for system design and quality Cree is adding “TEMPO 24” to its comprehensive suite of Cree Services for LED luminaires.

The new TEMPO (Thermal Electrical Mechanical Photometric Optical) 24 service combines IES LM-79-08 photometric testing with an extensive set of LED performance tests that it says, surpasses all industry testing parameters and can help ensure total system design and quality.

The Cree Durham Technology Centre has been accredited by The National Voluntary Laboratory Accreditation Program (NVLAP) and furthers Cree's commitment to helping LED manufacturers overcome design challenges and bring quality products to market faster.

"LM-79 is a necessary test and has become a requirement for doing business in the Solid State Lighting market," says Mark McClear, director of global applications engineering, Cree. "TEMPO 24 includes a fully accredited LM-79 test, but goes well beyond this or any currently existing standards. Cree has identified through our years of SSL experience nearly a dozen other potential problem sources of LED luminaire design. Our goal is the same as our customers - and their customers as well --quality SSL products that save energy. TEMPO 24 helps ensure this and gives customers the information they need to design and specify an SSL product with confidence."

"In my experience, if I had to select a single document that's had the greatest impact in selling LED light sources to customers, it would be the Cree TEMPO report," adds Pierre van Helden, CEO, LED Lighting SA. "The service provided an independent and thorough review for our products and the results give us the confidence to sell our products with passion--giving our customers the assurance that our products are being designed and produced to the highest international standards."

TEMPO 24 provides LED luminaire tests that are not offered by any other third-party testing facility. In addition to LM-79 testing which is an approved method for taking electrical and photometric measurements, TEMPO 24 testing includes binning and color point evaluation, chemical compatibility and TM-21 lifetime projection. TEMPO 24 examines all aspects of an LED design and provides customers a true assessment of luminaire performance that can be used to promote and distinguish their product. Every TEMPO service delivers an accurate, easy-to-understand TEMPO report that includes all testing results and relevant performance data.

Cree's Durham Technology Centre NVLAP accreditation (NVLAP lab code 500070-0) ensures that TEMPO measurements are performed according to the Illuminating Engineering Society (IES) approved method for the electrical and photometric measurements of LED lighting - delivering lighting manufacturers consistent, accurate and repeatable measurements for luminaires.

NVLAP accreditation signifies that a laboratory has demonstrated it operates in accordance with NVLAP management and technical requirements pertaining to quality systems, personnel, accommodation and environment, test and calibration methods, equipment, measurement tractability, sampling, handling of tests and calibration items, and test and calibration reports. Cree laboratories also work to American National Standards Institute (ANSI) and National Institute of Standards and Technology (NIST) requirements.

Cree currently provides TEMPO Services out of its Cree Technology Centre located in Durham, N.C. and Santa Barbara, California.

SDK and Toyoda Gosei JV to accelerate GaN LED business

While the JV will focus on gallium nitride LEDs, SDK will concentrate on the production of LED chips made from other materials such as aluminium indium gallium phosphide and gallium arsenide

Japanese firm, Showa Denko K.K. (SDK) is splitting its business in GaN-based blue LED chips to form a new joint venture with Toyoda Gosei.

SDK will transfer 70% of shares in the new company, tentatively be called TS Opto Co., Ltd., to Toyoda Gosei by the end of this year.

The JV will focus on the production and sale of GaN-based LED products and will be established at SDK's plant in Yawata Kaigan Dori, Ichihara City, Chiba Prefecture.

SDK is already cooperating with Toyoda Gosei, a developer and marketing of GaN LEDs. By establishing a joint venture with Toyoda Gosei for the GaN LED business, SDK will further strengthen relations between the two companies and expand overall supply capacity. At the same time, research and development at SDK will focus on improving LED brightness and production efficiency.

In the LED business other than in GaN LED chips, SDK will continue its independent operations. The firm is currently producing and selling a wide variety of LED chips, including those based on AlInGaP, GaAs, GaP and GaN.

The new company is scheduled to be established in December 2012 and the intended capital at the time of the formation is planned to be Y490 million (USD \$6.05 million). Seventy percent of the JV is to be owned by Toyoda Gosei and the remaining 30 percent by SDK.

Lumileds' new LUXEON R is appealing for outdoor lighting

The new LED lowers outdoor lighting system costs and improves efficacy Philips Lumileds has launched a new LED designed for outdoor and industrial lighting applications such as streetlights, high-bay lights, wall packs and bollards. LUXEON R is an Illumination Grade LED, and therefore is Hot Tested and Specified at $T_j=85^{\circ}\text{C}$ so that its performance at operating conditions is well understood. The new module offers Freedom From Binning to ensure uniformity from solution to solution. LUXEON R is also footprint compatible with LUXEON Rebel and LUXEON Rebel ES, while delivering more light output, higher efficacy and better quality of light.



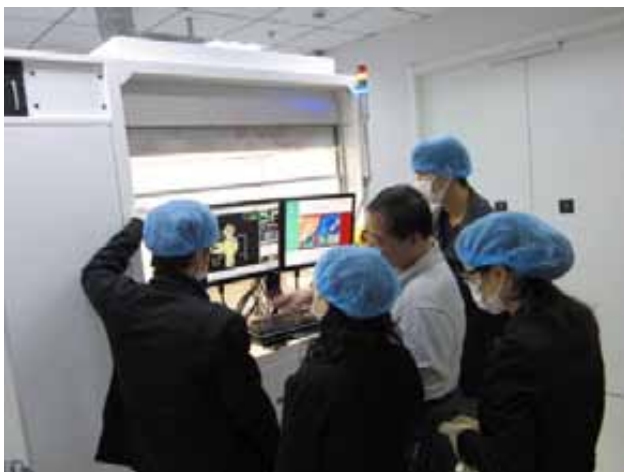
LUXEON R LED

The LED has a minimum colour rendering index (CRI) of 70, and minimum flux ranges from 160 to 200 lumens at a minimum forward voltage of 2.5V. Lumileds offers CCT options of 3000K, 4000K, 5000K, 5700K and 6500K. "LUXEON R represents the continued evolution of our industry-leading chip, phosphor, and packaging technologies", says Rahul Bammi, VP of Marketing at Philips Lumileds. "For our customers and ultimate end-users, our innovations are lowering the cost of providing ever improving lighting in parking lots and roadways." LUXEON R has already been implemented in Lumec's SoleCity, a uniquely modern family of outdoor lighting solutions that blends uniformity in design and optimum style with the performance and energy efficiency of LED technology.

Veeco Shanghai LED training centre reaches the 500 landmark

The centre trains customers on how to use the firm's MOCVD reactors employed in LED manufacturing and has been commended by Sanan Optoelectronics and Elec-Tech International

Veeco Instruments says that it has trained its 500th customer engineer at its state-of-the-art China Training Centre (CTC), located in Shanghai.



Veeco's China Training Centre, located in Veeco China's headquarters building in Shanghai

The CTC opened in mid-2011 to help key LED manufacturers, including its two largest customers, Sanan Optoelectronics and Elec-Tech International, scale-up production, optimise their use of MOCVD systems, and support the industry's rapid growth.

Lin Zhiqiang, Chief Executive Officer of Sanan Optoelectronics, comments, "We congratulate Veeco on achieving this impressive milestone. By having a strong presence in China and establishing this state-of-the-art centre, Veeco has demonstrated industry leadership not just in MOCVD technology, but in customer support as well."

"Sanan recently achieved record revenues in 2011 as an industry leader of high quality LEDs for applications such as general illumination, TV backlighting and outdoor displays. Veeco is helping Sanan to maximise the future LED growth opportunity by supporting our training needs and capacity ramp. We look forward to continuing our prosperous relationship with Veeco," she concludes.

Greg Crema, CEO of Elec-Tech International's LED Business, adds, "Veeco was first to recognise the importance of customer training as critical in the recipe for success in China. Their strong support, particularly in helping to train our engineers at the CTC, has enabled us to make significant progress scaling LED manufacturing capacity at our two sites in Wuhu and Yangzhou. Our goal is to become a top-three LED company by output and sales revenue in China within two years, focusing on the general lighting and BLU market, as well as other applications."

John Peeler, Veeco's Chief Executive Officer, comments, "In 2010 and 2011 China made an enormous investment to expand LED manufacturing capabilities to respond to its energy challenges and capitalise on the global opportunity as LED lighting hits an inflection point. During this timeframe, Veeco shipped over 400 MOCVD systems to Chinese customers, including the established LED manufacturers, joint venture entities, and start-ups. Every one of these customers is unique, and we are focused on delivering the best-in-class support and systems they will need for future growth and success."

Veeco's CTC is located in Veeco China's headquarters building and staffed by local, highly trained Veeco instructors. Approximately 1,700 square metres in size, it features three fully equipped classrooms as well as Veeco's TurboDisc K465i MOCVD System for hands-on training. The CTC has a comprehensive schedule of classes including basic MOCVD system training, epitaxial layer optimisation introductions and advanced hands-on classes in hardware maintenance and trouble-shooting.

Neo inaugurates gallium tri-chloride plant in Korean Republic

This manufacturing plant is now operational and is situated in

the heart of Korea's booming LED industry

Neo Material Technologies Inc. (Neo) has officially opened its gallium tri-chloride production facility in Hyeongok Industrial Zone, in the Republic of Korea.

Following the Company's acquisition of an 80% ownership in Oklahoma-based Gallium Compounds in August 2011, Neo initiated the design and construction of a new facility in Korea, utilising Gallium Compounds' technology for the production of gallium tri-chloride in Asia.

This second manufacturing facility is now operational and is strategically situated in the heartland of Korea's booming LED industry. This new plant will supply Asian markets as well as serve as a back-up for the plant located in Quapaw, Oklahoma. Neo owns 80% of this new production facility with the remaining 20 percent owned by the founders of Gallium Compounds, Greg Evans and Kevin Reading.

"We are extremely pleased with the progress we have made in the gallium tri-chloride market since acquiring a majority stake in Gallium Compounds," says Geoff Bedford, Executive Vice President and COO. "Our ability to have this new, state-of-the-art plant in operation within seven months is a testament to our ability to execute quickly in a high growth market. This is an important step in our growth strategy for rare metals."

Neo is a producer, processor and developer of many materials that are used in many of today's high technology products. These include rare metals products such as gallium, which are used in the wireless, LED, flat panel and solar industries.

Nichia fights back against Everlight in Germany

Yet another nitride LED patent infringement lawsuit has been filed, this time in Germany by Nichia

On April 18, 2012, Nichia Corporation filed a patent infringement lawsuit in Germany at the District Court Düsseldorf against the Taiwanese LED manufacturer Everlight Electronics Co., Ltd. and its German subsidiary Everlight Electronics Europe GmbH. In the lawsuit, Nichia is seeking permanent injunction, rendering account and damages against a white LED product (product number: SMD Low Power LED 61-238/LK2C-B56706F4GB2/ET) manufactured by Everlight, which Nichia believes infringes Nichia's YAG patent EP 936 682 (DE 697 02 929). On April 23, 2012, Nichia also filed another patent infringement lawsuit in Germany at the District Court Düsseldorf against the German distributor Future Electronics Deutschland GmbH selling the above mentioned Everlight's white LED product, which Nichia believes infringes Nichia's YAG patent EP 936 682 (DE 697 02 929), seeking permanent injunction, rendering account, damages, recall and destruction.

Blue hue high power diode for laser projectors

Osram's latest indium gallium nitride laser diode is also suited to other applications for high power components. These range from laser systems for stage and decoration illumination to medical applications

Osram Opto has unveiled its new high power laser diode, the PL TB450.

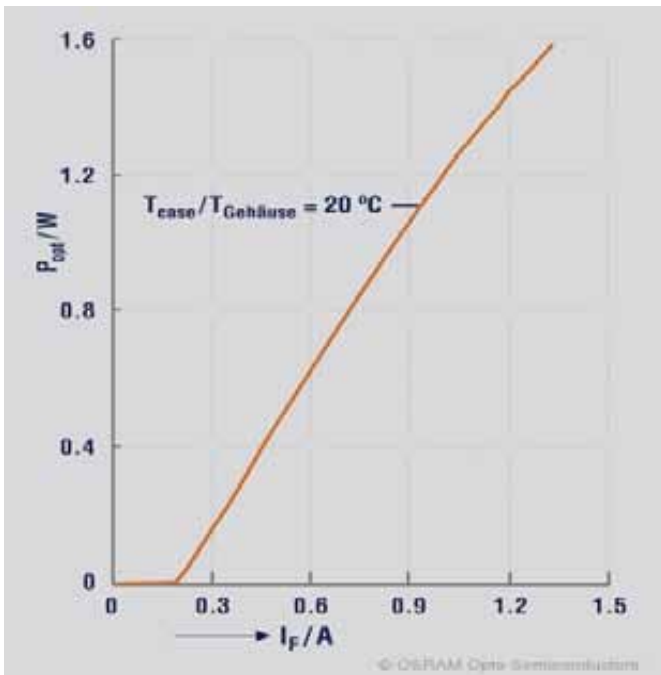
Mounted in a compact TO56 package, the blue laser diode has an optical power of 1.4 W. This makes it particularly suitable for high quality professional projectors.



Blue high power laser diode PL TB450

Professional projectors with a luminous flux of more than 1000 lumens are the main area of application for the PL TB450. With its wavelength of 450 nm, Osram says it produces exactly the wanted blue, and with 1.4 W (at room temperature and a current of 1.2 A), the high optical power required. The diode can be used at an operating temperature of 0 to 70 °C.

Its high efficiency of 27 percent means the temperature of the laser will rise only slightly. The efficiency is the ratio of light produced to electrical power consumed. Osram boasts the PL TB450 has a long service life, depending on its use, and up to 10,000 hours at 40° C in continuous operation. The long lifetime of projectors incorporating these devices promotes maintenance-free operation at low energy consumption.



Performance of PL TB450

There are various approaches for the use of the laser diode in a professional projector. Usually, red LEDs are combined with blue high power lasers. The green colour emerges when blue lasers excite a special phosphor to emit light. Red light can also be generated this way so that the projector light source can be designed without red LED, thus turning out even smaller, if needed.

“By starting serial production of a blue high power laser diode in the 1-Watt power range we further strengthen our leading role in the field of blue lasers,” points out Thomas Hofer, Head of R&D for infrared products and lasers at Osram Opto Semiconductors. “When developing these diodes we were able to draw on many years of experience with other types of lasers. And we could also implement the results of publicly funded research projects.”

The basic technologies for indium gallium nitride laser diodes had been developed in the course of the MOLAS Project, supported by the German Federal Ministry of Education and Research.

Multi-tool order shipped to global LED supplier by OEM Group

The firm's Cintillio surface preparation systems will be used in the manufacture of 150mm LED wafers

Global semiconductor capital equipment manufacturer OEM Group delivered the first systems of a multi-tool order to a major LED manufacturing innovator earlier this month.

The order included surface preparation tools Spray Ozone Tool (SOT) and Spray Acid Tool (SAT), from the firm's Cintillio product line, acquired from Applied Materials-Semitoil in May 2011.



Cintillio Spray Ozone Tool CintillioSAT Batch Spray System

“Cintillio's innovative and proprietary Enhanced Spray Technology, featuring up to six rows of nozzles, ensures high throughput and reliable wafer surface wetting with chemical mixtures,” comments OEM Group Chief Technology Officer Christian Forgey.

“Cintillio breaks technological ground in 25/50-wafer batch

process by offering a common platform for solvent, acid and ozone applications. And with the smallest cabinet footprint (1.78m²) among similar equipment, SAT/SOT saves fab-floor real estate while its convenient side access makes routine maintenance checks both safe and user friendly.”

Back in 2009, SOT’s HydroOzone post-ash clean was honoured with SEMICON West’s “ Sustainable Technologies Award”. The tool is claimed to eliminate thousands of gallons of sulphuric acid and hydrogen peroxide and reduce deionised water consumption by 84 percent. OEM Group says it also reduces cycle time and defects and increases yield.

OEM Group’s customer, an international supplier of LEDs for display, backlighting, automotive and general lighting applications, says it chose Cintillio SAT and SOT “because of the systems’ flexibility to handle both resist strip as well as organic cleaning after etching,” Forgey adds. The systems will support the LED manufacturer’s 150mm wafer production.

“Like so many chip makers we’ve talked with since we acquired the Cintillio portfolio last May, our LED customer was particularly impressed by the cost-effective high throughput potential of SAT and SOT. Because of Cintillio’s semi-automated batch-system capabilities, numerous wafer lots may be processed simultaneously. And that saves fab time and money,” OEM Group CEO Wayne Jeveli, says.

The Cintillio line also includes the single- and dual-chamber Spray Solvent Tool (SST) with one, two or three chemical system configurations that accommodate most solvent-based process applications.

Cintillio is the eleventh product line addition to OEM Group’s LEGENDS portfolio, which was launched at SEMICON West in 2008.

“Since our debut, LEGENDS systems have steadily expanded their reputation as field-proven and game-changing for both established semiconductor markets and emerging-technology innovators,” Jeveli says.

“The spray system manufacturing expertise we gained through last year’s (Applied Materials/Semito) acquisition bolstered LEGENDS’ value proposition by adding cutting-edge and proven dry-in/dry-out wet chemical process technology that optimises our customers’ processing times and return on investment,” he concludes.

SETi breaks barriers with UV-C LED efficiencies of over 10%

Bringing consumer disinfection markets within reach, SETi has developed a completely new p-type region using doped transparent aluminium gallium nitride. This, together with a transparent p-contact, significantly increases extraction efficiencies

Sensor Electronic Technology, Inc (SETi) has achieved, what

it says, are record efficiencies of ultraviolet light (UV) LEDs operating in the germicidal UV-C range.



UV Germicidal LED lamps with the power to disinfect water, surfaces and air

Literature says that the UV-C range peaks at around 254nm although the latest LEDs developed by SETi have been designed to emit at 278nm. The firm’s latest devices have an external quantum efficiency of 11% with a corresponding wall-plug efficiency of 8%. SETi says this is an “industry beating result”. It was achieved under the DARPA Compact Mid-Ultraviolet Technology (CMUVT) program and performed in collaboration with Army Research Laboratories (ARL). This latest development represents more than a five times improvement in performance. Traditionally, UV LEDs have been manufactured with GaN p-layers, due to the difficulties of p-doping AlGaIn materials. However, GaN absorbs wavelengths shorter than 365nm, reducing the extraction efficiency of UV LEDs operating at short wavelengths. SETi has now developed a completely new p-type region using doped AlGaIn, which is transparent, even in the UVC range. This coupled with a transparent p-contact significantly increases extraction efficiencies. The firm has also enhanced its proprietary MEMOCVD growth process to reduce dislocation densities in the quantum well structure of UV LEDs grown on sapphire substrates. The company has demonstrated threading dislocation densities of less than 2×10^8 , as measured by TEM. This improvement leads to a high internal quantum efficiency of 60%. “This milestone is a very exciting development of UV LEDs, and represents a major step forward in reaching efficiencies of incumbent technologies, such as medium pressure mercury vapour lamps, which typically operate at efficiencies of 15% or less,” notes Remis Gaska, President and CEO of SETi. The 350µm x 350µm encapsulated LEDs were designed for emission at 278nm and measured independently at ARL. SETi says the emission of 9.8mW at 20mA is the highest value ever reported for an LED shorter than 365nm at this forward current, and 30mW at 100mA. Details of the research will be presented at CLEO 2012 meeting, San Jose, California. SETi has previously reported LED based water treatment systems that disinfect with over 4 log reduction drinking water flowing at 0.5 litres per minute with less than 35mW of optical power at 275nm. The results from this development put UV LED disinfection systems within the reach of consumer markets for applications such as point of

use water purification.

Veeco celebrates growth of LED industry in Korea

Ceremony held recognising Veeco's investment in a new development centre devoted to accelerating the MOCVD technology used to make LED lights

Veeco Instruments recently participated in an investment signing ceremony at the 2012 Korea Investment Forum in New York City to commemorate the company's substantial investment in a new R&D facility in Seoul, Korea to advance high brightness LED technology.

The Investment Forum event, jointly sponsored by the Korea Trade-Investment Promotion Agency (KOTRA) and the Korea Ministry of Knowledge Economy (MKE), brought together government officials, investors, industry experts and business leaders from South Korea and the United States to celebrate and promote investment in South Korea by U.S.-based companies.



From left to right, Ki-won Han, Commissioner, InvestKOREA; Jin-Hyun Han, Deputy Minister, Korea Ministry of Knowledge Economy; and John P. Kiernan, Senior Vice President, Finance, Corporate Controller and Treasurer, Veeco Instruments, after a signing ceremony recognising Veeco's investment in a new Development Centre devoted to accelerating the MOCVD technology used to make LED lights

KOTRA (Korea Trade-Investment Promotion Agency) is Korea's national economic development agency and is committed to promoting collaborative business relationships between the United States and Korea. InvestKOREA is a division of KOTRA and is responsible for attraction of foreign direct investment.

New energy efficiency symbols for LED lighting and solar power

A collaborative workshop between Cree and The Noun Project has created new universal symbols for LED lighting

As the world prepared to celebrate Earth Day, which took place yesterday, Cree and The Noun Project released 15 new symbols for energy-efficient technologies. These included symbols for LED lighting, solar farms and solar panels. The logos were designed during the recent Iconathon at the Cree campus in Durham. "By collaborating with The Noun Project, we now have a universal symbol that represents LED lighting, filling a significant void in the energy-efficient lighting landscape," says Ginny Skalski, social media specialist, Cree. "As Cree continues leading the way for LED lighting adoption, this new icon will allow the public and the media to stop using antiquated Edison or swirly CFL bulb designs to symbolise lighting." The day-long collaborative workshop, led by The Noun Project co-founder Edward Boatman, included nearly 40 attendees who sketched new symbols for LED lighting and a variety of energy-efficient technologies. All of the designs were discussed and critiqued to ensure the best iconic representation for each of the 15 energy-efficient technologies and concepts, including wind and solar farms and energy audits. The sketches were recently digitized and are now available for public use under a Creative Commons license. "One of the core themes that emerged from the group discussions was that LED is a radically different light source from any of its predecessors," says Boatman. "Therefore, we all felt it was appropriate and necessary to break free from any past 'light bulb' design elements. LED lighting needed to have its own distinct and identifiable mark." "As a group we decided that the two essential elements to the final design were the LED component that produces the light, and of course light itself," Boatman continues. "The final design honours both of these elements with a three-dimensional diamond shape representing the component and the use of negative space to represent a powerful and focused beam of light." The Noun Project is a growing open sourced visual library of the symbols and icons that form the world's visual language. The Noun Project organises Iconathons around the country to collaboratively design new sets of civic symbols.

Everlight suing Nichia over LEDs in the U.S.

The battle between two of the major competitors in the LED manufacturing industry is hotting up

Everlight Electronics has filed a patent infringement lawsuit against Nichia in the United States District Court for the Eastern District of Michigan.

The lawsuit seeks to enjoin Nichia from manufacturing, using, importing, offering for sale, or selling its infringing products in the United States. Everlight is also seeking monetary damages.

What's more, Everlight is also asking the U.S. Court to declare two Nichia patents invalid, unenforceable and improperly issued by the U.S. Patent Office.

Everlight is seeking enforcement of a patent covering LED metallisation technology (U.S. Patent No. 6,653,215). Everlight says it is the exclusive U.S. licensee of the '215 Patent, which is owned by Emcore.

Uses for Nichia's LEDs being sold in the U.S. that are alleged to infringe on the '215 patent include residential lighting products, street lights and spotlights.

As we know, the market for these products is growing rapidly in the U.S. as consumers, electric utilities, and utility regulators all seek to reduce overall electricity consumption and cost. Highly energy-efficient LED lights consume substantially less electricity than equivalent incandescent light bulbs.

LED lights also last more than 100 times longer than equivalent incandescent bulbs and more than 10 times longer than equivalent compact fluorescent bulbs.

Everlight is also asking the U.S. Court to declare that Nichia's U.S. Patent Nos. 5,998,925 and 7,531,960 are invalid, unenforceable and improperly issued by the U.S. Patent Office and that Everlight's LED products do not infringe on those patents. The patents in question cover the use of certain types of phosphors in producing white-light LEDs.

Cree incomes slashed 50% from Ruud Lighting acquisition

Although order visibility is still limited, the firm believes it is well positioned to continue to lead the transition to LED lighting and drive growth in its business

LED innovator and dabbler in RF and power electronics, Cree, has reported its GAAP financial results for the third quarter of fiscal year 2012.



Cree 's revenue was \$284.8 million for its third quarter of fiscal 2012, ended March 25, 2012.

This is a 6% decrease compared to the second quarter of fiscal 2012. Net income for the third quarter was \$9.5 million, or \$0.08 per diluted share, a decrease of 50% year-over-year

compared to GAAP net income of \$18.9 million, or \$0.17 per diluted share, for the third quarter of fiscal 2011.

Revenue for lighting products did fall by almost 10% however, from \$95.7 million to \$86.5 million. This was mainly down to Cree integrating with Ruud Lighting and using a new bunch of agents.

"Our third quarter earnings per share were in the middle of our target range as strong factory execution and a tax benefit offset the impact of revenue being slightly below our target range," states Chuck Swoboda, Cree Chairman and CEO.

"Overall company backlog is stronger than it was at this point last quarter, with Lighting, LEDs and Power and RF all tracking ahead of Q2, although order visibility is still limited. Our focus remains on driving adoption through innovation and we believe we are well positioned to continue leading the transition to LED lighting and drive growth in our business."

Gross margin increased 30 basis points from Q2 of fiscal 2012 to 34.9% on a GAAP basis. Cash and investments increased \$22.8 million from Q2 of fiscal 2012 to \$710.1 million.

Net accounts receivable increased \$11.8 million from Q2 of fiscal 2012 to \$168.2 million, with days sales outstanding of 53.

Inventory increased \$9.5 million from Q2 of fiscal 2012 to \$196.8 million and represents 96 days of inventory.

Business Outlook (GAAP)

For its fourth quarter of fiscal 2012 ending June 24, 2012, Cree targets revenues in a range of \$295 million to \$315 million with gross margin targeted to be around 35%. Gross margin targets include stock-based compensation expenses of approximately \$2.5 million.

Operating expenses are targeted to increase by about \$5 million. The tax rate is targeted at 13.0% for fiscal Q4. Net income is targeted at \$5 million to \$12 million, or \$0.04 to \$0.10 per diluted share. The net income targets are based on an estimated 116.6 million diluted weighted average shares.

Novel RPCVD growth improves BluGlass's GaN film quality

TEM has shown that the crystalline gallium nitride films, grown using low temperature RPCVD, are of excellent quality. An optimised growth method minimises impurities to acceptable industry levels

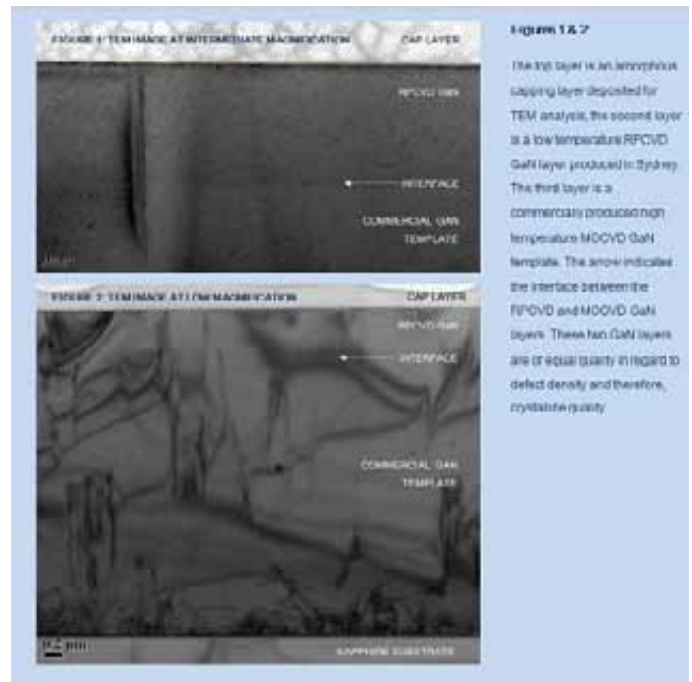
Sydney-based firm BluGlass says it has advanced its proprietary RPCVD technology and is now producing high quality GaN at low temperature on a commercial MOCVD GaN template. Transmission Electron Microscopy (TEM), performed by a third party, has revealed that BluGlass's latest Remote Plasma Chemical Vapour Deposition (RPCVD)

growth technology has minimised impurities to within industry acceptable limits.

The Australian-based firm says that the TEM report confirms an impressive microstructure with a defect density comparable to commercial MOCVD grown with a GaN underlying template. BluGlass reckons that its low defect density highly crystalline material grown at low temperature is a breakthrough, and is essential in demonstrating that its RPCVD method is commercially viable for LED chip growth. The firm believes its flexible RPCVD technology, because of its low temperature, offers manufacturers many potential benefits including higher efficiency, lower manufacturing costs and greater scalability. The superior material quality has been achieved partly due to reducing trace amounts of chemical impurities incorporated in GaN films during growth. In the past, BluGlass research has been limited by the presence of two impurities which were severely affecting material quality; oxygen and carbon.

Through hardware upgrades and process changes, oxygen impurities have been reduced to almost commercially acceptable levels and the firm says the material is no longer a hindrance to material quality. BluGlass says that carbon impurities are also being reduced towards industry acceptance with its new growth approach. BluGlass CEO, Giles Bourne comments, "These achievements demonstrate, for the first time, that high crystalline GaN films can be grown at low temperature using RPCVD. This is a critical step in proving to industry the potential of breakthrough technology. A low temperature commercial process would have been truly exciting implications for the LED industry. It has the potential to offer significant advantages for both device performance and low cost manufacturing." The company is now focussing on tweaking the process to reduce the impurities to within industry accepted limits.

The successful reduction of these impurities should enable BluGlass to achieve, in the short term, two main milestones. The first is to produce films with properties similar to MOCVD grown films with industry accepted electrical properties. The company is also striving to improve device efficiency and confirm the competitive advantages of its RPCVD process. BluGlass believes that achieving these targets will lead to customer engagement and the placing of a demonstration tool with a leading LED manufacturer. A basic LED is composed of multiple semiconductor layers. Low defect density, or high crystalline quality, are critical in order to achieve the necessary device performance for commercial applications. Attaining a low defect density is vital in improving device performance. TEM images illustrating the low temperature RPCVD top GaN layer are shown below in Figures 1 and 2. BluGlass says the defect density is not generally higher than those observed in a typical underlying high temperature, commercial MOCVD GaN



template. BluGlass adds that this dramatic improvement for RPCVD is largely due to the reduction of impurities incorporated in the GaN layer during growth. As its technology team continues to further reduce impurities, BluGlass is aiming to file patents for its novel RPCVD technology in the near future.

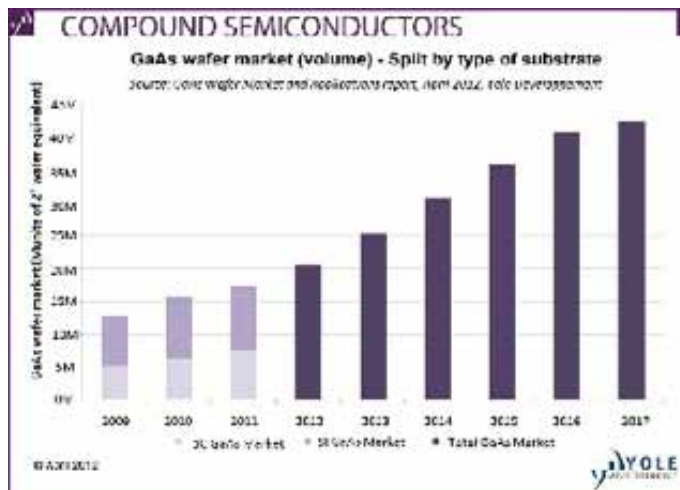
GaAs back on track with expanding RF wafer market

But LEDs will rapidly lead the growth according to Yole Développement's latest analysis

According to the new report "GaAs Wafer Market & Applications," the GaAs wafer market should represent a business of over \$650 million by 2017.

After the large recovery growth from 2009, the GaAs substrate market dramatically weakened in 2011 due to low demand for RF circuits, used in handsets and WLANs, and in optoelectronics, in particular, LEDs and laser diodes. With LEDs, there are now other substrates that companies are focussing on.

Apart from sapphire and gallium nitride, which are both very costly, silicon is the one to watch out for. Regarding power devices, silicon is also a main contender but on the whole, progress appears to be slow, particularly for 6" and 8" development. Since the strong growth rate of over 22% achieved in 2010, the GaAs substrate market only increased by just over 4% in 2011, reaching a value of nearly \$360 million.



On the plus side, the market is expected to recover in 2012. This would come down to a number of factors. The sheer volume of the handset market and the consolidation of the LED industry, after inventories have run out would be two of the major ones. By 2017, Yole believes that the GaAs substrate market should be worth over \$650 million, growing at a CAGR of nearly 12%. This would be fuelled primarily by the increasing GaAs content in handsets and the growing demand for LEDs in general lighting and automotive applications. Initially, RF electronics, which include power amplifiers and switches to name just a couple of devices, represented the main market for GaAs wafers and will continue to feed the business in the coming years.

The need for more sophisticated smartphones, faster 3G/4G networks and the increased demand for data communication will be the driving force in the GaAs substrate market. Having said that, recent developments in GaAs based technology is enhancing the market with high volume applications. LEDs are currently the main booming market due to advantages offered over traditional light sources and government initiatives encouraging the eco-friendly technology. Other devices such as solar cells for High Concentration Photovoltaic (HCPV) will also add to the development of the GaAs substrate market, but maybe not as much. Yole says that in 2011, the million dollar Semi-Inductive (SI) GaAs substrate market represented about 56% of the overall GaAs substrate market whereas Semi-Conductive (SC) GaAs accounted for around 44%.

“This trend is likely to reverse at short term as GaAs substrate demand for LEDs should rapidly surpass demand for RF electronics devices,” explains Pars Mukish, Technology & Market Analyst, LED & Compound Semiconductor at Yole Développement.

On a global scale, the LED penetration rate is increasing in several applications such as TV, signs & displays. But having spoken to industry experts, LED backlighting in TVs is often not worth the extra cash. It may sound flashy to have an “LED TV” but do the benefits outweigh the costs? General lighting is the next killer application for LEDs and should boost the SC GaAs substrate market by 2012-2013 if the basic technology improves and enhances LED efficiency and increases the total amount of light generated per package. What’s more, the automotive industry is also shifting from the use of traditional light sources to LEDs for products such as headlamps and interior lights. Because of this, the demand for SC GaAs

substrates and SI GaAs substrates is expected to be similar by 2013. This would largely be down to the steady growth of the RF electronics market rather than the currently booming optoelectronics market.

Following the earthquakes and tsunami which devastated northeast Japan in 2011, several Japanese manufacturing plants were destroyed. This strongly impacted the production capacity of some key GaAs substrate suppliers who lost market share to the gain of some competitors. Whether these companies will invest to recover operations, reduce operations or exit the business is still unclear. But the GaAs wafer industry is evolving and some players have already announced plant expansion in order to increase market share. “At this level, due to its lower labour cost, China seems the new “El Dorado” of GaAs wafer manufacturing: all expansions plans announced will be localised in the country,” says Brad Smith, Senior Analyst, from the Compound Semiconductor division for Yole Développement. All in all, here’s looking to a great year for GaAs!

EPIC appoints a new Director General to advance semiconductor photonics

The organisation aims to aid members in further developing display, laser, lighting, optical fibre, optic, photovoltaic, sensors and telecommunication technologies

The European Photonics Industry Consortium (EPIC), announced at its annual general meeting that Carlos Lee has been appointed as its next Director General.



Carlos Lee

He will succeed Thomas Pearsall who has led the association since its founding in 2003. Lee will take up the position immediately.

Carlos Lee is currently Director General at SEMI Europe, the Semiconductor Equipment and Materials Industry Association, where he leads the advocacy program. He has 15 years of experience in industry association management and extensive experience in building membership value. In the past he has

concentrated on standardisation, collaboration, networking platforms and events, and other activities of collective interest that benefit the industry at large.

Drew Nelson, CEO and President of IQE, and current President of EPIC says, "Carlos' appointment comes at a time of growth for EPIC. Over the last years we have increased our work in supporting our members and their business and in developing photonics technologies and innovation both in Europe and world-wide. Our objective is to build on this foundation, to further provide a strong platform supporting all actors and in particular SMEs. Carlos has a real passion for collaboration and is excellent at engaging members into working together to create value."

Welcoming his successor to the role, the current Secretary General Thomas P. Pearsall, adds, "I take particular pleasure to announce the successful completion of our campaign to recruit the next leader of EPIC. We have benefitted throughout from contributions from our membership and our Board in a search and dialogue with candidates with international experience at the highest levels. Carlos emerged as our first choice because of his experience and his energy to drive new initiatives to benefit our members. I will be working with Carlos throughout 2012 to help ensure a successful transition."

During his address to the EPIC membership, Carlos Lee comments, "As Director General I will further expand the solid value proposition for our members active in displays, lasers, lighting, optical fibres, optics, semiconductor, photovoltaics, sensors, telecommunication and other critical photonic related fields. I am pleased to announce that EPIC will open an office in Brussels. We will implement closer collaboration with the EU in order to better represent the interests of our members and photonics, a Key Enabling technology and future EU Public-Private Partnership."

With 80 voting members and over 400 associate members, EPIC is one of Europe's leading photonics industry associations. It promotes sustainable development for European organisations working in photonics. Working together, EPIC members have played a leading role in creating and operating the European Technology Platform, Photonics-21, as well as many influential European projects, such as LIFT for fibre laser development, and Nexpresso which supports commercial innovation by SMEs.

A solution for every lighting idea

Osram partner network "LED Light for you" went on show at the Light + Building 2012 from April 15th to April 20th. True to the motto "You have the idea – we have the solution" the Osram partner network will be demonstrating how architects, lighting consultants and luminaire designers can benefit from the certified expertise of LLFY members.

Since its establishment in 2006, "LED Light for you" (LLFY) has been providing professional support on LED lighting issues. At the Light + Building fair, the 16 international partners of "LED Light for you" will be demonstrating how they

develop individual, precisely tailored LED light solutions – for large, medium-sized and small manufacturers, as well as for specialists and newcomers in a wide range of fields and sectors. Many light solution manufacturers don't manage to harness the full potential of innovative, path-breaking LED lighting, which offers a virtually unlimited array of design and application options. In response, over 90 certified LLFY partners worldwide have proclaimed it their goal to provide advice on the development of standard solutions but also, and most especially, on the implementation of exceptional ideas, taking due account of the respective field of application and individual wishes. In other words, "LED Light for you" is a knowledge platform, providing advice exclusively from highly qualified partners specialised in optics, thermal management and electronics as well as comprehensive system integrators. All of the partners of the Osram network established in 2006 have undergone an extensive certification process and receive ongoing training.



Picture: OSRAM "You have the idea – we have the solution" – this is the motto for the 16 partners of the OSRAM network "LED Light for you" presenting themselves at the Light+Building 2012 – the world's biggest trade fair in the light and building sector.

"The experts in our network are professionals from such fields as optics design and thermal management or the system integrators. Offering wide-ranging specialist knowledge, they are available to help with all LED lighting problems and provide straightforward support with the implementation of new ideas. Instead of conducting their own research, customers can simply submit their ideas to the network and the appropriate partner will contact them directly. Needless to say, every project is treated in the strictest confidence to ensure that unique ideas remain unique," says Sebastian Lyschick, LLFY Project Manager at Osram Opto Semiconductors. At the Light+Building trade, "LED Light for you" will be located in Hall 4.1, Booth D 50.

Everlight shows off its Shwo D LED lighting series

The firm's new LED combines high power, luminosity and value for money for advanced lighting applications

Taiwanese firm Everlight Electronics is introducing a brand new high power, high brightness LED package, the "Shwo D" Series.



LED from the Shwo D series

This powerful bright and economic LED series come in a compact 3.5 x 3.5 x 0.58mm ceramic package.

The Shwo D series is a surface-mount high-power device featuring high brightness that is suitable for all kinds of lighting applications such as general illumination, flash, spot, signal, industrial and commercial lighting. With a standard operating current of 350mA, the Shwo D family can be driven at 1 W.

The minimum luminous flux (lm) of the 1W Shwo D can be up to 110 lm at 6500K (CCT) or 80 lm at 3000K (CCT) when driven at 350mA of current.

The thermal pad of this device is electrically isolated providing convenience in thermal and electrical design. The Shwo D series also has the advantage of low thermal resistance. It is one of the most promising devices in Everlight's high power Lighting Series product offering and is ready to face the challenges of today's Solid-State Lighting requirements. .

With ESD protection up to 8KV, the soldering method is SMT and the moisture sensitivity is level 1 . The LED is RoHS compliant and matches ANSI binning. The lumens maintenance testing conforms to IESNA LM80 test method applications. Directional lamps incorporating the LED are the MR16, GU10, and PAR . These are suited to spot lighting, flash and street lighting.

Intematix unveils remote phosphor for high-intensity LED lighting

The addition of the latest ChromaLit product expands the market with high lumen output and neutral off-state colour

Intematix, an innovator of patented phosphors and phosphor components for high-quality LED lighting, has released the ChromaLit XT.

This is the latest product in the award-winning ChromaLit line of remote phosphor technology.

Using a phosphor composite substrate separated from the blue LEDs, ChromaLit is claimed to increase light quality and lower systems costs. Intematix says improving on the conventional approach where phosphor coats the blue LEDs directly, ChromaLit offers glare-free, diffuse light, high colour rendering and consistent light quality.

By only using a blue LED engine instead of binned white LEDs, production is streamlined and inventories are reduced. What's more, system efficacy is increased by up to 30%, reducing lighting system material cost and power consumption.

Intematix says the ChromaLit XT offers a powerful and elegant solution for new applications like spotlights and floods, extending ChromaLit technology's light quality and adding higher light intensity, 65% lower cost per lumen. It is also claimed to enhance off-state neutral colour when compared to conventional remote phosphors that are yellow in colour. ChromaLit XT were on display for the first time at the Light+Building trade fair in Frankfurt, Germany during April 15th to 20th.

"ChromaLit XT is designed for the many applications that need high lumen output from a small space," says Julian Carey, Senior Director of Marketing at Intematix. "Lighting designers and architects will appreciate the ability to take advantage of ChromaLit's substantial benefits without sacrificing aesthetics based on ChromaLit XT's unique off-state neutral colour."

"ChromaLit XT allows us to push the envelope when it comes to providing higher outputs for smaller lighting apertures incorporating remote phosphor technology," adds Andrew Littler, Director of Vexica, an LED lighting solutions company.

Vexica's LUMAERA-50-RP module incorporates ChromaLit XT to provide customers with a wide range of LED solutions without expensive research and development costs. "The high CRI we can achieve with our LUMAERA-50 module using ChromaLit XT is a huge advantage for professional specification clients such as lighting designers and architects. Intematix is offering us a solution that gives us a competitive advantage in the high quality lighting arena."

ChromaLit XT is optically treated to maintain an off-state neutral appearance in order to look as good off as it does on – perfect for lighting designers. The added design freedom of ChromaLit XT means users can let exposed lights like pendant lamps and downlights integrate with the rest of the space without

sacrificing the high performance of ChromaLit. In highly visual environments like restaurants and hotels, ChromaLit XT allows fixtures to complement the design flow.

ChromaLit XT can also be used to make lighting better outdoors and meets UL standards and is offered in a wide range of CCT and CRI options. ChromaLit recently won a Product Innovation Award from Architectural SSL magazine in the "Arrays/Light Sources" category.

ChromaLit XT products are now available through Intematix sales and distribution partners Future Lighting Solutions and Digi-Key Corporation.

Shedding light on the p-type doping of GaN

UCSB theorists have revealed that magnesium in GaN is not a typical shallow acceptor

All electronic and optoelectronic devices require the ability to controllably dope the semiconductor.

Adding small amounts of impurities makes the material a conductor for electrons (*n*-type) or for holes (*p*-type).

In GaN, a material that enables the rapidly expanding technology of solid-state lighting and power electronics, *n*-type doping is straightforward, but adequate *p*-type doping is still difficult to achieve. According to UCSB researchers, intriguingly, magnesium is the only impurity that can turn GaN into a *p*-type semiconductor.

What's more, optical spectroscopy techniques that are routinely applied to characterise dopants in semiconductors have produced results for magnesium that are hard to reconcile with shallow-acceptor behaviour.

Magnesium-doped GaN exhibits two main photoluminescence signals; a peak in the ultraviolet (UV) region, at 3.27 eV, and a blue luminescence peak near 2.8 eV. The UV signal has conventionally been attributed to the "shallow" magnesium acceptor and the blue line to a magnesium-induced compensating donor.

These assignments, however, conflict with the behaviour observed during the post-growth annealing process that is necessary to activate magnesium acceptors. In other words, annealing causes a decrease in UV and an increase in blue intensity.

Moreover, the researcher say that no evidence of a compensating defect participating in the blue line has ever been found.

John Lyons and Anderson Janotti, working in Chris Van de Walle's Computational Materials Group at the University of California, Santa Barbara (UCSB) have now unravelled this behaviour using state-of-the-art first-principles methods. They found that the magnesium acceptor exhibits dual character.

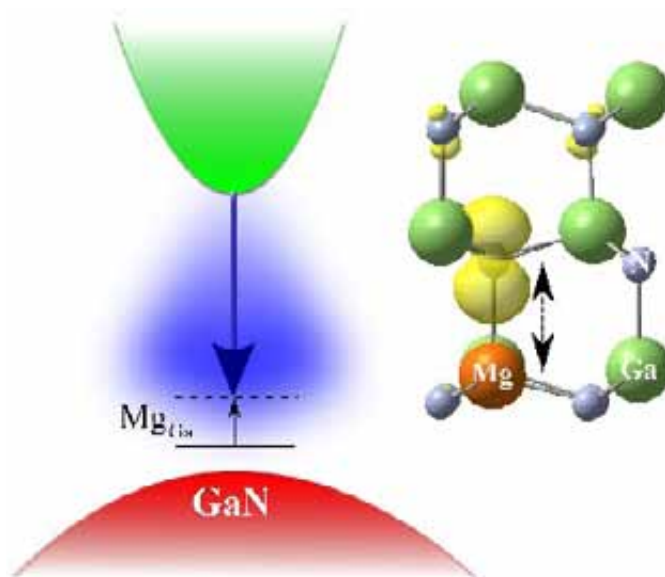


Figure: Magnesium in GaN exhibits behaviour characteristic of a "deep centre". Its electrical level (solid line) lies close enough to the valence band to generate a modest concentration of holes, but in optical experiments (dashed line and arrow) a deep level is observed. The model shows the large atomic displacements that occur when a hole (spin density illustrated by the yellow isosurface) is trapped in the neutral charge state of the acceptor.

From an electrical point of view, magnesium induces an acceptor level just slightly above the valence band, with an ionisation energy small enough to allow for modest *p*-type doping. In all other respects, however, magnesium exhibits the features of a deep centre. This means that the hole state is highly localised, and leads to broad deep level luminescence in the blue region of the spectrum, at an energy well below that expected for a shallow impurity. The blue luminescence observed in magnesium-doped GaN is therefore caused by the magnesium acceptor itself!

"Magnesium in GaN only "accidentally" behaves as a shallow acceptor," comments Van de Walle. "It's truly lucky that its electrical level lies close enough to the valence band to generate enough holes for *p*-type conduction, otherwise blue LEDs and solid state lighting would not be possible!"

As to the UV signal, the researchers propose it originates from the Mg-H complex that is present in as-grown GaN. This assignment is consistent with the decrease of the signal observed upon annealing, which breaks up the Mg-H complexes.

All in all, the results explain a host of previously puzzling experimental observations, and pave the way towards better control of *p*-type doping in this key material.

This work has been described in more depth in the paper, "Shallow versus Deep Nature of Mg Acceptors in Nitride Semiconductors," by John L. Lyons *et al*, Physical

Review Letters, 108, 156403 (2012). DOI: 10.1103/PhysRevLett.108.156403

This research was supported by the National Science Foundation and by the UCSB Solid State Lighting and Energy Centre.

GE launches landmark LED modules

The Zhaga compliant Infusion LED devices are a significant step in achieving interchangeability

GE Lighting says it has made a significant breakthrough in the move toward greater standardisation of LED light engines with the announcement of its first Zhaga-compliant products.

GE Lighting's full range of Infusion LED modules will be showcased at Light+Building, one of the world's largest trade fairs for lighting and intelligent buildings.

The modules have been designed to comply with the Zhaga 'Book 5' specification for Socketable Light Engines with Separate Electronic Control Gear. The Zhaga Consortium creates specifications aimed at ensuring the interchangeability of LED light sources from different manufacturers.

"These specifications are the path forward for LED modules and fixtures that can truly transform the way we light commercial and residential spaces," says John Strainic, global product general manager, GE Lighting. "Lighting designers and specification professionals around the world now have more freedom to think big because GE and the industry have progressed toward standards established by the Zhaga Consortium."

GE Lighting is also extending the range with the introduction of four new LED module products: a module for downlight applications, a modular system for creating high-intensity narrow beams, a new format spotlight engine based on Zhaga specification in 'Book 3', and a high lumen option. All have been designed with new interchangeable light engine specifications recently approved by the Zhaga Consortium.



GE Infusion LED Module

In addition to the extended Infusion LED module range, GE Lighting also will launch its range of Lumination LED Downlights, new state-of-the-art luminaires, which will embody Infusion modules.

GE Lighting has been a member of the Zhaga Consortium—a global consortium of companies from the lighting industry and beyond, since the consortium's establishment in February 2010. In view of the rapid and sustained development of LED technology, the Zhaga Consortium focuses on the mechanical, photometric, thermal and electrical compatibility of LED modules and controls.

More than 180 companies from Asia, Europe and the USA have already joined the Zhaga Consortium. They include luminaire and lamp manufacturers, LED module makers and companies that supply the lighting industry.

"Modularity and interchangeability will benefit manufacturers and end users alike," explains Andy Davies, sales development director for LED modules, GE Lighting. "The adoption of Zhaga specifications will speed product introduction, and reduce risk and development cost, while still encouraging design innovation. The further we travel down this path, the more accessible LEDs will become."

Davies adds, "The launch of our Zhaga-compliant Infusion(TM) modules, and the other product developments that will be introduced at Light+Building, represent a significant milestone on the road to interchangeability,"

Osram Opto unveils first chip-on-board LED

The Soleriq E nitride LED for downlights can cope with requirements demanding high lumen packages between 1500 and 4500 lm

Downlights provide high-quality background lighting in shopping malls, offices, industrial buildings and high-end residential premises.

The luminaires used in these places need a high luminous flux to make you feel comfortable. Osram Opto says this is just what its new Soleriq series, claimed to incorporate the first chip-on-board LED, provides. Even at high application temperatures they create the basis for highly efficient luminaires with a luminous flux of 1500 lm to 4500 lm.



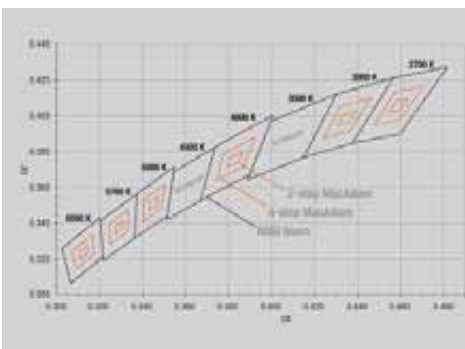
Large lumen packages for use in downlights – the new chip-on-board LED Soleriq E

Only one Soleriq E LED is needed to give a luminaire enough light. This makes designing luminaires much easier because only one component has to be integrated instead of multiple LEDs. The individual chips are all under the conversion layer (chip-on-board), giving the impression of a homogeneous light emitting surface.

Ensuring a uniform colour and light appearance in the luminaire and even coupling into external light-guiding optics is very simple. The light generated can be used with much lower optical losses, making the LED lamps and luminaires more efficient. Osram says typical LED benefits such as high energy efficiency and long lifetime have an excellent impact on downlight performance.

The Soleriq E, available in two versions, covers the entire colour spectrum from 2700 to 6500 K. Even at a temperature of 85°C, which corresponds closely to the temperature in the application, the two LEDs offer an impressive efficiency of 103 lm/W at 4000 K. At this temperature the 36 mm x 36 mm x 1.7 mm E 45 achieves a typical brightness of 4000 lm (rated current 880 mA); the 30 mm x 30 mm x 1.7 mm E 30 produces a lumen output of 2700 lm (at 600 mA).

Good colour homogeneity is achieved by the narrow white grouping of the Soleriq E, corresponding to a range of 4-step MacAdam ellipses. For solutions that need a particularly high level of colour homogeneity, grouping based on 2-step MacAdam ellipses is also available.



High colour homogeneity in the application: Soleriq E is grouped by 4-step MacAdam ellipses

Andreas Vogler, Marketing Manager General Illumination at Osram Opto Semiconductors, says, “Downlights are in widespread use in many areas such as shop, office and residential lighting but need high lumen packages between 1500 and 4500 lm to perform their task. We can achieve these high values with just one LED component. This makes it easier to couple the light into external optics and to integrate the light source in the luminaire.”

Both the E 30 and E 45 have a beam angle of 120° and a lamp life of over 50,000 hours. Thermal resistance is 0.38 K/W for the E 30 and 0.25 K/W for the E 45. Both devices also have a metal core board.

Cree’s new lab LED breaks barriers with 254 lumens-per-watt

Based on silicon carbide technology; this milestone exceeds Cree’s previous R&D industry record of 231 lumens per watt

Cree says it has delivered another industry first with a whopping 254 lumen-per-watt white R&D power LED.

Elements of Cree’s SC³ Technology Platform, used in Cree XLamp LEDs, enable this “record-breaking” R&D result. The SC³ Technology Platform, built on Cree’s advanced SiC technology, features advancements in LED chip architecture and phosphor, and boasts a new package design to deliver the most advanced LED components in the industry.

Cree reports that the LED efficacy was measured at 254 lumens per watt, at a correlated colour temperature of 4408 K. Standard room temperature, 350 mA testing, was used to achieve the results.

“The latest innovation from our R&D labs is another game changer for the industry,” says John Edmond, Cree co-founder and director of advanced optoelectronics. “The core of the Cree R&D culture is a relentless focus on innovation that ultimately drives LED adoption. Higher-performance LEDs can enable new and better LED-based applications and drive down the solution cost of LED designs.”

Korean research centre chooses Veeco MOCVD system for LED R&D

The reactor will be used for gallium nitride based green and UV HB-LED research

LED-IT Fusion Technology Research Centre (LIFTRC) of Korea recently placed an order for one of Veeco’s TurboDisc K465i GaN MOCVD systems. The tool will be used for research and development of high brightness LEDs, including green

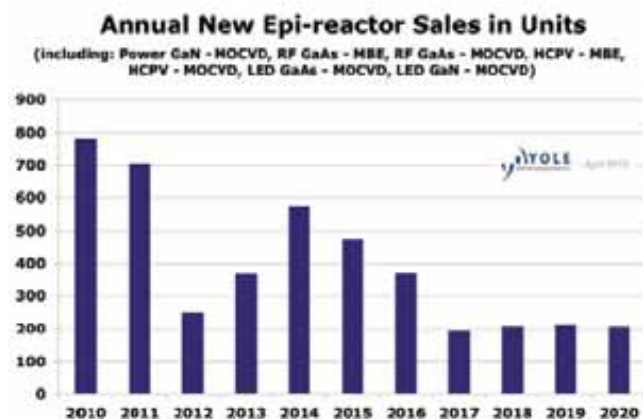
and ultraviolet (UV) LEDs. Ja-Soon Jang, Chief Director, LIFTRC, and a professor, at the Department of Electronic Engineering, at Yeungnam University comments, "Veeco's K465i enables us to conduct research and development of next generation LED technology on a fully-automated, low cost of ownership platform. Veeco's industry-leading position, localised support and technical expertise will help us achieve our goal of collaborating with local and worldwide LED manufacturers." William J. Miller, Veeco's Executive Vice President, Process Equipment, adds, "We are very pleased that LED-IT Fusion Technology Research Centre, a top research organisation, recognises the benefits of the TurboDisc K465i MOCVD System. We look forward to supporting LIFTRC and their partners and believe Korea will continue to drive the advancement of LED technology."

Will we recover from the III-V decline?

Yes, says Yole Développement; the compound semiconductor III-V market should see a \$6.1 billion opportunity by 2020

MOCVD and MBE are the main epitaxial methods used to manufacture III-V based devices .

According to Yole Développement, the combined revenue opportunity for MBE and MOCVD is estimated to be around \$6.1 billion for the 2012-2020 period.



LED is by far the single largest application for MOCVD. In 2010 and 2011, the MOCVD market experienced the largest investment cycle in its history driven by a combination of the demand for LED backlit LCD TVs and subsidies by the Chinese central and local governments. Expected demands for the general lighting market was also a big factor.

This has put the market into a significant overcapacity situation that could take 12-18 months to recover from. The next investment cycle, driven by lighting applications and expected to start in 2013, will be more limited than the previous cycle due to improvements in equipment throughput and yields.

Following this cycle, further Cost of Ownership (COO) improvements offered by the next generation of MOCVD reactors should justify the replacement of 2-generation-old

reactors installed during the 2010-2011 boom and drive a last small equipment cycle in the second half of the decade. By then, GaN power will also represent a substantial upside for reactor manufacturers.

Overall MBE use is heavily driven by R&D systems, capturing over 50% of the total market.

In the future, Yole expects the MBE market will be essentially driven by the continuous growth in the cell phone and wireless applications that are making heavy use of GaAs based RF components. Emerging applications like smart grid and the trend toward increasing connectivity and "intelligence" incorporated in many consumer products will provide further opportunities.

However, alternative technologies such as silicon CMOS, LD MOS, SoS, and HR SOI, represent a potential threat and could capture shares of the GaAs RF market and reduce the opportunity for MBE.

What's more, MOCVD is making progress in HEMT manufacturing. HCPV, however, could provide a small potential upside for MBE makers.

The MOCVD and MBE equipment markets are duopolies but many emerging players could change the landscape.

Aixtron and Veeco are leading in MOCVD and together represented 96% of the market in 2011. MOCVD production systems are complex. Design and optimisation require expertise in multiple fields including flow dynamics, thermodynamics, chemistry, mechanical and electrical engineering.

Applied Materials is also working with imec to create the ideal MOCVD reactor for 8-inch GaN-on-Silicon for use in LEDs and power devices.

Technological barriers to entry are fairly high. More than fifteen emerging players have been identified but so far have been struggling to capture any sizeable share of the market. But the pressure is mounting and established MOCVD makers will need to maintain that technology gap to keep emerging competitors at bay.

MOCVD Cost of Ownership Drivers



The main problem is total cost of ownership. Established

MOCVD makers all have technology roadmaps to enable COO reduction by three or four times within the next 5 years through a combination of improved yields, throughputs and precursor utilisation efficiency.

For MBE, Yole says Riber and Veeco are the only two players offering large capacity / large throughput MBE production tools for volume manufacturing. The market research firm expects both firms will maintain their dominant positions. However, there are about ten other MBE manufacturers offering R&D or pilot production systems that also have a strong presence on the general MBE market, such as DCA, SVT and Eiko.

The Metal Organic precursor market will also be driven by LED applications. But MOCVD reactor technology improvements, including yield, consumption and wafer size, will lower the amount of TMGa and TMIIn needed per cm² of epiwafer.

The 2010 metal organic shortage ended in mid 2011 thanks to aggressive capacity expansion by leading suppliers. Further capacity expansion plans from established and emerging suppliers could come online within the next 3 years.

If executed as announced, Yole expects significant oversupply starting from 2012 that could continue through 2016 and beyond. This situation could put pressure on prices. Further MO synthesis technology improvements could provide opportunity for cost reductions. However, the usually volatile prices of raw indium and gallium also have a significant impact on cost.

Yole's report provides Metal Organic precursor price, volume & revenue trends and data on over 150 companies.

Cree pushes performance with 25 percent brighter LEDs

The new XLamp MT-G2 LEDs showcase the advantage of Cree's SC³ Technology Platform

Lighting innovator Cree, has unveiled the MT-G2 LED, its first EasyWhite LED array built on the SC³ Technology Platform.

The new XLamp MT-G2 LED delivers LED lighting manufacturers 25 percent brighter LEDs compared to the previous MT-G, enabling a wider spectrum of high lumen applications.

MT-G2 LEDs are designed for high-output, directional lighting applications and are the ideal replacement for lighting applications that currently use halogen lamps. The MT-G2 LEDs are optimised for use in track, accent, lamp retrofit, down lighting and other applications where colour quality, consistency and optical control are required.

"The MT-G2 LED truly pushes the envelope of what's possible, redefining lumen levels and efficacy while delivering colour consistency and superior optical control," notes Richard Turner, R & D director at Havells Sylvania. "Combined with the

small footprint and uniform emitting surface, the MT-G2 is an especially attractive device to further grow our leading position in professional-quality LED retrofit lamps."

Featuring Cree EasyWhite Technology, the MT-G2 LED delivers up to 2100 lumens in warm white (3000K) at 25 W, 85°C and provides one of the industry's best colour consistencies, with excellent optical control.

The new, brighter MT-G2 LED shares the same footprint as the original MT-G LED, providing customers a seamless upgrade path to shorten the LED luminaire and retrofit lamp design cycle and improve customer time-to-market. The MT-G2 LED is designed to be used as a single component in an LED design to better emulate the filament appearance of incumbent lighting products and simplify design and manufacturing.

"Innovation in performance and optimization of LEDs to a variety of applications are critical to driving LED adoption," says Mike Watson, Cree senior marketing director, LED components. "The new MT-G2 LEDs enable true halogen performance across a wide range of single source lighting applications and provide the industry's best colour consistency. Cree's continued breakthrough in high lumen output demonstrates the advantages delivered by leveraging the SC³ Technology Platform."

The MT-G2 LED is the latest product built on Cree's SC³ Technology Platform, joining XB-D, XT-E, XT-E High-Voltage and XM-L High-Voltage LEDs. The SC³ Technology Platform leverages Cree's SiC technology, features advancements in LED chip architecture and phosphor, and showcases a new package design to deliver the most advanced LED components in the industry.

With an 8.9mm x 8.9mm footprint, the MT-G2 LED is available in 2- and 4-step EasyWhite colour temperatures ranging from 2700K to 5000K. The new LEDs are available in minimum 80 and 90 CRI options and feature multiple voltage selections, including higher voltages that enable the use of smaller, more efficient drivers to lower system cost.

XLamp MT-G2 samples are available now and production quantities are available with standard lead times.

Lumileds' LUXEON M is a game changer

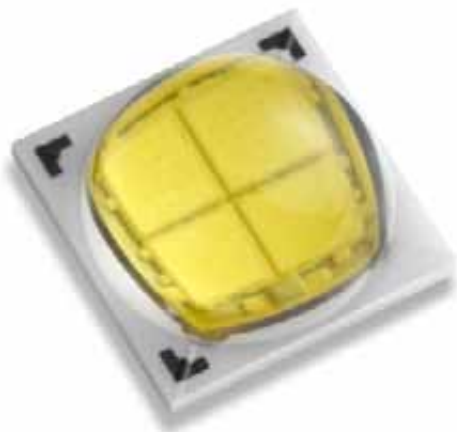
The new LUXEON M LED, designed for industrial outdoor applications, like streetlights, improves the design and reduces the cost of new products in much the same way the LUXEON Rebel did in 2007

Philips Lumileds has fully launched its LUXEON M LED, which is now in volume production.

The new emitter has already been approved for street lighting in major US cities with designs to be showcased at the Light + Building conference .

LUXEON M's high lumen output, of more than 1100 lumens,

and a typical voltage of 11.2V, drives down system cost and improves system performance through the use of low cost, highly efficient drivers. Lumileds says the tremendous light output and efficacy at operating conditions lowers overall solution costs.



LUXEON M LED

What's more, solutions are simpler and use fewer parts and off the shelf drive electronics, optics, and thermal solutions are readily available. This results in a cheaper module with better optical control and light quality for outdoor applications.

"LUXEON M is a game changer and fundamentally improves the design and cost parameters of new solutions in much the same way LUXEON Rebel did in 2007," says Rahul Bammi, VP of Marketing for Philips Lumileds. "Everything from the footprint to the drive requirements has been optimised based on hundreds of discussions with our customers, municipalities, and private property owners to ensure that LUXEON M exceeds their expectations and objectives."

The LUXEON M comes in three different correlated colour temperatures; 3000K, 4000K, and 5700K. All deliver more than 1100 lumens with a minimum CRI of 70. Every LUXEON M is Hot Tested and Specified at 85°C and offer Freedom From Binning.

LUXEON M is now available from Future Lighting Solutions which also provides the full range of complementary components and solutions. The new products will be exhibited at both Lumileds and Future Lighting Solutions stands at the Light + Building convention in April and the LIGHTFAIR conference in May.

Cree XSP LED street lights put competitors in the shade

The firm's latest family of LED street lights use innovative technologies to further obsolete inefficient predecessors Cree says it has made a breakthrough innovation in street lighting.

The LED innovator reckons its' new XSP Series LED Street

Light is the most affordable and efficient Cree LED street light and is designed to speed payback to cities and municipalities.

Using nearly 50 percent less energy and designed to last over three times longer than traditional high-pressure sodium street lighting, Cree says the XSP Series can double the lumens per dollar compared to previous generations of Cree LED street lights.

"Cree XSP Series LED Street Lights can help municipalities address budget constraints and provide the best of all worlds – outdoor lighting that lowers energy expenses and reduces maintenance costs," says Jeff Tews, acting director of street lighting, city of Anchorage.

"Anchorage has already made the business case work for LED street lighting with more than 5,000 Cree LEDway luminaires installed across the city. The new XSP Series LED Street Lights should make every municipality take notice."

Cree says its breakthrough engineering has improved optical efficiency of previous generation LED street lights by 15 percent and has more than halved the number of LEDs used without sacrificing performance. Fewer LEDs enable lower luminaire costs and faster payback for customers.

NanoOptic Precision Delivery Grid optic technology efficiently delivers light to the street, making communities appear cleaner and safer.



XSP Series LED Street Light

The new XSP Series was designed to deliver superior system efficiency of up to 100 lumens per watt and to provide a L70 lifetime of more than 100,000 hours. Cree says the street light delivers up to twice the lumens per dollar compared to previous generations and can pay for itself the first time a city avoids sending a crew and truck to replace a bulb.

"Cree XSP Series is a giant leap forward in outdoor lighting and is made possible by innovation in every aspect of the product,"

comments Christopher Ruud, vice president and general manager, Cree lighting.

“Capitalising on innovations in Cree LED chips and components, optic technology and design, and overall luminaire design, the XSP Series exemplifies the best of Cree integrated technology. The result is the best alternative to traditional street lighting with better payback, better performance, and better pricing, allowing municipalities to focus their resources where it matters most.”

The Cree XSP Series LED Street Light is sold through Cree lighting sales channels with select versions to be available in May 2012.

Asian consumers to dominate LED replacement lamp market

Lamp manufacturers will continue to benefit from the oversupply of LED governmental subsidies. The LED replacement market unit growth rate is expected to be the highest in China at 44% CAGR

Market research firm Strategies Unlimited’s report, “LED Replacement Lamps Market Analysis and Forecast”, projects unit growth of 30% in 2012 – 2016 for LED replacement lamps. The global market is anticipated to grow from \$2.2 billion in 2011 to \$3.7 billion in 2016. The revenue growth will be moderated by a forecast 14% per year decline in the average selling price. The research covered LED lamps that are used in existing sockets and serve as replacements for legacy lighting sources in residential and commercial indoor applications. On the supply side, manufacturers will continue to benefit from the oversupply of LED and governmental subsidies that aim to advance the adoption of LED lighting. On the demand side, the LED replacement market units growth rate is expected to be the highest in China at 44% CAGR. In 2011, the LED replacement A 19 bulbs were the highest selling product with Japan leading the number of units sold. Sales of PAR LED lamps and LED MR 16 were driven mostly by commercial applications in developed economies. However, this trend will be reversed as the construction sector recovers in developing countries. LED replacements for linear fluorescent lamps yielded the highest units sales numbers in China and Japan; between 2010 and 2011 the average selling price declined at 23%. The U.S. and European markets yielded fewer sales due to stricter requirements for product quality.

Bridgelux in the spot light with new Cetero module

The Cetero SLM will offer light output ranging from 800 to 2300 lumens across multiple colour temperatures all in one common form factor. Bridgelux is introducing the Cetero Spot Light Module (SLM), a compact high flux density light source.

The company says it delivers clean and consistent white light without pixilation and is engineered to comply with the upcoming Zhaga spot light module specification.

Bridgelux is an active member of Zhaga, an industry-wide cooperation aimed at the development of standard specifications for the interfaces of LED light engines.

The Cetero SLM will offer light output ranging from 800 to 2300 lumens across multiple colour temperatures all in one common form factor. Its mechanical compatibility with the upcoming Zhaga interface specifications will ensure interchangeability and a modular product platform that will expand luminaire design options for our customers.

With more than 180 members from the lighting industry, Zhaga is a global consortium aimed at ensuring interchangeability of LED light sources from different manufacturers.

Adherence to this design specification allows for design flexibility and a future proof upgrade path for both OEM customers and end users, addressing market concerns regarding the rapid evolution of LED technology and delivering on the promise of sustainability.

“Bridgelux remains committed to providing customers with leading-edge LED technology in a package that simplifies their design efforts and reduces product development risks and costs,” says Jason Posselt, vice president for channel marketing at Bridgelux.

“We believe that working with Zhaga to help develop common standards will help pave the way for accelerated adoption of solid state lighting technology. The Cetero, with its simple bolt down installation and wire connection features, combines the high quality of light benefits delivered by Bridgelux LED arrays with a simple to install standardized interface to help speed time-to-market.”

The Cetero modules will be available in 2700, 3000, 3500 and 4000 colour temperature options - all providing a minimum 80 CRI and 3 SDCM colour consistency and leveraging the production proven Bridgelux ES product family.

Three lumen categories will be initially available, delivering operational lumens of 800, 1100, and 2000 lumens all in a common light emitting source area to enable compatibility with secondary optics. The Cetero SLM will be commercially available in late 2012.

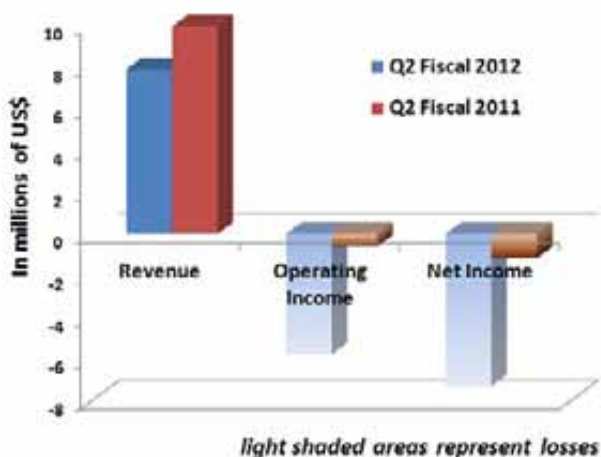
Bridgelux showcased its latest products at Light+Building in Frankfurt, Germany during April 15-20, in the company’s booth located in Hall 4.2, stand J31.

SemiLEDs revenues not so bright with 21% tumble

Although second-quarter net loss was 26 cents per share, the company fared slightly better than the loss of 27 cents per share expected by analysts. Revenues of \$7.9 million, compared to \$10.0 million in the same quarter last year, was

also slightly better than the \$7.5 million predicted by analysts. The outlook for the third fiscal quarter though, is disappointing

GAAP financial results for FY Q2 2012 & 2011



SemiLEDs Corporation LEDS has announced its financial results for the second quarter of fiscal year 2012, ended February 29, 2012. Revenue for the second quarter of fiscal 2012 was \$7.9 million, a 21% decrease compared to \$10.0 million in the second quarter of fiscal 2011. "Given the ongoing challenging industry environment, we are pleased with our quarterly financial and operational results. Our strategy of pursuing the indoor lighting market has proved successful as it continues to improve our revenue growth, and we remain cost conscious in areas of the business that won't impede our innovation and technology advantage," says Trung Doan, Chairman and CEO of SemiLEDs. "We look forward to working within a better economic climate but for the time being we continue to maintain the slow, steady growth and improvement that we have shown over the last two quarters," continues Doan. GAAP net loss attributable to SemiLEDs stockholders for the second quarter of fiscal 2012 was \$7.1 million, or a loss of \$0.26 per diluted share, compared to GAAP net loss attributable to SemiLEDs stockholders of \$1.2 million, or a loss of \$0.05 per diluted share, for the second quarter of fiscal 2011. GAAP gross margin for the second quarter of fiscal 2012 was negative 9%, compared with positive gross margin for the second quarter of fiscal 2011 of 23%. Operating margin for the second quarter of fiscal 2012 was negative 73%, compared with negative 6% in the second quarter of fiscal 2011. Margins continue to improve through continued expense management. The Company's cash and cash equivalents were \$66.4 million at the end of the second quarter, compared to the prior quarter ending balance of \$74.0 million. Cash used in operations was \$4.5 million in the second quarter of fiscal 2012. Financial Outlook For its third quarter of fiscal 2012 ending May 31, 2012, SemiLEDs expects revenue in a range of \$7.9 million to \$8.9 million with GAAP net loss attributable to SemiLEDs stockholders of \$7.5 million to \$7.0 million, or a loss of \$0.27 to \$0.25 per diluted share, based on an estimated 27.5 million diluted weighted average shares. GAAP gross margin is expected to be negative. Conference Call Information SemiLEDs discussed these financial results in a conference call. An audio replay of the conference call replay was available until Tuesday, April 10, 2012 at 11:59 p.m. Eastern Daylight Time and can be accessed by dialling 888-

203-1112 (from within U.S.) or 719-457-0820 (from outside the U.S.) and entering the replay pass code 7604422. A replay of the webcast can be accessed via the Investors section of the Company's web site and will remain available for approximately 90 calendar days.

Stylish Aeroblades luminaires use cutting-edge technology

Cree's revolutionary luminaires are suited for architectural street, area and security lighting

Cree is introducing the Aeroblades series of luminaires, demonstrating the continued evolution of outdoor LED lighting. Based on Cree's BetaLED Technology with NanoOptic lighting control, Cree says its Aeroblades luminaires represent the intersection of industry-leading LED innovation and high design.



Cree Aeroblades luminaire

"Cree is a proven leader in LED-based street and area luminaires," says Christopher Ruud, vice president and general manager, Cree lighting. "Building on that success and combining cutting-edge form and function, Aeroblades luminaires leverage Cree LED technology while incorporating forward-thinking and aesthetically pleasing architectural design to enhance the surroundings." Designed and engineered with Speirs + Major, one of the world's leading lighting design

firms, the Aeroblades luminaire series takes a bold approach to architectural street, area and security lighting. They by enable beautiful LED implementation while optimising thermal management, light control, efficiency, longevity and payback.

“While everybody else was creating standard shoeboxes and other conventional designs, we were approached with a revolutionary technology that allowed us to throw out all preconceptions of how urban luminaires should appear,” says Keith Bradshaw, director, Speirs + Major. “The result is the Aeroblades luminaire, designed for the best LED performance and the form followed.” The Aeroblades series boasts a unique modular design that allows the state-of-the-art light engine to bring unprecedented versatility and precision to outdoor applications. Aeroblades luminaires can be fine-tuned with NanoOptic technology optical control and the number of luminaire blades to meet specific illumination needs in smaller increments than either traditional designs or competitive LED products. Bradshaw adds, “Cree Aeroblades luminaires redefine our understanding of what an LED outdoor luminaire should look like and how it should perform. What we have achieved could only be done with LEDs and Cree’s innovative technology.” Breakthrough engineering includes an innovative thermal management system that enables higher lumen output and provides significant boosts to lifetime, efficacy and colour consistency. All luminaires have the option of 0-10V dimming, are designed to meet a minimum L70 (lumen maintenance) of 80,000 hours and feature a five-year warranty. The extremely versatile and modular design of the Aeroblades series enables customers to custom-design luminaires to best fit their application. Aeroblades luminaires will initially be available in more than 300 combinations, including: two, four or six blade versions, 20 optical distributions, four colour temperatures (3000K, 3500K, 4000K and 5700K), four drive currents, two pole mount and wall mount versions and seven DeltaGuard paint finishes. The Aeroblades series is sold through Cree lighting sales channels with sample quantities targeted for availability in calendar Q2, and full availability targeted to begin in Q3 of 2012.



Philips Lumileds 5630 LED

“The lighting industry’s performance expectations of mid-power LEDs is well below the expectations for power LEDs,” says Rahul Bammi, VP Marketing at Philips Lumileds.

“We believe that distributed light solutions like those found in offices should deliver quality of light, colour stability and useable lifetimes similar to what our LUXEON LEDs deliver. Most importantly, lighting designers and technical specifiers should have the confidence that the light source inside will perform as intended. We are certain that the new Lumileds 5630 emitters will outperform other options over their lifetime.”

Lumileds has utilised its know-how, including proprietary phosphor technology, to create its first illumination mid-power LED.

“We believe that many of the mid-power solutions being implemented today will see unplanned and unexpected colour shift over time and we think the industry needs better LEDs,” concludes Bammi.

Philips Lumileds other mid-power products include SuperFlux, SnapLED and SignalSure LEDs, which are widely used LEDs for automotive exterior lighting.

Lumileds mid-power LEDs for lighting raise the bar

The firm says the guaranteed minimum CRI, specified R9, and leading performance over time bring newfound confidence to solutions with white mid-power LEDs Philips Lumileds has launched its first white, mid-power LED.

In doing so, the company believes it has raised expectations for mid-power reliability, performance over time and temperature, and colour maintenance.

Intended for office and other distributed LED lighting solutions, Philips Lumileds uniquely specifies CCT, CRI, and R9 for each of its new mid-power emitters.

Cree reveals brightest ever LMH2 LED modules

The new 2000 and 3000 lm modules are aimed at eliminating the need for compact fluorescents in commercial lighting Cree extends its high-performance LMH2 module family with new 2000 and 3000 lumen output options.



Light source using Cree LMH2 module

The LED lighting innovator says they deliver better performance, longer lifetime and lower system cost than comparable compact fluorescents in commercial lighting. The LMH2 module family now enables a wider range of lighting applications within a compact, cost-effective design.

The LMH2 is claimed to be industry's only LED module family delivering 82 lumens-per-watt system efficacy combined with a CRI greater than 90 in all available colour temperatures. The LMH2 LED features Cree TrueWhite Technology, a revolutionary way to generate white light with LEDs.

Cree TrueWhite Technology delivers high efficiency with beautiful light characteristics, while maintaining colour consistency over the rated lifetime of the product. The LMH2 module family is available in a range of lumen, colour temperature and driver options, enabling lighting manufacturers to meet their needs quickly and easily.

"With its high lumen output and superior combination of high efficacy and high CRI, the new Cree LMH2 LED module enables us to address the commercial lighting market," says Antonio Di Gangi, General Manager of DGA. "The compact, two-piece design of the LMH2 gives us the flexibility needed for rapid LED luminaire design and development."

The LMH2 module separates the light source and power supply to enable a wide selection of mounting and wiring options – giving lighting manufacturers the flexibility needed for rapid LED luminaire design and development. LMH2 modules also feature primary thermal management – potentially eliminating the need for costly secondary thermal management systems.

"The LMH2 LED module family now obsoletes the need to even consider compact fluorescent alternatives," says Mike Watson, Cree senior director marketing, LED components. "Not only does the family of LMH2 LED modules outperform this traditional lighting technology, but it does so across a wide range of colour and lumen options with unparalleled colour quality, efficacy and warranty, enabling lighting manufacturers to address an entire range of lighting applications."

LMH2 modules deliver 82 lumens-per-watt system efficacy combined with 90+ CRI in colour temperatures of 2700 K, 3000 K, 3500 K and 4000 K. The module is available with Digital Addressable Lighting Interface (DALI) and DALI touch dimming. Designed for 50,000 hours of operation and dimmable to five percent, the LMH2 comes with Cree's industry-leading warranty.

Luminaire makers seeking ENERGY STAR qualification will have access to specification and performance data, including LM-80 reports, which can speed regulatory approvals

Luminus certified in environmental and health and safety

The Big Chip nitride LED manufacturer is now qualified in ISO 14001:2004 and OHSAS 18001:2007 Luminus Devices, the manufacturer of Big Chip LEDs, has announced two important certifications for its Massachusetts facilities.

ISO 14001:2004 recognises the company's ability to meet rigorous international criteria in the management of environmental and sustainability processes. OHSAS 18001:2007 is awarded to companies meeting occupational health and safety management system specifications.

The company is also ISO 9001:2008 certified for quality management processes and has recently been accredited to the ISO 17025:2005 laboratory standard.

"Our team has worked hard to become a great company, in addition to manufacturing some of the most unique and energy-efficient LEDs in the world. We are equally proud that this is a healthy and safe place to work," says Keith T.S. Ward, President and CEO of Luminus.

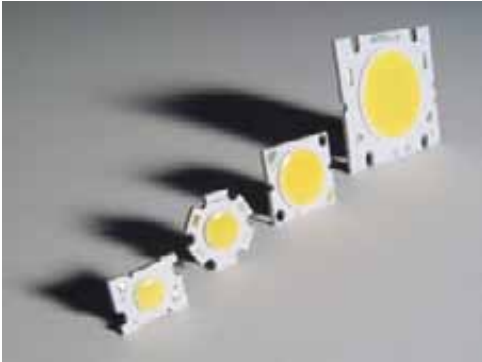
"I believe these new certifications, integrated into our quality management systems, demonstrate with clarity to customers that they will receive superior, innovative products made by people from a company dedicated to global professional standards as well as the environment."

Luminus currently holds more than 144 patents and patents pending for its Big Chip LEDs.

Furthering its green initiative, the company also announced recently that 100% of the electricity at its Woburn, Massachusetts manufacturing facility is being purchased with Renewable Energy Certificates (RECs.) The Luminus RECs will help the nation avoid emission of 946 metric tons of CO₂ in 2012, aiding greatly in reducing America's carbon footprint.

Bridgelux expands portfolio to address retail & hospitality sector

The firm's Decor LED array series now offers increased efficiency as well as a broader range of light sources - from 500 to 5000 lumens in colour temperatures of 2700, 3000 and 3500K. Bridgelux has announced the expansion of its Decor line of ultra-high colour rendering index (CRI) LED arrays.



Bridgelux Array Product Family

Addressing growing demand in the shop and retail, architectural, hospitality and museum lighting markets for the energy efficiency and high quality light offered by LED technology, Bridgelux has expanded its successful Decor 97 CRI product series introduced in October 2011.

The Decor series now offers increased efficiency as well as a broader range of light sources - from 500 to 5000 operational lumens in three colour temperatures, 2700, 3000 and 3500K. The firm hopes to satisfy the increasing number of applications demanding very high light quality.

Bridgelux says its Decor series expands lighting options available to the lighting designer, complimenting the standard minimum 80 and minimum 90 CRI products also available from the company.

With a CRI of 97 and a 3-step MacAdam Ellipse colour control option, the Decor arrays are claimed to enable lighting designers to accurately render a full palette of colours over a wide range of light levels to create stunning and sophisticated lighting effects.

The Decor series has been spectrally engineered to virtually replicate the light quality of halogen and incandescent light sources. These arrays deliver R9 and R15 values of 98, to both enhance reds and more accurately represent many skin tones, delivering clean and natural lighting.

"Bridgelux's introduction of the higher lumen output Decor arrays will allow us to significantly expand our ARONDO LED luminaire line," comments David Rice, vice president BAERO North America. "Designed specifically for supermarket lighting, BAERO's ARONDO LED fixtures currently offer 10 different light engine options with 3 of those options utilizing the high 97 CRI Decor arrays for premium presentation."

He continues, "Fixtures with the Decor option range from 1,936 to 3,304 lumens while also providing unmatched colour. This has allowed BAERO to capture a greater share of applications in supermarket lighting, converting them from conventional lighting technologies to energy efficient solid state lighting. The quality and performance is excellent as is the support we have received from Bridgelux as we developed the ARONDO LED."

The Decor arrays feature the same form factors as current Bridgelux array products, allowing a simple upgrade path for existing customers while minimising design efforts. Bridgelux showcased its latest products at stand J31 in Hall 4.2 at Light+Building in Frankfurt, Germany, taking place between April 15th and 20th, 2012.

Cree's new LED troffers aim to eliminate fluorescents

New additions to Cree's CR troffer series include surface-mount, in-ceiling retrofits and suspended light engine luminaires. The company says they are faster and more affordable than ever. Cree is expanding its CR troffer family to address more applications.

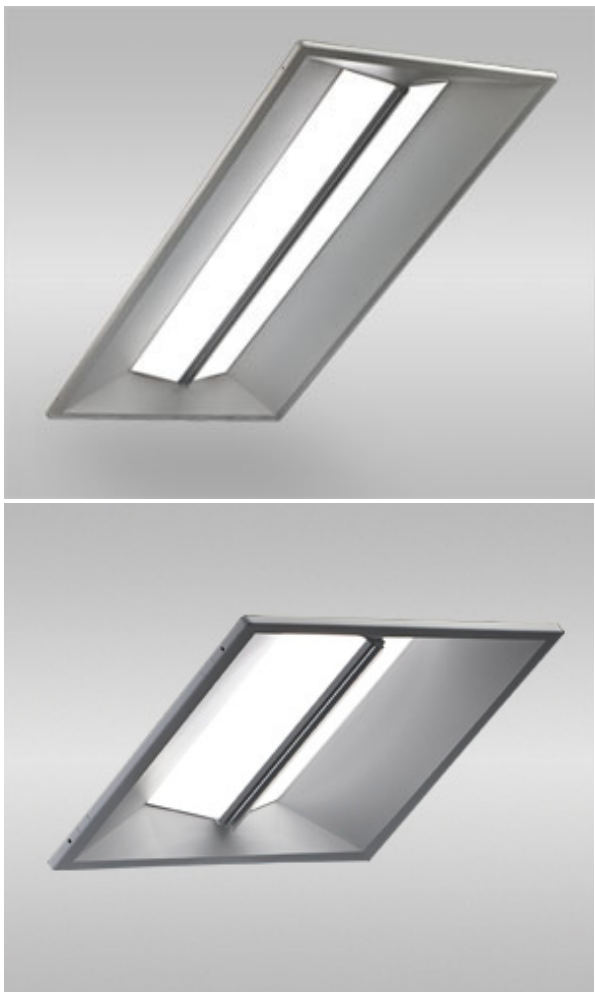
The firm says its new products are capable of replacing antiquated fluorescent technology in new or retrofit commercial and industrial settings.

The firm has also changed its pricing to drive even faster payback for building contractors, designers and owners.

Cree says its CR series offers payback-friendly pricing and a no-compromise alternative to fluorescent lighting; its LED equivalents consume nearly 50 percent less energy than a comparable linear fluorescent and deliver more than twice the lifetime.

With an estimated payback of less than a year in a typical new office installation, Cree says its troffers provide superior performance and greater energy savings over fluorescent options.

The new troffers now address three times the number of applications, including surface-mount, in-ceiling retrofits and suspended light engine luminaires.



CR24 troffer CR22 troffer

The CR24 and CR22 troffers are available to ship directly from stock to accommodate high demand and jump-start end-user payback.

“Pricing for 0-10V dimming control to five-percent is significantly reduced, which means daylight harvesting has never been more affordable”, says Cree.

“In my 28 years in the electrical industry, I have never had as much excitement and success with a product line as I have with the Cree CR series LED troffers,” comments David Fredd, manager lighting business development, Graybar.

“No other lighting manufacturer offers this level of energy saving performance and colour quality - Cree CR series troffers deliver a combination of performance, pricing and efficacy that is truly untouchable.”

The CR series has expanded three-fold by offering CR24 upgrade kits, a standalone light engine and SMK Series surface mount kits. The CR24 UPKIT provides a quick upgrade solution to replace existing, outdated fluorescent luminaires while leaving the ceiling intact.

The light engine, CR-LE, is now available as a standalone luminaire and offers an economical alternative to replacing

fluorescent strips in “back-of-the-house” lighting applications.

The entire CR Series of troffers and light engines can now be installed in surface mount applications. This extends payback beyond T-bar ceilings. All of these solutions are built on the CR troffer and are available in the new 3000K colour temperature for retail and hospitality applications demanding beautiful, warm light.

Cree CR troffers, CR24 UPKIT and CR-LE products are also now available with an integrated LED battery pack. The 1400 lumen battery pack eliminates the cumbersome task of rewiring a fixture just to change the battery.

Cree reckons its CR troffers outperform traditional lighting options and now deliver the widest range of lumen levels (2200, 3100, 4000 and 5000 lumens) for the popular CR24, CR14 and CR-LE products. The CR Series is powered by Cree TrueWhite Technology to deliver a combination of 90 CRI and up to 110 lumens per watt.

“Cree changed the indoor lighting industry one year ago when we introduced the first affordable LED troffer series,” says David Elien, vice president, Cree lighting. “The CR Series is now the industry’s best-selling LED troffer. With this success, Cree announces major extensions and says thank you by making our CR Series even more affordable to drive faster payback.”

Compound semiconductor industry revenues drop, but not for long

The need for increasing bandwidth for mobile handsets will continue to power revenue growth in the compound semiconductor industry in the future. Compound semiconductor manufacturers Skyworks, RFMD and Freescale experienced revenue declines at the end of 2011.

However, bandwidth consumption and mobile handset sales are still increasing.

The Strategy Analytics GaAs and Compound Semiconductor Technologies Service (GaAs) viewpoint, “Compound Semiconductor Industry Review January 2012: Microelectronics,” captures product, technology, contract and financial announcements for these companies, as well as others such as Fujitsu, Anadigics, Agilent, Hittite Microwave, TriQuint Semiconductor, Avago, Soitec, Analog Devices and Microsemi.

“Even though we are seeing revenue growth rates slow from some of the larger compound semiconductor manufacturers, this should not set off too many warning bells”, notes Eric Higham, Director of the Strategy Analytics GaAs and Compound Semiconductor Technologies Service. “The need for bandwidth, especially due to ever-increasing sales of mobile handsets, will continue to power revenue growth in the compound semiconductor industry.”

Asif Anwar, Director, Strategy Analytics Strategic Technologies Practice adds, "Revenue is typically the highest in the third quarter, as manufacturers increase production in advance of the holiday season. Despite the declines at the end of the year, Strategy Analytics expects 2012 revenue growth for the industry to be close to the historical average of 6 percent."

The Strategy Analytics report reviews a variety of commercial and military applications that use GaAs, GaN, SiC, SiGe and complementary metal-oxide-semiconductor (CMOS) technologies. It summarises financial, product, contract and employment developments from leading compound semiconductor device suppliers from January 2012.

SÜSS MicroTec acquires Tamarack

The German based firm aims to expand its knowledge in projection photolithography Headquartered in Garching near Munich, SÜSS MicroTec has acquired Tamarack Scientific Co. Inc., which is based in Corona, California, USA.

Both parties have signed a purchase agreement which stipulates the purchase of 100% of Tamarack's shares for a total price of \$ 9.34 million plus a variable earn-out component. The additional cost will depend on revenues in the next three financial years.

The requirement for greater functionality and performance of electronic devices drives the increasing needs for semiconductor components with higher complexity.

This trend is expected to prevail in the future and require the adoption of innovative technologies in the semiconductor backend sector. In the past two years, initiatives were undertaken to focus and reposition SÜSS MicroTec to ensure that the company will remain in a position to respond to market and customer requirements in a fast and flexible manner. The further strategic step is the recent acquisition of Tamarack Scientific.

Tamarack develops, manufactures and distributes UV projection lithography systems as well as laser micro-structuring tools for the Advanced Packaging, 3D Integration, MEMS and LED markets. These systems are used in high volume industrial manufacturing as well as research and development.

With the acquisition of Tamarack, SÜSS MicroTec is pursuing a consolidation strategy in the semiconductor backend equipment industry by complementing its exposure technology portfolio with projection lithography.

"With this acquisition, we enlarge our company's lithography segment by adding a new product line and core technology, both of which are highly complementary to our existing exposure capability", says Frank P. Averdung, President and CEO of SÜSS MicroTec AG.

"SÜSS MicroTec thereby becomes the leading backend lithography equipment and solution provider by offering the

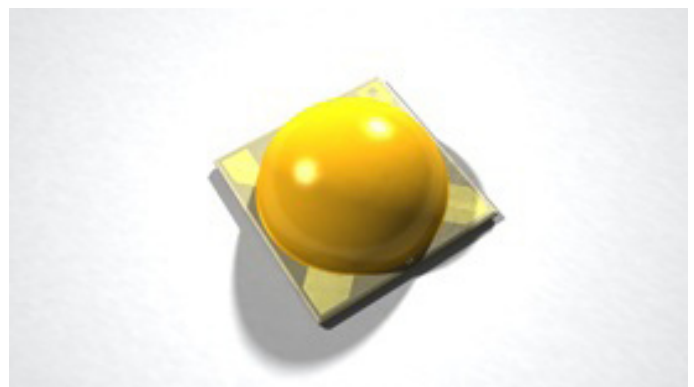
most comprehensive set of products and technologies to the market. This enables us to uniquely satisfy a range of customer's needs and allows us to offer a broad product range to meet the different price and performance points required by the industry."

"We are pleased to become a part of SÜSS MicroTec, a company with a strong market position in semiconductor backend lithography, a global sales and service infrastructure as well as a solid financial position. Together with SÜSS MicroTec, we can now expand our lithography and laser processing systems business faster and more successfully in our target markets," adds Courtney Sheets, Chairman and CEO of Tamarack Scientific.

Bridgelux's new micro LED for commercial lighting

A smaller footprint on the 20 - 40 W replacement market segment constitutes a \$1 billion opportunity in the \$100 billion market for lighting Bridgelux is making its new Micro SM4 surface mountable LED component commercially available.

The LED innovator says this multiple die emitter will decrease the cost and improve the performance of lighting in commercial buildings.



Bridgelux Micro SM4 LED

The Micro SM4 is aimed at dramatically reducing the component count, cost, complexity and size of diffuse or directional lamps used in ceiling fixtures in modern office buildings and retail establishments.

This LED is a light source, analogous to the heated gases or hot wires found in fluorescent bulbs and incandescent lights. The difference comes in energy consumption, longevity and control. The Micro SM4 light source consumes only 4.2 W, but it emits as much light as a 20 - 40 W incandescent or 20-35 W halogen B10-style bulb and will last thousands of hours longer.

The Micro SM4 component also delivers high flux density in a smaller footprint, giving designers, architects and lamp manufacturers greater freedom when it comes to creating and illuminating interior spaces.

"We've developed products with Bridgelux LED arrays over

the last couple of years,” says Raimund Koehler, general manager at MeLiTec. “So we were very interested when Bridgelux told us about their new Micro SM4 light source. The smaller form factor delivering high quality light and excellent colour over angle performance gave us the edge for our new directional lamp applications. The continuing innovation that we see from Bridgelux is driving LED light source technology in the directions MeLiTec needs to cost-effectively develop the next generation of high quality, energy efficient retrofit lamps required for market conversion to solid state lighting.”

The new smaller footprint, surface mountable emitter requires fewer components for applications typically using discrete LEDs. The 20 - 40 W replacement market segment constitutes a \$1 billion opportunity in the \$100 billion market for lighting.

Using 4.2 W of power, the Bridgelux Micro SM4 component will deliver between 330 and 500 lumens in both warm white (2700 K and 3000 K) and cool white (5600 K) colour temperatures.

Minimum 80 and 90 CRI options, with 3-step MacAdam Ellipse colour selections, will be offered for warm white products. The new Micro SM4 light source features the latest technical advancements in epitaxial GaN layer growth, LED chip design and automated packaging technologies.

LED MOCVD sales to bottom out in first half of 2012

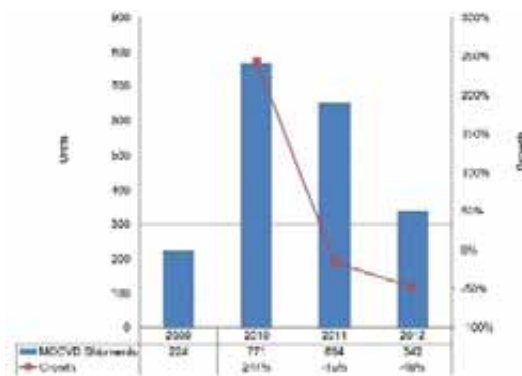
The first three quarters of 2012 combined are anticipated to be about the same as just one of the peak quarters of 2009 and 2010 when there were over 230 GaN MOCVD reactors shipped

According to IMS Research's "GaN LED Quarterly Supply and Demand report", 342 GaN LED MOCVD reactors will ship in 2012.

This compares to 654 tools shipped in 2011, a decline of 48%.

The first two quarters of 2012 are currently expected to experience the lowest shipment levels. This will hopefully be accompanied with a modest recovery in the second half of the year as companies begin adding capacity in response to expectations of rapid demand growth from the general lighting market in 2013 onwards.

The MOCVD market saw a large boom in 2009 and 2010 due to capacity needs for LED TVs and peaked in the second half of 2010. The following year saw lower but healthy shipment levels. This was partly due to new Chinese manufacturers and Chinese-Taiwanese joint ventures entering the market backed by government subsidies for MOCVD reactors despite an oversupply in the second half of 2010.



With the oversupply expanding in 2011 and China's MOCVD subsidies expiring in most regions, shipments and orders have since stalled. In addition to China's supply-side subsidies, the over-supply rose on weaker than expected demands. These included global macroeconomic weakness, slower than expected growth in LED TV penetration and the adoption of fewer LEDs per panel in many backlighting applications.

What's more, as LED lighting is still a relatively small market, MOCVD order intake sharply declined in the second half of 2011, resulting in low expectations for the first half of 2012 MOCVD revenues.

IMS Research analyst Jamie Fox explains, "We believe the market peaked in Q3'10 and Q4'10 with 239 and 238 GaN reactors shipments respectively. Almost every quarter since then has been a decline. For 2012, we expect the first three quarters combined to be about the same as just one of those peak quarters. Apart from China, the market is extremely quiet. Without the Chinese growth, the market would have almost completely collapsed."

However, even with this severe market decline, 2012 is still forecast to be 52% higher than in 2009 (342 vs 224).

IMS says that in Q4'11, shipments actually increased sequentially, as some big orders in China fell in the quarter, particularly for Aixtron. However both the survey of customers' purchase intentions, and the publically available information on Aixtron and Veeco's order intake, clearly tell the story of a big decline expected in Q1'12, which will see shipments of around half of Q4.

The report says that China accounted for 76% of the 2011 market, reaching a peak of 92 % in Q4'11.

Aixtron led in Q4'11 by units as predicted, but Veeco was #1 for the full year 2011.

Yangzhou Zhongke was the #1 customer in Q4 2011, and Sanan was #1 for 2011.

Elec-Tech heads the list for likely top customer of 2012.

Despite a trend to 4 and 6 inch wafers globally at tier 1 manufacturers, 2 inch remains the majority due to China's reliance on 2" wafers.

UV LED manufacturer SETi receives AS9100 certification

The manufacturer of nitride LEDs has met additional requirements necessary to serve the aviation, space and defence industries

Sensor Electronic Technology, Inc. (SETi), is now operating in full compliance of the International Aerospace quality standard AS9100:2009, Rev. C through NSF International Strategic Registrations.

AS9100 is an enhancement to the ISO9001 certification, which SETi received in December, 2009, and adds the additional requirements needed to address the aviation, space and defence industries.

This quality management system includes additional focus in the design and development functions of the business as well as a more sophisticated product quality control system. It provides the essentials of an effective traceability program from development through product sourcing.

“Achieving AS9100 certification is a true testament to our core values of continuous quality improvement and exceeding our customer’s expectations both in private and public sectors,” comments Remis Gaska, President and CEO of SETi.

SETi claims to have developed the broadest range of UV LEDs available on the market, with continuous spectral coverage from 240 nm to 355 nm.

The firm has extensive experience in developing specialised UV LED solutions for the defence and space industries; in 2007 SETi was announced as a DARPA/SBIR success story and in 2010, SETi’s UV LEDs were space qualified.

“This certification demonstrates our commitment to continue to develop and supply the world’s best UV LED technologies into aviation, space and defence programs,” concludes Gaska.

Azzurro and Sumitomo to support Asian customers in Taiwan

The pioneer in gallium nitride on silicon technology is strengthening customer support in Taiwan by assigning Sumitomo as its exclusive local distribution partner

Azzurro has announced that Sumitomo Taiwan is its sole distributor partner in Taiwan.

Capitalising on the overwhelming success and customer traction that have taken place in the region, Azzurro stepped up its customer support by opening its Regional Office Asia in Taipei, Taiwan in August 2011.

The firm is now expanding its support by signing an agreement

with Sumitomo Taiwan as its sole distribution partner in Taiwan.

Azzurro says high acceptance of its products in the power semiconductor and LED markets continues to rise. As the company’s production ramp is currently under way, it is important to have a smooth supply chain and be extremely reactive to customer and logistic market requirements.

By growing the GaN on large Silicon substrates using Azzurro’s proprietary strain engineering technology, companies can use their current standard Silicon processing lines.

The firm says that this is a breakthrough step in massively reducing the costs of LED and power semiconductor manufacturing. As such, Azzurro says it is poised to become a strong global player in the GaN markets.

Establishing an agile support structure for its Asian business partners with its own local expert facility in Taiwan was of high importance to Azzurro; customers will benefit from direct access to all design and engineering as well as corporate functions in Germany.

This pivotal bridge function aims to ensure smooth implementation of achieving product roadmaps for Azzurro’s customers, who will be able to use it to optimise their products. Azzurro will also be able to adapt processes according to its customers’ technical requirements and describe the latest market trends and showcase suitable Azzurro products.

Erwin Ysewijn, VP Marketing & Sales of Azzurro Semiconductors says, “The agreement will considerably contribute to establish Azzurro further in the pivotal Asian markets, where Taiwan is in the spearhead position. We see Sumitomo as a well established player in the market, close to customers having an entrenched relationship and able to fulfil regional business requirements. This agreement will assure that our customers will receive optimum care and service.”

Shin Udatsu Managing Director Sumitomo Taiwan adds, “We are welcoming the innovative product line from Azzurro to our line-up of products to serve the emerging markets for next generation LED and power semiconductor devices. Our customers will now have the access through Sumitomo to the top notch technology option from Azzurro.”

Small power packs make a big impression

Osram’s new Ostar Stage LEDs have a flat glass window with an anti-reflective coating, giving the LED a much flatter profile. At a quarter of the usual height, the LEDs enable much more compact spotlights

With their much flatter profile the new Osram Ostar Stage LEDs provide the basis for compact spotlights with an extremely narrow beam and high luminance.

These LEDs are ideal for moveable stage lights, known as moving heads, which provide powerful light beams for rock concerts and other impressive lighting arrangements.



The new Osram Ostar Stage LEDs for bright spotlighting with colour mixing

Instead of the usual lens, Osram Ostar Stage LEDs have a flat glass cover with an anti-reflective coating, giving the LED a much flatter profile. At only 1.23 mm, a quarter of the usual height, spotlights can be made much more compact.

The glass cover on the new LEDs has been optimised for injecting the light into lens systems. Its etendue (the emission angle/area ratio of the emitting light surface to the projected light surface) in conjunction with customer optics enables a very narrow beam of light (+/- 9°) to be produced. This beam is twice as small as those used in spotlights based on plastic-encapsulated LEDs. This optimum bundling of light increases the luminance of the spotlight by a factor of two.

These powerful light sources are based on the successful Osram Ostar SMT platform. They contain four different chips in red, green, blue and white and Osram says they can produce virtually any colour. All four chips are manufactured using efficient thin-film technology so that almost all the light produced internally is emitted at the top and more light can be focused in the customer optics system. In pulse mode, the individual chips can be operated at a current of up to 2 A, and up to 1 A in continuous mode.

This gives maximum values of 146 lumen (lm) in red, 234 lm in green, 1.3 W in blue and 286 lm in white. The overall brightness of an LED at a typical output of 10 W could be up to 700 lm.

The LEDs have a compact footprint of only 5.9 mm x 4.8 mm x 1.23 mm. At 3.1 K/W the thermal resistance is very low and Osram says that heat removal is “no problem at all”. In constant use, the LEDs will last for more than 50,000 hours, giving the moving heads a very long life. What’s more, the LEDs can be used in spotlights of any size, from small stage spots to large moving heads.

With a beam angle of 120°, the wavelengths of the LEDs are 625 nm for red, 527 nm for green and 455 nm for blue. The colour temperature of the white LED is 6500 K and the operating current in pulse mode for each colour is 1 A.

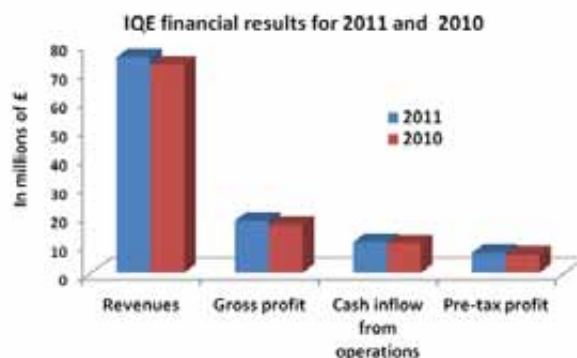
Volker Mertens, LED Marketing Manager at Osram Opto explains, “Osram Ostar Stage has a wide range of applications

with different colours and configurations – a real treat for lamp designers. More colour combinations are in the pipeline for the Ostar platform. By mixing the different Osram Ostar types it is possible to create an enormous range of colours, including pastel shades.”

IQE annual revenues grow despite massive increase in capital expenditure

The wireless market accounted for more than 73% of revenues but the company lost out in the electronics sector where it made an operating loss of £548,000

IQE has announced its final results for the year ended 31 December 2011.



Total revenues were up 4% to £75.3 million from £72.7 million in 2010 despite a second half 2011 inventory correction. The global supplier of advanced wafer products and wafer services to the semiconductor industry also showed continued improvement in gross margins, which were up from 22.8% to 24.1%. EBITDA also rose by 6% to £14.0 million. Pre-tax profit was also up 9% from 2010 to £6.9 million and retained profit up 12% to £8.4 million.

Adjusted EPS was 1.86 pence (p), down from 2010, when it was 1.91p. Basic EPS was slightly down at 1.62p at the end of 2011, compared to 1.63p in 2010.

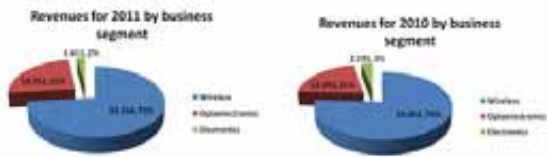
Capital expenditure in 2011 totalled £17.4 million, an over 210% rise from 2010, when it was £5.6 million. The company says this reflects the capacity expansion undertaken to meet the anticipated sales growth. In addition, £3.7 million was invested in new product development, as compared to £3.4 million invested in 2010.

Cash generated from operations was up from £10.3 million in 2010 to £10.8 million last year.

At the end of the year, IQE had a net debt of £3.9 million, whereas at the end of 2010, the firm had net funds of £7.0 million.

IQE’s three primary markets are wireless, optoelectronics and electronics. Below is a breakdown of the revenues for these

segments in 2011 and 2010.



Drew Nelson, IQE Chief Executive, comments, "Our strong growth momentum was temporarily impacted in the fourth quarter by inventory corrections at two of our major wireless customers. Despite this, I am pleased to report a year on year increase to record revenues and profits. These inventory corrections continued into the first quarter, but as anticipated, customer forecasts now reflect a return to growth as expected for Q2 and onwards."

"New product qualifications have progressed very well, with newly qualified products now ramping into production and other qualifications nearing completion. Furthermore, our capacity expansion programme remains on track, which is providing customers with a high degree of confidence in IQE as a key supplier as they keep their allocation of supplier shares under review."

"Our optoelectronics business has a number of near term opportunities which have progressed well during 2011 and which could result in a number of key products ramping to volume production as early as 2013. Following the year end, we announced a strategic investment in Solar Junction Corporation and an exclusive long-term supply agreement, a move that will accelerate our penetration into the exciting, third generation CPV solar market."

Nelson concludes, "The Board remains confident that IQE is well positioned for strong growth in 2012 and beyond."

Mid-power LEDs from Cree add to its multipurpose lighting family

Cree's new XLamp LEDs are designed to optimise and simplify luminaire designs Cree has unveiled a new range of mid-power XLamp ML-C and ML-E LEDs, bringing increased versatility and flexibility to a wide spectrum of lighting applications.



Cree's XLamp ML LED

Designed to accelerate the adoption of LED lighting, the expanded XLamp ML family now offers red, green and blue colour options, high-voltage and three different price-performance options in the ML package. Cree says the ML LED high-voltage options can enable the use of more efficient, smaller drivers to lower cost for applications such as LED replacement lamps.

XLamp ML LEDs offer the flexibility and optimisation needed to quickly design a portfolio of products for multiple lighting applications, including architectural, hospitality, emergency vehicle, decorative lighting, and linear florescent LED replacements.

With a shared 3.5 mm x 3.45 mm footprint, customers can quickly and easily expand or update their product portfolio by leveraging a common ML package.

"Using products from Cree's ML LED family gives us great flexibility," says Michael Pena, President, Blue Ridge Lighting Solutions. "From a full white colour temperature spectrum and different power ratings to the offer of colour LEDs, the family of ML products gives us the capacity to offer our customers a full range of lighting options."

"Providing the broadest portfolio of LED components is essential to accelerate LED adoption," adds Mike Watson, Cree senior marketing director, LED components. "Cree's expanded family of optimised ML LEDs further extends the options for our customers to support a wide array of lighting applications without sacrificing lighting-class performance."

The ML-C LED delivers luminous flux up to 37 lumens in cool white (5000 K) and up to 31 lumens in warm white (3000 K), both at 100 mA.

The series versions of XLamp ML-C and ML-E white LEDs have typical voltages of 6.4 V and 9.6 V, respectively, at 50 mA.

The entire family of XLamp ML white LEDs provides 6,000 hours of LM-80 data available now, which can speed up the ENERGY STAR qualification process. The XLamp ML white family is also available in minimum 80, 85 and 90 CRI options

GaN-on-diamond could improve sensors and LED efficiency

A new project focussed on developing a substrate material for Group4 Lab's novel technology combines diamond and gallium nitride. It is aimed at developing ways of rapidly, efficiently, passively, and cheaply extracting heat

Alfred University has signed a contract with Group4 Labs to develop sacrificial substrates to support the firm's GaN-on-Diamond technology.

The aim is to improve efficiencies in solid state lighting and

advance the sensing and communication industries.

Startup company, Group4 Labs, based in Fremont, California, has signed an agreement with Alfred University (AU) researchers to develop a sacrificial substrate for diamond coatings.

S.K. Sundaram and Scott Misture, who are Inamori Professors of materials science in the Kazuo Inamori School of Engineering at AU, will oversee the project.



Group 4 Labs' GaN-on-Diamond substrates

Misture and Sundaram are to develop a substrate material for Group4 Lab's novel technology which combines diamond and semiconductors to extract heat rapidly, efficiently, passively, and cost-effectively.

According to Sundaram, the micron-sized diamond coating is first applied to a sacrificial substrate. When the sacrificial substrate is removed, the diamond coating will then serve as the substrate for further processing of the semiconductor coating.

Misture and Sundaram believe that cordierite glass-ceramics are most suitable as a diamond coating substrate because the two materials are well matched with regard to thermal expansion as well as chemical and thermal stability under the processing conditions of interest to Group4Labs. The "sacrificial" substrate must also be inexpensive because it is disposed of during processing.

In the past, diamonds had been deposited on substrates with different thermal expansion coefficients, which resulted in "mismatch failure and thermal cracking," according to Misture. The main challenge is matching the thermal expansion coefficients of the substrate and the coating. Misture and Sundaram hope to accomplish that by manipulating the glass chemistry and controlling a specific crystal phase from crystallising out.

Graphensic kicks off production

Using a novel growth method, a Swedish university spin-off has begun to grow graphene consisting of a single layer of carbon atoms, on silicon carbide. The growth method concentrates on how the heating process can control the interaction of silicon and carbon at the surface of the material

A group of researchers at Linköping University are now marketing their method of producing graphene.

There is great interest in the Nobel Prize-winning material,

which is suitable for things such as high-frequency electronics.

High quality graphene manufactured at Linköping has been supplying other research teams with the material for several years. The demand is now so great that the researchers have formed a company, Graphensic AB.



Professor Yakimova

"As part of research, we deliver material to several projects, both in Sweden and throughout Europe. This strengthened our opinion that there is now a commercial market for our material," says Rositza Yakimova, who leads the research group.

Graphene consists of a single layer of carbon atoms. Yakimova's group starts with SiC, which is heated to a very high temperature. Their success lies in understanding how silicon and carbon act on the surface, and how a heating process that controls this surface can be implemented. The process is under application for a patent.

"We've already transferred one manufacturing technology for the material for a white LED, which is being industrialised in Japan, and now we're initiating the industrialisation of the graphene method," says Mikael Syväjärvi at Graphensic AB.

The hope is that Swedish graphene research and its graphene industry will get a breakthrough owing to billions in investments in Europe. However taking the step from research to commercialisation requires help.

"Alongside InnovationskontorEtt at Linköping University, we've developed a strategy for how to grow with the market and build our Swedish company further to deliver the material internationally. There aren't any applications on the market yet, but the material is needed to develop them," Yakimova adds.

Graphensic AB was established by Rositza Yakimova, Mikael Syväjärvi, and Tihomir Iakimov, and is supported by the LEAD business incubator. The company has its headquarters in Linköping in East Sweden, and uses equipment and offices at Linköping University.

ProPhotonix has a new joint broker

XCAP Securities has been appointed as joint broker by ProPhotonix

ProPhotonix Limited, a designer and manufacturer of LED light engines and laser diode modules, has appointed XCAP Securities plc as its joint broker with immediate effect.

ProPhotonix Limited, headquartered in Salem, New Hampshire, is an independent designer and manufacturer of diode-based laser modules and LED systems for industry leading OEMs and medical equipment companies.

In addition, the Company distributes premium diodes for Opnext, QSI, Ondax, Sanyo and Sony. The Company serves a wide range of sectors including the machine vision, industrial inspection, defence, sensors, and medical markets.

ProPhotonix has offices and subsidiaries in the U.S., Ireland, and the United Kingdom.

LED market revenues to peak before the saturation

Between 2013 and 2017, market penetration is expected to grow from 2% to around 10% in 2014 and 25% by 2017

The value of the market for HB-LEDs used in general lighting applications is likely to peak in 2017 before dropping away as the cost of the technology falls sharply.

That's according to IMS Research market analyst Jamie Fox, who told delegates at a euroLED event, that the "best years" for LED vendors selling into the general lighting market would be 2013 - 2017.

Over that period, market penetration is expected to grow massively from its current unit level of around 2%, to 10% in 2014 and 25% by 2017. And although the cost of LEDs is likely to fall quickly over the next five years, that won't be enough to hold back the value of the market for LED chips in general lighting until after 2017, Fox indicated.

But from 2018, saturation will take over and the falling prices of LEDs, combined with reduced rates of lamp replacement thanks to their long lifetime, will see the market for LEDs used in general lighting begin shrinking.

Speaking at the same event, European marketing director at chip producer Bridgelux, Tom van den Bussche, said that the switch to a Silicon platform would cut costs by 75%. This would be partly through the lower price of Silicon, but also through enabling a larger (8-inch) platform that takes advantage of obsolete Silicon wafer manufacturing fabs whose owners have now largely moved on to 12-inch Silicon.

Van den Bussche added that Bridgelux, fresh from another \$20

million injection of venture funding that brings its total capital raised to more than \$200 million, could be in production with GaN-on-Silicon LEDs by the end of this year.

Tom van den Bussche and Jamie Fox will be giving more in depth expert opinions on the future of LEDs at this year's euroLED conference, between 13th and 14th June, NEC, Birmingham, UK.

Van den Bussche was on this year's euroLED advisory board, which helped to build the conference agenda, bringing together a great line up of speakers to discuss market forecasts, new technology launches, regulations and standards and much more.

Other speaking companies include Philips Lumileds, Nichia, Osram, Cree, GE Lighting, European Commission, Luckgar, Forge Europa, Tridonic, Future Lighting Solutions, City University, LUX-TSI LTD and Helvar.

Aucksun Opto orders five Aixtron reactors to make HB-LEDs

The company says it will return to Aixtron in the future to help with its plans for ramping up the production of gallium nitride based materials

Aixtron SE has a big MOCVD system order from Huaian Aucksun Optoelectronics Technology based in China.

The new customer, Aucksun Opto, has placed a contract for five Aixtron multiwafer MOCVD systems which will be dedicated to the growth of GaN-based materials for HB-LEDs.



The order for two AIX 2600G3 IC reactors, both in a 49 x 2-inch wafer configuration, and three AIX2800G4 reactors, each in a 60 x 2-inch wafer configuration, was placed in the first quarter of 2012 and delivery will take place in the second quarter of 2012.

Kai Chen, General Manager of Aucksun Opto, comments, "We are familiar with the very high quality of service and equipment we can expect to receive from Aixtron, and their MOCVD systems will provide the perfect solution for the development and production of wafer materials for HB-LEDs. This is an

exciting new venture for us and knowing that we have a world leader like Aixtron at our side is very reassuring.”

“Aixtron equipment features excellent process technology and productivity with high uniformity and ergonomics. The company has a strong presence in China and their local service team will play a key role in assisting our internal efforts as we ramp up production. We shall be returning to Aixtron in the future to help us with our plans for the production of HB-LEDs based on gallium nitride materials.”

Aixtron launches new MOCVD technology centre in Suzhou

The training and demonstration laboratory supports China's global LED ambitions

A ceremony held on 16th March marked the opening of Aixtron SE's new training and demonstration centre at SINANO - the Suzhou Institute for Nanotechnology and Nanobionics.



Attendees present at the ceremony in the city of Suzhou, China, included a representative of the National Development and Reform Commission (NDRC), the German Consul General in China and many of Aixtron's key customers. Also taking part were numerous partners from universities and research institutes from across Greater China.

At the Suzhou Industrial Park (SIP) in the Yangtze River Delta – one of China's most influential business locations – future Chinese MOCVD experts will be trained in the latest semiconductor technology and manufacturing processes.

The Aixtron centre will be able to draw upon the collaborative synergies between exceptional industrial and institutional research and also offers training.

“In order to achieve China's aim of global LED leadership, LED products made in China need to be able to take the

lead in lighting quality, efficiency and cost-effectiveness. I believe that this cooperative arrangement will make a significant contribution toward achieving these goals,” said a spokesperson from SINANO. “One of the new facility's main priorities will be to provide Chinese customers with the depth of process knowledge they need in order to optimise their devices.”

“China is now playing a significant global role in the emergence of the LED lighting market through the extensive national and regional encouragement of LED applications.” Aixtron's President & CEO Paul Hyland said in his speech.

“At the new centre, we will be able to proactively support our customers' technology developments by utilising the very latest Aixtron technologies and by providing the highest quality training, not only in the field of LEDs but also in other nanotechnology areas, including GaN-on-Silicon,” he added.

The cooperative agreement with SINANO will facilitate the full process and characterisation of LEDs, the technical properties of which are essential to lighting product quality.

The training courses offered will use Aixtron's latest generation CRIUS II-XL and AIX G5 HT systems and will be held in a production cleanroom environment, labs, and classroom training facilities that occupy a total area of 350 square metres.

“We will focus on the most critical factors in the manufacturing process, which will enable operators of MOCVD facilities to achieve better system utilisation times and higher yields, thereby reducing their operating costs – our focus will be on operational efficiency, maintenance routines, process optimisation and fab management,” commented Nicolas Muesgens, Director of the Aixtron Training and Demonstration Centre. “In Suzhou, we will offer intensive, science-based, hands-on training courses to small groups, led by Aixtron's highly qualified and experienced engineers.”

Aixtron has more than 30 years of experience in developing MOCVD production technologies for a wide range of innovative and highly complex semiconductor devices, such as LEDs, lasers, transistors and solar cells.

The new training centre in Suzhou will also pay special attention to operational health and safety issues and to the protection of the environment; it will adhere to and promote German, international and Chinese product-safety and waste-management standards.

Compound Semiconductor Award Winners 2012

Leading III-V chipmakers, first-rate toolmakers and the most innovative start-ups grabbed the 2012 Compound Semiconductor Industry Awards.



Winners of the CS Industry Awards 2012 were announced on Monday 12 March at CS Europe, one of the world's leading compound semiconductor conferences. At this event, which attracted 250 delegates to the Hilton Hotel, Frankfurt, six companies netted awards in categories covering all the key areas associated with compound semiconductor manufacturing and chip development. These winners included some of the biggest names in the field and some of the most exciting start-ups: TriQuint, Veeco, Cree, Ammono, KLA-Tencor and Solar Junction.

TriQuint won the R&D award for its involvement in the Microscale Power Conversion programme, which promises to set a new benchmark for variable-voltage, high power switch-modulators. Commentating on this award, Richard Stevenson, editor of Compound Semiconductor magazine, said: "GaN is widely touted as the most promising material since silicon. This wide bandgap semiconductor has already spawned a multi-billion dollar LED market, and with TriQuint's help, it is going to make a big splash in the switching arena."

The Compound Semiconductor Manufacturing Award went to Veeco for its TurboDisc MaxBright GaN MOCVD Multi-Reactor System. "Higher throughput and a lower cost-of-ownership are top priorities for LED manufacturers worldwide. Full marks to Veeco for a tool that excels in both these areas," remarked Stevenson.

Cree was victorious in the category for the Device Design and Packaging with its XLamp MT-G EasyWhite LEDs, which combine a 50,000 lifetime with for high-lumen, small-footprint requirements of 35 and 50 Watt halogen retrofit lamps. "Cree is playing a major role in driving the LED lighting revolution with its incredibly impressive portfolio of XLamp products," said Stevenson

The Substrates and Materials Award went to Ammono, a pioneer of a novel GaN crystal growth method. "Ammono's growth technique is a wonderfully elegant way to address the challenging problem of how to form GaN substrates," said Stevenson. "The tremendously flat, ultra-high-quality substrates that result should help to spur further improvements in laser and LED performance."

KLA-Tencor picked up the Test and Measurement Award with its Candela 8620 Wafer Inspection System. "For years and

years, LED chipmakers have had to use wafer inspection tools designed for silicon wafers. But thankfully these days are now over, due to Candela's introduction of tools focused on scrutinizing LED wafers, such as the 8620 inspection system," claimed Stevenson.

The Stanford start-up Solar Junction netted the most innovative device award for its high efficiency SJ3 product, a platform that has enabled the company to fabricate cells with a record-breaking 43.5 percent efficiency. "Dilute nitrides have always held promise. Until now massive commercial success has failed to followed, but that will change with Solar Junction's revolutionary multi-junction solar cells," predicted Stevenson.

Voting by the readers of Compound Semiconductor magazine and its associated web-site determined the winners of these awards. More than 17,000 votes were cast. Commenting on the awards, David Ridsdale, Editor-in-Chief of the Semiconductor and Solar Group said: "In a very short time, Compound Semiconductor has become a key member of our stable of microelectronics' manufacturing magazines. In line with our other products we introduced the CS Industry Awards to ensure peer recognition of the constant innovation that occurs in the industries we work within. The CS Industry Awards have already become a key industry event applauding the best achievements by those working in the field." <http://www.csawards.net/winners/2012>

OCI aspires to become a top provider of sapphire

The Korean-based manufacturer is currently shipping GTAT's ASF-grown sapphire material to large LED customers in Taiwan, Korea, China and Japan. The firm hopes to be one of the top 3 ingot providers of 6" sapphire by 2015

OCI has begun manufacturing sapphire boules and cores in its new facility, using GT Advanced Technologies' equipment.

The company says it has now completed the initial installation of GT's ASF sapphire growth furnaces that were purchased in January 2011.

OCI held a ceremony on March 2nd 2012, to inaugurate its new sapphire production facility in Jeonju, North Jeolla Province in South Korea.

The new eco-friendly plant has an annual production capacity of 4 million millimetres of sapphire.

OCI said it has begun the shipment of 6-inch sapphire cores as well as 2-inch and 4-inch products to 5 leading LED manufacturers located in Taiwan, China, and Japan. The firm is also shipping to Korean companies.

According to a report by Goldman Sachs, the LED market is estimated to grow into a \$13.7 billion business and is expected to have an average annual growth of 16% by 2015. And the LED lighting market is forecast to post an average annual growth of 30% over the same period.



GT's ASF sapphire growth furnace which utilises HEM for producing high quality boules and cores suitable for the LED industry and other industries requiring high quality material

A recent article in The Korean Times reported that GT's ASF furnaces, which use the Heat Exchanger Method (HEM) growth process, incorporate a cost-effective sapphire crystallisation methodology for the high yield production of quality material.

HEM, was initially developed in the US to produce 8" - 12" single-crystal sapphire in 1971. OCI says it is different from other methods as the single-crystal sapphire ingots grow from bottom to top. What's more, HEM produces large diameter single crystals with precise control over the temperature gradient.

"Starting up a new sapphire production facility takes tremendous planning and coordination to ensure a successful launch," notes Cheryl Diuguid, GT Advanced Technologies' vice president and general manager of its Sapphire Equipment and Materials Group. "I am proud of the effort of our service and installation team who worked closely with OCI's production and engineering team throughout the entire process to deliver a state-of-the-art sapphire production facility that is now producing high quality material."

OCI says its ability to produce LED-grade sapphire at diameters of up to six inches will help to position it as a top sapphire producer in the region. The company's entrance into the LED industry using GT's ASF sapphire growth technology expands the relationship between the two companies. OCI and GT have successfully partnered together for a number of years in the PV industry.

Now OCI says it is looking to capture a 20% share of the global ingot market by 2015 and to emerge as one of the world's top 3 ingot providers.

OCI CG Business planning team leader Yang Jae-yong concludes, "After pilot operation at the end of last year, the mass production has been put in place, and the product has passed the sample tests of the world's leading wafer manufacturers. We will focus on 6-inch ingot, a high value-added product, and try to increase consumer satisfaction and secure competitiveness in the global market."

Gallium nitride development efforts escalate

TriQuint, Mitsubishi Electric, Nitronex, RFMD and Cree are among the companies announcing new developments on GaN devices

As products using GaN technology continue to gain acceptance in military and commercial applications, development activities at microelectronics companies are accelerating.

The Strategy Analytics GaAs and Compound Semiconductor Technologies Service (GaAs) viewpoint, "Compound Semiconductor Industry Review October-December 2011: Microelectronics," captures product, technology, contract and financial announcements for companies such as RFMD, Skyworks, Fujitsu, Anadigics, Agilent, Hittite Microwave, TriQuint, Avago, NXP Semiconductors, Microsemi, Renesas Electronics, Freescale, Broadcom, Cree and Murata Manufacturing.

"GaN-based products have demonstrated performance advantages for military systems for some time and they are finally beginning to see acceptance in commercial applications, such as CATV and wireless infrastructure," notes Eric Higham, Director of the Strategy Analytics GaAs and Compound Semiconductor Technologies Service. "As these application areas broaden, the industry is responding by increasing their efforts to develop new products, processes and partnerships."

Asif Anwar, Director, Strategy Analytics Strategic Technologies Practice, adds, "Recent announcements indicate growing interest in GaN-on-Silicon processing to reduce cost and higher voltage GaN processes, which will improve power handling performance."

The October - December quarter of 2011 saw mostly positive revenue reports from microelectronic companies, with Skyworks cementing its position as the leading GaAs device manufacturer. Companies continue to diversify through reorganisation, partnerships and product development aimed at adjacent and high performance market applications. GaN development activity continues strongly with several foundry and product announcements.

In the report, Strategy Analytics has summarised financial, product, contract and employment developments from leading compound semiconductor device suppliers in Q4 2011. These announcements address a variety of commercial

and military applications that use GaAs, GaN, SiC, SiGe and complementary metal-oxide-semiconductor (CMOS) technologies.

QD Vision wins \$1.38 million contract

The firm will develop its QLED technology to eventually produce devices that can be employed by U.S. forces QD Vision was recently awarded by the Department of Defence for specialised devices based on electroluminescent quantum dots.

The 12-month program will result in the development of prototype devices that can be tested under real-world conditions, and that will ultimately be employed by U.S. forces.



QLEDs made by QD Vision

Quantum dot technology developed at QD Vision provide some advantages in numerous display and lighting applications. Quantum dots are semiconductor nanocrystals that can be tuned to emit light at specific wavelengths, and quantum dot LEDs (QLEDs) are thin-film, low-voltage devices with the capability to emit in both monochrome and full-colour modes.

“This award demonstrates QD Vision’s leadership in emissive materials and devices, and combines our strengths in inorganic chemistry, thin-film deposition and electrical device physics,” says Jason Carlson, President and CEO of QD Vision. “We are excited and honoured to take on this challenging program to provide important new devices and technology to the United States Department of Defence.”

Intematix phosphors invigorate LEDs

With \$16.2 million in funding the firm is expanding its capabilities to better address the LED market needs with its phosphor products which it says improve LED light quality

Intematix, an innovator of patented phosphors and phosphor components for LED lighting, has received \$16.2 million in funding.

The cash has come from current investors Draper Fisher Jurvetson and Crosslink Capital, as well as a new financial investor.

The company plans to use the latest round of investment to continue tackling challenges for the LED industry. Intematix hopes to expand its facilities and working capital and

development of its phosphor products and ChromaLit remote phosphor products.



“LED technology is the future of lighting, and Intematix phosphors and remote phosphors are key components to making this possible,” says Maurice Carson, Chief Financial Officer for Intematix. “This investment further enables Intematix to continue its growth trajectory as it addresses the light quality needs required by the general lighting and display markets.”

While lighting LEDs have grown in efficiency, they have faced challenges in colour quality and thermal management in small form-factors. Intematix says its phosphors enable white light comparable to conventional sources and ChromaLit remote phosphor systems have shown more efficient cooling leading to compact light bulb solutions.

“Intematix is a key provider of the light quality needed for general adoption of LEDs in lighting,” comments Alain Harrus, board member of Intematix and partner at Crosslink Capital. “Intematix is extremely well positioned to advance solid-state lighting technology across the world, and to benefit from the current intense market focus on quality of light.”

Intematix reckons that many people do not know that phosphor is “the magic ingredient” that makes LED lighting possible. It turns the unattractive blue light produced by an LED into a broad spectrum of warm light hues that are more appealing to consumers.

The new Intematix investment comes on the heels of the company’s expansion into the Chinese market, with a new factory and prestigious awards from a top Chinese market research firm and lighting organisation announced last month.

Intematix’s growth as a company and focus on China points to a larger trend in the industry. China is producing a third of the

world's LEDs at a growth rate of 18 % and Intematix is one of the key suppliers that makes phosphor materials so important in the industry.

OLED inventor joins QD Vision science advisory board

The innovator of Quantum Light product platform harnesses the unique light-emitting properties of a new class of nanomaterials called quantum dots

Ching Tang, inventor of the organic light emitting diode (OLED) and a winner of the prestigious Wolf Prize in the field of chemistry, has joined QD Vision on the company's scientific advisory board.



Ching Tang, Scientific Advisor, QD Vision

Currently the Doris Johns Cherry Professor at the University of Rochester, Tang is credited with several key innovations that led to the commercialisation of OLED flat-panel display technology, including the discovery of the basic heterojunction device structure.

"Ching Tang is an extraordinary talent and we are thrilled to have him join Professor Vladimir Bulovic and Professor Mounji Bawendi on QD Vision's three-member scientific advisory board," says Seth Coe-Sullivan, QD Vision founder and Chief Technology Officer.

"His creation of the OLED and organic photovoltaic fields has shaped 25 years of research and technology around the world, changing how we display information and harvest solar energy. We look forward to him having a similar impact on our quantum dot devices in the lighting and display markets."

In addition to the Wolf Prize, Tang has received numerous industry awards. These include, the Daniel E. Noble Award, which recognises outstanding contributions to emerging technologies, the Humboldt Research Award, and the Jan Rajchman Prize from the Society for Information Display. His seminal paper on OLED technology was published in 1987 in the journal Applied Physics Letters, and is said to have been

cited by more scientists than any other papers published in the history of the journal.

Tang is a member of the National Academy of Engineering.

"QD Vision's leadership in the commercialisation of quantum dot materials, and its ground breaking research into electroluminescent applications of the technology, is really impressive" says Tang. "I am truly excited to be joining this world-class team of scientists and engineers in the field of nanotechnology."

Kyma saving energy with new funding

The supplier of crystalline III-nitride semiconductor materials including GaN, AlN, AlGaIn and related products and services, has received funding from the NC Green Business Fund

Kyma Technologies is making energy saving measures to complete in 2011, one of the largest geothermal HVAC systems for cleanroom air handling in North Carolina.

Funded by the North Carolina Green Business Fund, Kyma contracted TriMech to install a 30 ton geothermal HVAC system and a 20 ton energy efficient industrial chiller. The company also enlisted Danco Electrical Contractors to install energy efficient lighting and Kyma itself also installed a facility-wide data acquisition system for energy usage analysis and optimisation.

Kyma estimates that the energy needed to run the facilities for its cleanroom has been reduced by 68% and that overall energy usage of the company has been reduced by 35%.

In addition to immediate energy savings, the data acquisition system will allow continued analysis of other energy-consuming systems to identify additional energy savings opportunities.

The geothermal HVAC unit controls all of the air handling for Kyma's class 10,000 (ISO 7) cleanroom, and maintains stringent temperature and humidity requirements with 25 air changes per hour using 100% outside air. This unit is one of the largest geothermal units in the state of North Carolina and is claimed to be the only one that uses 100% outside air.

Addison provided the custom HVAC unit that is uniquely designed for parameters outside the normal design space. Kyma is continuing to work with TriMech and Addison engineers to monitor and optimise the operation of the machine.

According to Paul Penland, President of TriMech, "The end results of this very unique and challenging project were very satisfying. This is the only known geothermal heat pump in the state using 100% outside air, and we are breaking new ground in showing that this type of system works and is very energy-efficient."

Heather Splawn, Chief Operating Officer and Director of Business Development who led the project for Kyma, adds "This project has helped us to significantly lower our costs

while simultaneously lowering our impact on the environment. Additionally, we now have a much better understanding of our energy usage which will help in downstream decisions. We are very thankful for the vision of the North Carolina Board of Science and Technology and those state legislators who support the NC Green Business Fund.”

The market for nitride semiconductor devices was \$12 billion in 2010 and is expected to reach \$90 billion over the long term; \$60 billion in visible lighting applications and \$30 billion in power device applications.

Quantum Wafer uses Aixtron to ramp up production

The three reactors will be used to produce gallium nitride chips for use in HB-LEDs

Aixtron SE has a new MOCVD systems order from existing customer Quantum Wafer Inc., China.

The new contract is for three more Aixtron MOCVD units. All systems will be dedicated to the growth of high brightness LED (HB-LED) wafers based on GaN materials.

The order was placed in the fourth quarter of 2011 and delivery will take place during the first quarter of 2012. Aixtron's local support team will install and commission the new reactors in a state-of-the-art clean-room facility at Quantum Wafer's factory in China.

“We have been very impressed with the performance of the two 42 x 2” Aixtron G4 MOCVD systems that we purchased in 2011,” Shu Yuan, General Manager of Quantum Wafer, comments. “We therefore wish to add more equipment from Aixtron, as we implement the next step in our strategic plans.”

Quantum Wafer is a semiconductor optoelectronic materials and device company located at the heart of the Zhujiang Delta Industry Area of China. A manufacturer and provider of semiconductor wafers, the company supplies materials for the manufacturing of LED devices, as used in a wide range of applications such as LED TVs, mobile phones, solid-state lighting, large-screen displays and traffic lights.

Seren's substantial funding to brighten up the LED market

The £1.8 million will be used to purchase key capital equipment for HB-LED pilot scale development and create a specialist engineering team

Fusion IP's LED technology division, Seren Photonics, has raised £1.8 million in equity funding .

Seren says this will enable the firm to transfer its cutting edge

technology to manufacturing partners around the globe.

The first of these exploitation agreements was recently announced with an Indian manufacturer.

Seren's revolutionary new processing technique, developed by Tao Wang, a professor at the University of Sheffield, is claimed to greatly increase the efficiency at which a HB-LED converts an applied voltage into light. This significantly reduces heat generation under normal operating conditions.

Successful demonstrations of the patent pending technology have resulted in a significant increase of the light output compared to untreated devices. This means that either much brighter LED lamps can be manufactured or that the power consumption of LED lamps can be reduced.

Seren's technology is targeted at the large and fast growing white light HB-LED markets, such as back lighting for laptops and TVs, signs and displays, as well as domestic, architectural and street lighting.

Godfrey Ainsworth, Seren's Chairman comments, “This market is currently worth an estimated \$7 billion in 2011 and is set to grow to \$20 billion by 2014. HB-LEDs are set to replace incandescent lamps as governments around the world bring in legislation banning the manufacture and sale of incandescents and concerns increase about the poor light quality and environmental contamination fears from compact fluorescents. The rate of adoption will accelerate as the brightness of HB-LEDs increases and the cost of manufacture reduces.”

Seren's funding round raised a total of £1.8 million from a number of investors, including I2BF Global Ventures (£1,100,000), Fusion IP plc (£300,000) and IP Group plc (£400,000).

The funding will be used to purchase key capital equipment for HB-LED pilot scale development and create a specialist engineering team for the transfer of Seren's processes to its commercial manufacturing partners.

Post funding Fusion will have a 40.2% undiluted shareholding in Seren.

Carl Griffiths, CEO of Seren Photonics says, “We are delighted to have secured this significant investment from our existing shareholders and from I2BF. The funds will enable us to accelerate the transfer of Seren's technology to manufacturing partners. This will start with our existing collaboration partner in India and we are already in discussion with HB LED manufacturers in China about the possibility of licensing or creating a joint venture manufacturing facility. We will continue to look for other potential partners outside of these territories .”

David Waserstein, Partner and Director of Investments at I2BF, adds, “We believe LEDs will play a large role in reducing energy intensity for a range of municipal and industrial users, and that Seren is well-positioned to help drive that growth due to the double impact of its technology on both brightness and reduction of heat loss. We are also pleased to be supporting a UK university spin out at this time, which has been ably supported by our co-investors Fusion IP PLC.”

Peter Grant, Operations Director for Fusion IP concludes,

“We are very pleased to join I2BF Global Ventures and IP Group in this funding round, which will enable Seren to continue its impressive development of its LED technology. We remain confident that Seren can make a significant contribution to enabling the use of LEDs in a variety of different energy efficient applications where there is a continuous need to reduce power consumption and improve product performance. With this funding in place we look forward to the Company securing further deals for the use of its technology internationally.”

Meaglow InN wafers are nitrogen rich

Scientists from the firm have found that low temperature growth encourages nitrogen incorporation in indium nitride. Meaglow says it has made a breakthrough in understanding the compound semiconductor indium nitride.



InN wafers grown by Meaglow

Indium nitride (InN) when alloyed with GaN forms the light emitting component that powers a greater than \$10 billion dollar LED industry.

In its own right, InN is being developed as an advanced material for solar cells, high speed transistor devices and other applications. However the material is still very mystifying.

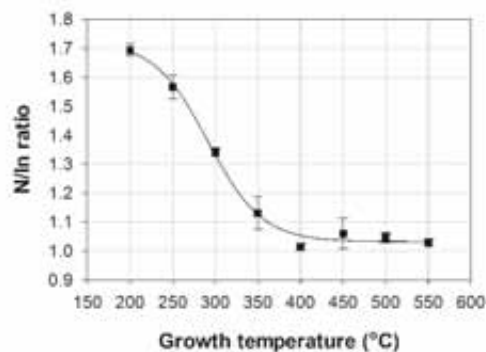
For instance, based on theory it had long been assumed that it simply wasn't possible to produce nitrogen rich InN. So it was a surprise a few years ago, when samples made at low temperatures were measured with greater than 30% excess nitrogen present.

How could this be?

Many researchers didn't believe the measurements, though they were subsequently repeated by many groups. Theory didn't seem to agree with experiment.

Now, scientists at Ontario-based Meaglow have used a technique called Heavy Ion Elastic Recoil Detection Analysis, or HIERDA, to determine the nitrogen to indium ratio in InN grown at different temperatures. This is a very accurate stoichiometry measurement technique and the graph below illustrating the

HIERDA results, reinforces that very nitrogen rich InN can be grown at low temperature.



The material was grown by a plasma based technique known as RPECVD.

How the excess nitrogen could occur remained largely unexplained until now.

“Basically the excess nitrogen is seen when forming the material at relatively low temperatures using plasma based nitrogen sources. These plasma sources provide the extra potential energy needed for nitrogen rich material to form. To a greater, or lesser, extent excess nitrogen species are probably present in most InN samples, as plasma techniques are commonly used,” says Butcher. “It may take some years for the research community to come to terms with this, but nitrogen rich InN is a reality, and now it's a reality we understand.”

Nitrogen rich InN may also be important from another perspective. InN is plagued by a surface current problem which is limiting its development. However, the excess nitrogen species, previously ignored, may hold the key to solving this problem. As pointed out by Butcher, these species are fairly mobile and migrate to sample surfaces. “They seem to fit the bill as a culprit for this phenomenon.”

Meaglow is officially launching a range of nitrogen rich InN wafers for sale exclusively on its website to further research and industry collaborations so that all parties can obtain a stronger understanding of InN, and so that the material can realise its full potential.



Patented Migration Enhanced Afterglow (MEAglow) Reactor that grows the InN wafer

Meaglow is based in Thunder Bay, Ontario, Canada and produces a range of epitaxy equipment and MBE and MOCVD accessories, and also provides specialised thin films.

Further details of this work have been published in the paper, "Low activation energy for the removal of excess nitrogen in indium rich indium nitride", by Butcher *et al*, *Applied Physics Letters*, 100,011913 (2012).DOI: 10.1063/1.3673839

Customised handlers for semiconductor and LED customers

Owens Design says its customised automated solutions enable low risk and lost cost entry into new market applications

The firm says it has delivered multiple customised film frame automated handling solutions to customers in the semiconductor and LED industries.

The large variety of film frames and film frame cassettes has created a need for customisable solutions for a variety of process tool applications. By working with its customers in a collaborative design and build approach, Owens Design has developed an automated film frame handling solution that can easily be customised to address a variety of non-standard form factors.

Until recently, the loading and unloading of film frames into a process tool has been mostly a manual operation. Today's semiconductor manufacturers, however, need to automate the process to address the timing needs of back end of line (BEOL) inspection and test applications. At the same time, LED manufacturers need an automated solution to enable greater volume production to support the increasing demand for LEDs in a variety of markets.

"LED usage is becoming widespread in an ever-growing number of applications, including aviation and automotive lighting, household appliances, remote controls for electronic systems and traffic signals," says John Apgar, president of Owens Design. "The LED market, however, is extremely price-sensitive, so LED manufacturers are looking for ways to increase productivity, while lowering manufacturing costs. Our customisable automated film frame handler solution provides a low-risk approach to meeting both these needs."

Owens Design offers semiconductor, solar and LED capital equipment manufacturers a proven methodology to reduce tool development costs, minimise technical risk, and speed their time to market. By working closely with an established design and manufacturing company such as Owens Design, a capital equipment company can focus its internal efforts on its core technology. In turn, the design and manufacturing services company can focus on integrating this new core technology into a system level platform that has been optimised to meet the equipment manufacturer's performance specifications.

"Developing an easily customisable handling solution for our customers required expertise in film frame extraction, alignment and transport, expertise that Owens Design has developed over many years of successfully delivering a wide range of automation solutions to our customers," said Jack Yao, Director of Business Development for Owens Design.

"Our collaborative design and manufacturing approach has a proven record of delivering the kind of low-risk, low-cost, and rapid time-to-market solutions our customers have come to rely on. Automating film frame handling with a customised solution helps our customers leverage existing tool sets and enter new markets, while also enabling their customers to reduce manufacturing costs and increase volume production."

HB-LED market still going strong

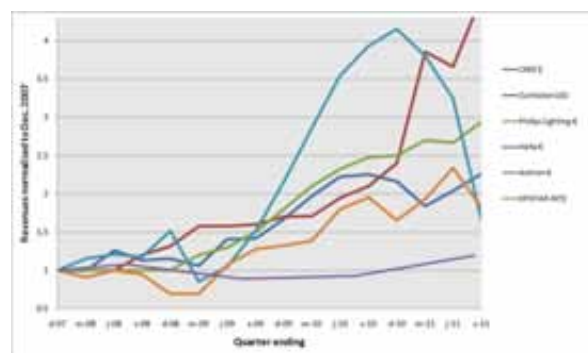
According to a new European Photonics Industry Consortium (EPIC) report, the HB-LED market made a 7% increase on a year-to-year basis in 2011

The report, which is distributed exclusively to EPIC members, tracks the response of the lighting and display industries in one of the most difficult economic crises in recent years.

The new report "LEDs: The 2011 Market Review," says the market volume for high brightness LEDs (HB-LEDs) reached \$12 billion in 2011, a 4.3% growth over 2010. While the demand for LED BLU (back light unit) systems is still growing, the demand for LED chips is falling.

Fewer LEDs are needed to realise a BLU and with the cost per LED also dropping, revenues attributed to LEDs for each display screen are dropping rapidly. The production of BLU based on LEDs should continue to rise through 2014. The demand for LEDs to produce edge-lit BLU has peaked and will settle at about 70% of its maximum value in 2010-2011.

The EPIC Bellwether Index of key companies is an important indicator of the commercial development of solid-state lighting in general. In 2011 the Bellwether companies showed rather different levels of performance.



Revenue performance for the EPIC Bellwether Index companies

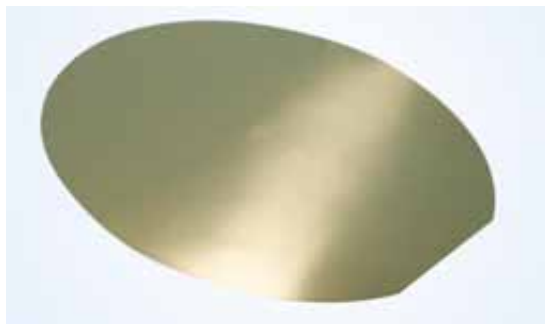
Aixtron was challenged by scale-back of MOCVD purchases due to slowing demand in the back lighting market, and the end of purchase subsidies by the Chinese government. Chip manufacturers like Epistar and Cree showed mixed results, while lighting systems companies like Philips and Zumtobel fared very well.

Mo-Cu wafer substrate for LED chips

A new material which has the same coefficient of thermal expansion as sapphire, minimises cracks in nitride semiconductor layers grown on these wafers which are used to make LEDs

With Mo-Cu R670, Plansee High Performance Materials has developed a new molybdenum-copper composite material for semiconductor wafer substrates.

The high thermal conductivity of Mo-Cu R670 ensures optimised heat dissipation in LED chips. The new material has the same coefficient of thermal expansion as sapphire, and therefore reduces defects in the semiconductor structure which can occur during the hot bonding process. In this way, Mo-Cu R670 helps ensure the reliable production of LED chips and increases the efficiency of the light source.

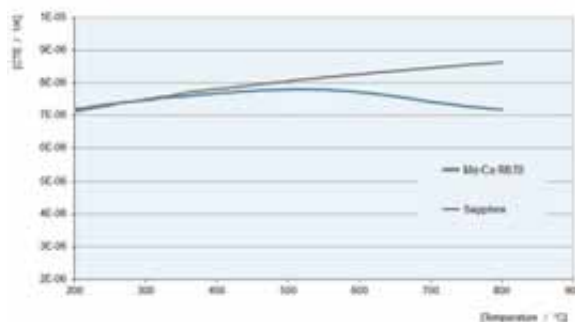


Mo-Cu R670 substrate

In the most commonly used process for the production of blue spectrum chips- including white LEDs - GaN-based semiconductor layers are grown on sapphire substrate (Al₂O₃) using epitaxial growth methods like MOCVD.

A metallic wafer, intended for the dissipation of heat, is then bonded to the semiconductor layers at high temperatures using various joining technologies. Stresses caused by different coefficients of thermal expansion can lead to cracks in the semiconductor layers. To prevent these defects, the metal wafer substrate ideally possesses the same coefficient of thermal expansion (CTE) as sapphire.

Offering good thermal conductivity and having a very high heat-resistance, molybdenum is commonly used for such wafer substrates. However, molybdenum has a lower coefficient of thermal expansion than sapphire. That's why Plansee developed wafer substrates made from the molybdenum-copper composite material R670 especially for sapphire-based and high temperature-bonded LED chips. R670 has a thermal conductivity of 170 W/mK and, with 6.7 ppm/K, the same coefficient of thermal expansion as sapphire.



Plansee can supply Mo-Cu wafer substrates with coatings made from nickel-gold, ruthenium, chromium, silver and other interface materials. These coatings protect the wafer substrate against corrosion and optimise its surface properties for the subsequent bonding process.

As a manufacturer of refractory metals and composite materials, Plansee supplies metallic wafer substrates for heat dissipation and also numerous other components for the production of LED chips and LED packages.

These include furnace components and molybdenum and tungsten crucibles for sapphire single crystal growth, components for MOCVD/MBE reactors, evaporation boats and coils for metallic mirror or barrier layers and base plates for improved thermal management of high-power LEDs.

Cree LEDs illuminate public school in Washington

The firm's LR24 luminaires have been installed at Monroe Elementary School in the Everett district

The school recently installed nearly 450 LED fixtures made by Cree. This makes it the first predominately LED-lit school in the Everett Public Schools district.

Cree LR24 LED troffers now illuminate the newly rebuilt two-story, 68,000-square-foot elementary school, which serves about 600 students in grades K-5.

"We looked at a lot of LED fixture manufacturers but only Cree had fixtures that met all of our requirements for high-quality lighting and cost savings," says Harold Beumel, director of facilities and planning, Everett Public Schools.

"Since the lights are designed for 50,000 hours of life, the Monroe Elementary School should see ongoing operational savings due to decreased energy consumption and decreased maintenance compared to linear fluorescents. Cree LR24 luminaires provide consistent, even lighting, furthering our goal of enhancing the district's educational program and providing a better learning environment."

Everett Public Schools' leadership first explored broad adoption of LED lighting after realising all of the benefits that came from the installation of LED lights during the conversion of shop classrooms into general classrooms at Heatherwood

Middle School. With those results and additional testing of LED fixtures from a variety of manufacturers, district leadership determined that Cree LR24 luminaires could bring a reduction in maintenance costs and interruptions to the students' learning environment, since there would be no on-going need to change ballasts or lamps.

According to Beumel, Everett Public Schools continues to embrace energy-efficient LED lighting, with an all-LED school planned for completion in fall 2012. View Ridge Elementary School plans to install Cree CR24 troffers, which provide higher-quality light, longer life and greater energy savings than comparable fluorescent options, delivering beautifully lit classrooms for years to come.

"Proper illumination is essential for academic settings," adds Al Safarikas, marketing director, Cree lighting. "Using Cree's LED lighting solutions is a win-win for educational institutions. Not only do the students get to work under much higher quality light than the previous fluorescent fixtures, but schools can also save significantly on maintenance and energy costs, allowing administrators to invest in other academic priorities."

Telecoms

TriQuint's new GaAs DVGAs on the radar

The gallium arsenide based devices provide receiver or transmitter gain control in base station transceivers, repeaters, point-to-point microwave radios, and satellite communications terminals

TriQuint Semiconductor has released two compact, digitally-controlled variable gain amplifiers (DVGAs) that integrate key functionality and reduce bill of material part counts.



The primary active components in the DVGAs use GaAs and a mature, cost-effective technology that integrates functions such as gain blocks, amplifiers, attenuators, and related control and biasing functions. These devices are them mounted onto standard laminate substrates (industry standard practices) and over-moulded in RoHS-compliant plastic.

These high-performance solutions provide receiver or transmitter gain control in base station transceivers, repeaters, point-to-point microwave radios, and satellite communications terminals. They are also suited for any application that requires

automatic gain control to increase system dynamic range.

The TQM829007 operates from 600 to 1000 MHz while the TQM879008 operates from 1.5 to 2.7 GHz.

Both are highly-integrated modules that simplify circuit design by combining all required components within leadless 6 x 6mm, industry-standard SMT packages.

The modules include gain blocks, a highly-linear amplifier, matching components, bias chokes and blocking capacitors, as well as a digitally-controlled, 6-bit attenuator that varies amplifier gain in 0.5 dB steps (across a 31.5dB range) via a serial programming interface (SPI). The new DVGAs operate over a temperature range of -40° to +85° C and have a minimum MTTF of 1,000 years at a mounting temperature of +85° C.

Today's transceivers require the highest possible levels of functional integration with high performance to cost-effectively simplify RF design and manufacturing.

TriQuint says the TQM829007 and TQM879008 are designed to achieve this goal, eliminating the need for commonly-used external components found in discrete designs to provide a complete gain-control solution optimized for best performance. They are also pin-compatible with TriQuint's TQM879006 DVGA that covers 1.4 to 2.7 GHz and provides 31dB of gain control, +25.4dBm RF output and a 1.5dB noise figure.

The TQM829007 complements other TriQuint devices with similar performance at key cellular frequencies including the TQM879006 (1.4-2.7 GHz) and TQM879008 (1.5-2.7 GHz.)

Technical Details:

TQM829007 600 to 1000 MHz DVGA; 31.5dB gain control range in 0.5dB steps; 31.5dB gain; +24.3dBm P1dB (+39.5dBm OIP3) RF output; 2.1dB noise figure. It draws 174mA from a 5V supply and is housed in 28-pin, 6x6mm leadless SMT package

TQM879008 1.5 to 2.7 GHz DVGA; 31.5dB control range in 0.5dB steps; 41.5dB gain; +27.3dBm P1dB (+48.5dBm OIP3) RF output; 3.9dB noise figure. It draws 285mA from 5V supply and is housed in 28-pin, 6x6mm leadless SMT package

The TQM829007 and TQM879008 are now in production. Fully-assembled evaluation fixtures (including a USB control board and related software) are also available.

NASA awards Nitronex further funding for GaN PA development

The gallium nitride-on-silicon innovator will use the funding to research GaN X- and Ka- band power amplifiers

Designer and manufacturer of GaN based RF products, Nitronex, has been awarded a Phase I SBIR.

The aim is to develop a highly efficient 20W X-band GaN power amplifier MMIC for use in long range RF telecommunications.

Since 2005, Nitronex has won 16 government contract awards that have funded the development of materials, devices, discrettes, MMICs, and process technologies, as well as manufacturing maturation.

This is the third X- or Ka- Band contract awarded to Nitronex, further enhancing Nitronex's GaN-on-Silicon power amplifier technology.

GaN has much higher power density than incumbent GaAs technologies, allowing MMIC designers to achieve higher output power and higher system efficiency. This allows system engineers to increase transmit power and reduce associated thermal and power management overhead, lowering size, weight, and power consumption (SWAP).

Nitronex says GaN-on-Silicon technology has several performance advantages over competing GaN-on-SiC offerings. GaN-on-Silicon HEMTs have industry-leading thermal performance using 2mm thick substrates, which have very low thru-wafer source inductance. GaN-on-SiC-based HEMTs have optimum thermal performance with substrates around 4mm thick, but this results in higher thru-wafer source inductance, reducing amplifier gain.

What's more, silicon substrates can use thermally superior gold-silicon (AuSi) die attach rather than other methods required by non-silicon substrates.

Nitronex uses industry standard ultra-low loss semi-insulating silicon substrates having 0.05dB/mm loss at 10GHz for a 50Ω transmission line, similar to that of GaAs, which is used upto frequencies significantly higher than even Ka band. Reuse of the silicon industry's mature supply chain results in manufacturing and cost advantages versus SiC-based technology.

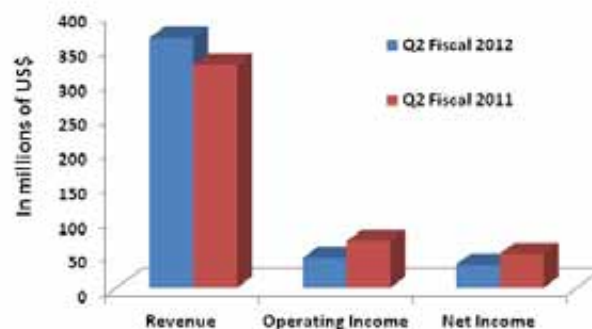
"GaN-on-Silicon has inherent performance, reliability, manufacturing and cost advantages, especially when used for MMICs, which have large die sizes. We believe GaN-on-Silicon is an enabling technology for high-performance, high-reliability, and cost effective MMIC products." says Ray Crampton, VP of Engineering. "Leveraging our standard NRF1 production-qualified process with over 650,000 production devices shipped, our 0.25 micron gate process platform has no known limitations compared to competing GaN technologies for X- and Ka- band applications.

Skyworks soars exceeding revenue guidance

The company expects sequential growth in the current quarter to be driven by LTE and smartphone program ramps as well as increasing traction in adjacent high performance analogue applications

Skyworks Solutions has reported second fiscal quarter 2012 results.

GAAP financial results Q2 FY 2012 & 2011



Revenue for the quarter was \$364.7 million, up 12 percent when compared to revenue of \$325.4 million in the second fiscal quarter of 2011 and exceeding the company's guidance of \$360.0 million.

The company did not do as well as last year in terms of operating and net incomes, though.

On a GAAP basis, operating income for the second fiscal quarter of 2012 was \$43.8 million and diluted earnings per share was \$0.18. For the same period last year, operating income was recorded as \$68.1 million.

Net income dropped from \$50 million in Q2 FY2011 to \$34 million in Q2 FY2012.

The firm generated \$117 million of cash flow from operations, retired convertible bonds and achieved a debt-free balance sheet.

"Skyworks continues to outperform our addressable markets through diversification, content growth and market share gains," said David J. Aldrich, president and chief executive officer of Skyworks. "At the highest level, we're capitalising on the mobile Internet and demand for ubiquitous connectivity by solving our customers' size, performance, complexity and battery life challenges."

"As a result, Skyworks is at the heart of the world's most popular smartphones, tablets, ultrabooks and e-readers as well as within the supporting network infrastructure. Looking forward, based on recent design win momentum and the depth of our product pipeline, we're well positioned to deliver accelerating growth," he concluded.

Third Fiscal Quarter 2012 Outlook

"We expect both top and bottom line sequential growth in the current quarter driven by LTE and smartphone program ramps as well as increasing traction in adjacent high performance analogue applications," said Donald W. Palette, vice president and chief financial officer of Skyworks. "Specifically, we expect revenue of \$383 million."

Conference Call Comments

In a conference call hosted by the company, Palette said,

"We had three 10% customers for the quarter, and they were Foxconn, Samsung and Nokia". It was also revealed that two other firms who are close to the 10% mark are Chinese firms Huawei and ZTE.

Aldrich, President and CEO, mentioned that currently the firm's revenue was about 65% in the mobile space, and 35% came from its diversified HPA business, and within the high-performance analogue sector. He added, "And within that 65%, our goal would be as diversified as we possibly can be with the products that we address."

Aldrich also commented, "We're seeing some strength in our Korean customer base, we're seeing strength with some of our Chinese customers like Huawei, our HPA portfolio is performing very well, the catalogue business is strong, and we're seeing WiFi in some of the connect rate with gaming and some of the home automation markets doing very well for us." He also mentioned that Skyworks was in a very strong position with the leading chipset provider and that he could see very good visibility into the chipset in the OEM side.

Regarding Nokia, Liam K. Griffin, Executive Vice President and General Manager, High Performance Analogue commented, "Nokia...are a 10% customer for us, and we have a very broad footprint from 3G, very high-end, even LTE-enabled phones, and in this year, down to the lower-end 2G business. We continue to work very hard to gain share. I think one of the things that you should expect from us, as we get into 2013, is to go beyond the power amplifier space. We're currently working with them on GPS products. We have a great opportunity for the antenna switch modules. And quite frankly, the power management IP that we bring forth today could be a real driver for us into 2013."

Mobile and defence & aerospace market hinder TriQuint shares and revenues

The firm predicts continued weak demand from its largest mobile device customer and increased litigation costs in the next quarter. These are two of the contributors to TriQuint shares tumbling nearly 13% after the quarterly earnings release

TriQuint Semiconductor has announced its financial results for the quarter ended March 31, 2012.



Revenues for the first quarter of 2012 were \$216.7 million, down 3% from the first quarter of 2011 and down 5% sequentially. Networks market revenue grew 10% sequentially while mobile devices market revenue and defence & aerospace market revenue decreased 8% and 4%, respectively.

GAAP gross margin for the first quarter of 2012 was 28.9%, down from 39.0% from the equivalent quarter last year, and sequentially from 29.5%.

Operating expenses for the first quarter of 2012 were \$66.2 million, or 31% of revenue, up from \$61.6 million in the previous quarter partially due to an increase in litigation expenses.

Operating income nose dived from \$20.3 million in Q1 2011 to a loss of \$3.6 million in Q1 2012.

Net income for the first quarter of 2012 was \$1.9 million or \$0.01 per diluted share, down from \$4.3 million, or \$0.03 per diluted share, in the previous quarter, and down from \$12.4 million in the same quarter last year. Included in net income for Q1 2012 was a gain on a previously impaired investment of \$7.0 million.

Cash and investments grew by \$32.6 million to \$194.9 million in the quarter due primarily to improved working capital management and lower capital expenditures.

During a conference call discussing the first quarter of 2012, Ralph Quinsey, President and Chief Executive Officer, commented, "I would first say that the short-term dip that we're seeing in the current quarter as, it's all about existing products. Products that have been in the marketplace." He also said that last quarter, TriQuint was seeing a good uptake of its MMPA, and transmit modules. "We're seeing that in Korea, we're seeing that in greater China," he added.

"Our revenue was better than normal seasonality in the first quarter and we saw signs of improvement in some of our infrastructure markets. While we anticipate a challenging second quarter in the mobile devices market, specifically with our largest customer, I believe this dip will be temporary and remain confident about our long term position. We have achieved design win success with our new products and I believe we will return to normal revenue levels and growth in the second half of 2012," concluded Quinsey.

When asked about who TriQuint's largest customer was, Quinsey remained tight-lipped, but did say that the declining orders were nothing to do with the firm's products.

Regarding the mobile market, Steven Buhaly, Chief Financial Officer, TriQuint, said that with 3G/4G, the most important issues were to have the right products, the right technology and have the capacity to grow with the customers. With 2G, however, he pointed out that due to that market being fairly competitive, TriQuint would participate, but was not in a position where it wanted "to chase a lot of low margin 2G opportunity." Quinsey, on the other hand, said, "We should see some good uptake over the next several quarters in 2G GSM."

Outlook:

The Company believes second quarter 2012 revenues will be between \$170 million and \$185 million. The company expects

to return to normal revenue levels in the second half of 2012. TriQuint is 91% booked to the midpoint of revenue guidance.

As part of a planned transition in filter packaging technology and due to a change in product mix, the company plans to restructure its filter related operations during the second quarter.

Quinsey added that TriQuint was also restructuring in order to move from chip scale packaging (CSP) to wafer level packaging (WLP). Regarding this transition, Quinsey commented, "We are already using a first-generation wafer level packaging. It's in our dual products and we're in the sampling customer design in phase of our dual product. So I expect that will start to move into production in the second half of the year. I think by the time we get into the middle of 2013, we will be in full swing of our wafer level packaging. Keep in mind, we're not abandoning CSP. There are still markets and applications where CSP is absolutely the right situation, particularly in some of our networking applications. So we will maintain some capacity capability for CSP to support the opportunities where that's the right solution. The high, high volume solution is typically associated with mobile devices, but not always, is going to transfer to our wafer level packaging."

TriQuint expects to record a GAAP restructuring charge of between \$12 and \$14 million, consisting of a non-cash charge for excess equipment of between \$10 and \$12 million and a cash charge for the remainder that is primarily related to severance costs.

During the conference call, Steve Buhaly also said that litigation charges in the second quarter of 2012 are expected to be as high as \$11 million.

API secures \$1.5 million funding for F-35 aircraft quality control

The innovator of III-V compound semiconductor APD and PIN photodiode technology says the success of this contract will allow API to penetrate many applications in both military and industrial markets

Advanced Photonix, Inc (API) has been awarded a follow on 21 month contract from the Air Force for \$1.5 million to provide terahertz process control instrumentation.

The contract will support production of the F-35 Joint Strike Fighter (JSF).



F-35 Joint Strike Fighter

The contract is a commercialisation pilot program (CPP) award to optimise the quality of specialty stealth coatings applied by Northrop Grumman to a sub-system on the F-35. The purpose of the CPP is to accelerate the transition of Small Business Innovation Research funded technologies to Phase III production and deployment purchases by the DoD.

Previous Phase I and II contracts demonstrated feasibility in the lab and in Northrop Grumman's facility. This contract funds further application and system development culminating in delivering two production units for deployment on the manufacturing floor by the end of 2013.

Once completed, the system will consist of the T-Ray 4000 control unit which is connected to a miniature terahertz transceiver via a flexible umbilical up to 100 metres in length mounted onto an existing robot arm within a paint booth. The fibre-optic coupled terahertz (THz) technology employed is well suited to the application, as the sensors are small, light weight and freely positionable. A hand-held version that would allow measurement on cured coatings without the robot is also planned.

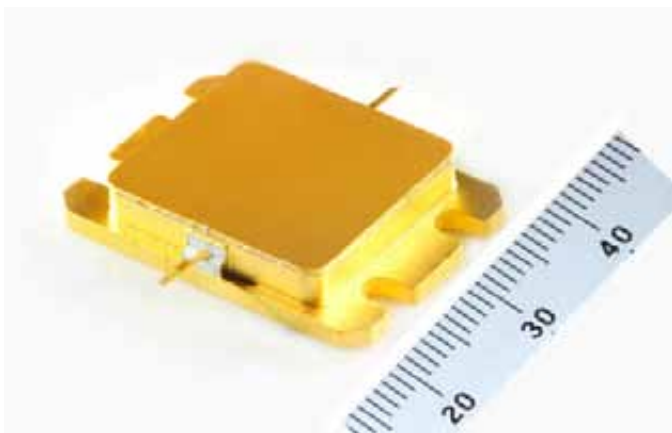
The proposed system and software will not only be able to function as a real-time sensor for applying the sprayed-on stealth coating on the F-35 for the Air Force, but also other coatings of interest to the Army and Navy. The sensors could also be applicable for monitoring and inspecting coatings and paints applied in industrial settings, such as automobile manufacturing.

"Demonstrating the capability of our equipment in a paint booth shows just how robust our terahertz system has become," states Richard (Rick) Kurtz, Chairman and CEO of API. "The success of this contract will allow us to penetrate many applications in both military and industrial markets providing significant long term growth for our T-Ray product line."

Record breaking output power achieved in GaN Ku-band PA

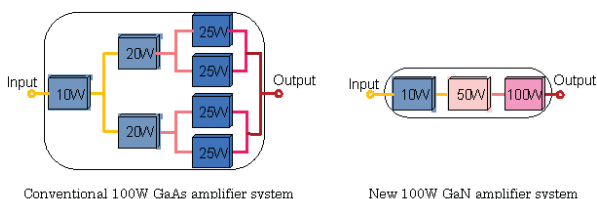
Mitsubishi Electric's latest gallium nitride power amplifier is expected to contribute to smaller and lighter transmitters for terrestrial stations used in satellite communications. What's more its output power is quadruple that of the firm's gallium arsenide amplifier and is a sixth of the size

Mitsubishi Electric has developed a prototype GaN HEMT amplifier, with it says, is currently the world-leading in Ku-band (14GHz) satellite communications, achieving 100W output power.



100W Ku-band GaN amplifier

The high-output GaN HEMT amplifier features a downsized configuration and a low-loss circuit. Output power is double that of the company's existing GaN HEMT amplifier and quadruple that of Mitsubishi Electric's GaAs amplifier. The new amplifier's ability to perform the tasks of four conventional units represents an important contribution to downsize transmitters to one sixth the size of a GaAs amplifier.



Vital satellite communications require robust systems that must work under adverse conditions, such as during natural disasters. High-power output is required for radio transmission from terrestrial stations to satellites in geostationary orbit 36,000 km above sea level. Also, terrestrial stations must be small enough to be transported by vehicles and installed. GaAs amplifiers have been used commonly for satellite communication transmitters, but GaN amplifiers have recently become increasingly popular because GaN transistors can handle very high voltages.

		Output	Gain
New	GaN amplifier	100W (50dBm)	8dB
	GaN amplifier	62W (47.9dBm)	8dB
Previous (Mitsubishi Electric)	GaN amplifier	62W (47.9dBm)	8dB
	GaAs amplifier	25W (44dBm)	5dB

Comparison of new and previous amplifier characteristics
Mitsubishi Electric began to ship samples of C-band 100W GaN HEMT power amplifiers for satellite communications in 2011.

Sofradir develops next generation 10-micron pitch IR detector

The detector uses mercury cadmium telluride (MCT/HgCdTe), a cooled IR technology for use in military and defence applications

The image quality of an infrared detector depends on its spatial resolution, which is related to the size and number of pixels. The higher the number of pixels and the smaller the pixel size, the sharper the image.

Sofradir is now using a compact 10-micron pixel pitch in its latest MWIR detector, which is suited for use in military, defence and space applications. The French firm says the small pitch in its prototype detector, means that the number of pixels on a standard size chip can be doubled.

With this significant increase in image resolution, fighter pilots and soldiers will be considerably more effective in distinguishing between small objects at long distances (up to ten km) during the day and night, and through fog and smoke.

Targeted military applications of Sofradir's 10-micron pixel pitch IR detector will include Infrared Search and Track Systems (IRST), targeting and reconnaissance pods, long-range surveillance and armoured vehicles.

"It is critical for the military to see first and see the right target, whatever the weather conditions. This is what the higher resolution, higher range 10-micron pixel pitch infrared detector helps provide," says Philippe Bensussan, chairman and CEO at Sofradir.

"Sofradir continues to build on its legacy of innovation. We were the first to introduce the 15-micron pixel pitch TV format IR detector, a compact high-resolution product that brought system integrators significant advantages in performance and footprint and has become an industry standard. We're taking the lead once again by pushing the bar from 12-micron pixel pitch that exists today to 10-micron. Our customers can look forward to the ultimate performance in IR systems."

The focal plane array prototype was developed with the support of DGA (Direction Générale de l'Armement) by CEA-Leti at DEFIR, the joint laboratory of Sofradir and CEA-Leti. CEA-

Leti is a European microtechnology, IT and health technology research centre.

Sofradir credits its Mercury Cadmium Telluride (MCT/HgCdTe), a cooled IR technology using a silicon-like photodiode implantation process, for enabling the development of the 10-micron pixel pitch IR detector.

MCT is extremely effective at controlling pixel diodes. What's more, Sofradir's indium bump positioning process is claimed to be very accurate. The bumps are connection pads that join the detection circuit and the read out integrated circuit together. This level of control offers Sofradir two options: It can fit more pixels on the IR chips currently in use and therefore further enhance image resolution or develop smaller IR chips for overall IR system cost-savings.

Sofradir demonstrated a prototype of what it says is the first 10-micron pixel pitch IR detector for tactical applications at SPIE DSS in Baltimore, April 23 – 27 stand #1711.

Murata to buy RF Monolithics

The acquisition is targeted at increasing the value of Murata's wireless module solutions

Murata Electronics North America, Inc., a fully owned subsidiary of Japanese firm Murata Manufacturing Co., Ltd., has signed a definitive agreement to acquire RF Monolithics, Inc.

Then all cash transaction is targeted to close in the third calendar quarter of 2012, and the deal will pay the holders of RFM common shares \$1.78 per share.

RF Monolithics (RFM), headquartered in Dallas, Texas, is a provider of solutions-driven, technology-enabled wireless connectivity for a broad range of wireless applications—from individual standardised and custom components to modules for comprehensive industrial wireless sensor networks and machine-to-machine (M2M) technology.

"RFM's proven success in developing business in the healthcare, energy and industrial markets compliments Murata's growth strategy. Additionally, leveraging RFM's expertise in design and development of production ready RF modules, SAW based & RFIC short-range radios, stand-alone radio systems and platforms for M2M applications will enable Murata to increase the value of the wireless module solutions delivered to Murata's existing and future customers in the global marketplace," comments David M. Kirk, President and CEO of Murata Electronics North America, Inc., the Regional Headquarters of Murata Americas.

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Feel the love with IPKISS, parametric software for integrated photonics

Coming in a number of different license options, the framework is currently geared towards the design of photonic components and complex photonic integrated circuits

Ghent University and imec are launching IPKISS, an open source software platform.

IPKISS is a generic and modular software framework for the parametric design of photonic integrated components and circuits. The software platform is made available by means of a GPLv2-licensed code base (free of charge), a custom developer license and a custom commercial license. With this launch, Ghent University and imec say they are providing the integrated photonics design community access to a powerful and flexible software platform.

IPKISS was originally conceived in 2002 by the Photonic Research Group of Ghent University and imec as a programmable generator of Mask Layouts (GDSII) written in Python, but has since then evolved significantly.

Its main use is currently the design of photonic components and complex photonic integrated circuits. In IPKISS, a designer can quickly define photonic components, directly simulate them in electromagnetic solvers and integrate them into a circuit on a photomask for fabrication. For this, IPKISS integrates easily with popular third-party simulators.

While currently most applicable to photonics, IPKISS is conceived as a generic and flexible framework. IPKISS can be customised for use (and is already used) in many other domains related to micro- and nano-electronics such as microfluidics, plasmonics and MEMS.

As the scripting is based in Python, imec and Ghent University say IPKISS is easy to learn and extremely flexible. The user can specify parameters in how a component is represented.

Internally, the component knows how to generate its layout, its input/output connections with other components, its internal circuit representations, and so on. This ensures a separation between the formal specification of a component or circuit and different representations that can be derived. For example, a mask layout in GDSII, a 2D or 3D model or a circuit model.

Components can be defined to accept outside technology information provided by the fab, effectively allowing a design that could be fabricated in different locations. Design kits for imec's silicon photonics technologies are made available through ePIXfab, a European foundry service for Silicon Photonics prototyping and through imec directly for customised photonic IC development.

The developers say the IPKISS design approach is powerful and flexible, while at the same time very accurate, resulting in a productive design cycle with little margin for copy-and-paste errors. This contrasts with a design workflow which is static and cannot be influenced by the user, or where the user is limited to the functionality provided in a graphical user interface. Users of IPKISS will have access to a powerful and flexible software platform that can catalyze their research with a relatively small incremental effort.

The IPKISS framework is available under different open source licenses.

For the community, a GPLv2-licensed code base of IPKISS will allow access to the framework for free. The objective of this license scheme is to encourage people into developing the IPKISS framework, so a thriving community can evolve around the framework.

For the developer, a custom license with an annual fee allows the licensee to develop plug-ins and add-ons for distribution.

There is also a custom commercial license which is targeted as software developers who wish to incorporate IPKISS into a product, and bundle a modified version of the code base with their own additions. This license and its cost would be tailored to each individual case.

The platform was launched at SPIE Photonics Europe 2012—Exhibitor Product Demonstrations on Tuesday April 17th, 1:30 p.m. More about the product can be found at the conference at the Innovation Village and European Network, space 24: ePIXfab at the IPKISS booth.

GigOptix reveals new silicon germanium amplifier for 40G networks

The linear Transimpedance Amplifier (TIA) incorporates two balanced linear TIAs integrated on a single silicon germanium die

GigOptix is making available samples of its new generation GX3122B. Designed for use in 40Gb/s DWDM coherent optical receivers, the device consists of two balanced linear

TIAs integrated on a single silicon germanium die. The device amplifies weak signals received from photodiodes to drive the analogue to digital converters and digital signal processor in a coherent optical system. The GX3122B is designed to provide excellent signal fidelity by having total harmonic distortion of less than 5% over 30dB of dynamic range. It can handle the high AC and DC currents seen in coherent receivers. GigOptix says the highly integrated solution with dual channel TIAs reduce system complexity and cost and has an increased differential gain of 5KΩ. What's more, the low power consumption device comes in automatic or manual gain control options and has a peak detection function and an input power monitor. "We are very excited to provide an innovative solution for the 40G coherent market which according to Ovum market research is one of fastest growing segments in the 40G and 100G optical networking market," says Raluca Dinu, Vice President and General Manager of the Optics Product Line at GigOptix. "The increased demand for bandwidth throughout the network driven by the near ubiquitous use of smartphones and the migration of applications from the desktop into the cloud is continuing to force network operators to upgrade their link capacity to handle the increasing traffic. The GX3122B addresses this space uniquely since it was designed in silicon germanium and therefore provides a superior solution in terms of both performance and price. We expect the GX3122B to be a significant contributor to our future growth in the 40G coherent optical market." According to Ovum's latest report on 40G and 100G optical components, the 40G coherent optical system is expected to grow with a compound annual growth rate of 64% until 2016.

TriQuint and U.S. army to develop GaN devices

The firm's gallium nitride technology in DARPA programs has led to a new beneficial joint venture with the ARL

TriQuint Semiconductor has signed a Cooperative Research and Development Agreement (CRADA) with the U.S. Army Research Laboratory (ARL) to explore and fabricate new high-frequency and mixed signal integrated circuits (ICs) based on TriQuint's GaN technology.

The CRADA is designed to accelerate new programs supporting communications, radar, electronic warfare and similar applications.

The CRADA will give Army researchers dedicated access to TriQuint's development, fabrication and packaging expertise. Researchers from both TriQuint and the ARL will benefit from the new co-development environment. Circuits created as part of the initiative are expected to be based on TriQuint's new E/D (enhancement-depletion mode) GaN technology.

This GaN process has been utilised in Defence Advanced Research Projects Agency (DARPA) initiatives, including the Nitride Electronic NeXt-Generation (NEXT) program that TriQuint now leads. Through NEXT, TriQuint continues to establish benchmark performance standards for mixed-signal (digital and RF) devices. TriQuint GaN achievements also led

to its selection as a prime contractor in the Microscale Power Conversion (MPC) program that is developing ultra-fast, high power DC-DC switch modulator technology for advanced integrated RF amplifiers.

TriQuint's role in MPC was recognised by Compound Semiconductor magazine on March 12 with a 2012 CS Industry Award.

"Creative partnerships through Cooperative Research and Development Agreements encourage outside businesses and university organisations to share in the discovery of and investment in technologies. In this case, ARL is leveraging industrial fabrication capabilities allowing ARL to maximize its return on investment," points out John Miller, Army Research Laboratory Director. "These advanced IC processes, coupled with ARL's design expertise, could lead to innovations and advancements in both military and consumer applications in communications, radar and electronic warfare."

"TriQuint's GaN research leads the industry. This new CRADA is another example of ways that our work in one program benefits other DoD agencies and service branches. We will provide access to our extensive development capabilities and the ARL will provide designs and test circuits in support of their advanced programs," adds James L. Klein, TriQuint Vice President and General Manager for Defence Products and Foundry Services.

TriQuint's new agreement with the ARL is designed to stimulate high performance monolithic microwave integrated circuit (MMIC) development. The ARL's design and testing capabilities will be leveraged with TriQuint's MMIC fabrication, testing and packaging expertise. Both TriQuint and ARL researchers will work towards identifying circuits of mutual interest that have the potential to advance state-of-the-art design programs.

TriQuint has been a pioneer in GaN development and research since 1999. The firm is involved in a number of GaN process and manufacturing technology programs for DARPA, the US Air Force, Army and Naval laboratories including the Defence Production Act Title III manufacturing enhancement program. TriQuint has also led two other DARPA programs that were part of the Wide Bandgap Semiconductor (WBG) RF research initiative.

RFMD reveals new InGaP amplifier

The new RFCA3302 linear CATV 40MHz to 1008MHz gallium arsenide-based amplifier is ideally suited to broadband cable applications

RFMD's new RFCA3302 is a high performance InGaP HBT MMIC amplifier designed to run from a single +5V supply without the need for an external dropping resistor.



RFCA3302

RFMD says the high gain, high linearity, and low distortion from 40MHz to 1008MHz makes this device ideal for broadband cable applications. An integrated bias circuit provides stable gain over temperature and process variations. It is offered in a small SOT-89 package and is RoHS compliant.

Applications include broadband 75Ω gain block, CATV distribution amplifiers, pre-amplifiers for CATV multi-dwelling units and drop amplifiers.

Features High gain: 21dB High linearity and low distortion 40dBm IP3 -65dBc CSO -83dBc CTB

The product is currently available in production quantities, with pricing beginning at \$1.51 each for 1000 pieces.

Enhancing InP HBTs with transferred substrate technology

Optimising high frequency and power performance, the 3" wafer-level process enables lithographic access to both the front- and backside of an Indium phosphide HBT. The vital step in gaining access to both sides is to completely remove the supporting substrate

Research on high-speed transistors is driven by applications for imaging and wide band communications.

Recent technical advances of InP-based transistors with several hundred gigahertz (GHz) operating frequencies, together with their outstanding material properties qualify them as key components in such systems.

At the Ferdinand-Braun-Institut (FBH), a transferred substrate (TS) technology has been established to optimise high frequency and power performance of InP heterojunction bipolar transistors (HBTs). The 3" wafer-level process enables lithographic access to both the front- and backside of the HBT aligned to each other.

The resulting linear device set-up, shown in Fig. 1, eliminates dominant transistor parasitics and relaxes design trade-offs. The essential step for gaining access to both sides of the epitaxial structure is to completely remove the supporting substrate.

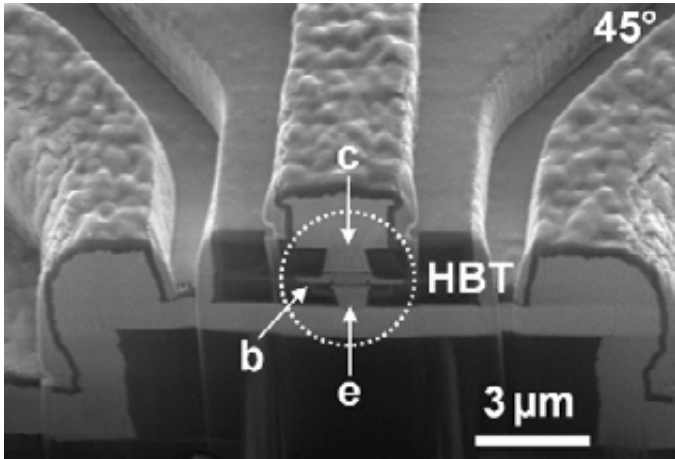


Fig. 1: FIB cross-section of a TS-HBT with emitter (e), base (b) and collector (c)

Therefore, a robust adhesive wafer bonding procedure via benzocyclobutene (BCB) has been developed. It yields a homogenous, crack- and void-free composite matrix of transistors transferred on a wafer-level scale.

The optimised device topology enhances the HBT performance dramatically. Transistors with $2 \times 0.8 \times 5 \mu\text{m}^2$ emitter area, as shown in Fig. 2, feature $f_T = 376 \text{ GHz}$ and $f_{max} = 385 \text{ GHz}$ at breakdown voltages $BV_{CEO} > 4.5 \text{ V}$.

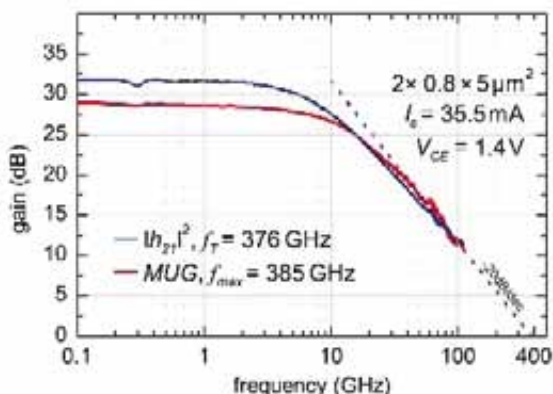


Fig. 2: Extrapolated f_T and f_{max} of a TS-HBT

They combine high frequency performance with saturated output power $P_{out} > 14.2 \text{ dBm}$ @ 77 GHz and an inherently good matching to 50Ω . As the device architecture is highly scalable, the researchers at FBH say they may be able

to further enhance the high frequency as well as power performance in the future.

In the study, the researchers designed and produced power amplifiers using TS technology for 90 GHz operation. The S-parameter measurements shown in Fig. 3 agree well with modelling.

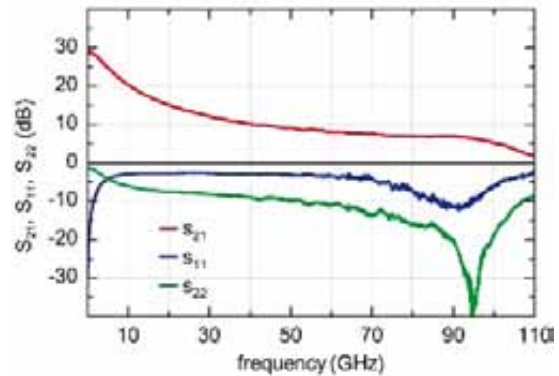


Fig. 3: S-parameter measurements of a 90 GHz power amplifier in TS technology

Currently, the innovative transistor set-up is utilised in an ongoing project to integrate InP-based circuits on top of BiCMOS wafers heterogeneously.

This research has been described in detail in the paper, "W-Band Amplifier with 8 dB Gain Based on InP- HBT Transferred-Substrate Technology," by T. Al-Sawaf *et al*, *Proc. German Microwave Conference*, Ilmenau, Germany, 12--14 March 2012.

Avago can repurchase up to 15 million shares

The amended share purchase mandate permits the company to repurchase up to 10 percent of its outstanding ordinary shares before its 2013 AGM

Avago Technologies, a supplier of analogue interface components for communications, industrial and consumer applications, has announced that its Board of Directors has authorised the Company to repurchase up to 15 million of its ordinary shares.

This replaces the share repurchase program announced by the company on June 9, 2011, which expired at the Company's 2012 annual general meeting on April 4, 2012.

This share repurchase program was adopted pursuant to the share purchase mandate approved by the Avago's shareholders at its 2012 annual general meeting. The share purchase mandate authorises the repurchase by the Company of up to 10 percent of its outstanding ordinary shares prior to the date of the Company's 2013 annual general meeting.

Share repurchases, if any, will be made in the open market at

such times and in such amounts as Avago deems appropriate. The company intends to effect any share purchases in compliance with Securities and Exchange Commission Rule 10b-18 or pursuant to a trading plan adopted pursuant to Rule 10b5-1.

The timing and actual number of shares repurchased will depend on a variety of factors including price, market conditions and applicable legal requirements. The share repurchase program does not obligate the company to repurchase any specific number of shares and may be suspended or terminated at any time without prior notice.

Advanced Photonix signs VAR agreement with ACT

The pioneer in III-V compound semiconductor APD and PIN photodiode technology will unite with ACT to provide the T-gauge system for use in terahertz industrial process control

Advanced Photonix Inc. (API) has signed a VAR agreement for its T-Gauge industrial terahertz gauging system, with Automation and Control Technology, Inc. (ACT).

ACT will add features and services to API's T-Gauge sensor technology and the integrated product or complete "turn-key" solution will go on the market.

The T-Gauge measurement system builds on the company's long history of terahertz products dating back over 10 years with the introduction of one of the world's first commercial terahertz systems.

Picometrix, a subsidiary of API, is a specialist in terahertz technology. The company has also been a supplier of high-speed optical receivers since 1992. Its products address the entire range of 10, 40 and 100 Gbps applications utilising proprietary III-V PIN and APD photodiodes. Bandwidths range from 2 GHz to 60 GHz and cover wavelengths from 700 nm to 1650 nm.

The new T-Gauge system is ruggedised for deployment on the manufacturing floor for quality assurance and process control. The technology is very adaptable to different sensor configurations, including robotic controls, to support many different applications. The resulting innovative gauge will help manufacturers to improve quality and reduce costs.

Charles Totel, President and CEO of ACT states, "The terahertz technology is the next generation of sophisticated measurement sensors that are destined to eventually displace many nucleonic and x-ray sensor applications. This next generation of safe sensors are capable of measuring multiple layer products and providing high precision measurements for each layer of a product. ACT is excited about the opportunity to provide this new technology to our valued customers."

David Pond, EVP & COO of ACT adds, "ACT delivers complete industrial gauging solutions (measurement, control and data management) which now include API's revolutionary

T-Gauge sensor technology. We are proud to be the first VAR in the world to have integrated and placed into production a terahertz sensor in an industrial multi-layer web based process application."

Rob Risser, COO of API concludes, "We are pleased to welcome ACT to our growing VAR partner network. Manufacturers are constantly looking for ways to reduce cost and improve quality. The industry expertise, application development, and established sales channels capability of our VARs, like ACT, will enable us to more rapidly deliver the improved quality and cost reduction capabilities of terahertz technology to the factory floor in a shorter time horizon."

The companies both exhibited at The International Plastics Showcase, NPE, one of the largest plastics exposition in the Western Hemisphere, in Orlando, Florida from April 1st to 5th, 2012. Both firms will have their full line of products on display. Picometrix will be at booth #32055 and ACT at booth #33066

TriQuint's multipurpose gain block family expands

The devices employ the firm's high reliability indium gallium phosphide / gallium arsenide HBT process technology. They are particularly suited to commercial and defence applications

TriQuint Semiconductor has added the TQP369185 device to its family of broadband, cascadable Darlington-pair amplifier RFICs that operate from DC to 6 GHz.



Claimed to have excellent efficiency, they deliver strong performance as general-purpose gain blocks for IF and RF buffer gain stages in commercial and defence applications ranging from base station transceivers (BSTs) and repeaters to CATV and SATV systems, test equipment and numerous other RF and microwave systems.

The new InGaP/GaAs HBT gain block RFICs include the TQP369180 and TQP369181 that deliver 15 dB of ultra-flat gain and the TQP369182 and TQP369184 that deliver 20 dB of gain. Both 15 dB gain and 20 dB gain models are available in a choice of two.

The latest addition to the family, TQP369185, offers up 20.5 dB of gain and up to 19.7 dBm of P1dB and also integrates an internal active bias.

All are internally matched to 50 Ω , requiring only an external RF choke, dropping resistor, and blocking/bypass capacitors for operation. TriQuint says they are also very rugged, meeting Class 1C HBM (up to 2 kV) electrostatic discharge (ESD) requirements.

Gain blocks are some of the most widely used active components in all types of RF and microwave systems, and they must combine excellent performance with very good cost efficiency.

TriQuint says its five new devices meet these requirements and are available in two plastic package styles. They offer a choice of gain levels that the firm says, meet almost any design need, whilst consuming minimal power. Their broad frequency range makes them well suited for many applications through 6 GHz.

The new Darlington-pair gain block RFICs are now in production. Samples, evaluation boards and software are also available.

TowerJazz and UCSD to launch SiGe 110 GHz transmitter

Targets for the silicon-germanium based phased array transmitters include automotive, radar, aerospace and defence, passive imaging, security, and millimetre wave imaging

TowerJazz and the University of California, San Diego (UCSD) aim to demonstrate what they say is the first wafer-scale phased array with 16 different antenna elements operating in the 110 GHz frequency range.

The first success of the collaboration was achieved for the RFIC using TowerJazz's proprietary models, kit and the millimetre wave capabilities of its 0.18 μm SiGe BiCMOS process, SBC18H3.

The SBC18H3 process targets applications for automotive radar, aerospace and defence, passive imaging, security, and millimetre wave imaging. The collaboration of the phased array chip was partly funded by DARPA.

The wafer-scale SiGe BiCMOS chip is 6.5 x 6.0 mm and combines the 110 GHz source, amplifiers, distribution network, phase shifters and high-efficiency on-chip antennas. This should allow a new generation of miniature and low-cost phased arrays for W-band (75 - 110 GHz) applications.

This advancement better serves the needs of the greater than \$100 million emerging markets of auto radar and passive imaging (security). The antennas are integrated on-chip which removes the expensive transitions and distribution network between the phased array and the off-chip elements.

This wafer-scale phased array with 16 radiating elements, together with all the necessary CMOS control circuits, is capable of electronic beam scanning to +/-40 degrees in all

planes.

The architecture could be scaled to 64 elements (8 x 8) or 256 elements (16 x 16) due to on-chip antenna integration and the single chip integration of multiple elements.

By developing this wafer-scale chip, UCSD has successfully demonstrated independent amplitude and phase control at 106 - 114 GHz for all 16 different antenna elements, and provides commercial availability of highly scalable (from 16 elements to 256 elements) RF-IC transmitters for W-Band and D-Band phased array applications.

The chip was designed and tested by Woorim Shin, Ozgur Inac, and Bonhyun Ku, all from the Electrical and Computer Engineering Department at UCSD under the supervision of Gabriel M. Rebeiz, and was partially sponsored by the DARPA GRATE program under the direction of Carl McCants. The work was done under a subcontract to UCSD from TowerJazz.

The phased array chip was developed using TowerJazz's SBC18H3 BiCMOS process which offers both high-performance 0.18 μm SiGe bipolar and high quality passive elements combined with high density 0.18 μm CMOS, to enable high-speed networking and millimetre wave applications.

The process offers SiGe transistors with peak F_{max} of 280 GHz and peak F_t of 240 GHz, ideal for low-power, high performance millimetre wave circuits, while replacing the need for more expensive GaAs chips.

The SBC18H3 comes standard with 1.8 and 3.3 V CMOS (dual-gate), deep trench isolation, lateral and vertical PNP transistors, MIM capacitors, high performance varactors, polysilicon as well as metal and N-well resistors, *p-i-n* and Schottky diodes, high-Q inductors, triple well isolation, and six layers of metal.

"This is yet another advancement in the area of phased arrays that we are proud to announce. We have a track record of successful collaboration with TowerJazz and the ability to bring this innovative design from UCSD to market depends strongly on TowerJazz's SiGe BiCMOS process which enables lower-cost phased arrays by integrating many functions and high efficiency antennas on the same silicon chip," says Gabriel M. Rebeiz, Professor of Electrical Engineering at UCSD, the lead professor on this chip.

"We believe the results achieved by UCSD's phased array transmitter demonstrates the remarkable teamwork between TowerJazz, UCSD and DARPA to provide novel capabilities and technologies to both the aerospace and defence community as well as commercial markets," adds David Howard, TowerJazz's Executive Director and Principal Investigator for DARPA GRATE Program.

"TowerJazz enjoys the long term, very productive working relationship we have with Rebeiz, one of the top RF research professors in the world."

Opnext and Oclaro merger to be investigated

The investigation centres on whether Opnext shareholders are receiving adequate compensation for their shares in the buyout

Ryan & Maniskas, LLP is investigating potential claims against the board of directors of Opnext, Inc. concerning possible breaches of fiduciary duty and other violations of law related to the Company's efforts to sell Opnext to Oclaro, Inc. in a transaction valued at approximately \$177 million.

The investigation concerns possible breaches of fiduciary duty and other violations of law related to the approval of the transaction by the Company's board of directors. In particular, it centres on whether Opnext undertook a fair process to obtain fair consideration for all shareholders of Opnext.

Under the terms of the agreement, Opnext shareholders will receive a fixed ratio of 0.42 shares of Oclaro common stock for every share of Opnext common stock they own.

Ryan & Maniskas, LLP is a national shareholder litigation firm. Ryan & Maniskas, LLP is devoted to protecting the interests of individual and institutional investors in shareholder actions in state and federal courts nationwide.

RFMD powers flagship LG smartphones

LG's Optimus 4X HD Android 4.0 Smartphone and Optimus 3D Max feature multiple RFMD components

LG has selected RFMD to supply multiple components to support its LG Optimus 4X HD and the Optimus 3D Max smartphones. Both of these smartphones are anticipated to be available globally in 2012. The LG Optimus 4X HD features a 4.7-inch HD display (1280 x 720), Android 4.0 "Ice Cream Sandwich," a quad-core 1.5 GHz processor, 21 Mbps HSPA+ performance, front (1.3 MP) and rear (8 MP) cameras, and dual-band Wi-Fi connectivity, all encased within 8.9 mm. The LG Optimus 3D Max features a dual-core 1.2 GHz processor, 8 GB of storage, a 5 MP dual-lens camera, Android 2.3 "Gingerbread," and LG's "exclusive brightened" WVGA 4.3-inch display, all housed in a compact 9.8 mm shell. The RFMD components enabling LG's flagship smartphones include the company's PowerSmart power platform, and its RF5501 802.11 b/g/n Wi-Fi front end module. RFMD says its PowerSmart features a revolutionary RF Configurable Power Core that delivers multiband, multi-mode coverage of all cellular communications modulation schemes, including 4G, up to LTE 64QAM. The RF5501 Wi-Fi front end module is claimed to satisfy smartphone and tablet manufacturers' requirements for aggressive size reductions in 802.11b/g/n front end solutions, whilst delivering high linear output power and reduced component count. Bob Bruggeworth, president and CEO of RFMD, says, "RFMD is pleased to expand our relationship with LG and support these flagship smartphones with our industry-leading cellular and Wi-Fi components. RFMD's PowerSmart

power platforms continue to lead a product category that is reshaping the future of multimode, multi-band cellular RF architectures, and we anticipate sequential growth in PowerSmart shipments throughout the calendar year."

Oclaro and Opnext to merge

The union of the telecom and datacom innovators hopes to create a new leader in the fast-growing optical components and modules market, which is forecast to reach \$9.2 billion in 2015

Oclaro and Opnext have entered into a definitive agreement to merge in an all-stock transaction.

Under the terms of agreement, Opnext shareholders will receive a fixed ratio of 0.42 shares of Oclaro common stock for every share of Opnext common stock they own.

The Oclaro and Opnext merger is expected to mark a major transformation in the optical industry, bringing together over 30 years of combined telecom and datacom optical technology innovation. The merger aims to create a new industry leader in the fast-growing optical components and modules market, forecast to reach \$ 9.2 billion in 2015.

The broad product portfolio, technology innovation, engineering resources, cost structure and strategic customer relationships of the combined company are expected to expand its opportunities for growth and to create long-term shareholder value.

Data-intensive applications such as video and cloud computing, and the proliferation of mobile devices, are driving the need for increased performance and bandwidth throughout the core optical networks, at the heart of the world's Internet traffic. These trends are also forcing enterprises and data centres to upgrade and deploy new data communications infrastructures.

As a result, traditionally separate telecom and datacom networks are converging, leveraging advanced optical networking technologies from companies such as Opnext and Oclaro.

The combined company will be well positioned to capitalise on these trends to become the No. 1 supplier to the core optical networks with a strong leadership position in the fastest-growing 40 G and 100 G segments. According to the Ovum OC Forecast, this market is expected to grow at a CAGR of 42 % through 2015. The broader product line resulting from the merger strengthens the combined company's position as a key supplier to existing and new customers.

"This merger clearly will be a unique and transformational opportunity for both Oclaro and Opnext," says Alain Couder, chairman and CEO, Oclaro. "Our respective customers want to work with fewer, more strategic suppliers who can deliver the breadth of technologies they need. Through this merger, the companies' complementary and vertically-integrated product portfolios, scale, and heritage of technology innovation will put the merged company in that valued strategic partner and leadership role. By doing so, and at the same time saving

significant costs, we also expect to generate substantially more long-term value for shareholders than either company could deliver alone.”

In addition to the telecom and datacom markets, there is a large and growing opportunity for laser diodes in a range of high-growth industrial and consumer markets. Through this transaction, the combined company says it will be the largest supplier of laser diodes for industrial and consumer applications. With a substantial portfolio of products and technologies, the combined company is well positioned to accelerate innovation and inroads into these high-volume markets.

The combined heritage of Oclaro and Opnext comes from some of the leading optical technology innovators over more than 30 years, including Hitachi, Nortel, Alcatel, Marconi, Corning, Opnext, Bookham and Avanex.

“Opnext and Oclaro share a rich history bringing to market some of the industry’s most advanced optical technology innovations over more than three decades,” comments Harry Bosco, chairman and CEO, Opnext.

“I am excited by the unique opportunity that will be created by this combination for customers, shareholders and for the employees of the merged company, who will leverage this deep legacy of technology innovation to lead the optical components and modules market and to achieve critical mass in the industrial and consumer laser diode segments”, he continues.

The combined company will be led by Alain Couder, who will serve as chairman and CEO. Upon closing, Harry Bosco will join the combined company’s board of directors.

Transaction Details

Upon the close of the transaction, Opnext shareholders will own approximately 42% of the combined company.

The combined company is expected to achieve positive non-GAAP operating income in the first full quarter after the close and is expected to achieve annualised cost synergies of \$35 million to \$45 million within 18 months of the close of the transaction. The company expects restructuring and system integration costs to total \$20 million to \$30 million.

The transaction is subject to customary closing conditions, including approval by the shareholders of both companies and the receipt of regulatory approvals in the U.S., and is expected to close within three to six months.

Oclaro and Opnext will each be filing the full text of the merger agreement with the Securities and Exchange Commission (the “SEC”) on Form 8-K in the next couple of days. Investors and security holders of each company are advised to review those filings for the full terms of the proposed combination, as well as any future filings made by the companies, including the Form S-4 Registration Statement and related Joint Proxy Statement/ Prospectus.

The management teams of both companies hosted a conference call discussing the agreement. An audio replay of the conference call was available until April 2, 2012, 11:59 pm Eastern Time. The replay may be accessed by dialling 1-858-

384-5517 using pin 4527215.

Odis achieves milestone in GaAs POET technology

A breakthrough in gallium arsenide technology should enable Odis to take the first step in realising a single device capable of interconnecting multiple processors

Opel Technologies Inc. and Odis Inc., collectively known as “Opel”, have made progress this quarter regarding POET technology to advance optical interconnection of high speed circuits.

Odis’ recent achievements, when successfully added to the POET platform under development, will make it possible to implement an optical interface as a single chip to connect existing CMOS processors.

The ongoing steps in the POET technology development have made it possible to produce a well defined military and commercial roadmap for POET.

ODIS’s optical interface chip will integrate a laser, optical modulator, modulator driver, detector, receiver amplifiers, SerDes, CDR and PLL circuits monolithically on a single chip. Opel says this breakthrough, utilising III-V GaAs technology, is the first step in achieving a single device capable of interconnecting multiple processors by waveguide and/or fibre to transport ultra-high speed signals.

This development should substantially simplify chip packaging.

What’s more, the optical interface chip bandwidth supports large data rates of greater than 100Gb/s for CMOS processor interconnects without the additional power otherwise required with conventional electrical i/o (input/output).

The new roadmap will outline the process for speed-to-market devices, capital requirements and monetisation opportunities in the commercial and defence technology markets.

Telstra the 100th customer to deploy Infinera’s InP PICs

The global supplier of network and hosting services, will use Infinera’s coherent 40 Gbps DTN solutions based on indium phosphide, for the optical subsea network in the Asia Pacific region

Telstra International, has become Infinera’s 100th customer and has deployed Infinera’s 40 gigabits per second (Gbps) DTN solution for its optical subsea network in Asia.

The deployment spans approximately 9,000 km between Hong Kong, Taiwan, Japan and South Korea. Telstra says it selected Infinera’s DTN solution for its simplicity, scalability and cutting

edge technology.

Telstra International is a division of Telstra Corporation Limited, one of Australia's leading telecommunications and media services companies.

Telstra International Group Chief Operating Officer, Martijn Blanken, says, "Telstra operates one of the largest and most diverse networks in Asia Pacific. We chose Infinera because it has demonstrated leadership in technological innovation, offering the most reliable and technically advanced DWDM system on the market. We are confident we have invested in a network that will accommodate the needs of our customers now and into the future."

Infinera's DTN platform enables service providers to upgrade existing submarine cables with coherent 40 Gbps waves supporting FlexCoherent. The Infinera solution is upgradable in the future to 100 Gbps FlexCoherent, including Soft Decision Forward Error Correction, which will deliver 7.3 terabits per second (Tbps) of capacity over Telstra's Reach North Asia Loop (RNAL) fibre plant.

"This is an exciting announcement for us," says Tom Fallon, Infinera's CEO. "We are pleased to announce Telstra International as our first named 40 Gbps customer and Infinera's 100th customer since shipping our market leading solutions in 2004. Leading global providers, like Telstra, trust us to deliver solutions that are simple, scalable and efficient to meet the needs of their customers. For Telstra's subsea network, Infinera's 40 Gbps solution delivers just that."

Infinera's Subsea Solutions have been deployed worldwide for customers, totalling more than 100,000 route-km, including routes across the Atlantic, between North, Central and South America, in the Middle East, and in the Indian Ocean.

M/A-COM Tech offers initial public share offering of \$19

5,556,000 shares are being offered by M/A-COM Tech and the remaining shares are being offered by a stockholder

M/A-COM Technology Solutions has announced the pricing of its initial public offering of 6 million shares of common stock at \$19.00 per share.

A total of 5,556,000 shares are being offered by M/A-COM Tech and 444,000 shares are being offered by a selling stockholder.

In addition, certain selling stockholders have granted the underwriters a 30-day option to purchase up to an additional 900,000 shares to cover over-allotments, if any. M/A-COM Tech will not receive any proceeds from the sale of shares by the selling stockholders. The shares began trading on Thursday, March 15, 2012 on The NASDAQ Global Select Market under the ticker symbol "MTSI".

Barclays Capital Inc., J.P. Morgan Securities LLC and Jefferies & Company, Inc. are acting as joint book-running managers. Needham & Company, LLC, Raymond James & Associates,

Inc. and Stifel Nicolaus & Company, Incorporated are acting as co-managers for the offering.

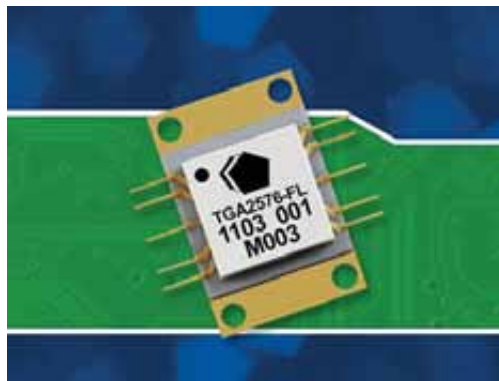
TriQuint unveils a versatile new 30 W GaN PA for telecoms

The company's new 2.5 - 6 GHz gallium nitride PA delivers 35% PAE for wide-ranging applications

TriQuint Semiconductor has released a new packaged, 30 W wideband GaN power amplifier with high power and efficiency for communications, defence and similar applications.

The device is released in conjunction with TriQuint's exhibit at GOMACTech 2012, the US government-sponsored microcircuit and critical technology conference. The event took place between March 19th and 22nd in Las Vegas, Nevada.

The TGA2576-FL delivers 30 W of output power (45.5 dBm) across the 2.5 - 6 GHz frequency range. The new device is fabricated using TriQuint's 0.25 μm , production-released GaN-on-SiC process and is available in a standard, surface-mount flange package.



The TGA2576-FL typically offers 35% PAE and 26 dBm of small signal gain.

TriQuint was recently honoured by the compound semiconductor industry with a 'CS Industry Award' for R&D excellence. The firm says the 2012 award spotlights TriQuint's leadership in the DARPA-funded Microscale Power Conversion (MPC) program that supports development of high power / high frequency GaN DC-DC switch modulators for next-generation RF amplifiers.

TriQuint says its GaN portfolio offers the performance and dependability that defence, aerospace and commercial customers demand. The company provides design assistance and support built around enabling customers' utilisation of new high-efficiency GaN circuits.

Interest in gallium nitride technology continues to grow as GaN transitions from defence applications that initially demonstrated its capabilities into mainstream commercial markets. The frequency range, power density, efficiency and device size of

GaN devices are superior to other semiconductor technologies.

Samples and evaluation fixtures for the TGA2576-FL which are generally exportable, are now available.

GigOptix mass producing driver for 40 G and 100 G optical systems

The firm's single channel GX6255 driver has been ordered by a number of tier one Asian telecom customers and is now being manufactured in volume

GigOptix, a fabless supplier of semiconductor and optical components that enable high speed information streaming is introducing its GX6255.

This is a surface mounted 8 Vpp Mach-Zehnder Modulator (MZM) single ended driver designed for use in both the 40 G RZ-DQPSK and the 100G DP-QPSK metro and long haul transponders. The firm is now ramping to mass production with orders from Asian telecom customers.



GX6255 32Gb/s MZM driver

GigOptix's GX6255 is a high performance, low power, compact, surface mounted technology MZM driver capable of driving 8 Vpp at up to 32 Gb/s. The GX6255 typically dissipates about 1.6 W of with 7.5 Vpp output. The device is designed to be fully compliant with industry standard single drive 40 G RZ-DQPSK and 100 G DP-QPSK modulators and GigOptix says that it meets all the telecom qualification spec demands.

Ovum has stated in a recent market report that it expects the 100 G market to grow by 107 % Compound Annual Growth Rate and the 40 G market to grow by more than 40 % CAGR.

"We are very excited about the ramp up of our latest 40 G and 100 G driver, the GX6255, to mass production," says Raluca Dinu, General Manager and Vice President of the Optics Product Line at GigOptix.

"With the advent of cloud computing, the migration of data services to the web, coupled with the mass adoption of smartphones and tablets, we are seeing increasing consumer driven demand for more bandwidth across the network. GigOptix continues to benefit from our focused strategy of developing products for the 40 G and 100 G communications markets. The new driver joins our large driver portfolio, which in combination with our comprehensive TFPSTM modulator offering and the variety of the dual channel transimpedance amplifiers, enable GigOptix to offer our customers the most comprehensive and richest selection of 40 G and 100 G component solutions in the market," concludes Dinu.

Imec's BOOM project on SOI photonic integration a success

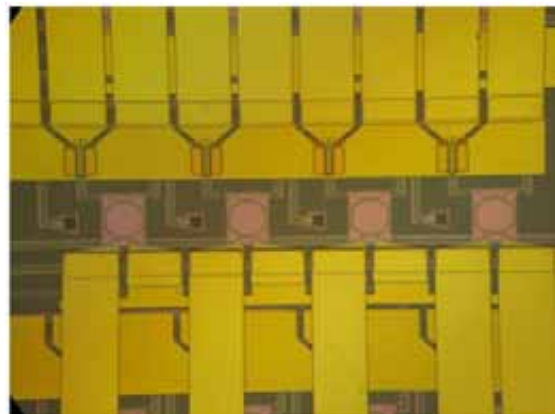
The EU-funded project, which integrated SOI with indium gallium arsenide detectors, has succeeded in developing cheap and power efficient devices for telecoms

Imec and its partners have completed the 'BOOM' project funded by the European Union.

The project was coordinated by the National Technical University of Athens (NTUA).

By advancing silicon-on-insulator (SOI) photonic integration technology, compact, cost-effective and power efficient components have been developed. These are envisaged to enable photonic Tb/s capacity systems for current and new generation high-speed broadband core networks.

As part of the project, imec has realised an optical label extractor consisting of a high-resolution demultiplexer integrated with highly efficient InGaAs photodetectors.



Four channel label extractor with four high-finesse ring resonators integrated with InGaAs photodetectors

The BOOM project was focused on the development of a

photonic routing platform relying on hybrid SOI integrated photonic ICs to incorporate all the routing functions. These included label detection (imec), control signal generation (HHI, IHP), wavelength conversion (NTUA, TU/e, TU Berlin) and wavelength routing (Lionix, AMO).

Finally, a routing machine with over 160 Gb/s aggregate capacity was built by NTUA and Telecom Italia Lab.

Imec says the project has answered the growing demand for bandwidth hungry internet applications which stresses the available capacity and performance of current optical core networks. Power efficiency, size and equipment costs are key issues in these networks and increasingly more difficult to keep within acceptable limits.

Electronic carrier routing systems consume and dissipate large amounts of electrical power and heat respectively. Bringing photonics technologies deeper and deeper within these routers can improve their performance and decrease power consumption, says imec.

The R & D institute's work within the project focused on the optical label detector. In the proposed routing architecture the optical data packets are labelled with a wavelength code, which has to be extracted from the packet and sent to the routing unit.

The label extractor consists of an optical demultiplexer with very high resolution (12.5 GHz) fabricated on imec's Silicon photonics platform and integrated with high efficiency InGaAs photodetectors.

Imec adds that reaching the required resolution turned out to be very challenging and needed an in-depth study of silicon micro-ring resonators. The specifications could be met by using single ring resonator based filters.

The ring resonators have integrated resistors, which allow fine tuning of the wavelength channels (bottom electrodes) through the thermo-optic effect. They are connected to evanescently coupled InGaAs photodetectors using the heterogeneous integration technology developed by INTEC, imec's associated laboratory at Ghent University.

The detectors had an efficiency of close to 1 A/W and were operating at the speed of 1 GBit/s (up to 5 GBit/s). Finally the device was packaged in collaboration with Fraunhofer IZM group based in Berlin. The device is now ready for operation in a system test bed.

The results obtained in the project and in particular the exhaustive study on the micro-ring resonators, are not only relevant for realising the optical label extractor. Imec says they also form an important input for the institute's optical interconnect program which requires high performance demultiplexers for increasing the bandwidth in optical chip-to-chip links. What's more, they could be used in optical sensors and non-linear devices.

Riber and imec continue to merge III-Vs with CMOS

The two organisations aim to advance CMOS devices using high-mobility Germanium and III-V compound semiconductor channels

MBE kit supplier Riber has signed an agreement with R&D institute imec to continue to collaborate on developing epitaxy process technologies for next-generation III-V CMOS devices.

The agreement follows a successful collaboration in the field of advanced channel materials for high-performance CMOS scaling, Germanium and III-V compound semiconductor materials.

In the quest for miniaturisation, technology has come to a point where CMOS scaling beyond the 45 nm node cannot be achieved by simply reducing transistor dimensions. What's more, the need for small form factors coupled with the stringent requirement of low current leakage or low energy performance has become critical, especially in next-generation mobile devices.

Imec and its core partners on the Germanium and III-V devices program are exploring the efficacy of high-mobility channel materials for CMOS devices for advanced nodes. Together with Riber, the bottleneck issue of gate stack passivation have been tackled, resulting in effective passivation techniques for Germanium and GaAs.

Riber's 200 mm III-V and metal oxide MBE cluster offered the required extremely clean background and absence of any interfering gas phase components, enabling material and interface control on the atomic level.

This resulted in the successful development of a passivation scheme for the MOS gate stack module. Amongst others, it was shown that controlling the GaAs surface reconstruction followed by a H₂S passivation treatment and in-situ high-*k* deposition was crucial to create a well-passivated MOS structure with record-low interfacial state density. What's more, the world's first successful MOS capacitors on a new high-mobility candidate material, GeSn, were made in the 200 mm Riber MBE cluster.

In the new project, the suitability of Riber's 300 mm UHV chamber (ISA300), equipped with in-situ tools for surface analysis, and clustered with 300mm Si CMOS production equipment, will be evaluated for the production of advanced CMOS devices based on high-mobility Germanium and III-V channels.

The project has three main aims. Firstly Riber's UHV chamber will be analysed for its control of surface structures. The collaboration will also see how moving from a research environment 200 mm platform to a 300 mm fab will affect gate stack passivation. The final target is to demonstrate the technological viability of a 300 mm MBE-module, clustered with 'standard' 300 mm Si CMOS production equipment.

Frédéric Goutard, Riber CEO comments, "Participating in early stage research is intrinsic to Riber's aim to strengthen

our leading position in the compound semiconductor industry. MBE is considered to be most efficient technology to leverage compound semiconductors towards high-end applications with a tremendous market potential, such as mobile phones, telecom, automotive, satellite, Using our ISA300 chamber in a 300 mm cluster configuration will allow for higher performance in terms of devices operating at high frequencies with reduced energy consumption, etc. We are therefore convinced that this project will clearly demonstrate the attractiveness of our technology in the production of next generations CMOS devices.”

Hans Lebon, VP of fab operations and process step R&D at imec adds, “Through the collaboration with Riber, imec can integrate the power of UHV-systems into state-of-the-art semiconductors production equipment on large diameter wafers. This will allow the application of powerful in-situ surface analysis tools in CVD and ALD equipment which so far was not feasible due to the gas phase environment. Also, MBE-like UHV-techniques for interface control and passivation come in reach which will benefit the development of next generation CMOS technologies.”

Avago announces \$0.13 interim dividend

The innovator of a broad range of analogue semiconductor devices with a focus on III-V based products says the dividend is payable from March 30th 2012

Avago Technologies has announced that its Board of Directors has approved a quarterly interim cash dividend of \$0.13 per ordinary share.

The dividend is payable on March 30th 2012 to shareholders of record at the close of business (5:00 p.m.) Eastern Time on March 19th, 2012.

Avago Technologies has an extensive portfolio which includes over 6,500 products in four primary target markets: wireless communications, wired infrastructure, industrial and automotive electronics, and consumer and computing peripherals.

Infinera & JDSU join forces to optimise 100 G networks

JDSU's solution accelerates the development of Infinera's optical transport network-based systems which are based on indium phosphide technology

Infinera has chosen the JDSU ONT 100G Tester Solution to help ensure the high quality and reliability of its new Multi-Terabit DTN-X platform.

Infinera will use JDSU's products to validate the quality performance of its customers' 100 G solutions whilst demonstrating the DTN-X platform on the Infinera Express.

This is a mobile demo truck, which was showcased during the Optical Fibre Communication Conference and Exposition (OFC), last week in Los Angeles.

The Infinera Express tours the globe to offer hands-on experience in cutting-edge optical transport innovation, like 500 Gb/s super-channels, coherent modulation and digital automation. It will use JDSU's 100 G test solutions during these key field demonstrations with communications service provider customers and at industry forums worldwide.

“Successful 100 G deployments are essential for service providers to meet the challenges resulting from growing traffic and ensure high quality of service for the end user,” said Lars Friedrich, vice president and general manager in JDSU's Communications Test and Measurement business segment.

“Infinera's demonstrations with JDSU's ONT 100 G solution are a testament to our ongoing customer collaboration efforts to ensure that service providers receive high quality products and verify their performance before deploying 100 G services in their network.”

The explosion of network traffic, driven by the growing demand for video and other applications, exacerbates service quality challenges and contributes to the growing need for cost-effective transmission and switching technologies. JDSU's optical network tester (ONT) 100 G solution simulates the complexities of live network traffic with a very high degree of accuracy.

JDSU's ONT 100 G solution is well positioned to demonstrate end customer benefits and technical advantages with its industry leading breadth and depth of functionality in all required areas such as physical layer testing, high speed Ethernet, IP and OTN switching.

“JDSU's 100 G expertise has been central in the lab and the field to help ensure the success of our customers' trials,” comments Michael Capuano, vice president of corporate marketing at Infinera. “The ONT 100G solution helps test multiple client-side services of 10 GbE, 40 GbE and 100 GbE on a line-side 500 G super-channel on the DTN-X. Ultimately this enables our service provider customers to confidently deploy Infinera solutions maximising efficiency of their optical transport network.”

The DTN-X is one of the industry's first multi-terabit packet-optical transport network platforms based on the ground-breaking InP 500 Gb/s Photonic Integrated Circuits (PICs). It is purpose-built to integrate switching with DWDM without any trade-offs in capacity. The architecture of the DTN-X extends the ease of use and reliability of Infinera's successful DTN in a new multi-terabit platform that scales for the future, is simple to operate and efficiently reduces the number of elements in the network.

TriQuint inaugurates new international headquarters in Singapore

The new office will support the firm's growing global customers and strengthen operational efficiencies

TriQuint Semiconductor has officially opened TriQuint International Pte Ltd, its new International Headquarters in Singapore.

The facility will be the focal point for most international customers, suppliers and manufacturing partners.



"Our business outside of the United States now contributes about 70 percent of the company's annual revenue," says Ralph Quinsey, President and CEO of TriQuint. "With Asia's appetite for new technologies, particularly in mobile devices, and government support of the latest communications infrastructure, we believe Asia will continue to offer great opportunities for business growth. It is with that long term view that we further globalise our business, in order to strengthen our relationships with international customers and drive greater efficiencies across our supply chain."

The new TriQuint International Headquarters is located at the Changi Business Park, close to Singapore's Changi International Airport. This office will offer dedicated resources in a wide variety of areas ranging from customer service to supply chain management.

"We are pleased that TriQuint Semiconductor is establishing its International Headquarters in Singapore. The headquarters is testimony to Singapore's competitiveness as a preferred location for companies to gain supply chain efficiencies," comments Chong Joon Woon, Director of the Electronics Economic Development Board of Singapore.

TriQuint has just completed its sixth consecutive year of record revenue, largely driven by the proliferation of smartphones, tablets and the emergence of 3G/4G broadband wireless. Customers in Asia drove a big part of this growth and manufacturing partners in Asia assembled and tested almost all of the high volume TriQuint-designed products sold into these applications.

"We have solid plans to grow our share in the mobile device and network communications markets in Asia and

Europe. Singapore is a great location to recruit and develop experienced talent, given the number of multi-national semiconductor companies already located here" adds Glen Riley, Vice President and Managing Director, TriQuint International Pte Ltd. "Over time we also plan to work on technology innovations and new product designs out of Singapore, through close collaboration with international customers."

GaAs VCSELs help to transfer a trillion bits of information

IBM has found a novel technique of speeding up data transfer rates using tiny holes in a single quarter-inch chip using gallium arsenide

Imagine how long it would take to download 500 high definition movies.

It could take quite a while to transport the terabits of data you'd need with the technology we have today.

Now IBM scientists say they have developed a new compact prototype which efficiently delivers ultra-high interconnect bandwidth to power future supercomputer and data centre applications.

IBM's optical chipset, dubbed "Holey Optochip", is claimed to be the first parallel optical transceiver to transfer one trillion bits, or one terabit of information, per second. It integrates 850 nm GaAs based VCSELs with silicon.

With the ability to move information at blazing speeds – eight times faster than parallel optical components available today – the breakthrough could transform how data is accessed, shared and used for a new era of communications, computing and entertainment.

And you could download those 500 HD movies in a flash.

The raw speed of one transceiver is equivalent to the bandwidth consumed by 100,000 users at today's typical 10 Mb/s high-speed internet access. Or, it would take just around an hour to transfer the entire U.S. Library of Congress web archive through the transceiver.

Progress in optical communications is being driven by an explosion of new applications and services as the amount of data being created and transmitted over corporate and consumer networks continues to grow.

At one terabit per second, IBM says its latest advance in optical chip technology provides unprecedented amounts of bandwidth that could one day ship loads of data.

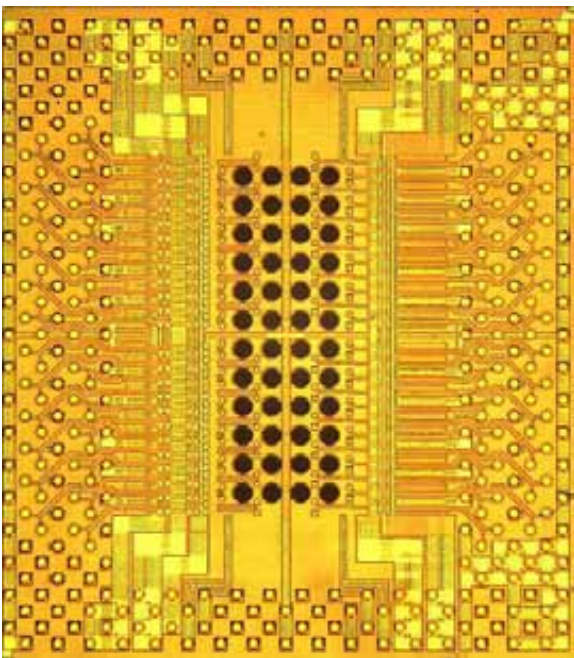
This will affect our modern world; social media sites, digital pictures and videos posted online, sensors used to gather climate information, and transaction records of online purchases to name but a few.

“Reaching the one trillion bit per second mark with the Holey Optochip marks IBM’s latest milestone to develop chip-scale transceivers that can handle the volume of traffic in the era of big data,” says IBM Researcher Clint Schow, a member of the team that built the prototype.

“We have been actively pursuing higher levels of integration, power efficiency and performance for all the optical components through packaging and circuit innovations. We aim to improve on the technology for commercialisation in the next decade with the collaboration of manufacturing partners.”

Optical networking offers the potential to significantly improve data transfer rates by speeding the flow of data using light pulses, instead of sending electrons over wires. Because of this, researchers have been looking for ways to make use of optical signals within standard low-cost, high-volume chip manufacturing techniques for widespread use.

Using a novel approach, scientists in IBM labs developed the Holey Optochip by fabricating 48 holes through a standard silicon CMOS chip. The holes allow optical access through the back of the chip to 24 receiver and 24 transmitter channels to produce an ultra-compact, high-performing and power-efficient optical module capable of record setting data transfer rates.



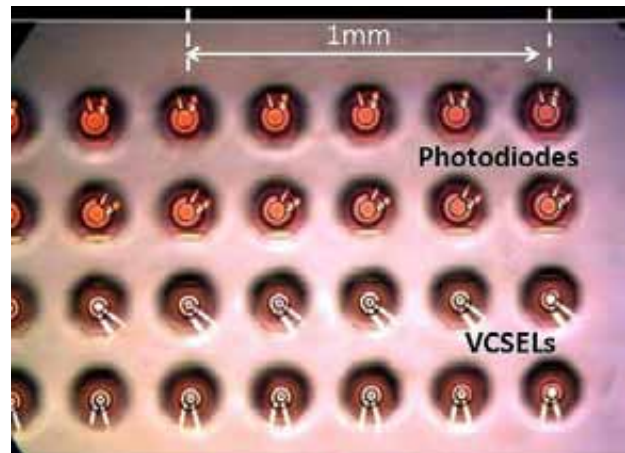
Photomicrograph of IBM Holey Optochip. Original chip dimensions are 5.2 mm x 5.8 mm

The compactness and capacity of optical communication has become indispensable in the design of large data-handling systems. Taking that into account, the Holey Optochip module is constructed with components that are currently commercially available, providing the possibility to manufacture on volume at a relatively low cost.

Consistent with green computing initiatives, the Holey Optochip achieves a speed at a power efficiency that is among the best ever reported. The transceiver consumes less than 5 W; the power consumed by a 100 W light bulb could power 20 transceivers. This progress in power efficient interconnects is

necessary to allow companies who adopt high-performance computing to manage their energy load while performing powerful applications such as analytics, data modelling and forecasting.

IBM says its Holey Optochip illustrates that high-speed, low-power interconnects are feasible in the near term and optical is the only transmission medium that can stay ahead of the accelerating global demand for broadband. The future of computing will rely heavily on optical chip technology to facilitate the growth of big data and cloud computing and the drive for next-generation data centre applications.



Photomicrograph of the back of the IBM Holey Optochip with lasers and photodetectors visible through substrate holes

Parallel optics is a fibre-optic technology primarily targeted for high-data, short-reach multimode fibre systems that are typically less than 150 metres. Parallel optics differs from traditional duplex fibre optic serial communication in that data is simultaneously transmitted and received over multiple optical fibres.

A single 90 nm IBM CMOS transceiver IC with 24 receiver and 24 transmitter circuits becomes a Holey Optochip with the fabrication of forty-eight through-silicon holes, or “optical vias” – one for each transmitter and receiver channel.

Simple post-processing on completed CMOS wafers with all devices and standard wiring levels results in an entire wafer populated with Holey Optochips.

The transceiver chips are a compact 5.2 mm x 5.8 mm in size. Twenty-four channel, industry-standard 850 nm VCSEL photodiode arrays are directly flip-chip soldered to the Optochip. This direct packaging produces high-performance, chip-scale optical engines.

The Holey Optochips are designed for direct coupling to a standard 48-channel multimode fibre array through an efficient microlens optical system that can be assembled with conventional high-volume packaging tools.

IBM presented this work at the OFC conference in Los Angeles and will also be describing other developments. These include

- Two optical links that are the most power efficient ever reported. Underpinned by a novel receiver design, a complete

single-channel VCSEL based link achieved 15Gb/s operation while consuming only 20 mW of power. This represents the first practical demonstration of an optical interconnect that attains the efficiency levels that will be required for exascale computers circa 2020.

· A complete single-channel 40 Gb/s VCSEL-based optical link that not only sets a new benchmark for speed, but also operates at this high data rate with significant margin. Transmitter pre-distortion for end-to-end link performance improvement, an equalisation technique that IBM has pioneered, enabled this breakthrough.

Heilind to provide FCI MergeOptics products

The company will sell FCI MergeOptics products, including those incorporating III-V VCSELs, designed for use in the optical communications, fibre and Ethernet industries

Heilind Electronics, one of the largest distributors of interconnect products in North America, is now stocking FCI's MergeOptics family of products.

FCI MergeOptics integrates optical components with high frequency electrical circuits into one compact module.

MergeOptics' products are designed for use in data communications, telecommunications, lasers, modulators and photo diode applications in the optical communications industry as well as in fibre and Ethernet markets.

Applications include 10GbE datacom and storage area networks (SAN/NAS) based on the IEEE802.3ae and Fibre Channel 10GFC Rev. 4.0 standards. Other uses are in Data Centres and high performance computing applications requiring short to moderate transmission lengths.

MergeOptics says it delivers efficient and flexible network management solutions that include X2, XFP, SFP+, QSFP and CXPO form factors that meet the InfiniBand Trade Association (IBTA), Fibre Channel, 10G Ethernet and IEE 802.3 specifications.

The firm's portfolio features products that integrate VCSEL based optical components and high performance photo diodes with high frequency electrical circuits in compact modules and cable assemblies that are compliant with industry standard optical and electrical interfaces and operate at speeds of 10 Gb/s or higher.

First commercially available 802.11ac platforms supported by Skyworks

The broad range of networking solutions leverage the firm's reference designs for mobile connectivity applications

Skyworks Solutions has announced that several of its precision analogue semiconductor solutions are being utilised in some of the world's first commercially-available 802.11ac platforms.

These include notebooks, ultrabooks, LED TVs, routers, USB data cards and Blu-Ray players.

IEEE 802.11ac technology allows consumers to download content substantially faster than equivalent 802.11n solutions, improving the wireless range in networking applications. With download speeds of greater than a gigabit per second, these devices offer consumers the world's fastest, most reliable wireless coverage for HD-quality video and near instant data synchronisation of music. These solutions also help address the growing need for a more robust and efficient wireless network.

"Skyworks is pleased to be at the forefront of 802.11ac applications," says Liam K. Griffin, executive vice president and general manager of high-performance analogue at Skyworks. "Our products continue to push the performance envelope while extending critical battery life. When combined with innovative chipsets, consumers are able to enjoy some of the fastest download speeds in their home or with other mobile platforms."

According to Gartner, WiFi-enabled devices will grow from less than one billion units in 2010 to more than three billion in 2015 – making it one of the most influential mobile and wireless technologies in the years to come. Cisco's 2011 Visual Networking Index Forecast says that video alone is expected to reach approximately 90 percent of global traffic.

Infinera's InP-based DTN-X to link Europe and Asia

Cable&Wireless Worldwide will deploy Infinera's 500 Gb/s super-channels, which employ indium phosphide technology, on one of the most advanced and reliable fibre optic networks in the region

Cable&Wireless Worldwide (CWW), an international integrated communications and data hosting provider, has selected Infinera's Digital Optical Network solution, based on the new DTN-X platform.

The solution will be used for CWW's Europe Persia Express Gateway (EPEG) network, delivering a reliable, high capacity network connection between Europe and Asia. CWW chose Infinera's DTN-X platform for its scalability, simplicity and efficiency, and ability to support a muliterabit network.

Cable&Wireless Worldwide is a global telecommunications company providing a wide range of high-quality managed voice, data, hosting, and IP-based services and applications. CWW's international cable network spans every continent covering more than 150 countries.

EPEG will stretch approximately 10,000 km from Frankfurt in Germany to Oman with the unique attribute of having only 246 km of undersea cable and all other routes terrestrial. EPEG will allow a telecommunication transit route alternative to the

Red Sea, Suez Canal, Egypt and the Mediterranean Sea regions. It can play an important role for traffic re-routing in the event of earthquakes and disasters, which have been known to affect multiple systems at once. A number of providers are collaborating on this project and building networks in their own regions, with CWW building out the segment from Frankfurt, Germany to the Ukraine/Russian border.

CWW's multiterabit EPEG optical network will use Infinera's Digital Optical Network InP solution, powered by Infinera's DTN-X, which includes the latest 500 Gb/s photonic integrated circuits (PICs).

The Infinera DTN-X delivers 500 Gb/s FlexCoherent super-channels and is upgradeable to 1 Tb/s super-channels in the future, providing scalability with investment protection. The platform integrates 5 Tb/s of OTN switching which will enable CWW to efficiently converge layers of the network resulting in reduced capital and operational expenses.

What's more, Infinera's intelligent GMPLS automation software will enable CWW to rapidly provision highly-reliable low-latency services, including 100 Gb/s Ethernet, making it highly competitive across the Europe to Asia route. The disruptive nature of Infinera's 500 Gb/s PIC also enables network operators, like CWW, to consume less space and power, making the platform one of the most efficient commercially available.

"We believe that the Europe Persia Express Gateway is an important international network development as it will be providing high capacity, diverse connectivity from the Middle East Region to Europe," comments Rick Perry, vice president international planning at Cable&Wireless Worldwide. "Infinera's solution is helping to underpin that development."

"We are excited to partner with Cable&Wireless to build what we believe is the most advanced and reliable optical transport network between Europe and Asia," adds Tom Fallon, Infinera President and CEO. "At Infinera we are focused on helping global network operators like Cable&Wireless Worldwide to improve the scalability of their networks while simplifying operations and increasing the efficiency of fibre assets."

Infinera's product portfolio includes Infinera's DTN long haul and metro platform, powered PICs and is designed to scale up to 6.4 Tb/s of transmission capacity per fibre; Infinera ATN, a scalable metro WDM transport platform; Infinera's DTN-X platform with 500 Gb/s FlexCoherent super-channels; and Infinera's Managed Services for global service and support

Fabrinet to manufacture OneChip indium phosphide PIC-based PON transceivers

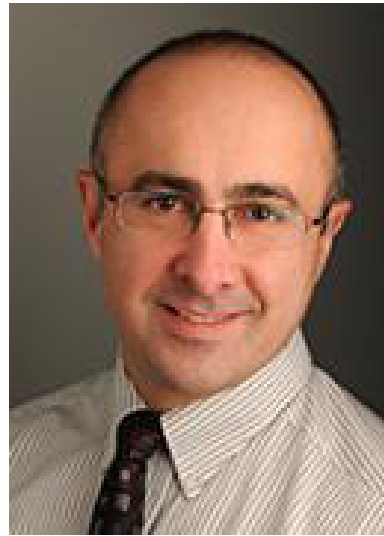
OneChip has also appointed compound semiconductor industry expert, Dan Meerovich, as Vice President of Global Manufacturing Operations

The company has enlisted Fabrinet to manufacture OneChip's

InP Photonic Integrated Circuit (PIC)-based Passive Optical Network (PON) transceivers.

OneChip Photonics has also appointed Dan Meerovich to a senior position in the company.

Meerovich is responsible for building OneChip's volume manufacturing capabilities and ensuring cost-effective and efficient operations across its supply chain.



Dan Meerovich, VP of Global Manufacturing Operations, OneChip Photonics

"Dan has a wealth of optical communications industry experience and a successful track record of growing and streamlining operations, while exceeding sales and profit targets," says Jim Hjartarson, CEO of OneChip Photonics. "He will play a key role in the introduction and volume manufacture of our unique optical transceiver product line."

Before joining OneChip, Meerovich served as VP of Operations at Xtellus, which was acquired by Oclaro in 2009. One year after the acquisition, he was instrumental in increasing revenue by 50 percent, while increasing labour efficiency by 70 percent. He also expanded the company's R&D and manufacturing capabilities in Korea and Thailand.

Previously, Meerovich was VP of Manufacturing Operations at Multiplex, where he established and managed a wholly owned manufacturing subsidiary in China. He also held senior-level operations positions at Asip / Apogee Photonics, JDS Uniphase and Tyco / Laser Diode.

According to Meerovich, OneChip selected Fabrinet as its contract manufacturer "because of Fabrinet's strong global footprint and its ability to get our manufacturing line up and running quickly."

"Fabrinet has extensive experience manufacturing optical components and systems and will help OneChip meet the high demand for our integrated optical transceivers," Meerovich adds.

Fabrinet will provide a range of manufacturing services for OneChip, including optical component attachment for

OneChip's Bi-directional Optical Sub Assemblies (BOSAs) and final integration and testing of its fully packaged optical transceivers.

Fabrinet, a vertically integrated manufacturer, will provide manufacturing services for OneChip at its Pinehurst campus in Thailand. On a global basis, Fabrinet has more than 1 million square feet of manufacturing space at its facilities in Thailand, the People's Republic of China and the United States.

Greg Reny, Senior Director of Business Development at Fabrinet, concludes, "We look forward to helping OneChip bring its breakthrough solutions to market globally. We are known for the quality and precision of our optical manufacturing, assembly and test processes, and we are excited to put our expertise to work for OneChip."

40 and 100 Gbps CFP GaAs optical transceiver modules for Ethernet

The new modules employ the firm's 850 nm gallium arsenide VCSEL and photodetector technology. They are designed to power next-generation capabilities that service providers are demanding

Emcore Corporation is introducing two new 40 Gbps and 100 Gbps form-factor pluggable optical transceiver modules for 40 and 100 Gigabit Ethernet short reach applications, respectively.

This highly flexible form-factor supports 40GBASE-SR4 and 100GBASE-SR10 optical interfaces with link distances up to 150 metres over multimode optical fibre and facilitates system design options including Ethernet rack-to-rack, ganged serial links, logic-logic data links, board-to-board and shelf-to-shelf configurations.

The SR4 CFP transceiver module is a 4-channel design with four synchronous 10.3125 Gbps electrical input lanes. The SR10 CFP transceiver module is a 10-channel design with ten synchronous 10.3125 Gbps electrical input lanes.

In both modules electrical signals are retimed by a multi-lane data clock recovery unit and then converted to optical signals using a multi-lane laser driver and an Emcore GaAs 850 nm wavelength VCSEL array. The optical signals are converted to electrical signals using an Emcore GaAs PIN photodetector array, along with a multi-lane transimpedance amplifier and are retimed and delivered to the host.

Both the Emcore SR4 and SR10 CFP transceivers are hot-pluggable and hot-swappable and have control and monitoring functions that are accessed through the microcontroller via a two-wire serial MDIO (Management Data Input/Output) port. The electrical interface consists of a 148-pin edge-connector compliant with the CFP MSA industry standard.

"These new CFP transceiver modules utilise our latest VCSEL and photodetector technology and are designed to power next-generation capabilities that service providers are demanding,"

comments Jaime Reloj, Emcore's Vice President of Business Development.

"By leveraging our in-house optoelectronic component capability, we can optimise optical performance and tailor solutions to very specific customer needs. Emcore will continue to advance the technology for high-performance data and telecommunications and demonstrate the same quality, reliability, on-time delivery and competitive pricing our customers have come to expect," continues Reloj.

Emcore were at the 2012 Optical Fibre Conference (OFC) at the Los Angeles Convention Centre between March 6th and 8th in the Corporate Village, suites 2555 and 2557.

Oclaro unveils new micro-iTLA and InP coherent receiver platform

The receivers employ indium phosphide integration technology to deliver reliability and are one of the first receiver solutions to package a signal power monitor diode

Oclaro has strengthened its 40 Gbps and 100 Gbps coherent optical portfolio with the introduction of a new micro-iTLA and 40 Gbps PM-BPSK modulator.

The company has also announced the volume production of its 40 Gbps and 100 Gbps PM-DPSK modulators and its coherent receiver platform.

By providing an expansive line of both coherent components and module solutions, Oclaro is enabling its customers to quickly and cost-effectively deliver next generation network equipment that provides scalable and flexible future proof architectures.

These products will be on display at the OFC/NFOEC show in the Oclaro booths #1957 and #2058.

Oclaro says it is well positioned to establish a leadership position in the high-bit rate 40 Gbps and 100 Gbps coherent markets, which analyst firm Ovum predicts to grow from \$360M in 2011 to more than \$2.1B in 2015. Coherent detection is widely considered the leading technology for enabling higher optical transmission speeds such as 100 Gbps because it delivers the scalability and flexibility needed for transmitting more bandwidth cost-efficiently over fibre optic networks.

As a result, network equipment manufacturers are rapidly embracing this detection format and are installing 40 Gbps coherent networks as a stepping stone to 100 Gbps or going directly to deploying 100 Gbps networks for long-term sustainability.

"PM-QPSK Modulators, coherent receivers and narrow line-width micro-iTLAs are the complete set of optical components that customers need for deploying high-speed coherent 40 Gbps and 100 Gbps systems," says Robert Blum, Director of Product Marketing for the Oclaro Photonic Components

Business Unit.

“As a one-stop-shop supplier for all these critical pieces of the network, Oclaro is enabling customers to save a significant amount of development time, ensure the highest level of integration on their line-cards, and deliver the network architecture that service providers need for long-term success,” continues Blum.

At the OFC/NFOEC show, Oclaro is introducing a new 40 Gbps PM-BPSK modulator targeted for ultra long haul transmission systems such as those used in submarine applications. The new modulator is sampling today with production scheduled to start in June 2012.

The firm’s products for all 40 Gbps modulation formats allows customers to maintain their existing 10 Gbps networks while also gaining the flexibility to upgrade to higher-speed coherent networks in the future.

The firm’s coherent receiver platform has completed qualification and is entering volume production. The receivers are more than 50 percent smaller than the 100G footprint defined by the OIF - while also providing an option to maintain full compliancy with the OIF standard.

The receivers utilise Oclaro’s indium phosphide integration technology to deliver reliability and are one of the first receiver solutions to package a signal power monitor diode. In the past, customers needed to add a discrete monitor photodiode onto their line cards. By integrating this functionality directly into the receiver, customers can now save valuable line card space, while also lowering costs and reducing development time.

The new micro-iTLA delivers the small footprint, optical power, narrow linewidth and low power consumption needed to transmit at higher data rates across the network. The micro-iTLA delivers a 3 times reduction in size over standard iTLA products while also meeting the requirements for advanced coherent applications.

Oclaro worked with other laser and network equipment manufacturers through the OIF to define a micro-iTLA Multi Source Agreement specification in 2011, specifically defining reductions in footprint and height. With its new micro-iTLA, Oclaro also achieved reductions in power consumption, which will allow its customers to produce efficient designs in small form factors.

The micro-iTLA leverages upon Oclaro’s proven tunable TOSA packaging and solid state tuning based InP DS-DBR chip technologies, of which well over 300,000 tunable lasers have now been deployed. Oclaro’s InP capabilities enable its customers to reduce power consumption and space constraints whilst offering advanced performance.

Oclaro’s micro-iTLA is scheduled to ship to key customers during Q2 of 2012.

Single multicore fibre breaks records with Emcore’s VCSEL technology

OFS says this is an important milestone in the development of next-generation supercomputer and data centre networks

OFS, a developer and supplier of innovative fibre optic network products, has announced a world record transmission of 120 Gb/s over 100 metres across a single strand of multimode fibre.

The joint demonstration was enabled by a seven-core laser-optimised multimode fibre made with OFS LaserWave fibre technology interfaced with custom-designed transceivers from IBM Research (Yorktown Heights, NY), using custom-designed VCSELs and photodiodes from Emcore. It exceeded both the previous transmission length record by 60 metres and the previous data rate record by 50 percent.

“This demonstration illustrates the viability of multi-core multimode fibre as a transmission medium for next-generation high-performance computer networks,” said Durgesh S. Vaidya, senior manager of R&D at OFS. “With advanced light sources such as the Emcore custom arrays, systems designers will be able to achieve the extremely high transmission speeds predicted for future networks while increasing cable density with the opportunity for reducing packaging costs.”

The OFS fibre consists of seven graded-index multimode cores in a hexagonal array. Each of the six outer cores transmits at 20 Gb/s over 100 metres. They employ Emcore’s two-dimensional VCSELs arrays and vertically illuminated photodiodes, fabricated, in a commercial process, with a geometry corresponding to the outer six cores of the fibre. The fibre’s 26 µm core size is directly compatible with the photodiodes needed for 25 Gb/s (20 – 30 µm diameter). The 20 Gb/s VCSELs were flipped chip packaged on an IBM-designed transceiver package with 130 nm CMOS ICs, and the full link was characterised by IBM Research with all six channels running error-free simultaneously.

OFS believes the additional bandwidth density provided by the multi-core fibre link over standard multimode links will help to enable efficient next-generation high-performance computers and data centres, while the larger core sizes compared to single-mode fibre solutions serve to help keep packaging costs sustainable.

“The expected increase in demand for optical fibre cable in these applications will result in significant network design challenges,” Vaidya said. “While bandwidth requirements continue to grow, network managers face considerable constraints on power and cost budgets, not to mention the physical space required by the fibre cabling. Increasing the bandwidth available on each fibre is a critical step in developing optical interconnects for future networks, not only for high-performance computing but also for data-centres, another key growth market for optical fibre.”

OFS’ corporate lineage dates back to 1876 and includes technology powerhouses such as AT&T and Lucent Technologies (now Alcatel-Lucent). Today, OFS is owned by

Furukawa Electric, a multi-billion dollar global leader in optical communications.

OFS will be showcasing its products at OFC/ NFOEC 2012 at booth #2125. The conference took place at the Los Angeles Convention Centre from March 4th to 8th in Los Angeles, California.

The Terabit age advances with Infinera's InP PICs

The company will host the first public demonstration of its 2 Tb/s small form factor DTN-X indium phosphide based platform

Infinera is participating at OFC/NFOEC this week and plans for the first public demonstration of its 2 Tb/s small form factor DTN-X platform.

OFC/NFOEC took place at the Los Angeles Convention Centre from March 4th to 8th in Los Angeles, California.

At the conference, the Infinera Express mobile demonstration lab will showcase the firm's latest Digital Optical Networking solutions designed for the Terabit age. Inside the Infinera Express at OFC/NFOEC, the company will have on display a pair of DTN-X platforms configured with 500 Gb/s FlexCoherent super-channels.

At OFC/NFOEC, Infinera is providing the first public demonstration of the half-rack small form factor XTC-4 chassis with 2 Tb/s of integrated OTN switching and simulating typical high-bandwidth transport links on customer networks. The XTC-4 provides a DTN-X class solution in a smaller form factor for operators who have space constraints or a need for lower total chassis capacity. The DTN-X platform in a full-rack XTC-10 chassis with 5 Tb/s of integrated OTN switching was demonstrated in September 2011. Both the XTC-4 and XTC-10 are planned for availability in the first half of 2012.

The Infinera Express will also showcase the DTN platform which interoperates with the DTN-X for cost effective service delivery. Both the DTN and DTN-X boast an 8th generation common intelligent GMPLS control plane along with a common DNA management system for rapid service turn up via point and click provisioning, auto-discovery and automated service restoration.

Infinera's says its DTN-X platform is the industry's only super-channel DWDM solution based on 500 Gb/s photonic integrated circuits (PICs); it also integrates OTN switching and a GMPLS control plane without any performance compromise.

The InP based PICs integrate more than 600 optical functions, traditionally implemented on discrete components, onto a pair of chips significantly improving reliability, increasing system density and reducing power consumption. They deliver the world's first 500 Gb/s FlexCoherent super-channels based on 100 Gb/s channels—providing service providers a network that scales for the future, is simple to operate enabling agile service deployment, and efficiently uses fibre resources ultimately benefitting an operator's bottom line.

Infinera's executives and engineers will make presentations addressing new developments in technologies that enable next-generation optical networking solutions including photonic integration and coherent transmission.

Co-founder and Chief Strategy David Welch spoke on Monday, March 5th where he presented "Disruptive Technologies: What to PIC?"

KuangTsan Wu, Infinera Fellow and one of the world's foremost coherent transmission architects spoke on Thursday, March 8th on "Techniques in Carrier Recovery for Optical Systems."

Infinera's Vice-President of Development and Manufacturing, Fred Kish, presented on Monday, March 5th during a workshop titled "Optical Component Technology."

Vice-President of Product Marketing, Antti Kankkunen, spoke on Thursday, March 8th on a panel titled "Photonic Integration in Long Haul Transport Networks."

Han Sun, Senior Principal Engineer focused on coherent algorithms, also presented on Thursday March 8th on "Clock Recovery and Jitter Sources in Coherent Transmission."

RF Electronics RFMD annual incomes crash over 82%

In the last quarter, the firm was adversely affected due to the depleted demand from China and a major European handset manufacturer, though this was offset by increased market share gains in smartphones. In the next quarter, RFMD is expecting a growth of about 50% in its gallium nitride business

RF Micro Devices has reported financial results for its fiscal 2012 fourth quarter, ended March 31, 2012 as well as annual results for fiscal year 2012.



During fiscal year 2012, the firm had revenues of \$871.4 million, down 17.2% from the \$1051.8 million it made in FY 2011. Operating incomes slid over 82.4% from last year from \$139.5 million to \$24.6 million. And net incomes crashed by a

whopping 99%, from \$124.6 million to \$857 thousand from FY 2011 to FY 2012.

Fourth quarter revenue was \$187.9 million, a decrease of approximately 16.6% sequentially and down 11.9% from the same quarter last year. On a GAAP basis, gross margin was 30.1%, quarterly operating loss totalled \$11.0 million, compared to operating incomes of \$13.2 million in Q4 FY 2011.



The company also suffered quarterly net losses, which were \$13.0 million, or \$0.05 per diluted share in the last quarter. This compares to net incomes of \$24.1 million from the same quarter last year. During the March quarter, RFMD generated approximately \$20.5 million in cash flow from operations and \$10.9 million in free cash flow.

The sequential decline in revenue in the last quarter reflected greater-than-seasonal declines among manufacturers of handsets in China and at a leading European handset manufacturer. These were offset partially by sequential increases in sales of RFMD's PowerSmart power platforms and RFMD's ultra-high efficiency 3G/4G power amplifiers (PAs), as well as better-than-seasonal performance in MPG revenue.

In a conference call discussing the results, the firm says the growth in PowerSmart in the last quarter was across multiple baseband manufacturers, the largest one still being the Intel Mobile Communications baseband.

The firm's main customer was Samsung, who was a 10% customer. Regarding another major smartphone customer, Robert A. Bruggeworth comments, "Nokia was significantly less than 10% in the March quarter. I think all the way down over the last few quarters, we've taken a conservative stance and they roughly come in line with estimates, with what we thought was going to happen with them. We expected a significant decline in the March quarter, and we saw that. As far as the June quarter, yes we're expecting another decline with them."

Financial Outlook

RFMD says it is winning share on multiple flagship smartphones and anticipates continued sequential growth in 3G/4G components during the June quarter. Among handset manufacturers headquartered in China, RFMD also sees strengthening demand and projects sequential growth next quarter. In the markets served by MPG, RFMD sees stabilising demand and improving order visibility and expects MPG revenue in the June quarter to be approximately flat, versus the March quarter.

The firm expects to see another quarter of some R&D growth and then probably flattening out from there.

RFMD anticipates June quarterly revenue to grow approximately 8% sequentially to approximately \$202 million and also expects gross margin to improve approximately 100-200 basis points.

Bob Bruggeworth, president and chief executive officer of RFMD, says, "RFMD is growing with the industry's leading smartphone manufacturers and diversifying across a broad set of customers serving all geographies and segments. We anticipate sequential growth in the June 2012 quarter, supported by increasing sales of our 3G/4G components and a resumption of growth among handset manufacturers in China."

"As we begin fiscal 2013, we are especially enthusiastic about RFMD's incremental growth drivers in new segments, including antenna control solutions, 802.11ac front end modules and GaN power devices, where RFMD's proven technology leadership and early mover advantage position us to capture market share leadership as these markets grow."

Bruggeworth also says, "From a revenue growth in CPG, we're clearly expecting the growth to come from PowerSmart, Phenom and our switch-based products that we've been talking about, that being switches and some of the antenna control solutions. And all three of them, we expect significant growth. And then in MPG, we've talked about the three areas that we're looking at but clearly in WiFi, we're expecting to be able to grow our business significantly this fiscal year, coupled with growth of about 50% in our GaN business as well."

Dean Priddy, CFO and vice president of administration of RFMD, adds, "In the June 2012 quarter, we expect a stronger, more diversified customer base will support a resumption of sequential revenue growth and continued margin expansion."

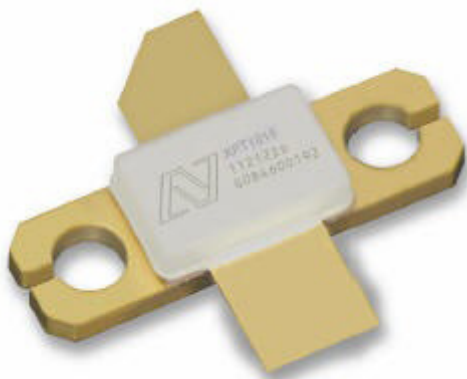
"We have structured the RFMD operating model to deliver significant leverage, and we anticipate our product portfolio and R&D investments will continue to drive revenue growth and margin expansion throughout calendar 2012. Importantly, we're confident the targeted, incremental R&D investments RFMD is making in 2012 will generate incremental revenue beginning as early as the September 2012 quarter," he concludes.

Nitronex's GaN transistor raises the robustness bar

The firm's latest rugged gallium nitride RF transistor, the XPT1015, has been designed to work in severe operating environments

Nitronex, a designer and manufacturer of GaN based RF products, has developed a rugged transistor technology capable of surviving the industry's most severe robustness tests without significant device degradation. The XPT1015, based on this new rugged technology, is a 28V, DC-3.0GHz, 40W power transistor with 17.5dB small signal gain and 65% peak drain efficiency at 2GHz. The thermal resistance of the XPT1015 is 1.9°C/W and is amongst the lowest in the industry

in this power class.



XPT1015 module

Nitronex says the XPT1015 leverages its existing 28V NRF1 process platform which has been used to ship more than 650,000 production devices. This includes more than 50,000 MMICs, since volume shipments began in 2009. One hundred XPT1015 devices from four wafers were subjected to a 15:1 VSWR at all phase angles at a 90°C base plate temperature. During VSWR testing, all devices were operated in a saturated average power condition, being driven by a 4000 carrier 200MHz wideband signal with a 19.5dB peak-to-average ratio. These devices all survived and had only about a 0.2dB average change in saturated output power.

Ray Crampton, VP of Engineering, says, "Historically there have been markets which Nitronex could not address because our products did not meet their stringent robustness requirements. We made reliability, robustness, and ruggedness a priority over the last several quarters. Our new XPT1015 is our first 28V product explicitly designed for severe operating environments. In addition, our recently announced 48V platform was also designed from the ground up to meet very severe environmental requirements." "We are excited to have expanded our addressable markets and applications by offering this new rugged technology capability." Nitronex says its patented SIGANTIC GaN-on-Silicon process is the only production qualified GaN process using an industry standard 4" silicon substrate. This results in a robust, scalable supply chain and positions Nitronex well for the growth expected from emerging GaN markets such as military communications, CATV, RADAR, commercial wireless, satellite communications and point to point microwave. Nitronex is currently providing prototypes to select customers and the XPT1015 is expected to be commercially available later this year.

RFMD co-founder Jerry D. Neal retires

Neal is now looking forward to pursuing other opportunities including entrepreneurial, advisory, and charitable endeavours

Jerry Neal, co-founder and executive vice president of marketing, is retiring from RFMD, effective May 31, 2012.



Jerry D. Neal

Neal has had a distinguished career in the communications technology industry, including the co-founding of RFMD and his role in the subsequent growth of the company. As a co-founder of RFMD, Jerry Neal was responsible for securing the Company's initial venture capital investment, as well as multiple licensing deals, branding, and mergers and acquisitions. He was also primarily responsible for many of the Company's corporate relationships, including TRW (now Northrop Grumman), Nokia, IBM, TowerJazz, and others.

Reflecting on his twenty-one year career at RFMD, Jerry Neal comments, "RFMD is both a pioneer and a global leader in communications technologies, and it is an honour to have played a major role in starting and building the Company. With my retirement from RFMD, I look forward to pursuing other passions in my life including entrepreneurial, advisory, and charitable endeavours. I sincerely wish the greatest success to my many friends and colleagues at RFMD."

Bob Bruggeworth, president and chief executive officer of RFMD, says, "RFMD has benefited tremendously from Jerry Neal's contributions and expertise. I personally have enjoyed working with Jerry and have valued his counsel and the strategic relationships he has built in the industry. All of RFMD wishes Jerry Neal much success as he focuses his time and energy on other ventures."

Jerry Neal is active in business, education, and charitable organisations and has served on the Boards of Directors of several semiconductor companies.

Skyworks diversifies to stay top dog in GaAs device manufacturing

Branching out with smartphone customers, products, technology and market applications have enabled Skyworks to perform way over the odds, along with WIN Semiconductors

Although the GaAs device market growth plummeted in the second half of 2011, with overall revenue increasing by only

six percent, Skyworks secured its position as the largest GaAs device manufacturer with a 27% growth in revenue.

The Strategy Analytics report, "Skyworks Remains the Largest GaAs Device Manufacturer," explores 2011 GaAs device revenue results and growth trends, as well as revenue performance of leading device manufacturers. These include the likes of RFMD, Skyworks, TriQuint Semiconductor, Avago Technologies, Renesas Electronics, Hittite and WIN Semiconductors.

"While the 2011 growth rate of the GaAs device market was right around its historical average of 6 percent, Skyworks and WIN Semiconductors did more than significantly better," notes Eric Higham, Director of the Strategy Analytics GaAs and Compound Semiconductor Technologies Service. "The big increase at Skyworks is a testimonial to their efforts for diversifying smartphone customers, products, technology and market applications."

Asif Anwar, Director, Strategy Analytics Strategic Technologies Practice, adds, "The growth at WIN Semiconductors indicates their commitment to expansion, and also reflects success for outsourcing foundry operations in the GaAs device industry."

RF component market to rocket to \$4.7 billion in 2016

Gallium arsenide is still dominating the PA market by far but is poised to lose market share as CMOS PA technology advances. At the antenna switch level, players with early involvement in SOI switches, like Skyworks and RFMD are gaining market share over players involved in GaAs, such as TriQuint

The radio-front end is a key component in every cell phone, from low cost GSM handset to multi-mode multi-band LTE smartphones. The market is very fragmented in terms of architecture, however there are a few types of components that are key. Filters or duplexers, power amplifiers (PAs) and antenna switches are at the heart of every cell phone radio. Most antenna switches and PAs currently incorporate III-V compound semiconductors and many employ GaAs pHEMT and to a lesser extent, GaN technologies. Laurent Robin, Activity Leader, Yole Développement, says that the three key components represented a \$3.6 billion market in 2011 and are currently growing at a 5.6% annual rate, expected until 2016. The market research firm's new report, "RF filters, PAs, Antenna Switches & Tunability for Cellular Handsets," highlights that as this market becomes increasingly attractive, major technical evolutions and changes are occurring in the competitive landscape for those categories of devices. Filters and duplexers are the most dynamic market.

Driven by duplexers which are growing at a 10.5% rate annually, this market will reach \$1.7 billion in 2016. Indeed smartphones are widely using WCDMA bands and LTE is a new strong driver. Depending on each band, SAW or BAW developments are candidates for further growth. While Epcos and Murata dominate the SAW area, Yole has seen fierce competition between Avago and TriQuint in the BAW segment.

Power amplifiers are another strategic component in the RF part. Although this market is maturing, Yole Développement analysts still see many new technologies which are impacting the PA market. One current trend is that more integrated PAs and broadband PAs are increasingly being accepted on a commercial level. GaAs is still dominating the PA market by far but is poised to lose market share as demand for CMOS PAs is growing. What's more, another competitor is SOI technology, which could be used for PAs in the near future. There is thus still room for many changes in the competitive landscape dominated by Skyworks, with RFMD, TriQuint, Avago and Murata / Renesas as challengers. Also, as antenna switches become more mature, Yole Développement anticipates evolutions in two directions. Firstly, the team sees a move towards higher performance in the new LTE bands and increasing number of throws.

This is where Peregrine Semiconductor has a leading position. Secondly, they see massive adoption of SOI technology, which they have observed has become more and more popular since 2010. All the big players are now involved in this technology, which offers a good price/performance ratio. GaAs switches are thus decreasing, although some players still release products with exceptional performances, such as Sony. At the same time, new technologies are coming closer to production, as has been seen with MEMS. Tuneability and changes in architecture Tuneability is a new hot topic for radio front end modules. Indeed, after years of development, antenna tuners have been widely accepted since 2011. Apart from GaAs switches, ferroelectric capacitors and MEMS variable capacitors have been successfully integrated into flagship products such as some Samsung Galaxy S2 smartphones. While there is no consensus yet on this topic, antenna tuners are now providing a very significant value proposition. Yole expects it to be the next very hot market in this area.

New types of tuners and massive deployment of LTE within 2014 will be additional drivers for tuneability. Leading the MEMS field, Wispry will be a key player to watch, while Sony and Peregrine also offer promising approaches based on alternative technologies. The acquisition of Paratek by RIM in March 2012 is also a sign that antenna tuners will be a strategic technology to be integrated in many cellphone platforms in the near future. All those changes at the component level (PA, ASM, filters, and so on) and the rise of tuneability are having a dramatic impact in the global RF part architecture evolutions. Both technical and competitive challenges and opportunities are shaping the architecture of future front end modules. Similarly, the trend for integration in various types of modules is driving changes at the individual component level. New packaging technologies now enable compact multi-chip packages: Rx modules, PA modules, multi-duplexers. In total, the front-end modules were already a \$2 billion market in 2011 and grew 12% annually. This represents more than three times the revenues of standalone PAs, filters/duplexers and tuners predicted for 2016. Rapid evolution of technology and competitive landscape While the analysts' team starts to see some level of consolidation, the competitive landscape in this RF market is changing quickly. Some companies are concentrating more on vertical integration, such as Murata. Since its acquisition of Renesas' PA business, this may translate into a change in the business model of the company. As highlighted in the report, there are today a limited number of companies which dominate this RF space, but generally those players are involved in very specific market space, this

meaning that significant developments can be expected in the near future. For instance, Skyworks is leading the PA market and is big in switches but has no activity in filters. Avago, on the other hand, is a large PA vendor and dominates the BAW filter market, but is neither involved in SAW filters nor in antenna switches. The evolution of architecture towards modules is one driver that pushes each company to enable itself to handle all types of components or to set up specific partnerships. Another driver for competitive change is the speed of technical advancements in this area. At the antenna switch level, players with early involvement in SOI switches, like Skyworks and RFMD are gaining market shares over players involved in GaAs, such as TriQuint. Yole expects this type of change to also be observed in PA technology.

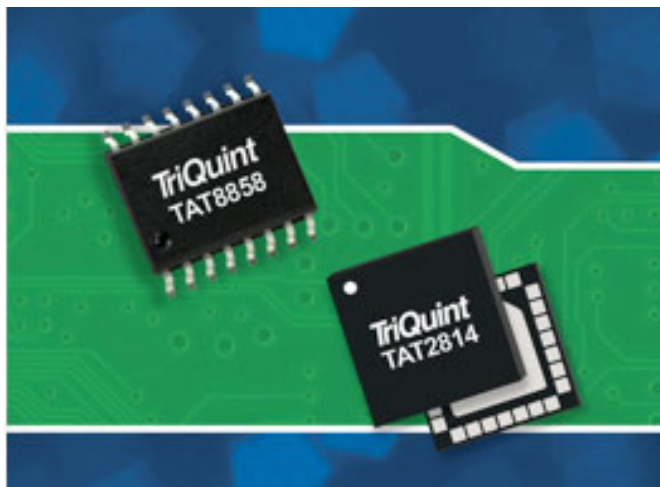
New cost-effective CATV products simplify RF connectivity

TriQuint's two new chips, which employ the firm's gallium arsenide pHEMT technology, are suited to cable TV and broadband applications

TriQuint Semiconductor has announced the availability of two new innovative "TriAccess" amplifiers that can replace multiple products in CATV systems.

Both products were released simultaneously at the CCBN (China Content Broadcasting Network) broadband exposition in Beijing and in Silicon Valley, USA.

TriQuint's new devices offer manufacturers across the globe economical RFICs built with market-tested GaAs technology that supports greater functional integration and higher efficiency. All devices have been utilised successfully in multiple worldwide CATV systems.



TriQuint's new TAT8858 is a 34db integrated push pull amplifier ideally suited for a variety of 75 Ω amplifier and transimpedance receiver applications. TriQuint says it offers superior flexibility since it is able to operate efficiently at gain levels from 26 dB to 34 dB. The amplifier can also be used in 12V as well as 24V

applications, which can lower operational costs by significantly reducing current consumption. The device's high gain also off-loads output amplifier demands, while providing very low noise performance. The device uses TriQuint's patented on-die integrated linearisation. Its performance enables the TAT8858 to replace multiple discrete components in CATV infrastructure RF designs.

TriQuint's new TAT2814A satisfies the DOCSIS 3.0 specification with typically more than a 4 dB performance margin. By integrating two stages of amplification and a variable gain attenuator, the TAT2814A can greatly simplify CATV RF design by reducing the number of discrete RF components compared to products previously needed to achieve this level of performance.

Legacy solutions require up to five times the PCB space to deliver DOCSIS 3.0 performance while consuming up to twice the electrical power. TriQuint's new product solution is ideal for DOCSIS 3.0 output stage amplifier designs including Edge QAM and CMTS (cable modem termination system) applications. The TAT2814A is also ideally suited for Ethernet over Coax (EOC) approaches that are designed to support DOCSIS 3.0 power amplifier levels.

TriQuint claims to simplify RF connectivity by providing product solutions including the TAT8858 that enable a whole family of push-pull amplifiers and receivers based on a single RF circuit. The ability of the TAT8858 to work in 12 V and 24 V designs supports triple-play (voice-video-data) broadband designs such as network upgrades and greenfield deployments. The new TAT2814A offers wide performance margin to significantly overcome losses before the RF chain output connector.

Technical Specifications:

TAT8858

40 -1000 MHz ; Flexibility enables family of push-pull applications from single RFIC; 26 to 34 dB gain configurations; 270mA bias; High gain, Low noise; 12V / 24V application circuits

TAT2814A

45-1003 MHz; Fully integrated two stage amplifier with variable gain attenuator; meets DOCSIS 3.0 with +4dB typical performance margin;

RFMD ships over one billion PAs to China

The company is celebrating the tenth anniversary of its Beijing manufacturing facility and fifth anniversary of its Shanghai design centre

RF Micro Devices says it has shipped over one billion cellular power amplifiers (PAs) to handset manufacturers headquartered in the Greater China area.

RFMD says this significant industry milestone demonstrates

the firm's ongoing commitment to providing China-based customers with operational scale, technological innovation and an industry-leading cost structure.

RFMD opened its first manufacturing facility in Beijing in 2002 in support of local China-based manufacturers and international manufacturers with operations in China.

The company extended its commitment to China in 2007 with the opening of its Shanghai Design Centre and a major expansion of its Beijing facility. Today, RFMD offers one of the industry's most complete end-to-end sources for design, manufacturing, field applications engineering and sales support. RFMD has approximately 2,000 employees located in China supporting hundreds of customers and baseband providers.

Bob Bruggeworth, president and CEO of RFMD, comments, "This considerable milestone exemplifies RFMD's long-standing commitment to our customers based in China. As we commemorate our tenth year of operations in Greater China, we anticipate strong growth with China-based customers, driven by continued innovation in 2G components and the industry's most innovative and most reliable RF product portfolio for the rapidly growing 3G and TD-SCDMA/TD-LTE smartphone markets."

TriQuint to update us on its GaN R&D achievements

The firm will describe its developments on E/D mode III-nitride devices and integrated gallium nitride X-band amplifiers

Scientists from TriQuint will present papers highlighting GaN advancements at the 2012 GOMACTech conference.



The convention is to take place between March 19th and March 22nd in Las Vegas. Presentations will detail state-of-the-art E/D Mode InAlN/GaN devices that deliver record high-frequency performance in DARPA-funded programs.

Integrated GaN X-band amplifiers will also be explored. The firm's new GaN X-band paper details how TriQuint researchers have integrated RF matching and bias circuits in a 66 W high-

efficiency GaN device.

TriQuint says its R&D programs set new standards while also enabling a wide selection of design-ready GaN products for commercial and defence applications.

The firm's products include a full range of FETs, MMICs, packaged transistors, high-power RF switches, and it also provides foundry services. TriQuint develops and manufactures standard and custom GaN, GaAs, SAW and BAW products.

TriQuint's Debbie Burke awarded for HR leadership

Burke was recognised for supporting the company's growth through compelling and innovative Human Resource programs

RF solutions supplier, TriQuint Semiconductor, has announced that Debbie Burke, Human Resources Vice President, was named 'HR Leader of the Year'.

Burke was awarded at the Portland Business Journal's second annual HR Leadership Awards ceremony. She received the honour in the large company category.



TriQuint says that Burke is known throughout the company for her commitment to developing individual employees and effective managers. As an example, she customises Leadership and Management Development forums to align with corporate strategies; these forums develop skills and share knowledge to reach organisational objectives.

TriQuint says that besides her focus on developing leaders, the firm's employee headcount growth and industry-leading retention of valuable talent has been expertly managed through Burke's leadership.

"Debbie is a business partner with a passion for excellence in support of our customers and employees. She leads with enthusiasm, is both encouraging and demanding in setting high standards, and is trusted by all those she works with because she cares as much for the people as she does for the business," says Ralph Quinsey, TriQuint President and Chief Executive Officer.

Burke has embraced the "Lean" concept of continuous improvement to optimise the quality and efficiency of the HR department. To support TriQuint's growth initiatives, she

conceived a new model that transformed the “traditional staffing group” into a strategic, proactive sourcing team to recruit the specialised talent TriQuint needs.

Once the right candidates join TriQuint, the company’s impressive development, training and benefits programs help retain them. Burke has encouraged her team to develop programs for the company’s “Live Well” initiative.

Employees can offset healthcare costs through education and doctor visits for preventative care. The company also sponsors friendly competition like “Most Active Site” contests to increase exercise and spark interest toward wellness goals around the world. Other stand-out HR benefits include a tuition reimbursement program, sabbaticals and Technical Ladder career paths. Innovation is rewarded at TriQuint, and employees are passionate about transforming how the world communicates. The company is currently hiring for a variety of jobs.

The HR Leadership Awards program is an annual event created not only to shine a spotlight on the strategic importance of the HR field but to “recognise the region’s top human resources executives for the excellent work they do in a somewhat unheralded field of expertise.”

RFMD expands PowerSmart family

The extension of the gallium arsenide based series will include multiple new 3G and 4G LTE power platforms variants

RFMD’s PowerSmart power platforms are aimed at converging front ends in multimode, multi-band applications, including smartphones, tablets, and other data-centric mobile broadband devices.

The firm’s newest PowerSmart power platforms include PowerSmart 4G, a converged multimode multi-band power platform capable of up to 12 bands of 4G LTE, 3G and 2G. The PowerSmart 4G is specifically designed for 4G LTE operation and expands upon RFMD’s first-generation PowerSmart power platform by adding three additional bands of 3G or 4G LTE coverage.

PowerSmart 4G also includes all necessary switch and signal conditioning functionality in a compact reference design, providing smartphone manufacturers a single scalable source for the entire front end.

RFMD’s expanded PowerSmart product family also includes a new power platform optimised for emerging 3G entry (3Ge) applications and capable of multimode multi-band coverage of up to seven bands of 3G or 2G. Similar to PowerSmart 4G, RFMD’s PowerSmart power platform for emerging 3Ge applications includes all necessary switch and signal conditioning functionality in a compact reference design.

In addition to the 4G and 3Ge power platforms, RFMD is expanding the PowerSmart product family to include multiple 3G and 4G discrete power amplifiers (PAs). The discrete

PAs can be placed optionally with any RFMD PowerSmart power platform to achieve additional band or mode coverage. Architected in tandem with the RF Configurable Power Core in each PowerSmart power platform, these discrete PAs can deliver significantly improved PA efficiency at backed-off power.

Eric Creviston, president of RFMD’s Cellular Products Group, says, “As the world’s only truly converged solution with single-die multimode performance, RFMD’s PowerSmart is positioned to drive the cellular wide area network experience across a broad range of mobile devices, including tablets, notebooks, ultra-books, e-readers and next-generation in-vehicle networking. RFMD is delivering the industry’s most innovative converged front ends for multimode multi-band applications, and we expect these new products to support multiple cellular handset and smartphone manufacturers this calendar year.”

Multimode reference design win for RFMD

The design win is for the firm’s second-generation ultra-high efficiency family of power amplifiers

The new reference design win is on a highly integrated multimode multi-band 3G/LTE solution.

Eric Creviston, president of RFMD’s Cellular Products Group, says, “We are excited to expand our relationship with this leading chipset supplier to include our ultra-high efficiency 3G/4G power amplifiers. RFMD is already supporting our mutual customers with high-performance 3G/4G switches and switch-based products, and we are enthusiastic about the incremental growth opportunities presented by our increasing participation on 3G and LTE reference designs.”

RFMD’s second-generation ultra-high efficiency 3G and 4G LTE PAs deliver an enhanced user experience by extending battery life and reducing the thermal impact of data usage in smartphones.

The product family currently covers WCDMA bands 1, 2, 3, 4, 5, and 8, and LTE bands 4, 7, 11, 13, 17, 18, 20, and 21 – addressing the most common UMTS/HSPA+ and LTE frequency bands and band combinations. Additional multimode, multi-band (MMMB) and single-mode LTE variants will be introduced in the first half of calendar 2012.

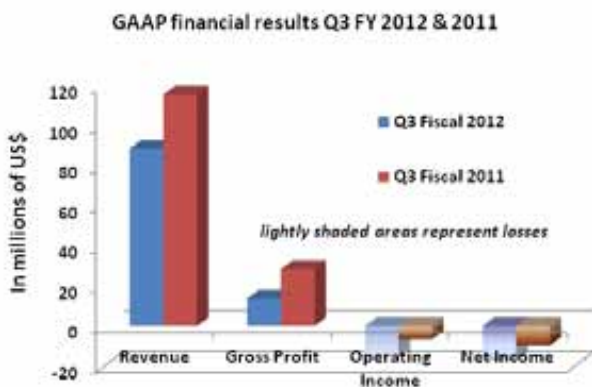
RFMD offers a broad portfolio of 3G and 4G LTE solutions in single-mode and converged architectures to ensure alignment with leading chipset providers and enable worldwide network compatibility. RFMD’s 3G and 4G LTE product portfolio reduces the thermal impact of data usage in smartphones while enabling increased battery life during data-centric applications, such as web surfing, video calls and internet radio services.

Lasers

Thailand floods still creating havoc with Oclaro revenues

The laser manufacturer expects a fair increase in revenues next quarter though. The firm believes revenues to be in the range of \$100-\$109 million in Q4 FY 2012, which ends June 30, 2012

Oclaro, a provider and innovator of optical communications and laser products, has announced financial results for its third quarter of fiscal year 2012, which ended March 31, 2012.



Revenues were \$88.7 million for Q3 FY 2012, compared with revenues of \$86.5 million in Q3 FY 2012 and \$115.7 million in Q3 FY 2011. Like the previous quarter, revenues and operating results for the last quarter were impacted by the flooding in Thailand. Revenues for Q3 FY 2012 were also adversely impacted by approximately \$4 million by a short-term work stoppage in Shenzhen, which has since been resolved. All results described below use GAAP principles. Gross profit for Q3 FY 2012 was \$13.7 million, slightly higher than the previous quarter where it was \$10.9 million, but more than half of the gross profit achieved the same quarter last year, where \$28.4 million was recorded. Gross margin was 15% for the third quarter of fiscal 2012, compared with a gross margin of 13% in the second quarter of fiscal 2012 and 25% in the third quarter of fiscal 2011. Operating loss was \$15.9 million for the third quarter of fiscal 2012, which included \$3.3 million of flood-related income from insurance advances, net of additional write-offs and expenses, due to the flooding in Thailand, compared with a GAAP operating loss of \$33.6 million in the second quarter of fiscal 2012, which included \$9.1 million of flood-related write-offs and expenses. Operating loss in Q3 FY 2011 was \$6.6 million. Net loss for the third quarter of fiscal 2012 was \$17.2 million, which included \$3.3 million of flood-related income from insurance advances, net of additional write-offs and expenses, due to the flooding in Thailand, compared with a net loss of \$30.8 million in the second quarter of fiscal 2012, which included \$9.1 million of flood-related write-offs and expenses. Net loss was \$9.8 million in Q3 FY 2011. Cash, cash equivalents and restricted cash were \$51.1 million as of March 31, 2012, compared with \$54.2 million at the end

of December. The balance at March 31, 2012 included an additional \$6 million drawn in the quarter under the Company's \$45 million credit facility, for a total outstanding balance of \$25.5 million drawn at March 31, 2012.

"This quarter demonstrates our continued progress across all of our strategic initiatives and in our Thailand flood recovery, which is largely behind us," says Alain Couder, chairman and CEO of Oclaro. "We successfully announced our relationship with Venture and will transition to an outsourced back-end assembly and test model over the next three years. We announced plans to merge with Opnext, which will put us in the #2 position in optical components and modules market. Despite lower-than-forecasted revenues resulting from a short-term work stoppage in our China factory, progress with our cost-reduction and margin improvement initiatives enabled Oclaro to achieve gross margin and Adjusted EBITDA within the guidance ranges we provided on January 26, 2012." Oclaro expects revenues in the range of \$100 million to \$109 million for the fourth quarter of fiscal 2012, which ends June 30, 2012. This guidance is based on current expectations, including the impact of Oclaro's operations and financial conditions attributable to the flooding in Thailand. In addition, the foregoing guidance is based on Oclaro's performance as a standalone company and does not include any of the operating results of Opnext

Laser development to commence at Changchun with the help of Aixtron

The MOCVD reactor will be used to develop aluminium indium gallium arsenide and gallium indium arsenide phosphide advanced lasers

Aixtron SE has an order for a new MOCVD system from new customer, Changchun University of Science and Technology (CUST) in China. CUST has placed a contract for one Aixtron multi-wafer MOCVD reactor which will be dedicated to the growth of quaternary materials for laser diodes. The order was placed in the fourth quarter of 2011, and delivery will take place in the third quarter of 2012. Aixtron's local support team will install and commission the new reactor in a state-of-the-art cleanroom facility at CUST in Changchun, Jilin province, China. Liu, Director of epitaxy facilities at CUST, comments, "Aixtron MOCVD systems have a very high reputation worldwide for the development and production of compound semiconductor materials. We received excellent reports of these capabilities from our colleagues at the Changchun Institute of Optics, Fine Mechanics and Physics (CIOMP) at the Chinese Academy of Sciences (CAS), who have successfully demonstrated a similar application using Aixtron equipment." "Our team therefore considers the reactor to be a suitable choice for the development of our InGaAlAs and InGaAsP materials systems, which will form an excellent process technology foundation for the fabrication of advanced lasers. Aixtron technology also comes with a responsive local service team, and this will help to ensure smooth and efficient progress when we begin materials development using the new system," he concludes. Founded in 1958 by the Chinese Academy of Sciences, Changchun

University of Science and Technology has evolved into a multidisciplinary university with optoelectronics technology as its main focus, along with the integration of optics, mechanics, electronics, computer science and materials science.

Lasertel to light up capacity with Veeco MBE system

Veeco's GEN200 Edge system is suited to growing gallium arsenide and indium phosphide based wafers for devices such as pump lasers, VCSELs and HBTs

Lasertel, a subsidiary of SELEX Galileo is purchasing a second high-throughput, multi-wafer GEN200 Edge MBE production system from Veeco to increase its manufacturing capacity for laser diodes.

"The additional GEN200 Edge production MBE system provides the extra capacity required to support the increased demand for Lasertel devices. The GEN200 system offers advanced automation, precise process control, and in-situ process monitoring. It is the core enabling technology for Lasertel's leading-edge, high performance semiconductor diode laser devices," says Mark McElhinney, President of Lasertel.

Lasertel is enhancing the manufacturing capabilities of its high volume, semiconductor laser fabrication and packaging facility in Tucson, Arizona to support growing demand for its current class-defining product portfolio. This brings its in-house complement of MBE tools to four with the latest to be used to accelerate the development of next-generation, high performance diode laser products. The expansion is planned to be completed by Q4, 2012.

Jim Northup, Vice President and General Manager of Veeco's MBE Operations, concludes, "We look forward to supporting Lasertel in their continued growth with the Veeco GEN200 system, part of our suite of the industry's most cost-effective and highest-capacity production MBE systems."

New lasers are 'Superradiant'

The novel laser traps a million rubidium atoms in a space of about 2 centimetres between two mirrors. The atoms synchronise their internal oscillations to emit laser light

Physicists at JILA have demonstrated a novel "superradiant" laser, which they say, has the potential to be 100 to 1,000 times more stable than the best conventional visible lasers.

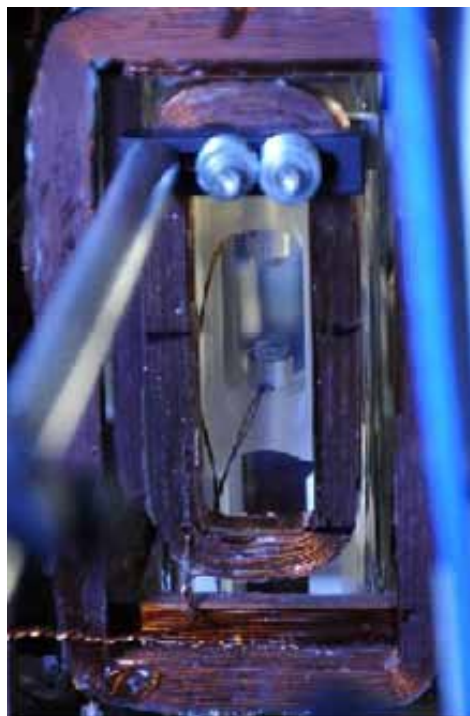
This type of laser could boost the performance of the most advanced atomic clocks and related technologies, such as communications and navigation systems as well as space-based astronomical instruments.

The JILA laser prototype relies on a million rubidium atoms doing a kind of synchronised line dance to produce a dim beam of deep red laser light.

JILA is a joint institute of the National Institute of Standards and Technology (NIST) and the University of Colorado Boulder (CU).

JILA/NIST physicist James Thompson says the new laser is based on a powerful engineering technique called "phased arrays" in which electromagnetic waves from a large group of identical antennas are carefully synchronised to build a combined wave with special useful features that are not possible otherwise.

"It's like what happens in the classical world but with quantum objects," Thompson explains. "If you line up lots of radio antennas that each emit an oscillating electric field, you can get all their electric fields to add up to make a really good directional antenna. In the same way, the individual atoms spontaneously form something like a phased array of antennas to give you a very directional laser beam."



Super-radiant laser (Credit: Burrus/NIST)

JILA's superradiant laser traps 1 million rubidium atoms in a space of about 2 centimetres between two mirrors. The atoms synchronise their internal oscillations to emit laser light.

An ordinary laser relies on millions of particles of light (photons) ricocheting back and forth between two mirrors, striking atoms in the lasing material and generating copies of themselves to build up intense light.

Photons with synchronised wave patterns leak out of the mirrored cavity to form a laser beam. The laser frequency, or colour, wobbles slightly because the mirrors are vibrating due to either the motion of atoms in the mirrors or environmental disturbances. This could be as subtle as people walking past the room or cars driving near the building.

JILA says this doesn't happen in its new laser simply because the photons don't hang around long enough. The atoms are

constantly energising and emitting synchronised photons, but on average, very few - less than one photon, in fact - stick around between the mirrors.

This average, which scientists calculate indirectly, based on the laser beam's output power, is just enough to maintain an oscillating electric field to sustain the atoms' synchronised behaviour. Nearly all photons escape before they have a chance to become scrambled by the mirrors and disrupt the synchronised atoms—thus averting the very effect that causes laser frequency to wobble in a normal laser.

Thompson engineered a system that first traps the atoms in laser light between two mirrors and then uses other low-power lasers to tune the rate at which the atoms switch back and forth between two energy levels.

The atoms emit photons each time their energy level drops. The atoms ordinarily would emit just one photon per second, but their correlated action boosts that rate 10,000-fold - making the light superradiant, Thompson says. This "stimulated emission" meets the definition of a laser (Light Amplification by the Stimulated Emission of Radiation).

"This superradiant laser is really, really dim - about a million times weaker than a laser pointer," Thompson says. "But it is much brighter than one would expect from the ordinary uncoordinated emissions from individual atoms."

Thompson's measurements show that the stability of the laser beam frequency is less than 1/10,000th as sensitive to mirror motion as in a normal optical laser. This result suggests the new approach might be used in the future to improve the best lasers developed at NIST as much as 1,000-fold. Just as important, such lasers might be moved out of the vibration-controlled laboratory environment to be used in real-world applications.

Despite its dim light, the extraordinary stability of the superradiant laser can be transferred by using it as part of a feedback system to "lock" a normal laser's output. The bright laser, potentially 100 to 1,000 times more stable than today's best lasers, could then be used in the most advanced atomic clocks to induce the atomic oscillations that are the pendulum ticks of super-accurate clocks.

The added stability allows for a better match to the atoms' exact frequency, significantly boosting the precision of the clock. The improvement would extend to atomic clock-based technologies such as GPS, optical communications, advanced geodetic surveys and astronomy.

Thompson's work confirms predictions made several years ago by JILA/NIST Fellow Jun Ye and JILA/CU theorist Murray Holland, who is also a co-author of a new paper, describing this work. Thompson stresses that for the new laser design to achieve its highest potential stability and be of practical use, it will need to be re-created using different atoms, such as strontium, which are better suited for use in advanced atomic clocks.

The research is supported in part by the National Science Foundation, NIST, the Army Research Office and the Defence Advanced Research Projects Agency.

This work is further described in the paper, "A steady state superradiant laser with fewer than one intracavity photon," by J.G. Bohnet *et al Nature*, 484, 78-81 . DOI:10.1038/nature1092099

Opto Diode releases "super high-power" AlGaAs IR emitter

The first in the series of aluminium gallium arsenide based devices is suited to night vision and other military imaging applications

California based Opto Diode is releasing the first in a new series of super high-power AlGaAs infrared emitters.

The new OD-110L device features an ultra high optical output with a very narrow optical beam, making it ideal for night vision (NV) and other military imaging applications.

The OD-110L is housed in a standard 3-lead, hermetically-sealed TO-39 package to accommodate the compact (0.026" x 0.026") chip. There are four wire bonds on die corners and all surfaces are gold-plated for added durability.

Typically, the total power output (at 250C) is 110mW and the minimum output is 55mW with a peak emission wavelength of 850nm.

The absolute maximum rating at 250C (case) for power dissipation is 1000mW, with a continuous-forward-current rating set at 500mW. The OD-110L lead-soldering temperature (0.0625" from the case for 10 seconds) is 2600 C.

Storage and operating temperatures range from -400 C to 1000 C, making the devices suitable for harsh environments and for integration into illuminators and markers, and systems utilising NV goggles and cameras.

Emcore to sell VCSEL-based product line assets to SEDU for \$17 million

The firm is selling fixed assets, inventory and intellectual property for the VCSEL-based product lines within Emcore's fibre optics business unit. The transaction will allow the company to invest further in telecom, broadband and specialty photonics products

Emcore is to sell certain assets and transfer certain obligations of its Vertical Cavity Surface Emitting Lasers (VCSEL)-based product lines to Sumitomo Electric Device Innovations USA, Inc. (SEDU).

Subject to closing adjustments, the consideration for this sale will be \$17 million in cash.

The assets to be sold include fixed assets, inventory and intellectual property for the VCSEL-based product lines within Emcore's fibre optics business unit. These product lines include VCSEL and photodiode components, parallel optical transceiver modules, and active optical cables.

Emcore will retain its Telecom and Broadband fibre optics products that include its market leading tuneable lasers, tuneable XFPs, cable TV modules and transmitters, FTTx transceivers, InP-based lasers, photodiodes, and modulators, video transport and specialty photonics products.

The sale of the VCSEL product line allows Emcore to focus its fibre optics product portfolio in areas of strong product differentiation. In fiscal year 2011, the VCSEL-based product lines contributed approximately 5 % of Emcore's overall revenue.

Emcore says the sale of the VCSEL-based product should simplify the firm's operating structure, reduce fixed costs, and improve market focus. Emcore's core competencies in compound semiconductor-based products and performance capabilities remain the cornerstones of its Fibre Optics business, addressing high-speed fibre optic transmission for telecom, broadband, and military and defence applications.

"The decision to sell the VCSEL-based product lines is strategic and market driven," comments Hong Hou, Emcore's Chief Executive Officer. "Our product and technology portfolio is strongly aligned to support current and future requirements in tuneable, coherent high-speed transmission systems and next-generation broadband architectures."

"The proceeds from the transaction significantly improve our balance sheet and the sale is expected to reduce the time to reaching profitability. Along with the improved operating model, the transaction will benefit our customers as we focus our investment in telecom, broadband and specialty photonics products to remain industry leaders in those respective product lines in our fibre optic business segment", concludes Hou.

The transaction is expected to close shortly after securing regulatory approval by the Committee on Foreign Investment in the United States ("CFIUS").

NTT Photonics chooses Aixtron reactor to develop lasers

The Japanese firm will use the MOCVD tool for indium gallium arsenide phosphide research

Japanese firm NTT Photonics has placed an order for an Aixtron CCS reactor MOCVD system for InGaAsP quaternary diode laser research.

Ordered in the second quarter of 2011, the reactor will be delivered in the first quarter of 2012.

A local Aixtron service support team will install the reactor at

the NTT Photonics Device Laboratory in Atsugi, Kanagawa Prefecture, Japan.

Aixtron says its CCS MOCVD reactor has set new standards in laboratories and companies worldwide.

The new reactor for NTT Photonics will come with several special features including an EpiCurveTT, ARGUS, Gap Adjustment and the Epison 4 in-line gas concentration monitor.

These tools monitor the growth of the epiwafers and provide vital information for future growths .

For NTT Photonics, another important factor was the excellent Group V efficiency of the CCS reactor contributing to significantly lower operating costs.

Able to deliver very challenging MOCVD applications, the Aixtron CCS reactor has very good process flexibility thanks to the Showerhead concept and uniform flow distribution. Combined with gap adjustment and ARGUS in-situ monitoring for temperature mapping of the entire susceptor, it is suitable for research and development of high-end devices such as InGaAsP quaternary diode lasers.

Nitride sensors can cope with high temperatures and harmful radiation

Scientists have developed Hall effect gallium nitride based magnetic field sensors which can be used in space crafts and nuclear power stations

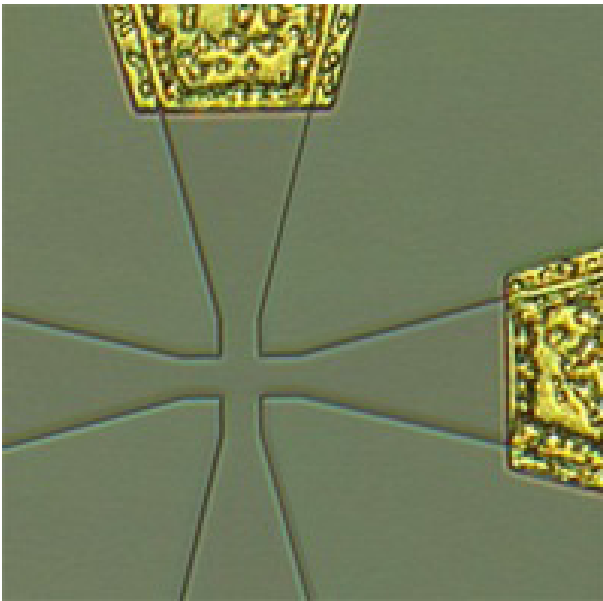
Toyohashi Tech researchers have fabricated Hall effect magnetic field sensors which can operate above 400oC.

Under extreme radiation conditions, the gallium nitride-based heterostructures operate with a two-dimensional electron gas.

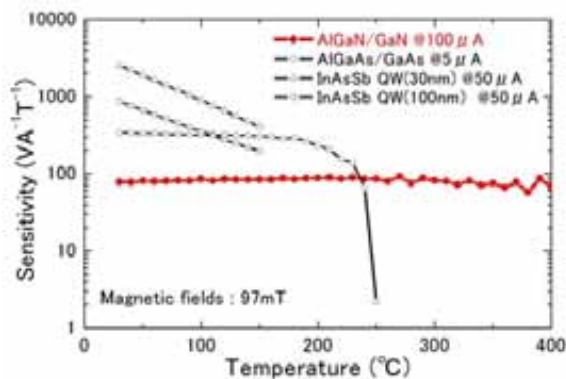
Silicon and III-V compound semiconductor Hall effect magnetic field sensors are widely used in the electronics industry for monitoring rotation in equipment such as optical memory disks and for banknote authentication in vending machines.

However, the use of Hall sensors for monitoring magnetic fields in outer space and nuclear power stations is more challenging. This is due to large fluctuations in temperature and harmful radiation in these environments. To resolve these issues, the Toyohashi Tech researchers used AlGaIn/GaN two-dimensional electron gas heterostructures to fabricate high sensitivity micro-Hall effect magnetic field sensors that are stable at high temperatures and high fluxes of proton irradiation.

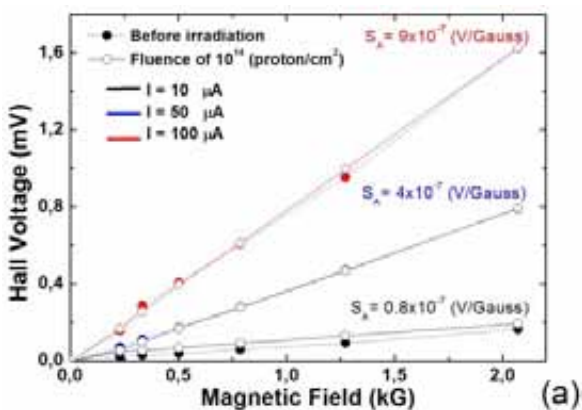
They used micro-Hall sensors based on AlGaIn/GaN. These devices were stable up to at least 400 oC, whereas sensors fabricated using GaAs and InSb degraded from about 120 oC.



Optical image of $5\mu\text{m} \times 5\mu\text{m}$ AlGaIn / GaN Hall sensor



Temperature dependence of current-related magnetic sensitivity. What's more, the electron mobility and two dimensional electron density of the AlGaIn / GaN micro-Hall sensors were only slightly affected by a $1 \times 10^{13} \text{cm}^{-2}$ proton dose at 380 keV.

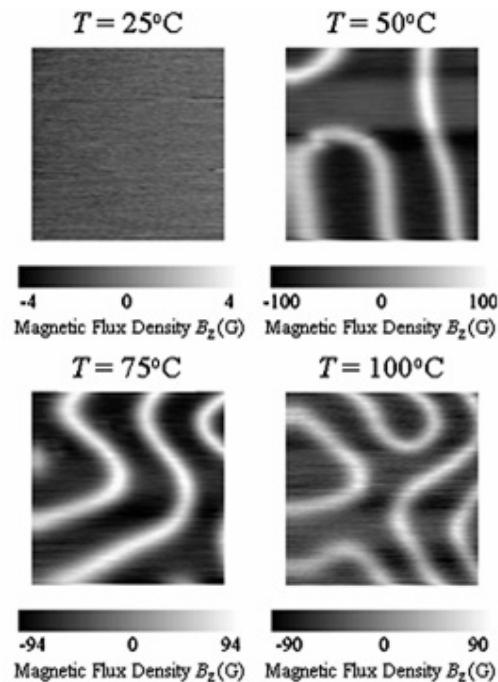


Variation of Hall voltage with magnetic field with drive current for an AlGaIn/GaN Hall sensor before and after irradiation with proton fluence of 10^{14}cm^{-2}

The researchers are actively seeking industrial partners to exploit the robust properties of the 2DEG-AlGaIn/GaN 2DEG

Hall sensors for operation at high temperatures and in harsh radiation environments.

A potential application included imaging of ferromagnetic domains at the surface of permanent magnetics. Adarsh Sandhu, a lead researcher at Electronics Inspired Interdisciplinary Research Institute, based in Japan, has previously demonstrated the imaging of magnetic domains in ferromagnetic materials with an AlGaIn / GaN micro-Hall sensor in a high temperature scanning Hall probe



microscope (SHPM). SHPM images of a bismuth substituted iron garnet thin films at 25–100 °C under an external perpendicular magnetic field H_{ext} of 150 Oe

Further details of this research will be available soon in the paper, "High Temperature Hall sensors using AlGaIn/GaN HEMT Structures", by S. Koide *et al*, *Institute of Physics Journal of Physics Conference Series* (<http://iopscience.iop.org/1742-6596>) (in press).

Ferdinand-Braun-Institut honoured with Transfer Prize

The team from the FBH has been awarded for the transfer of its powerful diode laser technology used for materials processing, into a manufacturing environment

At the opening evening of the Laser Optics Berlin trade fair which began on March 19th, 2012, a team from Ferdinand-Braun-Institut was awarded with the Transfer Prize WissensWerte 2011.

In this field, the Ferdinand-Braun-Institut (FBH) closely cooperates with Jenoptik Diode Lab GmbH, a spin off from the institute. Founded in 2002, the company runs a semiconductor

fabrication plant in Berlin at the Adlershof campus and continues to use research results from the FBH for its diode lasers.

Jenoptik Diode Lab is a subsidiary company of the Jenoptik Group. The partnership with Jenoptik has enabled the rapid transfer of FBH's state-of-the-art developments into an industrial environment.

The prize of €50,000 was assigned by the friends of the Technology Foundation Berlin (TSB). Six scientists from the Berlin institute have been honoured for the sustainable transfer of extraordinarily powerful diode lasers designed for materials processing.



The team of the Ferdinand-Braun-Institut, winner of the Transfer Prize WissensWerte, during award ceremony 19.03.2012 at Laser Optics Berlin fair.

FBH team from left to right: A. Maaßdorf, J. Fricke, H. Wenzel, G. Erbert, S. Knigge, P. Crump, N. Geyer (Board, Förderverein Technologiestiftung Berlin e.V.), G. Tränkle (Director of the Ferdinand-Braun-Instituts) (Copyright: FBH/P. Immerz)

"We are very proud of this award – it manifests and acknowledges the long-term and extraordinarily fruitful collaboration with industrial partners like Jenoptik", says awardee and team leader, Götz Erbert. "This cooperation is the basis for various developments in this application field helping us to ensure international technology leadership within the market for such laser systems".

This is the second time the FBH has been bestowed with the Transfer Prize; in 2004, the institute was awarded for the development of DFB high-power laser diodes. On that occasion, the collaboration was with another FBH spin-off, eagleyard Photonics.



Awardees of the Transfer Prize "WissensWerte", from left to right: H. Wenzel, G. Erbert, S. Knigge, P. Crump, A. Maaßdorf, J. Fricke (Copyright: S. Parsch)

The team who won the 2011 prize is developing a novel generation of diode lasers for powerful laser systems used for materials processing. These systems consist of single diode lasers, each delivering a typical output power of around 10 W.

In order to enhance their lasing performance, simply increasing the output power is not enough. One of the most important goals is to further increase efficiency. In doing so, the transformation of electrical into optical power is enhanced. Another key aim is to optimise the beam quality of the single diode lasers used in such systems.

Based on novel designs, the team has now developed diode lasers already achieving an efficiency of 63 percent at an output power of 12 W. The team anticipates that this efficiency will also be achieved at 15 to 20 W whilst also maintaining excellent beam quality. As such, FBH says diode lasers set the stage for purely diode-laser-based laser systems for materials processing in the future.

The ongoing collaboration between FBH and Jenoptik Diode Lab GmbH enables continuous improvements in performance and is thus the basis for a great variety of new developments. Due to high customer demands, the company is currently expanding its production capacities in close vicinity to the FBH. Jenoptik Diode Lab says these new developments will more than double the number of jobs at the firm.

Tiger Optics laser right on target with 2012 Golden Gas award

The firm's LaserTrace 3 detects moisture and oxygen in inert gases at limits that are more than two times lower than previous generations of the product line

Tiger Optics LLC has announced that its LaserTrace 3 has won the Golden Gas Award from Gases & Instrumentation International Magazine.

In the Gas Analysis & Detection category, this is the third such honour bestowed on Tiger Optics since the 2008 debut of the

annual competition.

Utilising Tiger Optics' patented Continuous Wave Cavity Ring-Down Spectroscopy (CW CRDS) technology, the LaserTrace 3 detects moisture and oxygen in inert gases at limits that are more than two times lower than previous generations of the product line.

Tiger Optics says the detection limits, accuracy, and response time for ultra-high-purity gas measurements are superior to the competing laser-based technology (Tuneable Diode Laser) and older vibrating crystal, electrolytic and chilled mirror instruments.

In a 'first' for the Gases & Instrumentation contest, two companies tied for the Gold award in the Gas Analysis & Detection Category.

G&I Publisher Paul Nesdore said that a Gold Award would be bestowed on both Tiger Optics and Mettler-Toledo International. The latter won recognition for its GPro 500 product. The trophies will be presented during the PITTCON 2012 exposition, which took place between March 12th and 15th in Orlando, Florida.

Tiger introduced its LaserTrace platform in 2003. Since then, it has become the company's most popular product family, with nearly 500 systems in use worldwide. The multi-species, multi-point, multi-gas product line accommodates up to four sensor modules in a standard 19-inch rack, or permits placement of individual sensor models as far as 50 metres from the computerised control unit.



LaserTrace+ O2 analyser

Tiger Optics introduced the LaserTrace O2 in 2005 and says it was the world's first laser-based, trace oxygen analyser to detect parts-per-trillion levels in ultra-high-purity gases.

In 2008, the LaserTrace+ made possible the lower detection limit (LDL) of 200 parts-per-trillion, affording the widest dynamic range of any dedicated analyzer currently in the market. The LaserTrace 3 was unveiled at the Semicon West trade show in July 2011.

Emcore launches micro-ITLA tuneable laser

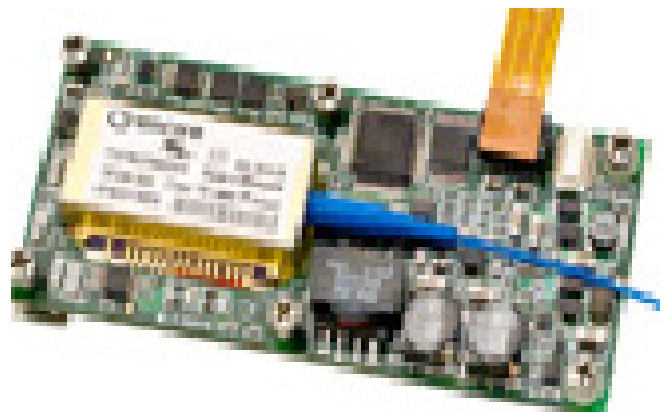
Suited to coherent applications, the device is ideal for use in high-speed 40 and 100 Gb/s coherent transmission systems

Emcore Corporation says it is providing samples of its new micro-Integrable Tuneable Laser Assembly (ITLA) to customers.

The firm expects the product to be in full production at some point in autumn 2012.



TTX1995 micro-ITLA tuneable laser assembly



TTX1994x ITLA tuneable laser assembly

The micro-ITLA is based on Emcore's external cavity laser (ECL) ITLA technology. The company says this product has been one of the most widely-used tuneable laser sources for high-speed 40 and 100 gigabit per second (Gb/s) coherent transmission systems thanks to its narrow line-width, low noise and excellent frequency accuracy. Additional standard features include a grid-agnostic channel plan, off-grid tuning, and in-operation power and frequency adjustment capability.

The Emcore micro-ITLA has the benefits of the Emcore ITLA in a form-factor that is three times smaller and with 25% less power consumption.

The micro-ITLA comes with a standard ITLA RS-232 digital user interface for convenient technology independent control of the product. The smaller form-factor and reduced power consumption enables customers to design higher densities and improved performance into their coherent system.

“Leveraging Emcore’s field-proven ClearLight ECL technology in an ultra-small form-factor, the micro-ITLA represents a dramatic next step in tuneable laser technology,” comments Jaime Reloj, Emcore’s Vice President of Business Development.

“Emcore is the industry leader in ITLA’s for the coherent market. By leveraging our in-house semiconductor design and manufacturing, we continue to provide our customers with highly-differentiated tuneable laser solutions for high-performance telecom applications, as well as pioneering products that are aligned with future network needs.”

Oclaro optimises InP ultra-fast switching lasers for Huawei

A collaboration between the two firms sees the performance of Oclaro’s indium phosphide tuneable laser rocket for Huawei’s future optical network

Oclaro has worked closely with Huawei to drive the development of Petabit Photonic Cross-Connect (PPXC) technology that can realise Petabit OTN switching in an all optical way with fine granularity.

As part of the collaboration, Oclaro optimised its InP tuneable laser technology to deliver prototypes of ultra-fast switching lasers that enabled Huawei to develop the PPXC system.

Huawei will be hosting a live demo of this PPXC system in a private suite at this week’s OFC/NFOEC show in Los Angeles, California.

Agile and ultra-large capacity OTN switching is a promising technology for future optical networks. A key component of this is fast tuneable laser technology, which Oclaro has successfully developed and optimised to meet Huawei’s optical networking needs for the future.

“Fast tuneable lasers have great potential in Huawei’s future optical network architectures and we are excited to see that Oclaro has successfully developed this enabling laser system with nanosecond tuning time,” says Changtian Cai, President of Huawei Transport Network.

“We believe that all-optical cross connect technology will give an unparalleled advantage to ultra large capacity OTN switch clusters of future transport backbone networks, large data centres and other application scenarios and by partnering with a proven technology and manufacturing leader such as Oclaro, we can bring higher performance network equipment into our customers.”

“As a leading provider of tuneable lasers, Oclaro has a deep understanding of the key technologies that are critical to delivering next generation optical networks,” adds Yves LeMaitre, Chief Commercial Officer for Oclaro. “By working with Huawei in these early stages of development, we can play a key role in driving the advancement of the core optical network and delivering the performance and scalability that service providers need for many years to come.”

The Oclaro fast tuneable laser utilises InP based technologies, which enable compact InP modulators and high performance widely tuneable lasers. To date, Oclaro has shipped over 300,000 tuneable lasers into the field as part of its iTLA, TTA, tuneable XFP, and SFF tuneable transponder products. More recently, to support the need for higher levels of integration, Oclaro has successfully demonstrated that fully monolithic PIC’s (Photonic Integrated Circuits) using InP can be used to deliver higher performance at lower cost.

Intense enlists a new director of European sales

The developer of semiconductor lasers, systems and solutions has recruited Beate Sauter to the position of Director of European Sales.

With over 25 years of international sales and marketing experience, more than half of which is in the photonics industry, Sauter will oversee all sales and marketing efforts in the EU for Intense.

This will include direct management of key accounts and channel partners in the region. She will also be responsible for business development and strategic marketing within the territory.



Beate Sauter, Director of European Sales, Intense

“As Intense continues to grow at an aggressive pace in the EU, our focus is supporting OEMs, end users, and distribution partners across the region.” says Kevin Laughlin, CEO, Intense. “We look forward to continuing that under the direction of Beate. She’s a seasoned, multilingual executive who knows how to balance the many demands of a global team. We will support her efforts by continuing to develop new and innovative, high performance products while providing the

highest level of customer support and service at a global level.”

Before joining Intense, Sauter served as Key Account Manager for South Europe for Edmund Optics. Prior to that, she held the position of Sales Manager, Italy, for Laser 2000, a Munich-based distributor of photonics products. She has also worked as Global Sales & Marketing Director for laser systems manufacturer Toptica Photonics.

Beate Sauter adds, “I am very excited about joining Intense. The company’s innovative products and knowledgeable staff have already developed a superior reputation in the European photonics market. I’m looking forward to adding my own brand of dynamism, experience, and enthusiasm to the team.”

First fully integrated silicon photonics transmitter

CEA-Leti and III-V Lab have developed the device which incorporates a hybrid III-V compound semiconductor tuneable laser on silicon

CEA-Leti and III-V lab, a joint lab of Alcatel-Lucent Bell Labs France, Thales Research and Technology and CEA-Leti, have demonstrated an integrated tuneable transmitter on silicon.

The researchers say this is the first time a tuneable laser source has been integrated on silicon, which represents a key milestone towards fully integrated transceivers.

The transmitter incorporates a hybrid III-V/Si laser-fabricated by direct bonding, which exhibits 9 nm wavelength tunability and a silicon Mach-Zehnder modulator with high extinction ratio (up to 10 dB), leading to an excellent bit-error-rate performance at 10 Gb/s. The results were obtained in the frame of the European funded project HELIOS.

Other contributors were Ghent University-Imec for the design of the laser and the University of Surrey which designed the modulator.

CEA-Leti and III-V lab also demonstrated single wavelength tuneable lasers, with 21 mA threshold at 20°C, 45 nm tuning range and side mode suppression ratio larger than 40 dB over the tuning range.

Silicon photonics is a very powerful technology, and CEA-Leti and III-V lab have now made a significant breakthrough in its development by integrating on the same chip complex devices such as a fully integrated transmitter working above 10Gb/s or a tuneable single wavelength laser.

Silicon photonics has the promise of bringing the large scale manufacturing of CMOS to photonic devices that are still expensive due to a lack of ubiquitous technology. One big obstacle to silicon photonics is the lack of optical sources on silicon, the base material on CMOS.

“We can overcome this problem by bonding III-V material, necessary for active light sources, onto a silicon wafer and then co-processing the two, thus accomplishing two things at

once,” explains Martin Zirngibl, Bell Labs Physical Technologies Research leader. “Traditional CMOS processing is still used in the process, while at the same time we now can integrate active light sources directly onto silicon.”

Based on the heterogeneous integration process developed by the CEA-Leti and III-V lab, III-V materials such as InP can be integrated onto silicon wafers. The fabrication process starts on 200 mm Silicon on Insulator (SOI) wafers where the silicon waveguides and modulators are fabricated on CEA-Leti 200 mm CMOS pilot line.

“We are proud to jointly present with III-V lab the results of the integrated silicon photonics transmitter and the tuneable laser,” said Laurent Fulbert, Photonics Program Manager at the CEA-Leti France. “The ability to integrate a tuneable laser, a modulator and passive waveguides on silicon paves the way of further developments on integrated transceivers that can address several application needs in metropolitan and access networks, servers, data centres, high performance computers as well as optical interconnects at rack-level and board-level. We are pleased to bring our contribution to these state-of-the-art results which can truly revolutionize optical communications.”

Results of this latest development will be presented during the Optical Fibre Communication conference 2012 in Los Angeles (USA) took place between March 4th and 8th, 2012. CEA-Leti will also showcase its products at booth #718 at the conference.

First demonstration of 40G CFP interoperability achieving expanded reach

Involving III-V based DFB lasers and transceivers, Opnext will show the ability to migrate to a 40G transceiver solution in a smaller package which consumes lower power

Opnext says it will host the industry’s first interoperability demonstration between a 1550nm wavelength CFP (cordless fixed part) MSA compliant module and a 1310nm wavelength 300 pin MSA compliant module at 40Gb/s.

The demonstration will be conducted during the Optical Fibre Communication Conference and Exhibition/National Fibre Optic Engineers Conference (OFC/NFOEC 2012) was held between March 6th and 8th in Los Angeles. It showed how technology paths for 40G transceiver solutions can support extended reach and lead to the development of smaller, pluggable transceiver technology with single mode fibre in a 1310nm wavelength.

This technology demonstration, using Opnext’s EA-DFB laser, will show how the module achieves 1310nm wavelength performance while interoperating with a currently deployed 1550nm wavelength-based optical transceiver.

Opnext will also show how migration from a 1550nm wavelength to a 1310nm wavelength can be achieved in a smaller form factor such as a CFP4 or QSFP+ without affecting

an existing deployed interface. Opnext's next generation 40G designs can offer lower power dissipation with extended reach compared to existing 1550nm wavelength-based solutions by using an uncooled laser source.

The Opnext 40GBASE-FR and SONET/SDH multi-protocol capable CFP MSA compliant module is currently sampling.

Solar

CIGS innovator Nanosolar completes \$42 million DOE project

The Solar America Initiative Technology Pathway Partnership program focused on lowering the cost of large-scale commercial CIGS PV installations

Nanosolar says it has successfully achieved or surpassed all 10 major tasks in completion of a \$42 million grant from the U.S. Department of Energy. The tasks were undertaken as part of the Solar America Initiative (SAI) Technology Pathway Partnership (TPP) program. Nanosolar was awarded the grant in 2006 to develop large-scale photovoltaic (PV) systems for commercial buildings that offer the best price per watt performance in the industry and received sign off from the Energy Department in early April 2012. One of the major achievements was that Nanosolar reached more than 13% cell power conversion efficiency on the production floor, which has been built out to a nameplate annual capacity of 115 MW, for its CIGS modules.

The firm also deployed 3.4 MW of panels specifically for pilot installations for this project, a 550 kW deployment for Camp Perry based in Ohio, and a 2.88 MW deployment based in Oregon. In addition, as of December 2011, Nanosolar has produced, sold, and deployed at 14 sites around the world. Based on third-party estimates, Nanosolar says it will reach grid parity economics by 2015 as per DOE program goals. The firm is continuing to collect performance and reliability data from third-party testing laboratories, and analysis of this data is carried out by independent engineering firms and institutions.

"Upon completion of the TPP grant, the Department of Energy indicated that Nanosolar met or exceeded every qualification," says Eugenia Corrales, CEO of Nanosolar. "The close of this grant validates Nanosolar's ability to execute to plan. We continue to drive toward delivering the most cost-efficient solar electricity." Nanosolar worked with three partners to complete this TPP project, which started in September 2007, and focused on developing solar electric solutions for flat commercial rooftops that can deliver grid-parity with other non-renewable energy resources. The team included Nanosolar's innovations in cell and module technology, inverter technology and systems optimization from Conergy AG and mounting technology from Sunlink LLC in a pilot installation by Suntechnics. The SAI team focused on using Nanosolar's uniquely scalable PV cell technology in large-scale commercial building installations to

deliver grid-parity PV systems through the development of an integrated suite of system components and designs based on innovations in module, inverter and mounting technologies.

Honda's demo test house features CIGS solar panels

Japanese firm Honda Motor Co. has unveiled a house it has built in the city of Saitama, Japan, for the demonstration testing of the Honda Smart Home System (HSHS).

The house features HSHS, which comprehensively controls in-house energy supply and demand, and helps manage both the generation and consumption of energy for the home such as heat and electricity, while utilising mobility products. HSHS is also designed to enable users to secure their own supply of energy and mobility in a time of disaster.

The HSHS installed in this demonstration test house consists of CIGS thin-film solar cell panels, a home battery unit (rechargeable battery), household gas-engine cogeneration unit and hot-water supply system, and the Smart e Mix Manager.

The Smart e Mix Manager, the core of the HSHS, is a comprehensive energy management device which applies optimal control to electricity supplied from the commercial grid and generated by each energy device that composes the system. The Smart e Mix Manager reduces CO2 emissions from the home and, at the same time, provides a backup supply of electricity so that the house can be self-sufficient in the event of a power outage or disaster.

Striving to realise "the joy and freedom of mobility" and "a sustainable society where people can enjoy life," Honda will conduct demonstration testing of the HSHS that is linked with electromotive mobility products such as electric vehicles, and the Internavi system. Through this demonstration testing, Honda will aim to reduce CO2 by 50% from the year 2000 and verify the future direction of personal mobility. What's more, Honda will verify the backup function for household energy supply, which will provide a sense of security and comfort to the customers.

As a part of its effort to further reduce CO2 emissions in people's everyday lives including mobility, on May 23, 2011, Honda signed an agreement to participate in the E-KIZUNA Project run by the city of Saitama. To conduct demonstration testing with the HSHS-equipped house as a part of the E-KIZUNA Project, Honda built two houses (each for single-family use) in the vicinity of Saitama University (located in the city of Saitama). A third house is scheduled to be built in the same location, where all three houses will be linked for smart community demonstration testing. These tests are scheduled to continue until 2018.

The houses will all feature CIGS thin-film solar cell panels. Honda aims to verify the superiority of power generation efficiency of an all-new CIGS thin-film solar cell module which is currently being developed.

New Ascent Solar member will achieve new heights

With a new board member, the CIGS company is focussing on targeting the rooftop solar market

Ascent Solar Technologies has appointed Xu Biao as a member of its Board of Directors. Winston Xu is the founder and Chairman of Radiant Group, a large metal roofing contractor and provider of building materials based in China. Xu is also the Chairman of TFG Radiant Investment Group Ltd., the single largest shareholder of Ascent Solar. With over 15 years of experience in investments, business start-up operations, developments, turnarounds, and private equity investments, Xu is a Fellow member of the Chartered Institute of Building (CIOB). Xu is also an industry expert in metallic roofing design and construction, building materials, manufacturing, and international trading.

Victor Lee, Ascent Solar President and CEO, says, "We are pleased to welcome Winston to the Board of Directors and look forward to leveraging his rooftop construction expertise in East Asia. Winston brings a wealth of experience related to international trade, construction and renewable power generation." Along with the appointment of Xu to the Board of Directors, Ascent Solar intends to intensify its pursuit of market opportunities, including re-entrance into the BIPV and BAPV sectors which were delayed in March, 2011. "Mr. Xu will play a key role in our immediate plan to re-enter the BIPV and BAPV sectors. As those sectors continue to develop, Mr. Xu's experience and relationships in the rapidly growing Chinese market will be invaluable," comments Amit Kumar, Chairman of Ascent Solar. "Ascent Solar's technology enables light and flexible PV products with applications in multiple markets, including BIPV, BAPV and consumer electronics. Near term, there are many opportunities to develop products in the consumer electronics market, especially in Asia. I am looking forward to helping guide Ascent into those markets as well as the BIPV and BAPV sectors," says Xu. Ascent Solar says it will continue to serve premium, off-grid markets in the near term while aggressively ramping production and certifying an updated line of modules to IEC and UL standards in the fourth quarter of 2012.

The firm expects to re-enter the rooftop solar market on a global scale, with particular focus on the rapidly growing Asia market where Radiant Group has a strong presence. Ascent will also continue to work with strategic partners across all market segments to develop innovative sources of solar power generation. Xu has been appointed a Class 3 director for Ascent Solar, and he stands for election at the Company's 2012 annual meeting. He was appointed to the Board as the designee of TFG Radiant pursuant to the Stockholders' Agreement between the Company and TFG Radiant.

Will First Solar suffer like Solyndra?

Hopefully not. Unfortunately, the firm's Oder manufacturing plant in Frankfurt is shutting down, and another four production lines in Kulim, Malaysia are going on hold indefinitely. The cadmium telluride solar manufacturing firm says it is downsizing staff by 30 percent

After announcing a change of its board of directors, First Solar is restructuring due to deteriorating market conditions in Europe. As part of this program, First Solar will close its manufacturing operations in, Oder, Frankfurt, Germany, in the fourth quarter of 2012. What's more, the company will indefinitely idle four production lines at its manufacturing centre in Kulim, Malaysia, on May 1, 2012. These actions, combined with other personnel reductions in Europe and the U.S., will reduce First Solar's global workforce by approximately 2,000 positions, about 30 percent of the total. The restructuring initiatives are expected to reduce First Solar's costs by \$30-60 million this year and \$100-120 million annually moving forward. The company's average manufacturing cost is expected to improve to \$0.70-\$0.72 per watt in 2012 as a result of the changes, below prior expectations of \$0.74 per watt. In 2013 the Company estimates average module manufacturing costs will range from \$0.60 to \$0.64 per watt. To achieve these cost savings, First Solar will record restructuring and other related charges of \$245-370 million, of which \$80-120 million are cash expenditures. These include \$150-250 million in asset impairment, primarily related to the Oder plants and \$50-70 million in severance and \$30 million for repayment of a government grant related to the Oder operations. Another \$15-\$20 million for other charges represents valuation allowances for deferred tax assets in Europe and costs associated with the repayment of the German debt. First Solar expects to incur these charges primarily during the first quarter of 2012 and the rest over the course of this year. In addition, the firm has voluntarily paid down approximately \$145 million of debt ahead of schedule in 2012, which represents repayment in full for outstanding amounts under the Company's German loan agreement.

"After a thorough analysis, it is clear the European market has deteriorated to the extent that our operations there are no longer economically sustainable, and maintaining those operations is not in the best long-term interest of our stakeholders," says Mike Ahearn, Chairman and Interim CEO of First Solar. "Decisions like this are not easy, especially given how important the European markets and our associates in Europe have been to the development of our Company and the solar industry as a whole. We are committed to treating all affected associates fairly, and to building our relationships with European business partners that are aligned with our strategy of pursuing utility-scale solar opportunities in sustainable markets around the world." "The solar market has fundamentally changed, and we are quickly adapting our market approach and operations to maintain and build upon our competitive advantage," adds Ahearn. "After a period of robust growth, First Solar is scaled to operate at higher volumes than currently exist following the reduction of subsidies in key legacy markets. As a result, it is essential that we reduce production and decrease expenses to reflect the smaller volume of high-probability demand we forecast. These actions will enable us

to focus our resources on developing the markets where we expect to generate significant growth in coming years.”

Will inorganic materials eclipse organics in printed electronics?

Perhaps, as the new inorganics, which include compound semiconductor quantum dots, appear to provide better performance than many printed organic electronic materials

A new report from Reportlinker.com, “Inorganic and Composite Printed Electronics 2012-2022,” says that there is increasing work on printed inorganics as organisations struggle to improve the performance of organics. To achieve better conductance and cost, for the best printed batteries, for quantum dot devices and for transistor semiconductors with ten times the mobility, Reportlinker.com says to look to the new inorganics.

The emerging world of new nanoparticle metal and alloy inks are miles superior in cost and also in terms of conductivity and stability. These include flexible zinc oxide based transistor semiconductors which operate at as much as at ten times the frequency of organic materials. They also offer excellent stability and life, along with many other inorganic materials. The report considers inorganic printed and thin film electronics for displays, lighting, semiconductors, sensors, conductors, photovoltaics, batteries and memory and coverage is global. Emphasis is placed on technology basics, commercialisation and the key market players.

The publication also looks at device fabrication and integration. IDTechEx forecasts a market of \$45 billion for printed electronics by 2022 and that market is expected to be split evenly between organic and inorganic materials. The rapidly increasing opportunities for inorganic and composite chemicals is now in new printed electronics, given that so much of the limelight is on organics. Inorganics encompass various metals, metal oxides as transparent conductors (such as fluorine tin oxide or indium tin oxide, extensively used in displays and photovoltaic technologies) or transistor materials as well as nano-silicon or copper and silver inks, whether in particle or flake form. Then there are inorganic quantum dots, carbon structures such as graphene, nanotubes and the various buckyballs among other novel devices. However, there is much more, from light emitting materials to battery elements and the amazing new meta-materials that render things invisible and lead to previously impossible forms of electronics.

Over the next ten years, improvements in inorganic conductors such as the use of nanotechnology and the lack of improvement of the very poorly conductive and expensive organic alternatives means that inorganics will be preferred for most conductors whether for electrodes, antennas, touch buttons, interconnects or for other purposes. In contrast, organic substrates for flexible electronics such as low cost polyester film and paper will be preferred in most cases because they are light weight, low cost and have a wide range of mechanical flexibility. The use of inorganic substrates such as glass represents a fall-back particularly required where there

is failure to reduce processing temperatures. Here stainless steel foil printed reel to reel is an improvement, where possible. In order to meet the widening variety of needs for printed and potentially printed electronics, not least in flexible, low cost form, a rapidly increasing number of elements are being brought to bear. Oxides, amorphous mixtures and alloys are particularly in evidence.

Even the so-called “organic devices” such as OLEDs can employ materials such as boron, aluminium, and titanium oxide and nitrides as barrier layers against water and oxygen. They also use aluminium, copper, silver, indium tin oxide as conductors, calcium or magnesium cathodes and CoFe nanodots as well as iridium and europium in light emitting layers. The report covers a number of different technologies which include non-silicon inorganic options such as CIGS, CdTe, CdSe, GaAs, GaAs-germanium, InGaP and InGaAs as well as other alternatives such as nanorods and carbon nanotubes.

MiaSole to tackle Indian solar market with new appointment

A new Country Manager based in India will lead and cultivate new business initiatives for the CIGS solar panel manufacturer

MiaSole, has appointed Preetha Nair as Country Manager India.

This latest executive hire reinforces MiaSole’s continued strategic global expansion, with particular emphasis on high growth solar markets such as India.

Nair has an extensive history in clean energy and trade finance, having previously served as the Senior Commercial Specialist at the U.S Commercial Service, U.S Department of Commerce at the American Embassy in New Delhi.

During her tenure with U.S. Commercial Service Nair advised over 500 U.S. companies in entering the India market, representing over \$4 billion in export sales. In March 2012, U.S. Secretary of Commerce John Bryson awarded Nair the Department of Commerce’s most prestigious Bronze honour award.

“MiaSole’s 14% efficiency solar panels are the highest efficient thin film modules globally, and ideal for hot temperature climates like India. The addition of Ms. Nair is a significant milestone in our long-term commitment to emerging markets like India,” says Rich Hossfeld, Vice President of Global Business Development and Sales for MiaSole.

“Ms. Nair’s insight and extensive experience will be integral in further driving the growth of our company as well as enhancing the value and service we offer our customers. I look forward to working with Preetha as we develop our strategy throughout India and deliver the lowest levelised cost of electricity.”

MiaSole has 8MW of solar projects in India completed or under construction, including a 2MW utility scale solar development project in Gujarat, India by Universal Solar System and

financially supported by the Export-Import Bank of the United States. Its 14% efficiency panels represents a greater than 30 percent year over year improvement in efficiency and demonstrates how the company is aggressively moving toward a cost structure that is competitive with top-tier global solar manufacturers.

III-V megawatt solar power system installed at Yokohama

The compact system, incorporates compound semiconductor CPV concentrator panels at an elevated position. They are claimed to offer 7.5 times greater output power than previous generations and are also thinner and lighter than conventional modules

Sumitomo Electric Industries, Ltd. (SEI) claims its new megawatt-class electric power generation/storage system consists of the world's largest redox flow battery and Japan's largest concentrated photovoltaic (CPV) units.

The Company is currently constructing a facility to test the system at the Yokohama Works (Sakae-ku Yokohama), and plans to start the demonstration in July 2012.

With companies striving to meet strict energy supply conditions, demand for distributed power systems using renewable energy is expected to grow in the future. To respond to demand, SEI has been working on the research and development of technology for effective power conversion, control and generation as well as storage.

The Company began testing its micro smart-grid system at the Osaka Works last June.

In this setup, natural energy sources, including an in-house developed CPV system, and a small redox flow battery are DC-interconnected, and the energy management system (EMS) controls fluctuations in natural energy (excluding solar and wind power) and power consumption by relatively small electric loads. Again, the latter excludes lighting and home appliances.

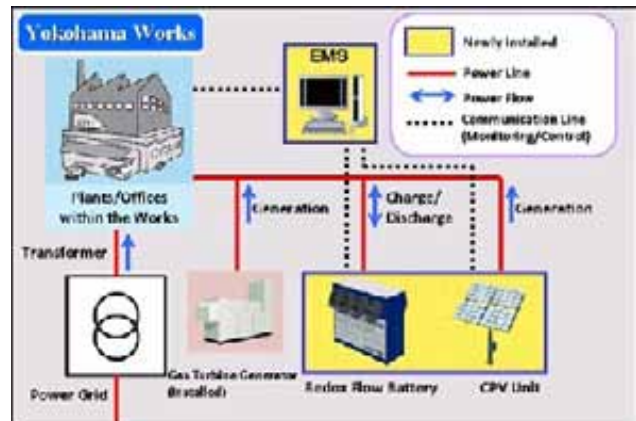
As a result, SEI says the overall system enables the most reliable and efficient power control, particularly from general consumers' standpoint.

Recently, there has also been an increasing expectation for major energy consumers, such as plants and companies, to promote the use of renewable energy and energy saving measures. To accommodate this, SEI has developed a large-scale electric power generation/storage system consisting of a redox flow battery and CPV units. The system with megawatt-level capacity and output power will be tested on the premises of the Yokohama Works with the aim of accelerating the development and commercialisation of large power systems and related facilities.

The system consists of 28 III-V semiconductor CPV units with a maximum total power generation of 200 kW as energy sources

and one redox flow battery. The battery has a capacity of 1 MW for 5 hours and acts as a storage facility of CPV-generated power and low-cost electricity provided by power companies during the night, while connected to external commercial power networks.

The EMS system aims to regulate the amount of electricity provided by power companies using the redox flow battery's charge/discharge control function. The system also aims to systematically use solar power using the battery to balance the fluctuations in CPV power generation that is susceptible to the weather.



Megawatt-Class Power Generation/Storage System □

The redox flow battery is a storage battery that comprises a charging/discharging cell section and a tank full of metal ion electrolyte. It charges and discharges through oxidation-reduction of vanadium or other ions.

The battery has a long service life as the electrodes and electrolyte are not subject to deterioration even after repeated charge and discharge operations. SEI says it is also easily maintained as it uses the same electrolyte in both the cathode and anode.

What's more, the battery is claimed to provide increased safety as it does not require any combustible substances and is operated at ambient temperatures. It is suitable for irregular, highly fluctuating charge/discharge operations, enabling accurate monitoring and control of stored electric power. Accordingly, it is an optimal storage battery for efficient use of renewable energy and surplus electricity supplied during the night.

The second part of the module is a CPV unit incorporating small-size photovoltaic cells for energy conversion, directing high-intensity sunlight converged by a lens to photovoltaic cells. The power generation efficiency of the CPV panel is claimed to be about twice that of silicon solar panels currently on the market as CPV cells are made from a special compound semiconductor material which SEI have remained tight-lipped about.

Installed at an elevated position, the concentrator panels provide usable space below them. The newly developed CPV unit offers 7.5 times greater output power (7.5 kW/unit), and yet the CPV panels are thinner and lighter than conventional ones.

The module comes with an energy management system (EMS), which monitors the amounts of electric power generated by the 28 CPV units, via commercial power networks which are stored in a redox flow battery, and consumed at an office or plant to manage the electric power flow. Obtained data is sent by optical communication networks to be collectively controlled at the central control server. This system will be used in the demonstration test held at the Yokohama to achieve optimal supply-demand balance (maximum demand control of 1 MW) and power demand control based on preset schedules.



Schematic and photo of SEI Yokohama Works

Solar Junction to use DOE cash to improve its III-V solar cell research

The SUNPATH award is aimed at expanding the firm's CPV cell manufacturing in the US and is aimed at 42% median cell efficiency on 150mm substrates

Solar Junction, a developer of high efficiency multi-junction solar cells for the CPV market, has been given a SUNPATH award from the Department of Energy (DOE) as part of a \$21.5 million program to increase its CPV cell manufacturing capacity.

Through this program, Solar Junction is targeting a median cell efficiency of 42% on 150mm substrates. These factors will make a substantial impact on reducing CPV's \$/W module costs by driving down the cost of the cell, while increasing the CPV module power output with increased cell efficiency.

«It is an honour to be in such a select pool of SUNPATH awardees through the SunShot program,» says Jim Weldon, CEO of Solar Junction. «This allows Solar Junction to move into the next phase of commercialization and will allow for a path to volume manufacturing.»

SUNPATH, Scaling Up Nascent PV at Home, falls under the Department of Energy's SunShot Program. This program aims to increase PV manufacturing in the U.S. through investments in technologies that are sustainable with competitive cost and high performance. SunShot investments are designed to help achieve \$1/W by 2020.

Solar Junction announced in February a \$19.2 million round, as well as an exclusive manufacturing agreement with IQE. Coupled with the SunPath award, Solar Junction is on the path to high volume manufacturing of its proprietary adjustable spectrum latticed matched (A-SLAM) cell.

Emcore secures \$6 million solar panel contract

The provider of compound semiconductor-based multi-junction solar cells has been awarded a manufacturing contract by Ball Aerospace & Technologies Corporation

Emcore Corporation has been awarded a contract by Ball Aerospace & Technologies Corporation (BATC) to design, manufacture, test and deliver solar panels for a new spacecraft.

The program is expected to last around 2 years, with a total contract value of nearly \$6 million.

The solar panels delivered to BATC will utilise Emcore's ZTJ multi-junction solar cells. The ZTJ is currently one of the highest performance space-grade solar cells available in volume production to the global market. Production of the solar cells and panels will take place at Emcore's manufacturing facilities located in Albuquerque, New Mexico, USA.

«We are very pleased to receive this award from Ball Aerospace & Technologies Corporation and recognise their confidence in our capabilities to manufacture and deliver the solar panels for this important mission,» says Christopher Larocca, Chief Operating Officer for Emcore. «Our proven manufacturing capability, technology leadership and high-reliability solar panels make Emcore the supplier of choice for demanding spacecraft power systems.»

Emcore is a global manufacturer of highly-efficient radiation-hard solar cells for space power applications. With a beginning-of-life (BOL) conversion efficiency close to 30% and the option for a patented, onboard monolithic bypass diode, Emcore's multi-junction solar cells provide high power to interplanetary spacecrafts and earth orbiting satellites.

Russ Wagner joins IQE as VP of Global Projects

With over twenty years of experience in the semiconductor industry, Wagner was most recently Vice President of Operations at Anadigics. He has also worked in Fairchild Semiconductor's RF Power Group and for Raytheon RF Components

IQE plc. has appointed Russ Wagner as Vice President, Global Projects.

Wagner's initial responsibility will be to drive strategic agreement with Solar Junction Corporation (SJC) to assist

IQE in becoming a leading global supplier of CPV wafers in solar power. This will include the transfer of CPV technology, establishment of wafer manufacturing capability, and subsequent ramp into high volume production. The firm hopes to accomplish this by working closely with various teams around the globe.



Russ Wagner, Vice President, Global Projects, IQE plc.

Wagner brings twenty years of valuable semiconductor industry experience to the position, most recently as Vice President of Operations at Anadigics. His previous positions include General Manager of Fairchild Semiconductor's RF Power Group, VP Business & Strategic Development at Raytheon RF Components, and VP Finance & Corporate Development of Litton Systems Inc.'s Airtron Division.

All of these included responsibility for strategic and tactical management of world-wide operations, partnerships, and corporate growth initiatives.

Drew Nelson, IQE's Chief Executive, comments, "Russ brings extensive industry experience and demonstrated success at creating value-generating partnerships to our team. I am confident that under his leadership IQE and SJC will achieve the goals we have set for our strategic relationship."

Wagner achieved his B.S. degree from the University of Dayton and has pursued post graduate work on the Litton Executive Education program at the Wharton School, University of Pennsylvania and the Raytheon Business Leadership program at the University of Chicago's Graduate Business School.

CdTe innovator First Solar to expand the Board

The firm has nominated George Hambro and Richard Chapman to serve as additional independent directors, while director José Villarreal will retire from the Board

First Solar has nominated two new candidates for election to

the Company's Board of Directors and is increasing the size of the Board from nine to eleven.

The vacancies are for two independent directors. As detailed in its Proxy Statement, which was filed yesterday with the Securities and Exchange Commission, First Solar nominated George "Chip" Hambro and Richard "Rick" Chapman to stand for election to the Board at the Company's Annual Meeting of Stockholders, which will be held on May 23, 2012. Chapman will serve as an independent director.

To fill the two new vacancies, First Solar has retained an executive search firm to help identify candidates with experience that will support the Company's strategy to compete as a vertically integrated provider of CdTe photovoltaic power plants in energy markets that are sustainable without subsidies.

The Company also announced that José Villarreal, a director since 2007, will retire from the Board due to personal commitments and will not seek re-election at the Annual Meeting.

"We are pleased to be adding two distinguished candidates to the First Solar Board of Directors. Chip and Rick are both knowledgeable about First Solar's strategy and operations and have diverse experience and expertise that will make them valuable additions to our board. We are also committed to further expanding our board by adding two additional independent directors to support our long-term strategic plan," says Mike Ahearn, First Solar's Chairman and Interim CEO. "On behalf of the First Solar Board of Directors, I extend my gratitude to José, who has been an engaged and dedicated Director for the past five years."

Chapman, 58, is CFO of Walton Enterprises, where he has worked since 1983. In his current capacity, Chapman oversees all aspects of the Walton Family Office in Arkansas. Chapman currently serves as a director on the boards of the Arvest Bank Group; the University of Arkansas Foundation, where he serves on the Executive and Finance Committees; and the Razorback Foundation, where he is a member of the Investment Committee. Chapman was previously a member of the Board of Managers of First Solar Holdings, LLC prior to the Company's initial public offering and JWMA (formerly True North Partners, L.L.C.), an equity investment firm. Chapman earned a B.S.B.A. in Accounting from the University of Arkansas and is a Certified Public Accountant.

Hambro, 48, previously held various positions at First Solar from June 2001 through June 2009, including serving as Chief Operating Officer from February 2005 through May 2007. Prior to joining First Solar, he held the positions of Vice President of Engineering & Business Development for Goodrich Aerospace from May 1999 to June 2001 and Vice President of Operations for ITT Industries from February 1997 to May 1999. For the last five years, Hambro has been a director of both the Toledo Zoo and Imagination Station, Toledo's children's science museum. Hambro currently serves on the board of directors of Soladigm, a developer of next-generation green building solutions. Hambro graduated from the University of California at Berkeley with a B.A. in Physical Science (Applied Physics).

Australia's largest solar PV project reaches a milestone

The western Australia minister for energy has helped to mark the commencement of First Solar's cadmium telluride solar panel installation

Australia's largest solar photovoltaic (PV) power project has reached a major construction milestone.

As contractor and technology provider, First Solar joined owners Verve Energy and GE unit GE Energy Financial Services to mark the commencement of panel installation at the Greenough River Solar Farm.

Western Australia (WA) Energy Minister, Peter Collier, landholders, members of the Geraldton community and local contractors were present to help celebrate this achievement.

"The demonstration of this proven technology in WA on a commercial scale should encourage the development of larger projects and reduce renewable energy costs in the medium to long term," the Minister says.

Construction of the 10-MW solar farm 50km south of Geraldton began just four months ago. With above-ground electrical work completed and structural supports now installed, the next phase of construction will see local workers install approximately 150,000 First Solar PV modules. Scheduled for completion in mid-2012, the project is expected to create almost 100 jobs.

"The successful delivery of the Greenough River Solar Farm will help kick-off a long-term, sustainable market for utility-scale solar in Australia. First Solar has a strong record of successful project delivery, enhanced by working with local communities to ensure projects make a meaningful and lasting contribution," says Jack Curtis, Vice President - Business Development & Sales, First Solar.

"When in operation, First Solar's panels produce electricity with no water use, no waste production and no CO2 emissions," Curtis adds.

"GE Energy Financial Services sees Australia as a key growth market that will continue to need capital to fuel its expanding renewable energy industry. We hope this is the first of many such milestones in the country," continues Jason Willoughby, GE Energy Financial Services' Australia business leader. "With our strong partners, Verve Energy and First Solar, we are pleased to help make this landmark solar project a reality."

"The Greenough River Solar Farm is providing valuable experience for Verve Energy in the development of solar energy in WA," says Tony Narvaez, General Manager, Strategy & Business Development, Verve Energy. "This experience will be very useful when Verve Energy pursues its aim to develop other solar farm Western Australian state-owned power utility Verve Energy and GE Energy Financial Services each own 50 percent of the Greenough River Solar Farm, with the WA Government having provided A\$20 million in funding (US\$ 20.6 million), including A\$10 million (US\$10.3 million) from the WA Royalties for Regions program. No debt has been raised to fund the project. First Solar is supplying its advanced thin film

PV modules and engineering, procurement and construction services, in addition to operations and maintenance support once the solar farm is operational.

The WA Water Corporation, which is building the Southern Seawater Desalination Plant near Binningup, has committed to purchasing 100 percent of the solar farm's output.

Antelope Valley Solar Ranch One coming on leaps and bounds

The Exelon-owned cadmium telluride solar photovoltaic project will be one of world's largest

Exelon Corporation and First Solar have announced that the Antelope Valley Solar Ranch One project has received the first advance of a loan guaranteed by the U.S. Department of Energy's Loan Programs Office, finalising Exelon's ownership of the project.

First Solar is constructing the 230-MW CdTe photovoltaic power project, one of the largest such projects in the world, in northern Los Angeles County and will operate and maintain the project for Exelon.

As Exelon and First Solar previously announced, the first portion of the project is expected to come online in late 2012, with full operation planned for late 2013.

AV Solar Ranch One will generate enough electricity to power the equivalent of 75,000 average California homes, with no water use, no air emissions and no waste production, displacing approximately 140,000 metric tons of carbon emissions per year, the equivalent of taking approximately 30,000 cars off the road. The project has a 25-year power purchase agreement, approved by the California Public Utilities Commission, with Pacific Gas & Electric Company for the full output of the plant.

Ascent Solar awards students for design innovations using its CIGS modules

Innovations included a portable solar powered water purification system, a scalable system of solar panels with a unique, flexible attachment method and a solar integrated beach umbrella

Ascent Solar Technologies has announced the winners of its company sponsored "Innovative Design Competition".

A team of students from Boston University, who developed a portable solar powered water purification system, won first

place as well as the Grand Prize of \$10,000 and a visit to Ascent's world headquarters and manufacturing facility in Colorado.

Second place was awarded to the team from University of California Berkeley, who developed a scalable system of solar panels with a unique, flexible attachment method.

Third place went to the team from Texas A&M University for their development of a solar integrated beach umbrella.

The competition, which began in August, 2011, included teams from Boston University, San Diego State University, Texas A&M University, University of California Berkeley and two teams from the University of Oregon. The aim was to develop the most innovative applications for Ascent's lightweight and flexible CIS solar panels.

The teams each developed working prototypes of their designs, which were enabled using lightweight, flexible, glass-free solar modules provided by Ascent Solar. In addition, Ascent provided financial support to the teams allowing them to fully explore the full potential of portable power.

Say hello to MoTa : the corrosion-resistant material for CIS

Molybdenum mixed with small amounts of tantalum combine the advanced properties of both metals as a back contact for CIS solar cells

Thanks to its good adhesion to glass and a high electrical conductivity, molybdenum is the back contact material in CIS solar cells.

However, exposed to corrosive atmospheres molybdenum can be prone to oxidation.

In order to avoid negative effects during the manufacturing process and solar module operation, Plansee has developed a material with improved corrosion resistance.

The company alloys pure molybdenum with small amounts of corrosion-resistant tantalum, thereby combining the advanced properties of both metals. Plansee says the superior corrosion resistance of molybdenum-tantalum (MoTa) has been proven in numerous tests.



Plansee's MoTa

Particularly on polymer-based substrates like polyimide, the high water and oxygen permeation can result in an increased

corrosion of the CIS back contact. With its higher corrosion resistance MoTa can minimise this effect.

But according to Plansee, MoTa is not just suitable as a back contact material. On flexible substrates like stainless steel foil and polyimide the new alloy can function as a corrosion resistant contact and protective layer. It effectively protects the backside of the stainless steel web during the selenisation step in the CIS manufacturing process.

Solar Frontier supplies 3.8 MW to CIS solar plant in New Jersey

Approximately 29,400 CIS thin-film solar modules will be installed at the Mill Creek Solar Farm in, New Jersey. The solar farm will provide enough emission-free electricity to power about 575 homes

Solar Frontier has supplied modules to a 3.8 MW installation for Public Service Electric and Gas Company (PSE&G), New Jersey's oldest and largest regulated gas and electricity utility. Solar Frontier supplied approximately 29,400 CIS thin-film solar modules to the Mill Creek Solar Farm in Burlington County, New Jersey. The solar farm is part of PSE&G's Solar 4 All program and was developed, designed, and built by juwi solar Inc (JSI).



Mill Creek Solar Farm (credit : juwi solar)

The Mill Creek Solar Farm will provide enough emission-free electricity to power about 575 average-size homes. The project illustrates PSE&G's commitment to solar power and the ever-growing significance of CIS technology in the industry. The Mill Creek Solar Farm is claimed to be the largest project of any thin-film solar technology in the state.

"This is another milestone for Solar Frontier in the U.S. market," says Greg Ashley, COO of Solar Frontier Americas. "With juwi's experience, expertise and proven track record, Solar Frontier has all the more confidence in providing economical and ecological solar energy in large-scale solar photovoltaic projects like this PSE&G project in New Jersey." "We are proud to have worked closely with Solar Frontier on its first deployment of modules to a large-scale utility project in the U.S.," says Michael Martin, CEO of juwi solar. "We firmly believe performance will meet or exceed our clients'

expectations and look forward to a continued relationship with Solar Frontier on future installations.” “A main objective of our Solar 4 All program was to help develop a strong solar industry,” adds Al Matos, vice president, renewables and energy solutions, PSE&G. “By partnering with a wide range of companies like Juwi Solar and Solar Frontier, we are helping businesses take root and grow, creating jobs and helping New Jersey to meet its renewable energy goals.” PSE&G owns and manages the Mill Creek Solar Farm through its nationally recognised Solar 4 All program that will develop 80 MW of solar energy in New Jersey—enough power to serve about 13,000 average-sized homes. In addition to increasing the amount of solar capacity in the state, Solar 4 All also creates jobs and helps to make New Jersey a centre for solar power in the country.

Solar Frontier to promote CIS technology in Japan

By integrating project development, construction, sales and maintenance, Solar Frontier and JAG will work together with construction contractors to provide value-added solar power plant solutions and services

CIS solar power innovator Solar Frontier has signed a memorandum of understanding (MOU) with solar project developer Japan Asia Group Limited (JAG). The firms will cooperate on promoting solar power businesses in Japan. Solar Frontier plans to provide products and services including consultation on project planning, CIS solar modules supply, and sourcing of balance-of-systems equipment for JAG on projects it is handling that total over 100 MW, which is enough to power 30,000 Japanese households. This agreement applies to an overall operation framework, and individual projects will be negotiated going forward. “Japan Asia Group’s subsidiary, Kokusai Kogyo Co. Ltd., worked with Solar Frontier to develop and operate the 1 MW Tsuno No.2 Solar Power Plant in Miyazaki,” says Tetsuo Yamashita, Chairman of Japan Asia Group. “Solar Frontier’s CIS modules delivered much higher power output than expected at that installation. This MOU is in recognition of the excellent performance of Solar Frontier’s CIS modules.” “We are delighted to be able to partner with Japan Asia Group, a company that has a wealth of experience in utility-scale projects in Japan and around the world and strong ties to local projects in Japan,” adds Shigeaki Kameda, President and CEO of Solar Frontier. “Solar Frontier’s panels are manufactured entirely in Japan to the high standards that our customers should expect with confidence. Through cooperation with leading companies like this, we will be able to deliver our economically compelling CIS thin-film solar modules to customers in Japan and around the world.” Solar Frontier has proven its outstanding CIS technology in terms of overall output through “megasolar” installations around the world and in Japan, including the recently announced 100+ MW “Catalina” project in California, USA, the 10 MW “Komekurayama” plant in Yamanashi, Japan, and the 1 MW “Yukigunigata” project in Niigata, Japan.

TU Ilmenau to use Aixtron MOCVD tool to develop III-V solar cells

The double 1 x 2-inch system will be used to develop III-V-based optoelectronics, high-efficiency CPV and III-V-integration on silicon and germanium

Aixtron SE has an order from existing customer Ilmenau University of Technology, a research institute in Germany. The order is for one Aixtron MOCVD system in a double 1 x 2-inch wafer configuration. The system will be used to develop new materials and structures for III-V-based optoelectronics, high-efficiency concentrator photovoltaics and III-V-integration on silicon and germanium. The reactor was ordered in the third quarter of 2011 and will be delivered and installed by Aixtron Europe’s service support in the third quarter of 2012 at the new facilities of the photovoltaics department at TU Ilmenau.

“This new R&D MOCVD system will make an enormous difference to the effectiveness of our new photovoltaics program,” says Thomas Hannappel, a professor at TU Ilmenau. “We will be able to use its process compatibility with our earlier generation reactors which springs from our long-standing close relationship with Aixtron. This is amongst the best technology available and has the ability to rapidly become effective for even the most challenging research. We also know we can call upon Aixtron’s experienced staff to provide back-up service. This combination will spur our endeavours and deliver world-class results promptly and efficiently.” “We are proud to be part of TU Ilmenau’s new research program in III-V-based photovoltaics, a very important area for the future use of energy,” says Aixtron’s COO Bernd Schulte. “By building on earlier successes we will strive to perfect highly efficient materials and devices with the best economics as the market evolves.”

Recently, Thomas Hannappel received a Chair for Photovoltaics from the TU Ilmenau. The position is associated with the scientific leadership of the SolarZentrum of the CiS Forschungsinstitut für Mikrosensorik und Photovoltaik GmbH in Erfurt. For many years, TU Ilmenau has been focussed on energy and environmental technologies. Under Hannappel’s leadership, the Ilmenau institute intends to complete basic scientific and industry-related research. TU Ilmenau also aims to further develop its relationship with the photovoltaic group at the Helmholtz-Zentrum Berlin für Materialien und Energie.

SoloPower to deploy CM systems to ramp up production

cmNavigo will support SoloPower’s move from development to mass production of CIGS modules in San Jose and Portland

Critical Manufacturing (CM) will provide SoloPower with its cmNavigo MES Productivity Suite software solution.

CM will implement a Manufacturing Execution System and Equipment Integration program, in SoloPower’s existing CIGS facility in San Jose, California and in its Portland, Oregon

facility. The latter plant is expected to begin high-volume production later this year.

SoloPower seeks to make solar power possible on any rooftop in the world. The company employs a proprietary manufacturing technology to produce low-cost, high-efficiency CIGS-based photovoltaic cells and modules. The firm says it currently holds the record on module aperture efficiency for flexible CIGS based modules, officially measured at 13.4 % by the National Renewable Energy Laboratory (NREL).

The cells are packaged into unique, flexible, lightweight CIGS solar modules which require less balance-of-system hardware and are easier to install than traditional silicon solar panels. SoloPower's operations in Portland are ultimately expected to have a capacity of 400 MW and employ 450 people.

"After developing the process in our demonstration line, the challenge was to introduce the proper equipment and automation to move to large scale manufacturing with high product repeatability while controlling costs." points out Ayush Jain, Director of IT for SoloPower.

"It was clear that timely production information through automated data collection, advanced reporting and enforced manufacturing protocols were an absolute requirement for a successful technology transfer into production. cmNavigo MES had the modelling flexibility, and represented the best match for our needs. Critical Manufacturing's product and the people working on this project exceeded our expectations" he adds.

cmNavigo Manufacturing Productivity software was developed from the ground up on Microsoft technologies, providing extensive out-of-the-box functionality and lower cost of ownership.

The system is completely scalable making it ideal from small R&D environments to large-scale high volume production facilities. A full range of MES capabilities facilitate increased control, visibility and productivity for manufacturers seeking higher profitability and a competitive edge.

"cmNavigo supports SoloPower's innovative technology and use of automation to reduce costs, increase efficiency and maintain high quality," comments Jeff Peabody, Critical Manufacturing's VP and acting Managing Director for North America.

"SoloPower has an aggressive schedule, complex environment and large quantities of data to be monitored. It's an ideal application for cmNavigo and the wide array of MES modules will allow them to minimise the total number of software solutions supporting the manufacturing operations."

TFG Radiant now owns 39 percent of Ascent Solar

The firm is now the CIGS innovator's largest shareholder

TFG Radiant Investment Group Ltd. has completed the acquisition of the Ascent Solar common stock owned by Norsk

Hydro Produksjon AS, as previously announced on January 4, 2012.

With the purchase, TFG Radiant's ownership interest increases from 19.4% to 39.0% of the outstanding common shares, making TFG Radiant the Company's largest shareholder. The shares were purchased for approximately \$0.50 per share.

Victor Lee, President and CEO of Ascent and Executive Director of TFG Radiant says "TFG Radiant Investment Group is extremely pleased to increase our investment in Ascent Solar as the company ramps its production and aggressively targets end-markets. We remain very excited about Ascent Solar's revolutionary technology and look forward to partnering for the long-term, realising the many opportunities for this transformational product in Asia, North America and worldwide."

Following the close of the transaction, Hans Olav Kvalvaag, a designated representative of Norsk Hydro, resigned from the Company's Board.

Regarding this, Victor Lee comments, "We would like to thank Hans Olav for his service to the Company. His support has been invaluable to the Company and we wish him well in his future endeavours."

TFG Radiant Group is a joint venture of Radiant Group, a Chinese conglomerate in construction and real estate, and Tertius Financial Group, a private investment firm based in Singapore. The Group, with more than 3,000 personnel, operates various businesses across China, Indonesia, Singapore and Malaysia, including in metal roofing and facades, import/export trading, real estate investment, project management and consultation, new-energy development, manufacturing and distribution, and gold mining.

Air Products CIGS coming home with new hydrogen selenide facility

The plant in Pennsylvania will produce products to serve the expanding CIGS market

Air Products is expanding its high-purity hydrogen selenide (H₂Se) production capabilities at its electronic specialty materials manufacturing facility in the Hometown, Pennsylvania. The new capacity was added to serve the growing CIGS thin-film solar cell manufacturing market. Air Products says it can deliver H₂Se to semiconductor and photovoltaic customers at more than 99.99 percent purity levels. "Air Products has a long history of supplying hydrogen selenide and will continue to deliver the cutting edge materials our customers need to manufacture state-of-the-art products," says Joe Stockunas, global business director, Electronic Materials for Air Products. Industry observers believe CIGS technology holds a lot of promise going forward based on the significant advances in efficiency improvement and high-volume manufacturing that producers have already made.

\$2 million could improve Ge-on-Si solar cell efficiency

IQE and Silex will unite in a \$2m Australian Solar Institute programme to improve III-V multiple-junction solar cells using novel Germanium-on-Silicon technology

IQE has been selected as a key wafer supplier by Australian CPV company Silex Systems as part of a \$2 million programme.

Together, the firms will develop high efficiency multi-junction solar cells on low-cost large-area Silicon substrates.

Silex Systems received the \$2 million grant from the Australian Solar Institute to support the company's development of solar cell technology which could reduce energy production costs by up to 20 %.

The aim of the programme is to develop, fabricate, and test novel next-generation multiple-junction solar cells used in the evolving utility scale CPV solar power station industry.

The key differentiator is the development of a new virtual 'Germanium' substrate wafer-based substrate where a thin layer of Ge is deposited on a Silicon wafer. This will reduce the cost and potentially improve the efficiency of the multiple-junction cells in CPV applications. The new substrates and resulting CPV cell structures will be fully characterised and analysed in the lab and then tested in on-sun in field equipment.

The grant from the Australian Solar Institute (ASI) which was established by the Australian Government in 2009 is for the development of high efficiency multi-junction solar cells on low cost large area Silicon substrates. The programme, by Silex's wholly owned subsidiary Solar Systems, has the potential to reduce the cost of energy production from CPV technologies by up to 20%.

Solar Systems will supplement the \$2 million grant by providing about \$3 million in project funding, with \$2 million of in-kind support and \$1 million in cash contributions over the three year project duration.

Project partner and Silex subsidiary Translucent will provide large area silicon substrate technology for the project, allowing for commercialisation of the technology to be fast tracked.

Andrew Johnson, IQE's CPV Technology Director says, "Silex Systems' selection of IQE as a partner for this programme clearly demonstrates that we are recognised as a key global player in CPV wafer products for advanced, high efficiency solar energy generation. This programme builds on our advanced capabilities in germanium on silicon for CPV applications that we launched in 2010 and compliments the range of CPV technologies in which we are active."

Other key CPV partners in the programme include Boeing-owned Spectrolab and Emcore Corporation for multi-junction cell production facilities.

These partnerships will allow for volume production of the solar cells, which will be incorporated into Solar Systems' dense array system to characterise the performance of the new CPV modules at the Bridgewater Test Facility in central Victoria.

Stion to ship CIGS panels commercially from Mississippi plant

The fully certified high-efficiency thin-film solar modules from the 100 MW line have begun shipping, with commercial shipments from the factory starting later this month

Stion has received both Underwriters' Laboratories (UL) and International Electrotechnical Commissions (IEC) certifications to ship modules produced at its Hattiesburg, Mississippi factory.

Stion modules with nominal power of up to 140 W are now available, with commercial shipments from the factory commencing later this month. The first phase of the 500 MW factory has 100 MW of annual production capacity, which is the equivalent of approximately 25,000 residential solar electric systems.

"Beginning shipments from Hattiesburg less than one year after starting construction represents a tremendous accomplishment by our team," says Chet Farris, CEO of Stion. "We are excited to strengthen our position as a leading U.S.-based manufacturers of solar modules, and bring thin film to a broad range of applications and markets globally."

The company's modules have a robust, simple monolithic circuit design, and are manufactured using proven industry standard production tools. They are specifically designed for use in all major market segments; residential, commercial, municipal and utility.

Stion's modules have a form factor of 65 cm x 165 cm that enables streamlined installation. The PTC / STC ratio - a measurement of the module's field performance versus standard test conditions - is higher than those for 95 percent of the products listed for use by the California Solar Initiative.

Stion will continue expansion of both its Hattiesburg factory and its San Jose headquarters. As part of its \$130 million funding round in December 2011, Stion is establishing a subsidiary in Korea with strategic partner Avaco to build a factory that will help serve the Asian and European markets.

"Early in 2011, the Mississippi Development Authority was pleased to work with Stion officials to announce the company's new manufacturing location in Hattiesburg, Mississippi, and it has been gratifying to see how quickly production has gotten under way at the plant," says Jim Barksdale, interim Executive Director of the Mississippi Development Authority. "I commend Stion officials on reaching this latest milestone, with commercial shipments of the company's Mississippi-made solar modules beginning later this month."

Soitec earns multiple qualifications for global quality, safety and environment

The firm, which produces III-V multi-junction solar cells using its Concentrix technology, is now qualified with TQM systems for ISO/TS, ISO 9001, ISO 14001 and OHSAS 18001

Soitec has gained new certifications from the International Standards Organisation (ISO) and the Occupational Health and Safety Assessment Series (OHSAS).

Soitec's customer base includes global microelectronics and energy leaders located on five continents. All of Soitec's operational sites worldwide, including its semiconductor material and solar module factories in France, Germany and Singapore, now meet ISO quality and environmental requirements.

As the result of the most recent audit conducted at the end of 2011, LRQA (Lloyd's Register Quality Assurance) has awarded:

ISO/TS 16949 certification to Soitec's semiconductor material operations in France at its Bernin and Paris Sud facilities, both of which demonstrated full compliance on their initial audits. The company's Singapore factory also achieved this compliance, so Soitec will now use the ISO/TS 16949 standard – which is more specific and stringent than the ISO 9001 standard – as the basis of its worldwide quality-management system.

ISO 9001 and ISO 14001 certification to Soitec's solar facility in Freiburg, Germany, where the company manufactures its concentrator photovoltaic (CPV) systems.

OHSAS 18001 health and safety certification to Soitec's Paris Sud facilities. Therefore, all of the company's semiconductor material operations are in compliance with OHSAS 18001. The company is now working to extend these protocols to its solar module facility located in Freiburg by the end of 2012.

"Soitec's corporate culture embodies continuous improvement," says Paul Boudre, chief operating officer of Soitec. "Our fully integrated quality, safety, health and environmental management system is focused on ensuring the superior quality and reliability of our products as well as maintaining our best practices to deliver the highest levels of customer satisfaction. Our employees' dedication to this company-wide initiative ensures Soitec's ability to anticipate and meet our customers' diverse requirements in both the electronics and energy markets."

Soitec's newest manufacturing solar plant in San Diego, California, is currently being refitted to produce CPV modules for the U.S. renewable-energy market. This facility aims to gain ISO 9001 and ISO 14001 certifications next year and OHSAS 18001 compliance by 2014.

CIGS innovator MiaSolé to expand in EMEA region

Michael Povlin has been appointed as Director Sales and Marketing to lead marketing strategy and sales execution throughout Europe, the Middle East and Africa

MiaSolé has promoted Michael Povlin to Director Sales and Marketing EMEA.

The company says this appointment emphasises its continued strategy to expand its business globally and to execute on strategic, international partnerships.

Povlin has a vast knowledge of the solar and technology industries, with more than 20 years of international management experience at high-tech companies.

Povlin also has proven experience in market development and sales strategies in Germany and throughout EMEA, having previously served as the director of sales and marketing EMEA at Abound Solar. Prior to joining Abound Solar, Povlin held management positions at Integrated Device Technology, Tensilicia and Intel.

"MiaSolé's 14% efficiency solar panels are the best thin film solution for European free field and rooftop applications, and Michael's appointment underscores our commitment to the European market," says Rich Hossfeld, Vice President of Sales and Business Development for MiaSolé.

"Michael's experience will be integral in further driving the growth of our company as well as enhancing the value and service we offer our customers. I look forward to working with Michael to develop strategies to drive our sales execution throughout EMEA and deliver the lowest levelised cost of electricity."

MiaSolé recently announced that it has achieved a major thin film efficiency milestone of 14% in CIGS production, representing a greater than 30 percent increase year over year.

Solar Junction scoops "most innovative device" award at CS Europe 2012

IQE's strategic CPV partner has been honoured for its SJ3 product, which enabled the company to fabricate III-V based solar cells with a record 43.5 percent efficiency

US based Solar Junction, with whom IQE last month announced a strategic investment and exclusive long-term supply agreement, netted the "most innovative device" award at Europe's premier compound semiconductor industry conference.

Winners of the CS Industry Awards 2012 were announced at last week's CS Europe conference, one of the world's leading compound semiconductor events.

Solar Junction bagged the most innovative device award for its high efficiency SJ3 product, a platform that has enabled the company to fabricate cells with a record-breaking 43.5 percent efficiency.

“Dilute nitrides have always held promise. Until now massive commercial success has failed to follow, but that will change with Solar Junction’s revolutionary multi-junction solar cells,” predicted Richard Stevenson, editor of Compound Semiconductor magazine.

Voting by the readers of Compound Semiconductor magazine and its associated web-site determined the winners of these awards. More than 17,000 votes were cast.

Commenting on the awards, David Ridsdale, Editor-in-Chief of the Semiconductor and Solar Group said, “In a very short time, Compound Semiconductor has become a key member of our stable of microelectronics’ manufacturing magazines. In line with our other products we introduced the CS Industry Awards to ensure peer recognition of the constant innovation that occurs in the industries we work within. The CS Industry Awards have already become a key industry event applauding the best achievements by those working in the field.”

CS-Europe attracted 250 delegates to the Hilton Hotel, Frankfurt, where six companies collected awards in categories covering all the key areas associated with compound semiconductor manufacturing and chip development.

Other winners were TriQuint, Veeco, Cree, Ammono and KLA-Tencor.



CS-Europe Awards 2012 : Drew Nelson, Conference Chairman and CEO IQE plc with Vijit Sabnis, VP Technology, Co-founder, Solar Junction

Visit <http://www.cseurope.net/> for more information about the CS-Europe Awards.

James Hughes hired by First Solar as Chief Commercial Officer

The new appointment should aid cadmium telluride solar manufacturer First Solar to advance in a number of areas. This will include business and project development, EPC and product management

In a newly created role designed to accelerate First Solar’s entry into emerging markets, Hughes will offer comprehensive

leadership responsibility in a number of areas.

He will contribute to global business development and sales, project development, engineering, procurement and construction (EPC), product management and international public affairs and communications.

Reporting to Hughes will be Jim Brown, Executive Vice President of Global Business Development; Maja Wessels, Executive Vice President of Global Public Affairs; Jim Lamon, Senior Vice President of EPC and Operations and Maintenance; Tom Kuster, Vice President of Product Management and Customer Service; and Ted Meyer, Vice President of Global Corporate Communications.

“Jim is extraordinarily prepared to help First Solar open new markets and reach revenue goals,” says Mike Ahearn, First Solar’s Chairman and Interim Chief Executive Officer. “We will benefit greatly from his diverse and extensive global and operational experience in the energy sector.”

Most recently, Hughes was CEO and Director of AEI, which owned and operated power distribution, power generation, natural gas transportation and services, and natural gas distribution businesses in emerging markets worldwide. Previously, he was President and Chief Operating Officer for Prisma Energy, which was formed out of former Enron interests in international electric and natural gas utilities.

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.

CIGS innovator SoloPower appoints Wesley K. Clark to its Board of Directors

Clark was keynote speaker at PV America 2012 West. He discussed solar’s future in a global environment

Former NATO Supreme Allied Commander, Europe and former U.S. Presidential candidate, General Wesley K. Clark, now retired, is an independent director of SoloPower.

Clark provided the keynote address at PV America 2012 West, where he related world events to the role of solar energy, energy scarcity and growing environmental challenges.

“SoloPower is thrilled to welcome General Clark to our Board of Directors. His insights, guidance and perspective will be a valuable addition to our company as we work to make solar energy a major power source for the world’s commercial and industrial buildings,” said Tim Harris, CEO of California-based SoloPower. “As a global leader and alternative energy champion, General Clark is a perfect fit for our dedicated Board, which provides critical leadership, advice and support to the SoloPower team.”

"I look for energy solutions that help to address the energy and environmental challenges we face as a global community, which is what SoloPower's lightweight, flexible PV panels do by maximising efficiency while keeping total installed costs low," said Wesley K. Clark, Board Member, SoloPower. "With growth capital in place and strong demand from the United States, Japan, South Korea and Italy, among other countries, I hope to help support SoloPower's continued global expansion."

In 38 years of service in the United States Army, Clark rose to the rank of four-star general as NATO's Supreme Allied Commander, Europe. Since retiring from the military in 2000, he has worked as an investment banker, alternative energy leader, author, cable network television military analyst and businessman. In September 2003, he ran as a Democratic candidate for President of the United States, where his campaign won the state of Oklahoma. He returned to the private sector in February 2004.

Wesley K. Clark has chaired several public and private companies and is a progressive leader in pursuing energy solutions. He graduated first in his class at West Point and completed degrees in Philosophy Politics and Economics at Oxford University (B.A. and M.A.) as a Rhodes Scholar.

While serving in Vietnam, he commanded an infantry company in combat, where he was severely wounded and evacuated home on a stretcher. His awards include the Presidential Medal of Freedom, Defence Distinguished Service Medal (five awards), Silver Star, Bronze Star, Purple Heart, honorary knighthoods from the British and Dutch governments and numerous awards from other governments, including the award of Commander of the Legion of Honour (France). He also serves as a member of the Clinton Global Initiative's Energy & Climate Change Advisory Board and ACORE's Advisory Board.

DayStar secures Sunlogics Power funds of \$500,000

The innovator of CIGS solar cells will use the cash to pay off outstanding liabilities and for other working capital purposes. Sunlogics Power Fund Management will also assist DayStar's management team with business development and exploring and evaluating strategic opportunities

CIGS solar developer DayStar Technologies, has entered into a Securities Purchase Agreement with Sunlogics Power Fund Management.

Pursuant to the purchase agreement, Sunlogics Power Fund Management has loaned the Company \$500,000 for payment of outstanding liabilities and other working capital purposes.

Salamon Group, a subsidiary of Sunlogics Power Fund Management, is a fund that provides investments to companies in the solar industry. It is a project-acquiring partner of Sunlogics PLC and its subsidiary, as well as other third party project developers, specialising in the design, development and operation of solar energy solutions. These include rooftop and ground mount solar power systems.

In addition to the Purchase Agreement, Sunlogics Power Fund Management has entered into a consulting arrangement with DayStar to assist the management of the Company with business development and also with exploring and evaluating strategic opportunities.

DayStar Chairman and Interim CEO, Peter Lacey, comments, "We are pleased to announce this relationship with Sunlogics Power Fund Management and are excited about the opportunities it presents to our shareholders and other stakeholders. We look forward to working with the Sunlogics team to explore strategic transactions which we believe will benefit the shareholders of both companies."

Sunlogics Power Fund Management CEO, Michael Matvieshen, concludes, "We are very excited to make this investment and look forward to working with the DayStar team to develop mutually beneficial business opportunities."

Sunshine PV receives TÜV SUD certification for CIGS modules

The firm is now qualified to sell the 1100 mm x 1400 mm in Europe, Asia and other countries

The firm's CIGS modules have received certification from the German certification body TÜV SUD.



This, says Sunshine PV, makes it the first manufacturer to be awarded this official recognition on 1100 mm x 1400 mm modules.

The firm says this certification not only validates the success

of Sunshine's efforts in CIGS over the past 4 years, but also attests to the performance and quality of Sunshine's product worldwide, especially in Taiwan.

This certification will now also help prospective customers qualify for loan programs in Europe and the US, to expand their markets, and support long-time customers of Sunshine in creating brighter futures in sustainable energy and low-carbon living.

By reaching production capacity and passing the TÜV SUD test for 1100 mm x 1400 mm size CIGS modules, Sunshine PV Corporation believes this has silenced many doubters that CIGS technology could not achieve such high efficiency on large areas.

TÜV SUD certification is based on the IEC 61646 and IEC 61730 standards and measure safety, performance, and environmental degradation. Products achieving certification are suitable for sale in Europe, Asia and other countries. Sunshine is also focused on Golden Sun Certification and expects to pass through certification programs in Q1 2012.

Semiconductor solar energy activity heats up

Spire, TSMC, Avancis, Soitec and centrotherm increased module manufacturing capabilities in the last quarter of 2011

Despite recent, highly publicised problems at Evergreen Solar and Solyndra, solar energy continues to play an essential role as governments seek sources for renewable energy.

The Strategy Analytics GaAs and Compound Semiconductor Technologies Service (GaAs) viewpoint, "Compound Semiconductor Industry Review October-December 2011: Optoelectronics, Materials and Equipment," offers a positive outlook for solar industry players.

Many companies are expanding their solar module or material capacity.

The report also captures product, technology, contract and financial announcements for companies in the optical and material supply chain, such as Aixtron, IQE, Kopin, Oclaro, GigOptix, Cree, JDSU, Avago Technologies, Finisar and Osram.

"It is easy to get a negative outlook about an entire segment when a couple of the high profile participants run into difficulties," observes Eric Higham, Director of the Strategy Analytics GaAs and Compound Semiconductor Technologies Service. "Solar energy has become a widely deployed form of alternative energy. This report provides a snapshot of the growth and activity in the compound photovoltaic technologies which underpin the solar market."

Asif Anwar, Director, Strategy Analytics Strategic Technologies Practice, adds, "Despite the bankruptcy proceedings at Solyndra and Evergreen Solar, photovoltaic device and module manufacturers continue to announce efficiency improvements

and capacity expansions."

CIGS firm TSMC Solar begins production

On receiving UL, IEC and ISO 9001 certification, the firm has started to produce modules at its manufacturing facility in Taichung, Taiwan

TSMC Solar has received both Underwriters Laboratories (UL) and International Electrotechnical Commission's (IEC) certification for a wide range of its TS CIGS series PV modules.

Modules with nominal power of up to 130 W are now listed on the California Energy Commission's (CEC) list of compliant PV modules.

"UL and IEC product certifications open the majority of the world's solar markets to TSMC Solar products," says Ying-Chen Chao, President of TSMC Solar. "We are also making rapid progress in acquiring the individual market and special purpose certifications required to compete in solar markets worldwide."

TS CIGS series modules entered production this year. The modules are produced at TSMC Solar's highly automated manufacturing facility in Taichung, Taiwan. Demonstrating its commitment to best practices in quality and manufacturing excellence, TSMC Solar has received ISO 9001 quality management system certification.



TSMC Solar's S-Fab, located in Taichung, Taiwan

"Our team has done an outstanding job to rapidly achieve these important milestones less than four months after completing tool move-in," Chao points out. "TSMC Solar is pleased to have third-party verification of its ability to leverage its parent company's quarter century heritage of delivering technology innovation, quality and manufacturing excellence."

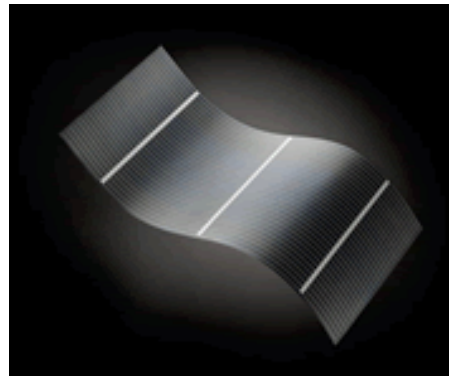
TSMC's solar business was founded in May 2009 and is headquartered in Taichung, Taiwan, with regional sales offices in Hamburg, Germany; San Jose, California and Boston, Massachusetts.

Masimo acquires Spire Semiconductor for \$8.5 million

The foundry business division of Spire will now be able to focus on Masimo's custom component requirements and accelerate technology advancements in non-invasive blood monitoring

Spire Corporation has completed the sale of most of the assets of Spire Semiconductor to Masimo Semiconductor for an aggregate consideration of \$8.5 million. Spire Semiconductor is a foundry services business. "With the divestiture of our semiconductor business to Masimo, Spire has strengthened its financial position and can now more aggressively pursue opportunities in its solar and biomedical businesses," says Roger G. Little, Chairman and Chief Executive Officer of Spire Corporation. "For the past several years, Masimo has been one of our largest customers and is an ideal strategic buyer for the business." Joe Kiani, Masimo CEO and Chairman of the Board continues, "Spire Semiconductor is a very innovative company. We have been extremely impressed with their technology and the service they have provided to us as a customer. We plan to continue building on the proprietary technology base established by Spire Semiconductor. The acquisition will permit us to focus the operation on Masimo's custom component requirements and accelerate technology advancements in our non-invasive blood monitoring products."

The asset purchase agreement provided that the aggregate purchase price for the Semiconductor Business unit was \$8.0 million plus the assumption of \$500,000 in liabilities, with the cash portion of the purchase price being reduced by retained cash and liabilities assumed by Masimo in excess of \$500,000. As a result, on the closing date, the Company received approximately \$7.2 million in cash and Masimo assumed approximately \$1.2 million in liabilities. Of the purchase price, approximately 10% of the cash portion was deposited into an indemnity escrow account for fifteen months. ThinkEquity LLC served as exclusive financial advisor to Spire Corporation.



SoloPower CIGS PV module

"Importantly, the cells were made in SoloPower's San Jose manufacturing facility, so we know we have the systems in place to deliver high-efficiency, light-weight, flexible modules to our customers around the globe," says SoloPower CEO Tim Harris.

"This benchmark is a testament to our technology team and to our commitment to continuously pushing the envelope in power and performance, while reducing costs for our customers."

"SoloPower's achievement of an aperture efficiency of 13.4% for our flexible CIGS modules is a result of efficiency improvement projects that have been in place during the past two years," adds Mustafa Pinarbasi, CTO at SoloPower.

"We were the first company to certify flexible CIGS modules to UL 1703 and IEC standards (61646 and 61730) in 2010. We have improved the efficiency from 11.2% to 13.4% with new processes implemented in our roll to roll production line and have a strong pipeline of improvements yet to come this year."

At this time, SoloPower is hiring engineers and technicians for its high-volume manufacturing facility in Portland, Oregon, which will begin commercial production later this year. SoloPower's operations in Portland are ultimately expected to have a capacity of 400 MW and employ 450 people.

SoloPower's CIGS flexible solar panel breaks barriers

The aperture efficiency of the firm's independently tested panel has increased from 11.2% to 13.4%. The efficiency was improved by using new processes implemented in SoloPower's roll to roll production line SoloPower says its next generation panel has achieved an aperture area efficiency of 13.4%. This, says the firm, is a record for flexible CIGS based modules.

The result was verified independently by the National Renewable Energy Laboratory (NREL).

SoloPower to bring jobs to Oregon

The CIGS manufacturer is recruiting engineers and technicians for a high volume manufacturing facility in Portland

San-Jose based SoloPower, a manufacturer of CIGS flexible thin film solar cells, is seeking engineers and technicians for its high volume manufacturing facility in Portland, Oregon.

The state-of-the-art facility is to begin commercial production later this year.

Upon completion, SoloPower's Portland facilities are expected to have a capacity of 400 MW and employ 450 people, strengthening the firm's ability to provide powerful, flexible, lightweight solar modules for its growing global customer base.

"We're excited about SoloPower's ability to bring clean tech jobs to Oregon and promote smart job-growth in the private sector, which would not have been possible without the visionary support we've received from the State of Oregon, the Oregon Department of Energy and the City of Portland, as well as the U.S. Department of Energy," said SoloPower CEO Tim Harris. "A big reason SoloPower chose to build our new manufacturing facility in Oregon was because of the highly skilled work force, and we look forward to drawing on that local talent as our facility comes online."

SoloPower attended the Interstate Career Expo, one of the largest regional job and career events in the Portland metro area, on March 7th, looking for equipment engineers, chemical engineers, production and process engineers and front-end and maintenance technicians.

Heliotrop announces contracts to supply over 70 MW in solar power

The producer of III-V based solar cells says that most of the submitted projects are hybrid solar power plants, mixing CPV and traditional PV technologies

Heliotrop, an innovator of multi-junction solar cells, says that its clients have submitted several bids for a total of more than 70 MWp to be realised in France. The projects include more than 20 MW of 1024-sun Heliotrop CPV units.

Clients include major project Developers, Engineering, Procurement and Construction companies and Independent Power Producers. This Call for Tender was organised by the French Power Regulatory body (Commission de Régulation de l'Énergie).

Most submitted projects are hybrid solar power plants, mixing innovative CPV and traditional PV technologies, which is a way for Heliotrop CPV technology to demonstrate its superior performances and accelerate its bankability.

Concentrated Photovoltaics technology is poised to become the leading solar technology, according to market reports and business analysts, with key advantages and low cost of electricity in sunny areas such as South of France and others locations with high direct normal irradiance.

Heliotrop 1024-sun CPV technology is being developed with several R&D laboratories and manufacturing companies. Laboratories include INES (Institut National de l'Énergie Solaire), part of Atomic Energy Centre (CEA). Units are manufactured by leading companies in their sector, Eolane for electronics & packaging and GMD for mechanics.

First Solar to build 26 MW Avra Valley PV solar project for NRG

The project will use First Solar's cadmium telluride cells and its tracker systems which provide more electricity in the afternoon, when energy demand is greatest

First Solar is to construct NRG Energy's 26 MW (AC) Avra Valley solar project near Tucson, Arizona.

Electricity from the Avra Valley solar project will be sold to Tucson Electric Power under a 20-year power purchase agreement.

The project will utilise First Solar's advanced CdTe thin-film photovoltaic technology, mounted on the company's single-axis tracker system. This rotates the solar modules to follow the sun throughout the day. The tracker system extends the peak energy production period, providing more electricity in the afternoon, when energy demand is greatest.

"NRG and First Solar have built a very strong working relationship, starting with our first 21 MW project in Blythe, California, to our most recently completed 20 megawatt Roadrunner solar generating station in New Mexico," comments James Kelly, Director of Development for NRG Solar. "We look forward to working with First Solar on the Avra Valley project that, when completed, will help Arizona meet its renewable energy goals."

Construction on the project, which is expected to begin this month, will create an estimated 200 jobs. First Solar expects to complete Avra Valley by the end of 2012.

"We are proud to once again work with NRG as they add to their renewable energy portfolio and create clean energy for Arizona," adds Jim Lamon, First Solar Senior Vice President for EPC and Operation and Maintenance. "We're excited to construct this utility-scale project using our proprietary tracker system, which maximises the energy output of a solar facility."

NextEra Energy completes acquisition of 40 MW plants from First Solar

The St. Clair Ontario Solar projects, which use cadmium telluride solar cell technology, have begun commercial operation

NextEra Energy Resources says it has completed the acquisition of two solar photovoltaic projects from First Solar.

The projects, totalling 40 MW are located in St. Clair, Ontario, Canada. They were designed, developed and constructed by First Solar, using its advanced thin film PV modules, and began commercial operation in February, 2012.

The two projects are owned and operated by subsidiaries of NextEra Energy Resources' Canadian subsidiary, NextEra Energy Canada, ULC, and provide enough power to serve about 6,440 homes. Each year the solar generation is expected to help avoid nearly 45,000 tons of CO₂, which is the equivalent of removing nearly 8,600 cars from the road every year for the life of the projects. The power is being sold to the Ontario Power Authority via long-term contracts under its Renewable Energy Standard Offer Program (RESOP).

"We are pleased to have completed the acquisition of our initial Canadian solar projects. This acquisition is consistent with our strategy to add fully contracted renewable assets to our portfolio," says NextEra Energy Resources' Senior Vice President of Development Mike O'Sullivan. "Solar power will help promote a clean-energy economy in Ontario and reduce its dependence on fossil fuels."

"The completion of the St. Clair projects helps Ontario meet its economic and renewable energy goals," adds Peter Carrie, First Solar Vice President for Business Development, Canada. "The projects employed 800 construction workers, including local First Nations workers, and are the first large-scale solar facilities permitted under the Province's Renewable Energy Approval process."

MiaSolé awarded \$55 million to expand its CIGS technology

The funding will allow the company to focus on building the commercial side of its business with both traditional glass-on-glass and flexible products

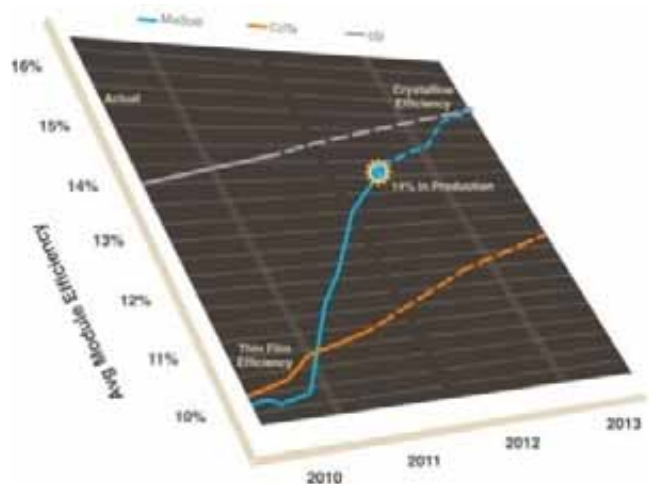
The California-based firm has secured the funding to drive its next wave of growth in the solar industry.

"This funding comes at a time when the company has begun production of 14% modules with the industry's lowest capex per watt, which is now under 50 cents. We are pleased that investors have demonstrated a powerful endorsement of our strategy and growing success in the market," says John Carrington, CEO of MiaSolé.

"This additional investment will allow us to take the company to the next level and we are focused on aggressively building the commercial side of our business with both our traditional glass-on-glass and flexible products. We have demonstrated technology leadership and are now focused on commercial performance: our investors have responded to that."

MiaSolé says it is one of the first companies to unlock the potential for CIGS thin-film solar technology, increasing panel efficiency by more than 30% from 2011 to 2012.

A roadmap of how the company hopes to progress is below.



Miasolé's panel efficiency roadmap

To date, MiaSolé has installed over 55 MW of solar modules in a wide range of global projects across North America, Europe and Asia. Its technology is also being applied to a high efficiency flexible rolled roof-top product that will address the fast-growing commercial and residential markets.

"MiaSolé is entering into an important time in its history," says Stephan Dolezalek, Managing Director at Vantage Point Capital Partners, on behalf of the MiaSolé board of directors. "It has the right strategy, the right technology and the right team to deliver a new benchmark in solar for cost, performance and capital efficiency with the enormous benefit of being able to compete in both the traditional glass and flexible panel markets."

"MiaSolé's ability to deliver 14 percent in production with demonstrated capability to achieve 17 percent further emphasises the progress we are continuously making against our roadmap," says Carrington. "We are excited about the road ahead and our ability to deliver the true promise of thin film technology - enabling the lowest levelised cost of electricity for our customers."

Oxford Instruments to host Nanoscale plasma processing seminar in Shanghai

Following its successful Seminar hosted with the IOS-CAS in Beijing last year, the firm held a one day Seminar on 19th March, 2012

This one day event, being held the day before Semicon China 2012, will feature talks by a number of invited guest speakers, specialists from China, Taiwan and Europe, in addition to Process and Applications experts from Oxford Instruments Plasma Technology.

These academic and industrial experts will discuss topics including Atomic Layer Deposition (ALD), Photovoltaics (PV), Deep Silicon Etch and Ion Beam technologies during the full

one day programme.

In addition to Oxford Instruments speakers, talks from guest speakers include:

- Introduction to ALD and its applications, including photovoltaics; Erwin Kessels, University of Eindhoven (TU/e), Netherlands
- Etch & deposition process in the OPTO and MEMS application device; Chu Ann-Kuo, Professor of Department of Photonics, National Sun Yat-sen University, Taiwan
- Infrared Focal Plane Arrays (IRFPAs) detector for space applications; Zhenghua YE, SITP (Shanghai Institute of Technology Physics)
- Micro/Nano fabrication and characterisation of Si field electron emitters; Guest Speaker: Juncong SHE, Sun Yat-Sen University, China
- ALD used in the MEMS application; Jerry Wang, Manager of Microsystems Technology Centre, ITRI, Taiwan

Jeffrey Seah, Asia Business Manager, Oxford Instruments Plasma Technology, who will open the Seminar comments, "We are anticipating a large audience at this Seminar in Shanghai, and are extremely honoured that so many distinguished guest speakers have accepted our invitation to speak about their work in Plasma Processing. Our Seminars are a great opportunity for the Plasma Processing community to come together, to share their experiences, and to learn more from leading international experts in their field."

Based on the success of the 2011 Seminar in Beijing, Oxford Instruments anticipates a very high level of interest from both academic and production participants, attracted by such an interesting programme and prestigious speakers.

The event is free to attend, but booking is essential via process. news@oxinst.com or lingling.wang@oxinst.com

CdTe thin-film solar industry leaders launch PVthin

The new coalition was founded by a number of organisations including Abound Solar, First Solar, GE Energy, Calyxo, Arendi and 5N Plus

An international non-profit organisation under Belgian law, PVthin was created to strengthen global energy security and help create sustainable energy infrastructures by promoting the social, economic and environmental benefits of thin-film solar photovoltaic technologies. PVthin represents companies committed to the development of thin-film solar PV products based on chalcogenide compounds. Founding members include CdTe solar cell manufacturers Abound Solar, Arendi, Calyxo, First Solar and GE Energy. Another founder of the project is 5N Plus which is one of the key suppliers of CdTe and CdS, essential components of thin-film solar modules.

"The success of thin-film solar panels is one of the most exciting developments in solar energy in recent years," said Andreas Wade, President of PVthin. "PVthin was created to champion the role of thin-film PV and communicate the unique technological, environmental and socio-economic aspects of this cost effective and environmentally friendly solar technology. PVthin complements the excellent work of umbrella associations such as EPIA in Europe, SEIA in the US, and BSW in Germany and does not seek to create a rival organisation" he said. As the name suggests, thin-film photovoltaic solar modules employ a very thin layer of semiconductor—usually just a couple of microns thick—in place of a traditional wafer. Simpler to manufacture, thin-film PV makes more efficient use of raw materials and energy and results in both lower costs and smaller carbon footprints.

Thin-film PV now accounts for around 18% of global PV sales, from almost nothing a decade ago, and is leading the way to affordable solar electricity. Thin-film PV also lends itself to relatively simple mechanical and chemical recycling, ensuring the recovery of valuable raw materials when the need to replace the modules arises—often at no additional cost. PVthin aims to strongly promote efficient and energy-saving production, raw material use and state-of-the-art PV recycling and recovery programs and technologies in cooperation with other organisations supporting this objective.

\$300,000 DOE grant to support CdTe solar cell research

The latest Department of Energy funds will develop ways to enhance the cadmium telluride back contacts by looking at new materials

Sylvain Marsillac, associate professor of electrical and computer engineering at Old Dominion University and an expert in photovoltaic (PV) energy cells, recently received the grant from the U.S. DOE.

This grant builds on his funded work from last year, when Marsillac brought more than \$1 million in awards to ODU for research on PV.

The new grant, awarded through the DOE's Foundational Program to Advance Cell Efficiency (F-PACE), involves research being done into improving the efficiency of solar cells. The cells are made from CdTe, a polycrystalline compound mostly used in infrared detectors and solar cells.

The material is deposited in a thin film form using high vacuum deposition systems, and the process creates a semiconductor layer designed to absorb and convert sunlight into electricity. Marsillac said this latest DOE-funded research will develop ways to enhance the CdTe back contacts by specifically looking at new materials based on chalcopyrite and delafossite structures.

"Better connection means better voltage, which means better efficiency for the PV cells," he said.

Marsillac is partnering on the grant with two long-time alternative energy colleagues. One colleague is at the University of Illinois, the lead institution on the grant. The other colleague is at the University of Toledo. At Toledo, his previous institution, Marsillac and his colleagues attracted more than \$20 million in funding for PV energy research.

Marsillac said each of the three researchers involved in this grant has a different sub-specialty in the field of photovoltaic energy research. Marsillac's specialty involves the fabrication of the solar cells themselves, something that he will be able to do more effectively at ODU in the soon-to-be-completed PV clean room that is being rebuilt in Kaufman Hall, home of the Batten College of Engineering and Technology.

Manz presents CIGS PV developments

The CIGS "innovation line" acquired from Würth Solar is also accelerating technological development

Manz AG presented the latest developments in its production lines for photovoltaic manufacturers at the World Smart Energy Week in Japan.

The main focus of interest was the Manz CIGSfab, a fully integrated, turnkey line for manufacturing CIGS thin-film modules, which is scalable for an output from 40 to 340 MW.

Dieter Manz, founder and CEO of Manz, says that efficient mass production of energy storage is becoming more important for the breakthrough of photovoltaic technology.

The World Smart Energy Week Japan unites various trade fairs under one roof, including the 5th PV Expo Japan, the 3rd Rechargeable Battery Expo Japan, and the 3rd Processing Technology Expo Japan.

That's why Manz also presented new production systems for lithium-ion batteries in Tokyo. "The combined trade fair in Tokyo was the perfect stage for two areas of our business and demonstrates how the topic of Smart Energy is understood in Asia - only powerful energy storage media will help a decentralised energy generation system based on photovoltaics to move mainstream," continues Manz.

The World Smart Energy Week 2012 in Tokyo had almost 2,000 exhibitors and drew 120,000 industry experts from 80 countries. In addition to the Manz CIGSfab, Manz also provided information on individual pieces of equipment for manufacturing crystalline solar cells and thin-film solar modules and lithium ion batteries.

In solar cell manufacturing, Manz benefits from its many years of expertise in automation, laser processing technology, and measurement technology.

Power Electronics

TriQuint to speed up GaN power switching with \$12.3 million

The firm is to develop highly-advanced, mixed-signal digital / RF gallium nitride circuits to pursue new opportunities in the MPC program

The Defence Advanced Research Projects Agency (DARPA) has entrusted TriQuint with leading a \$12.3 million development program focused on ultra-fast GaN switch technology for the Microscale Power Conversion (MPC) program.



TriQuint says its new GaN modulator has the potential to enable highly-efficient RF transmitters substantially smaller than current solutions. DARPA chose TriQuint as the prime contractor for MPC Technical Area I, which seeks to develop a high-speed, DC-to-DC switch (modulator) and related process technology based on the company's innovative enhancement-mode GaN transistors.

TriQuint's technology aims to improve the integration of power switches with advanced RF amplifiers to facilitate ultra-high efficiency, reduced-size amplifiers for radar and communications applications. As a pioneer in GaN development and research since 1999, TriQuint currently leads multiple GaN process and manufacturing technology initiatives for DARPA including the Nitride Electronic NeXt-Generation Technology (NEXT) program as well as endeavours for the US Air Force, Army and Naval laboratories. TriQuint is already exploring and bringing derivative devices to market made possible by milestones achieved in its many GaN programs.

"The break-through performance demonstrated in 'NEXT' has helped us develop new devices, like our GaN power switches, that will open up additional radar and communications applications. We can substantially improve performance in these types of systems," says TriQuint Vice President and General Manager for Defence Products and Foundry Services, James L. Klein. "This work is also leading to lower voltage GaN-based products. We see many exciting opportunities to develop more advanced RF amplifiers with integrated power

switches." The enhancement mode power switching device for the MPC program will be designed to have a blocking voltage of 200 V, ultra-low dynamic on resistance of 1 Ω -mm and a slew rate of 500 V per nanosecond. These capabilities will provide state-of-the-art solid-state technology. RF amplifiers employing these switches will target 75% system efficiency at X-band (8-12 GHz). TriQuint is teamed with Rockwell Collins, the University of Colorado at Boulder and Northrop Grumman, Technical Area II contractors, to create a new generation of RF power amplifiers that use contour modulation for very high efficiency performance that exceeds the capabilities of devices now available. Design approaches focusing on miniature system-in-a-package or monolithic integration to combine TriQuint's switch / modulator with the power amplifier micro-system will be given preference.

RFMD's new rGaN-HV process for power devices

The firm's new technology complements RFMD's two existing gallium nitride processes for high power RF applications and high linearity applications. As well as expanding its own opportunities in the power device market, the process will also be offered to foundry customers

RF Micro Devices has extended its GaN process portfolio to include a new technology optimised for high voltage power devices in power conversion applications.

RFMD's newest GaN process technology, known as "rGaN-HV", is claimed to enable substantial system cost and energy savings in power conversion applications ranging from 1 to 50 KW. The rGaN-HV delivers device breakdown voltages up to 900 V, high peak current capability, and ultra-fast switching times for GaN power switches and diodes.

The new technology complements RFMD's GaN 1 process, which is optimised for high power RF applications and delivers high breakdown voltage over 400 volts, and RFMD's GaN 2 process, which is optimised for high linearity applications and delivers high breakdown voltage over 300 volts. RFMD will manufacture discrete power device components for customers in its Greensboro, NC, wafer fab facility and provide access to rGaN-HV to foundry customers for their customised power device solutions.

Bob Bruggeworth, President and Chief Executive Officer of RFMD, comments, "The global demand for energy savings through improved power conversion efficiency is creating a tremendous opportunity for high-performance power devices based on RFMD's GaN power process technologies. We expect our newest GaN power process will expand our opportunities in the high-voltage power semiconductor market, and we are pleased to provide access to rGaN-HV to our external foundry customers to support their success in the high-performance power device market."

Skymake GaN-on-Diamond more than a best friend

A new technology, known as TEGaN, aims to triple the power handling capability of GaN devices

Raytheon has been awarded an 18-month, \$1.8 million contract by the Defence Advanced Research Projects Agency (DARPA) to develop next-generation GaN devices bonded to diamond substrates.

The technology, known as Thermally Enhanced Gallium Nitride (TEGaN), aims to increase the power handling capability of GaN devices by at least three times.

TEGaN enables state-of-the-art transistors and monolithic microwave integrated circuits (MMICs) to achieve their full performance potential by reducing thermal resistance. TEGaN acts as a multiplier for GaN's unique qualities, which may dramatically reduce the cost, size, weight and power of defence systems. Over the course of the 18-month contract, Raytheon seeks to develop and test TEGaN's capabilities and establish a clear path to technology insertion into military systems.

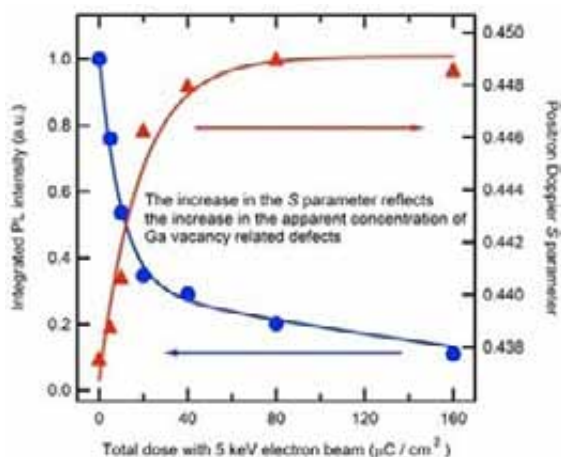
The uniqueness of GaN devices allows radar, electronic warfare and communications systems to be smaller, more affordable and highly efficient.

"Raytheon continues to be at the forefront of GaN technology development," says Joe Biondi, vice president of Advanced Technology for Raytheon's Integrated Defence Systems (IDS) business. "We are pushing the envelope of this proven technology to provide our war fighters with the most advanced sensing, communications and electronic warfare capabilities in the world."

Potential causes for current-induced nitride laser degradation

Decimation of optical quality associated with point defects has been identified as in-grown gallium vacancies rather than isolated gallium vacancies typically introduced by high electron energy irradiation

A team from Aalto University, Finland, suggests that current induced point defect activation is a possible cause for the degradation of GaN-based laser diodes. The researchers performed experiments on MOCVD-grown nitride device and GaN samples. They used a tightly focused low energy electron beam irradiation to generate local current densities up to 130 kA/cm² on the sample surface, about one order of magnitude higher than in GaN-based laser diodes during operation.



The team discovered that irradiation by 5 – 20 keV electron beam reduced the integrated band-to-band luminescence of the nitride samples by as much as 75 %, in correlation with the electron beam energy dissipation density and total irradiation dose. The findings were unexpected, since the threshold energies for vacancy generation in GaN, for example, are much higher, about 150 keV for nitrogen and 500 keV for gallium vacancies. Photoluminescence measurements revealed that the electron beam energy dissipation density was a key factor in luminescence reduction. The strongest decrease in luminescence intensity was observed with the lowest energy electron beam, which has very tight energy dissipation confinement. With the same irradiation energy the decrease in luminescence intensity showed an exponential decay as a function of irradiation dose. The degradation of optical quality was associated with the apparition of point defects, detected by depth-resolved positron annihilation spectroscopy. The point defects were identified as in-grown gallium vacancies rather than isolated gallium vacancies typically introduced by high electron energy irradiation. The apparent concentration of the in-grown gallium vacancy defects was found to increase up to low - 1017cm-3with increasing dose of the low energy electron beam. In comparison, gallium vacancy related defects in as-grown films are typically found with concentrations at or below the detection limit of around 1016cm-3.

These observations led the team to the interpretation that the low energy electron beam irradiation strips hydrogen from pre-existing inactive gallium vacancy – hydrogen complexes, causing their activation. A similar effect has been observed earlier in MOCVDgrown magnesium-doped p-GaN (Gelhausen *et al.*, Appl. Phys. Lett. 83, 3293 (2003)), where magnesiumacceptors are passivated by hydrogen during MOCVDgrowth. These magnesium-hydrogencomplexes can be broken by low energy electron beam irradiation to activate the acceptors.

The inactive in-grown galliumvacancies in MOCVDGaN are most likely passivated with more than two hydrogen atoms, since complexes with only one and two hydrogen atoms are readily detectable with positrons. According to earlier theoretical calculations (Wright, J. Appl. Phys. 90, 1164 (2001)) the gallium vacancy complexed with three hydrogen atoms is neutral, and the energy required to remove one hydrogen atom from the complex to activate it is relatively low, about 1 eV. Hence gallium vacancies passivated by three hydrogen atoms could account for the present observations. The team suggests that the presence of a rather large number of strongly

hydrogen-passivated in-grown gallium vacancies with a low activation energy would lead to current induced degradation of MOCVD grown GaN. This degradation mechanism could be behind the limited lifetime of GaN-based laser diodes.

Further experiments, especially with current densities generated by device-like operation, are necessary to shed more light on this issue.

More details of this work have been described in the paper, “Low energy electron beam induced vacancy activation in GaN”, by H. Nykänen *et al*, *Applied Physics Letters*, 10, 122105, (2012). <http://dx.doi.org/10.1063/1.3696047>

High voltage meter for high power semiconductor testing

Keithley's new tool is optimised for characterising many materials including gallium nitride, silicon carbide and other compound semiconductor materials

Keithley Instruments has unveiled the Model 2657A High Power System SourceMeter.

The Model 2657A adds high voltage to the company's Series 2600A System SourceMeter family of high speed, precision source measurement units.



Keithley 2657A SourceMeter

Together, these instruments allow the characterisation of a very broad range of power semiconductor devices and materials including GaN and SiC based materials.

A built-in 3,000 V, 180 W source enables the Model 2657 A to source up to five times as much power to a device under test as the nearest competitive system, at significantly lower cost.

The precision, high speed 6 ½ digit measurement engine built into the Model 2657A enables 1 fA (femtoamp) current measurement resolution to support the low-leakage

requirements of next-generation power semiconductor devices.

The Model 2657A is optimised for high voltage applications such as testing power semiconductor devices, including diodes, FETs, and IGBTs, GaN, SiC, and other compound semiconductor materials. It can also be used to characterise high speed transients and performing breakdown and leakage tests on a variety of electronic devices at up to 3,000 V.

Like the rest of the Series 2600A family, the Model 2657A offers a four-quadrant voltage and current source/load coupled with precision voltage and current meters. It combines the functionality of multiple instruments in a single full-rack enclosure: semiconductor characterisation instrument, precision power supply, true current source, 6 ½ -digit DMM, arbitrary waveform generator, voltage or current pulse generator, electronic load, and trigger controller, and is fully expandable into a multi-channel, tightly synchronised system via Keithley's TSP-Link technology.

Keithley says that unlike competitive solutions, which are typically limited in terms of power, the Model 2657A can source or sink up to 180 W of DC power ($\pm 3,000$ V @20 mA, ± 1500 V @ 120 mA).

The Model 2657A also offers 1 fA resolution, allowing it to make fast, accurate sub-picoamp measurements even when sourcing up to 3000 V.

The Model 2657A provides a choice of digitising or integrating measurement modes for characterising both transient and steady-state behaviour, including rapidly changing thermal effects. Each mode is defined by two independent analogue-to-digital (A/D) converters ; one for current and the other for voltage. Both run simultaneously to ensure accurate source readback without sacrificing test throughput.

The digitising measurement mode's 18-bit A/D converters support one-microsecond-per-point sampling, so users can capture voltage and current transients simultaneously. In contrast, competing solutions typically must average multiple readings to produce a result, so they aren't fast enough to characterise transient behaviour.

The integrating measurement mode, based on 22-bit A/D converters and common to all Series 2600A instruments, optimises the Model 2657A's operation for applications that demand the highest measurement accuracy and resolution. This ensures extremely precise measurements of the very low currents and high voltages common in next-generation power semiconductor devices.

Basic device characterisation can be performed with no need for software installation or programming with TSP Express, Keithley's LXI-based I-V test software utility. Users can simply connect a PC to the LXI LAN port and access TSP Express with any Java-enabled web browser. Test results can be viewed in either graphical or tabular format and then exported to a .csv file for use with spreadsheet applications.

Two additional tools for creating test sequences are provided with the Model 2657A: the Test Script Builder application (for creating, modifying, debugging, running, and managing TSP scripts) and an IVI-based LabVIEW driver (to simplify integrating the Model 2657A into LabVIEW test sequences).

The Test Script Builder application has new debugging capabilities that make test program development easier and more productive.

ACS Basic Edition software is also available as an option for component characterisation. The latest release offers a rich set of features for characterising high voltage and high current components. The included measurement libraries have been updated to support both DC and pulse mode operation of both the high voltage Model 2657A and high current Model 2651A High Power System SourceMeter instruments.

These libraries address a variety of power devices, including FETs, BJTs, diodes, IGBTs, etc., with tests that include input, output, and transfer characteristics on most devices. A special "Trace Mode" provides real-time control over an instrument's voltage or current output using a simple slider.

The Model 2657A can be connected to other instruments in a test system with standard safe high voltage (SHV) coaxial cable connections compatible with existing high voltage test applications. However, for applications that depend on getting the most from the instrument's low current measurement performance, Keithley also offers special HV triaxial (guarded) connections to optimise the Model 2657A's measurement accuracy.

The optional new Model 8010 High Power Device Test Fixture provides connections for testing packaged high power devices at up to 3000 V or 100 A, making it safer and simpler to configure a device test system that includes the high voltage Model 2657A, one or two high current Model 2651A instruments, and up to three low power SMU instruments (other Series 2600A instruments or the Model 4200-SCS semiconductor characterisation system).

As well as having standard banana jumpers, the Model 8010 has rear-panel oscilloscope and thermal probe ports to simplify system integration for further DUT characterisation. The system also has full safety interlock capability.

To prevent instrument damage if a device fault occurs, integrated protection circuits in the Model 8010 safeguard the inputs of the lower voltage Series 2600A instruments from the high voltages the Model 2657A can output. Individual protection modules are also available to simplify connecting multiple SMUs safely to a third-party probe station, component handler, or other test fixture.

Price for the model 2657A starts at \$17,900 depending on configuration and geography. Shipments will begin in May, with lead times of two weeks ARO.

ACS Basic Edition software is \$5,000 Model 8010 High Power Test Device Fixture is \$6,500.

Tokyo Electron sells SiC epi growth tool to Infineon

The Probus-SiC silicon carbide system will be used to volume produce advanced SiC power devices

Tokyo Electron Limited (TEL) has announced that Infineon Technologies in Germany has ordered its Probus-SiC kit.



Probus-SiC growth system

Its silicon carbide (SiC) epitaxial film growth tool, will be used for the mass production of advanced SiC power devices.

The Probus-SiC can handle film growth on substrates up to six inches. It also features automatic transfer and multi-reactor functions. It is claimed to be an ideal tool for improving device performance and productivity. This tool is scheduled to be delivered in the summer of 2012.

"We are honoured with the selection from Infineon Technologies for the Probus-SiC as a mass production tool for their advanced SiC power devices. In order to ensure the stable performance required for mass production, the Probus-SiC incorporates key design and development concepts to achieve good uniformity, low defect density, reduced surface roughness, high throughput and easy operability," says Yoichi Ishikawa, General Manager, New Product Development Division, TEL.

"With Infineon Technologies' validation of the Probus-SiC performance and design, TEL is looking forward to the opportunity to contribute to low-cost manufacturing of high quality SiC power devices and the further expansion of the SiC power device market," concludes Ishikawa.

SemiSouth injects \$18 million into developing SiC devices

The expansion, in its Mississippi plant is expected to drive the firm's silicon carbide fabrication facility. It will also improve customer service to those who are adopting the company's diode and power transistor products

SemiSouth Laboratories is further expanding its facility in Starkville for the second time in the past 18 months. With the extra investment of \$18 million, the firm is hoping to increase the availability of energy-efficient SiC power devices for the solar, wind, traction-drive, and automotive industries. This move will help to drive the continued growth in the firm's SiC fabrication facility and improve customer service to those who are adopting the company's diode and power transistor products. SemiSouth says its SiC technology enables ultra-efficient power conversion for solar and wind inverters, hybrid/electric vehicles, traction-drive and other applications that benefit from exceptionally high energy efficiency. "Today's announcement is a testament to SemiSouth's success with existing customers in solar inverter and industrial power supply market segments," comments Jeff Casady, President of SemiSouth. "We are ramping with our customers' demands for our industry-leading SiC power JFET and power diode products, and this new expansion will allow us to expand our volume another 50% for these customers and new ones starting up with us," he continues. Dieter Liesabeths, Senior Vice President of Sales & Marketing at SemiSouth, adds, "SemiSouth is continuously being recognised by its customers for having world-record, cost-effective, energy-efficient power semiconductor electronic products based on our proprietary SiC technology." "We have many customers in production with even more in development for our products in energy-sensitive markets such as solar inverters, server power supplies, wind inverters, and electric vehicle development," concludes Liesabeths.

GaN power semiconductors to go from zero to heroes

Despite gallium nitride being so illusive, IMS Research says that by 2021, the market for power devices using this material will exceed \$1 billion

The emerging market for GaN power semiconductors is forecast to grow from almost zero in 2011 to over \$1 billion in 2021, according to a new report from IMS Research.

The research firm analysed all of the key end markets for power products and found that power supplies, PV inverters and industrial motor drives would be the three main drivers of growth.

While SiC power devices have been around for some years, GaN power semiconductors have only recently appeared on the market. One of the main reasons is that GaN is a wide bandgap material which offers similar performance benefits to SiC but may be cheaper to produce.

“This is possible because GaN power devices will be grown on a larger, lower cost Silicon substrate”, says Richard Eden, Senior Market Analyst and author of “The World Market for Silicon Carbide and Gallium Nitride Power Semiconductors - 2012 edition”. “The key market driver is the speed at which GaN-on-Silicon devices can achieve price parity with Silicon MOSFETs, IGBTs or rectifiers with equivalent performance.”

IMS Research says the speed of GaN transistor developments has accelerated in the last two years, possibly due to its huge growth potential.

The launch of International Rectifier’s “GaNpowIR” and EPC’s “eGaN FET” devices started the low voltage market in 2010. The emergence of Transphorm and its 600 V GaN transistors in 2011 created considerable interest in the prospects of GaN competing with high voltage MOSFETs and IGBTs. Six of the world’s top ten discrete power semiconductor suppliers are planning to launch GaN power devices in the near future, and some may already be making devices for in-house end equipment.

IMS Research’s report analyses applications ranging from consumer electronics to industrial equipment and renewable energy. The first applications to adopt will be power supplies where the total system cost savings outweigh the unit price penalty of the device.

These include PC & notebook adaptors and servers as well as domestic appliances like air-conditioners, where efficiency improvements are being driven by Government initiatives or regulations. Once reliability and other potential problems are resolved, PV micro-inverters, electric vehicle battery charging and other new applications are likely to adopt GaN power devices in the future.

However, IMS Research says that there are some barriers to main-stream market acceptance of GaN power devices.

The first is availability, as few GaN transistors are available in mass production. Competing manufacturers’ products are non-standard and there are no second-sources.

Secondly, the technology lacks maturity. Overall device performance and GaN material defect rates need improvement.

A third issue is design inertia; the need to educate customers about both the potential benefits of GaN and how to use the devices.

Having said that, GaN could be the power of the future.

SiC inverters halve the size of EV motor systems

Mitsubishi Electric says its silicon carbide inverter-equipped EV motor system is the industry’s smallest

Mitsubishi Electric Corporation has developed a prototype electric vehicle (EV) motor system with a built-in SiC inverter.

The EV motor system is claimed to be the smallest of its kind; it measures just half the dimensions of Mitsubishi Electric’s existing Silicon-based motor system that uses an external inverter.

All power chips in the new inverter are SiC-based, resulting in over 50% reduction of loss compared to the company’s Silicon-based inverter system.

The firm’s existing Silicon-based system consists of separate motors and inverters driving the motors, which requires more space for these components and their wiring.



SiC inverter-equipped EV motor system

The new motor system is expected to enable manufacturers to develop EVs offering more passenger space and greater energy efficiency. The company plans to commercialise the motor system after finalising other technologies for motor/inverter cooling, downsizing and efficiency.

The global demand for EVs and hybrid EVs (HEVs) has been growing in recent years, reflecting increasingly strict regulation of fuel efficiency and growing public interest in saving energy resources and reducing CO2 emissions.

As EVs and HEVs require relatively large spaces to accommodate their robust battery systems, there is a strong need to reduce the size and weight of motor systems and other equipment to ensure sufficient room in passenger compartments.

Mitsubishi’s newly developed cylinder-shaped inverter matches the diameter of the motor, enabling it to be connected coaxially within a chassis, resulting in a substantial downsizing of the motor system.

Silicon chips have been widely used in power devices for inverter switching. Silicon carbide, however, is now recognised as a more suitable material for chips owing to its electrical characteristics, including a breakdown electric field that is 10 times greater compared to silicon chips. This greater breakdown electric field enables thinner chips, which reduces electrical resistance and lowers loss.

The improved winding density and magnetic efficiency achieve a smaller motor with higher output. The new product has a permanent magnet motor that uses a neodymium magnet. Mitsubishi Electric's proprietary dense-winding structure enabled the company to utilise its poki-poki motor production technologies to reduce the size of the motor.

What's more, the size and configuration of the stator and rotor poles have been optimised using Mitsubishi Electric's high-level magnetic-design technology. As a result, magnetic efficiency has been increased and power output improved by 5% over the company's previous motors.

GaN power device market to rocket to over \$1 billion

The GaN market will see current LED players broaden their horizons into power devices using their existing capabilities

Yolé Développement's new report says that in the next few years, cross-fertilisation with the LED industry will boost the GaN power market to unprecedented levels. The report "Power GaN 2012" offers full market coverage from epiwafer to final applications.

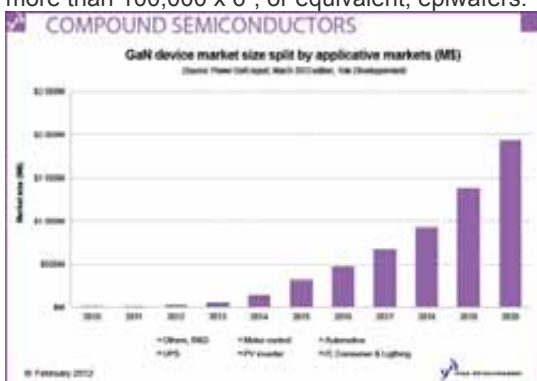
Yolé says the GaN power device industry has probably generated less than \$2.5 million in revenues in 2011, as only IRF and EPC are selling products on the open market. However, the overall GaN activity saw extra revenues as R&D contracts, qualification tests and sampling for qualified customers was extremely buoyant during the year.

In the very short term, IRF and EPC will probably remain the two main commercial vendors of GaN power devices in early 2012. This market is likely to stay below \$10 million for devices, with the rest being made through R&D sales.

2013 should signal the transition from qualification to production ramp-up for several new entrants. The device market could reach the \$50 million threshold.

In 2014, most of these new entrants will ramp-up their capacity, and by 2015 the availability and adoption of qualified 600 V+ GaN devices should see the market grow very quickly, and open doors to non-consumer applications.

In 2015, twelve to fifteen players will share the consumption of more than 100,000 x 6", or equivalent, epiwafers.



Beyond that, if GaN is qualified in the EV/HEV sector, GaN device business could cross the billion dollar line and the GaN-on-Silicon substrate market could exceed \$300 million revenues by 2019.

However, it is still unclear how car makers will choose between SiC, GaN or the current Silicon technology. At the substrate end, R&D activities are still divided between several options. These include GaN-on-Sapphire, GaN-on-SiC, GaN-on-GaN, GaN-on-AlN and GaN-on-Silicon.

Nevertheless, GaN-on-Silicon is likely to take a dominant position as 6" is now available with more than 7µm thick GaN epi and 8" is under qualification.

One of the organisations investigating 8" GaN-on-Silicon is R&D institute imec, which is collaborating with a number of partners for power devices as well as LEDs. Eight inch diameter availability is probably the parameter that will make this technology choice obvious.

The GaN power world is attracting more and more newcomers. Yolé has screened five companies who make the epiwafers, more than six GaN device pure-players and another fifteen Silicon-based power firms developing GaN technology.

One of the latest trends is that LED innovators are starting to look at power devices as a new business opportunity. They are focussing on diversifying their capabilities to convert existing extra LED capacity into power. That represents an "epsilon" today, but Yolé is assuming it may create some disturbances in the natural and organic expected growth.

GaN power electronics and the LED industry have always been and will always be intertwined; both are linked in technology and market dynamics. For instance, the premises of GaN epi technology came from the LED industry that has brought this technology from labs to mass production in the fab.

Today, the extensive developments of GaN-on-Silicon epiwafers fertilise both the LED and the Power industry. Most of the epiwafer vendors are targeting these two segments with dedicated products and offers.

Tomorrow, it is likely some incumbent LED pure-players will enter the Power industry world, using their extra-capacity and existing tool-sets to make, at least epiwafers, or even power devices.

So, at end of the day, instead of separating the two sectors it's better to talk about the "GaN device industry" as the main players could well be the same.

Power device makers usually buy polished Silicon wafers, conduct the epi (or buy Silicon epiwafers) if needed (FZ thin wafers don't require epitaxy), then process the devices. This is roughly the same for SiC technology.

In most cases, one of two scenarios could occur for those planning to enter the GaN field. Some players would not actually grow the GaN using MOCVD epitaxy. Instead, they will buy GaN epiwafers and process them in existing CMOS Front-End lines, as they use to do with Silicon or SiC substrates.

Others will try to fully integrate the process; they will start with

the bare substrate, grow the GaN epi and conduct the device processing.

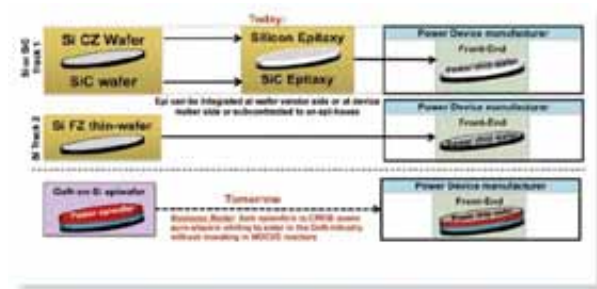


Figure 2: GaN technology will involve mixes in the established CMOS business model

The “Power GaN 2012” report provides a complete analysis of the GaN device and substrate industry in the power electronics field along with key market metrics. It provides company involvement as well as technology state-of-the-art. In addition, an extensive review of the possible substrates for GaN is provided and over 65 companies have been considered in the analysis.

The majority of information in this article has been detailed in the Yolé Development report, “ [Power GaN 2012](#)”.

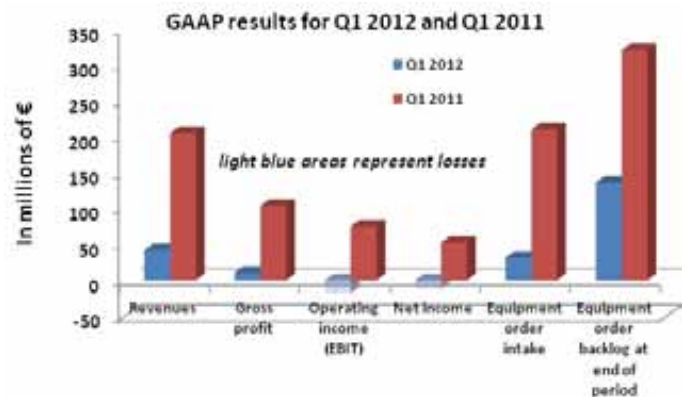
Equipment and Materials

Aixtron suffers severely with lack of orders and poor revenues

This was heavily influenced by poor consumer confidence, credit tightness, reduced subsidies and ongoing customer overcapacity. The order intake in the next quarter does not look bright either, so the firm aims to concentrate on R&D investments in the immediate future

Aixtron SE opened fiscal year 2012, as expected, with subdued Q1 revenues of € 42.0 million and a correspondingly negative EBIT of € -18.3 million, reflecting the current trough level market demand.

Despite the difficult market conditions, the company remains focused on delivering further improvements to existing products and services and on accelerating specific strategic R&D investments aimed at developing new products for future market opportunities. For the full year 2012, management reiterated the target of remaining EBIT profitable.



With the considerable reduction in order intake during the second half of 2011, in line with expectations Q1/2012 revenues came in at € 42.0 million for the quarter, 80% down on the € 205.4 million a year before, and 70% lower sequentially (Q4/2011: € 140.1 million). Gross profit decreased by 90% compared to the previous year from € 104.2 million to € 10.3 million and 13% sequentially (Q4/2011: € 11.8 million).

Consequently, and as already predicted by Management in Q4/2011, Q1/2012 finished EBIT negative at € -18.3 million, compared to € 74.9 million in Q1/2011 and € -16.9 million in Q4/2011.

The consolidated net result of the Aixtron Group came in at € -12.3 million for Q1/2012 (Q1/2011: € 52.3 million; Q4/2011: € -10.9 million).

Heavily influenced by fragile consumer confidence, credit tightness, reduced subsidies and ongoing customer overcapacity, the Company’s order intake visibility remains limited. The Q1/2012 order intake of € 31.5 million was sequentially broadly in line with the Q4/2011 level of € 29.3 million (Q1/2011: € 210.3 million) which suggest that the current order levels may represent the trough level of the current cycle.

Despite the current market conditions, Aixtron Management continues to be convinced that the development of a sustainable LED lighting industry will follow this uncertain transitory period. Set against this difficult environment, the Company remains focused on delivering further improvements to existing products and services and on accelerating specific strategic R&D investments focused on developing new products for future market opportunities.

This strong R&D focus is reflected in the 32% year on year increase in R&D costs of € 16.4m in Q1/2012 (Q1/2011: € 12.4m) and the 12% sequential increase compared to the prior quarter(Q4/2011: € 14.6 million), and additionally in the increased average number of 325 R&D employees in Q1/2012 compared to 316 in Q4/2011 and 252 in Q1/2011.

Management Review

Paul Hyland, President & Chief Executive Officer at Aixtron offers the following comment on the current business and market situation, “Times are undoubtedly very tough , but we remain convinced that we have built a strong and resilient foundation to our business, designed to protect the Company in the difficult climate that the whole industry is currently

operating in.”

“Furthermore, we have significantly enhanced our existing product portfolio over the last 18 months, so that we are confident of being highly competitive in the event of a sudden upturn of demand in the market. Additionally, despite the very volatile current economic environment, we have more than just sustained our MOCVD R&D efforts, we have accelerated our investments into both next generation MOCVD products and other ‘Beyond LED’ products that we believe are necessary to support our longer-term ambitions.”

Outlook

Order intake visibility has not improved to the point where Aixtron Management can yet predict a full year revenue figure. Nevertheless, the Company still targets to remain EBIT profitable in 2012 under the current circumstances. On a more positive note; there continues to be solid evidence of emerging new LED lighting product developments, increasingly proactive government engagements and clear company positioning investments.

Successful Oxford Instruments seminar held in Shanghai

Presentations held during the one day program included topics such as Atomic Layer Deposition, Photovoltaics, Deep Silicon Etch and Ion Beam technologies

The recent Nanoscale Plasma Processing Seminar organised by Oxford Instruments in Shanghai attracted over 70 attendees from both academia and production, from China and Taiwan.

The company organises these events worldwide several times a year, and has previously co-hosted with organisations such as the IOS-CAS in Beijing, LBNL, Caltech and Cornell in the USA, Universities of Southampton and Glasgow in the UK, and TU/e in the Netherlands.

As a supplier of systems and processes for plasma etch and deposition, the company was honoured that so many invited guest speakers participated, all specialists in their field from China, Taiwan and Europe. Process and Applications experts from Oxford Instruments Plasma Technology gave a number of talks on the company’s technologies and process solutions.



Oxford Instruments thanking their guest speakers for assisting in making the Shanghai Seminar such a success

These events aim to encourage interest in developments within industrial and research communities using Plasma and Ion Beam Etch and Deposition process techniques. They are an ideal means for participants to learn more about latest techniques and findings in an informal atmosphere where participation and interaction are encouraged.

Talks included topics such as Atomic Layer Deposition (ALD), Photovoltaics (PV), Deep Silicon Etch and Ion Beam technologies during the one day programme.

Guest speakers included: Erwin Kessels, from University of Eindhoven (TU/e), Netherlands; Chu Ann-Kuo, Department of Photonics, National Sun Yat-sen University, Taiwan; Zhenghua YE, SITP (Shanghai Institute of Technology Physics); Juncong SHE, Sun Yat-Sen University, China; and Jerry Wang, Manager of Microsystems Technology Centre, ITRI, Taiwan.

Mark Vosloo, Sales, CS and Marketing Director, Oxford Instruments comments, “We were pleased to have attracted such a large and high calibre audience to this Seminar in Shanghai, and are extremely honoured that so many distinguished guest speakers gave their time to speak about their work in Plasma Processing. Our Seminars offer a fantastic opportunity for the wider Plasma Processing community to meet and share their experiences, and to learn more from leading international experts in their field.”

Oxford Instruments is planning more seminars worldwide for 2012.

Innovative thin wafer handling for CS device processing

Brewer Science is introducing a thermal debonder, an enhanced ZoneBOND separation tool and a cleaning system for III-V compound materials such as gallium arsenide and nitride, indium phosphide and silicon carbide

Brewer Science has unveiled new processing equipment specifically designed for thin wafer separation and post-debonding cleaning of compound semiconductor materials.

These steps are critical for ultrasensitive compound semiconductor (CS) device processing.

Brewer says these latest tools enable thin wafer handling technologies and broaden the process window and lower total cost of ownership by reducing yield loss and increasing throughput.

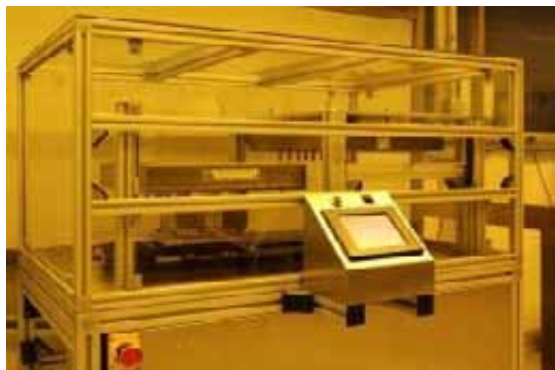
“Brewer Science Cee lab-scale processing equipment offers track-quality precision and is suitable for low-volume prototype processing that enables transfer to high-volume manufacturing,” says Wayne Farrar, Director of Equipment.

“No other company is as uniquely positioned as Brewer Science to offer complete solutions for your thin wafer handling needs. With our temporary bonding materials and

lab-scale equipment, we bring a breadth and depth of process experience that is unequalled by any other company," boasts Farrar.

There are three new semi-automatic thin wafer handling tools manufactured by Brewer Science for CS processing applications.

The first is the Cee 1300CSX thermal debonder, which enables high-temperature slide-off debonding of thinned III-V and CS materials including GaAs, GaN, InP, and SiC, in a confidential laboratory setting.



Semiautomatic Benchtop Debonder ; Cee 1300CSX

The ZoneBOND separation tool has been enhanced with compliant seal clamps and fail-safe abort hardware to accommodate thinned III-V and CS materials. Brewer says the its latest product provides superior precision control for debonding materials that are highly sensitive to mechanical and thermal shock, flexibility for sizes ranging from 2 inches to 300 mm, and very-low-stress room temperature debonding.



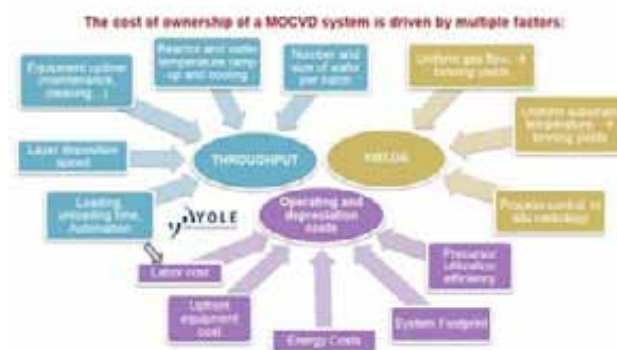
ZoneBOND Separation Tool

The final product is the Cee 300MXD megasonic cleaning system, which applies uniform acoustic energy to spinning substrates to gently remove adhesive residues and contaminants without damaging fragile device structures.



Megasonic Developer/Cleaner; Cee 300MXD

MOCVD Cost of Ownership Drivers



The main problem is total cost of ownership. Established MOCVD makers all have technology roadmaps to enable COO reduction by three or four times within the next 5 years through a combination of improved yields, throughputs and precursor utilisation efficiency.

For MBE, Yole says Riber and Veeco are the only two players offering large capacity / large throughput MBE production tools for volume manufacturing. The market research firm expects both firms will maintain their dominant positions. However, there are about ten other MBE manufacturers offering R&D or pilot production systems that also have a strong presence on the general MBE market, such as DCA, SVT and Eiko.

The Metal Organic precursor market will also be driven by LED applications. But MOCVD reactor technology improvements, including yield, consumption and wafer size, will lower the amount of TMGa and TMI needed per cm² of epiwafer.

The 2010 metal organic shortage ended in mid 2011 thanks to aggressive capacity expansion by leading suppliers. Further capacity expansion plans from established and emerging

suppliers could come online within the next 3 years.

If executed as announced, Yole expects significant oversupply starting from 2012 that could continue through 2016 and beyond. This situation could put pressure on prices. Further MO synthesis technology improvements could provide opportunity for cost reductions. However, the usually volatile prices of raw indium and gallium also have a significant impact on cost.

Yole's report provides Metal Organic precursor price, volume & revenue trends and data on over 150 companies.

Edwards turbo charges its pumps

A new series of pumps, suited for use in the MOCVD growth of compound semiconductors, offers approximately 40 percent more throughput and almost 90 percent higher maximum flow than previous versions

Edwards Limited has unveiled the STP-iXR1606 series of magnetically-levitated turbo-molecular pumps (TMP) with a fully-integrated onboard controller.



Edwards' STP-iXR1606 TMP pumps

The revolutionary new rotary design delivers approximately 40 percent improvement in throughput at high gas flow rates and an increase of nearly 90 percent in maximum gas flow, compared to existing products.

Edwards' new pump features a fully-integrated controller that eliminates the connection cable and rack conventionally required with a non-integrated controller. This helps reduce footprint, installation time and cost. What's more, the onboard controller incorporates a small power supply, which compared to existing products, delivers approximately 32 percent reduction in energy consumption at high gas flows.

"Our new STP-iXR1606 extends the already high performance of our industry-leading turbo-molecular pumps," says Masahide Tanaka, STP product manager, Edwards. "It matches the peak pumping speed of our highest performing pump in the 8-inch TMP class, but with significant improvements in throughput performance and maximum allowable gas flow. As with all of our magnetically-levitated TMPs, it requires no maintenance. The STP-iXR1606 series provides our customers with an all-in-one TMP solution for all their applications, with reduced footprint, simplified installation and reduced energy costs."

The STP-iXR1606 series, available now, delivers high reliability in dirty environments with equivalent IP54 protection against dust and humidity. The pumps have I/O remote, RS232C, RS485 and STP-link standard communication ports, with Profibus and DeviceNet available as options.

Oxford Instruments promotes Dan Ayres to Managing Director

The promotion aims to ensure that the firm aligns more effectively with its customers and the provision of high technology products and services geared to their specific requirements

Oxford Instruments Plasma Technology has appointed Dan Ayres to Managing Director with immediate effect.



Dan Ayres, Managing Director, Oxford Instruments Plasma Technology

Ayres previously held the position of General Manager at the company, and prior to this was Operations Director. With over 10 years experience within the Oxford Instruments Group, Ayres has held roles in the fields of Operations, Product Management and Project Management.

Dan Ayres will report to Jonathan Flint, CEO of Oxford Instruments plc, who comments, "Our business strategy demands an organisation that can meet the challenge of expanding markets, new products, and growing numbers of customers and employees. Dan's new appointment will ensure that Oxford Instruments Plasma Technology continues its current growth plans, and I am confident that with Dan heading the strong Executive Team in place at the company, this will be achieved."

"I am delighted to have this opportunity to lead our highly skilled team and I look forward to working with them to build on the success of recent years", comments Dan Ayres, "In line with our strategic plan we will focus on innovating improved etch, deposition and growth solutions to meet our customers' needs for new systems, continuous performance improvement and after-sales support. We will support our focus on innovation by investing in improved business processes to ensure we deliver a healthy and growing business for our employees, shareholders and other stakeholders"



Mark Vosloo, Sales, CS & Marketing Director, Oxford Instruments Plasma Technology

At the same time, Mark Vosloo, Sales & Customer Support Director has taken over responsibility for all customer facing functions including strategic marketing and holds the new title Sales, CS & Marketing Director.

Pintelon receives 2012 IEEE Keithley award

The researcher of parameter estimation, system identification, and signal processing has been awarded for innovative system identification methods for measurement applications

Rik Pintelon is the recipient of the 2012 IEEE Joseph F. Keithley Award in Instrumentation and Measurement.

Pintelon is being recognised for the development of innovative system identification methods for measurement applications. The award, sponsored by Keithley Instruments, is presented for outstanding contributions in the field of electrical measurement. It consists of a bronze medal, a certificate, and an honorarium.

Pintelon will receive the award at the 2012 IEEE International Instrumentation and Measurement Technology Conference,

on May 15, 2012, at the Grazer Congress Conference Centre, Graz, Austria.

Rik Pintelon received the degree of Electrotechnical-Mechanical Engineer in July 1982, the degree of doctor in applied science in January 1988, and the qualification to teach at university in April 1994, all from the Vrije Universiteit Brussel (VUB), Brussels, Belgium.

Until September 2000, he was a Research Director of the Fund for Scientific Research – Flanders (FWO) and part-time lecturer at the VUB in the Electrical Measurement Department (ELEC). He is currently a full-time professor at ELEC. His main research interests are in parameter estimation, system identification, and signal processing.

The award's IEEE Evaluation Committee consider innovation and development, social value, concept uniqueness, other technical accomplishments, and the quality of the nominations.

The award is administered through the Technical Field Awards Council of the IEEE Awards Board and is independent of Keithley Instruments.

SITE Services changes its name to Spintrac Systems

The name change is to re-brand the company and allow it to showcase the wide range of proprietary systems that SITE Services has developed. These include indium phosphide and gallium arsenide substrates

After more than 30 years of continuous operation under the name SITE Services, the company has changed its name to Spintrac Systems, Inc. "The change had been contemplated over many years as the nature of the company's business grew from being a service and training company (Semiconductor Industry Training and Electronic Services) to one that currently designs and builds its own line of photolithography coater and developer systems," says SITE Services President Alan W. Kukas. This name change is an opportunity to re-brand the company and allow the firm to showcase the wide range of proprietary systems that SITE Services has developed. The company's processing systems were initially targeted towards silicon wafers but now extend into many specialised substrates including compound semiconductors such as InP and GaAs. The firm also deals with sapphire, glass and ceramic varying in size from 2" to 320 mm x 380 mm plates. Many systems work in a 24/7 production environment while others are utilised in R&D facilities pertaining to nanotechnology, displays and process chemicals.

Eindhoven University adds two plasma systems to its cleanroom

The Oxford Instrument tools will complement an already existing tool set dedicated to the processing of III-V photonic devices. They will strengthen research capabilities in silicon containing materials as well as be used for etching more “exotic” materials such as niobium nitride

The open-access facility for nanotechnology-related research, NanoLab at the Eindhoven University of Technology (TU/e) in the Netherlands, continues to expand its capabilities.

The institute has recently added two new Oxford Instruments plasma systems to its cleanroom.



Cleanroom in TU/e

“The PlasmaPro System100 RIE and PlasmaPro System100 ICP-PECVD tools are multi-purpose systems that complement the already existing tool set dedicated to the processing of III-V photonic devices, many of which are Oxford Instruments tools”, says Erwin Kessels, a professor in the Plasma & Materials Processing Group at the Department of Applied Physics, TU/e.

“They strengthen our capabilities for our own research as well as that for our partners within the NanoLabNL initiative. They also complement the extensive ALD-capability of our clean room, that already contains the two FlexAL and one OpAL plasma and thermal ALD systems from Oxford Instruments.”

Kessels continues, “With the capability to run both F- and Cl-chemistries, the PlasmaPro System100 RIE tool will be used for “standard” processing of silicon-containing materials (SiO₂, Si₃N₄, Si) as well as for etching more “exotic” materials such as NbN.”

The etching of niobium nitride thin films is used to fabricate nanostructured superconducting single-photon detectors. For this application TU/e needed to define a ultranarrow (50 nm) constriction in a 5 nm-thick NbN film, by electron-beam lithography and etching with F-based chemistry.

When the resulting device is cooled down to 4 K and biased close to the critical current, a single-photon absorbed in

the constriction region (and only there) gives rise to a superconducting-resistive transition, producing a voltage pulse. This results in a single-photon detector with a spatial resolution of few tens of nanometres, which could be used for near-field imaging with unprecedented sensitivity.

Mark Vosloo, Sales and Customer Support Director at Oxford Instruments Plasma Technology recognises the importance of this additional system sale, “Our broad, flexible and reliable system and process offering has lead to a number of nanotechnology research institutes globally becoming established as Oxford Instruments centres of excellence.”

“Several long term relationships have developed between research centres and our Company, and TU/e is one of the establishments where we are delighted to collaborate. Our customers rely on our experience to provide the most advanced and innovative technology and service, to achieve their scientific goals”, concludes Vosloo.

Riber to supply Russian institute with MBE tool

The global provider of MBE systems will supply an Epineat MBE reactor for research and development of 4-inch III-V compound semiconductor materials in Russia

Riber has an order for one of its MBE systems to a research institute based in Russia.

The order, supplying one Epineat model MBE machine in 2012, will boost lab research capacities on III-V components.



Riber Epineat MBE49 4" reactor

Riber says its Epineat system is the most effective solution for basic research of compound semiconductor materials on 4-inch substrates.

Russia is one of the places where the compound

semiconductor industry is currently booming.

Eliminating waste gases without fuel

A new system developed by DAS Environmental Expert, safely and reliably abates dangerous waste gases from compound semiconductor manufacturing processes including MOCVD

German firm DAS Environmental Expert is now offering customers a new system for waste gas abatement. SPRUCE is a waste gas abatement system that operates entirely without fuel gas.



SPRUCE waste gas abatement system

“The new system closes a gap in our portfolio”, says Guy Davies, Director of Business Unit Gas Abatement at Dresden based DAS Environmental Expert.

“We noticed that the demand for such systems is very high. There are semiconductor fabs that basically want to avoid using fuel gas altogether. In addition, it is also easier to retrofit existing fabs with abatement equipment, if one can do so without installing a fuel gas feeding system. This is a big market and we are now offering the right product.”

SPRUCE was specifically designed for the waste gas

abatement of CVD processes in the semiconductor industry. Most of the time, the gases used in these processes are toxic, highly flammable, explosive, or harmful to the environment.

These include the gases phosphine and arsine, which are used to produce III-V based epiwafers which are manufactured using the MOCVD process.

SPRUCE reliably and cost-effectively eliminates residues of those gaseous substances from the manufacturing plant's waste gases. “Process waste gases are introduced through a maximum of four separate inlets into a reactor, which is heated electrically from the outside”, explains Davies.

“The heat inside the reactor breaks down the waste gases and, depending on their chemical composition, various reactions take place. In the subsequent scrubbing stage, gaseous and solid compounds generated by this process are absorbed and cooled down by a suitable scrubbing liquid, he continues.” Afterwards, the waste gases are cooled and cleaned can be released through the roof without any concern.

The waste gas abatement takes place without burning. Due to its small footprint, the equipment can be either installed in the fab's basement or in the direct vicinity of the CVD system itself.

“SPRUCE is characterised by its low cost of ownership and high level system availability”, concludes Davies. The system's integrated cleansing mechanism inside the reactor ensures long maintenance cycles and the equipment can easily be integrated into a monitoring network.

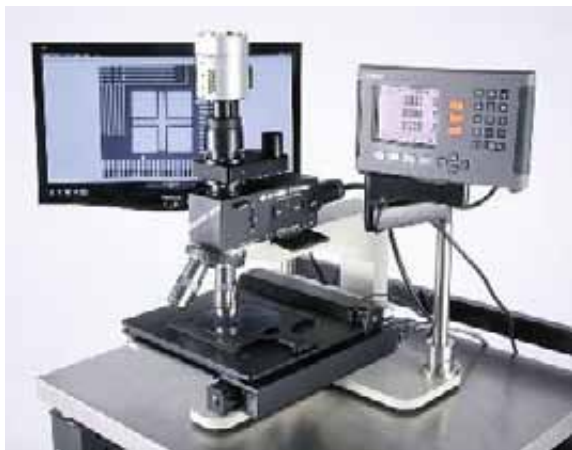
For applications that require close to 100% system use, DAS Environmental Expert has developed SPRUCE DUO. This variant of SPRUCE features two reactor/scrubbing systems which can work in parallel with each other. In the event of maintenance on one of the systems, the other takes over the entire waste gas treatment.

Affordable benchtop IR inspection tool revealed by McBain

The microscope incorporates a high resolution indium gallium arsenide camera. It allows an operator to see through materials that are transparent in the infrared range between 740 nm and 1700 nm

McBain Systems is introducing a new, more affordable system for interior, infrared inspection, for semiconductor and other advanced technology industries.

The new BT-IR Benchtop Infrared Microscope System allows an operator to see through materials that are transparent in the infrared range between 740 nm and 1700 nm.



McBain BT-IR inspection system

Despite its lower price, McBain says the new BT-IR provides exceptional performance and precision. Initial experiments indicate that it is able to penetrate thicker, more highly doped materials with rougher surfaces than other systems, and deliver higher quality images.

The BT-IR yields submicron-precision optical measurements, and its staging provides up to 0.1 μm linear encoder resolution. What's more, the system is reputed to have the highest resolution 900 - 1700 InGaAs digital camera in its class.

"The new BT-IR System fills an important market niche," notes Michael Crump, President and CEO of McBain Systems. "It is a manual system with a smaller footprint and lower price, yet it is designed to provide much of the power and flexibility of our higher end inspection systems. And users can start with the BT-IR and later scale up to one of our larger, more automated IR inspection systems, such as the DDR-300NIR or DDR-2000SWIR, as their needs grow."

The McBain BT-IR system features a motorised XY stage with joystick controls to navigate, observe and measure bonded wafer/die alignments, find defects in a manual mode and determine material stress via the system's optional birefringence capability.

The system is well suited for imaging, verification, inspection and metrology for a range of QA/Reliability and R&D applications. Typical in-process applications include verification of pre-bond and pre-hybridisation for critical-alignment applications. Post-process uses include validation, inspection, and measurement of critical sub-surface features in NIR / SWIR-transmissible materials.

Failure analysis applications include tool verification, part characterisation, qualification and environmental testing.

CVD to expand with a new plant

The firm's new facility in New York will concentrate on nanomaterial applications

CVD Equipment Corporation has completed the purchase of its planned new facility located at Central Islip, New York.

Leonard Rosenbaum, President and Chief Executive Officer comments, "With the completion of this purchase we now look forward to relocating into a facility two times our current space and the unification of our Application Laboratory under the same roof. With the purchase behind us, we will focus on both the relocation efforts and the multiple growth opportunities this relocation will enable."

With this expansion, the application laboratory will serve a number of purposes. Two of these are nanomaterials manufacturing, pilot production process development and demonstration for the transformation of nanomaterials to macro-sized materials and/or sub-assemblies. Another focus will be joint business and technology transfer developments for products enabled by nanomaterials, marketed through the firm's subsidiary, CVD Materials Corporation.

CVD Equipment Corporation offers a range of chemical vapour deposition, gas control and other equipment that is used by customers to research, design and manufacture a number of products. These include compound semiconductors, solar cells, graphene, nanowires, LEDs, MEMS, and equipment for surface mounting of components onto printed circuit boards.

Twin Creeks reveals multi-tasking production system for super slim wafers

Using PIE technology, the firm's new tool produces monocrystalline wafers that are less than a tenth of the thickness of conventional wafers used in solar, semiconductors and wireless devices

Twin Creeks Technologies has unveiled Hyperion; a wafer production system that drastically reduces the cost of solar modules and semiconductor devices.

The company says it can cut the amount of substrate materials by up to 90 percent.



Twin Creeks' Hyperion 2 wafer production system

The key to Hyperion is thinness.

Taking advantage of a technology called Proton Induced Exfoliation (PIE), Hyperion generates monocrystalline wafers that are less than a tenth of the thickness of conventional wafers.

With thin wafers, manufacturers can profitably produce solar cells and other devices well below today's best-in-class cost structure. Twin Creeks estimates that Hyperion will allow manufacturers to produce solar cells for under 40 cents a watt in commercial-scale volume production facilities with prices declining over time.

Hyperion 3, the third-generation wafer production system designed and built by Twin Creeks, is the company's first commercial offering. It is available for shipment now.

"The thickness of wafers today is based on wafer slicing capabilities and the handling requirements for device processing. In reality, only the very top layer of a substrate plays an active role in generating energy or transmitting signals - the rest is wasted," says Siva Sivaram, CEO of Twin Creeks. "By eliminating excess material, we will help solar manufacturers produce modules that compete with grid power and open up new markets for chip makers."

With PIE, Hyperion uses atoms as a scalpel. The machine embeds a uniform layer of high-energy protons, which are hydrogen ions, into monocrystalline wafers to a depth of up to 20 µm. When heated, this new layer expands, cleaving the top surface from the donor wafer to form an ultra-thin wafer that is otherwise identical to the original. The ultra-thin wafer is then further processed into solar modules or semiconductors. Creating wafers with PIE also eliminates the kerf, or wasted silicon, in solar manufacturing.

Hyperion is compatible with a wide variety of monocrystalline wafers. These include germanium (used to make CPV solar modules), GaN, sapphire and SiC (which are used to manufacture LEDs and power electronic devices).

In the past, Twin Creeks concentrated on helping manufacturers of crystalline silicon solar cells because of the urgent need to cut the cost of solar power. The lessons learned will further allow manufacturers to employ Hyperion for other applications, such as CMOS sensors.

By reducing the amount of silicon required in solar modules by 90 percent, Twin Creeks says the Hyperion can make the entire silicon wafer value chain more efficient and will dramatically lower the capital needs of its customers. Manufacturers won't need as many saws, furnaces and crystal pullers to make the same amount of wafers.

Hyperion is claimed to improve the monocrystalline silicon value proposition in other ways too. Apart from being much lighter than conventional solar cells, cells produced with Hyperion wafers are also bendable, allowing manufacturers to consider flexible packaging and encapsulants for modules instead of glass.

Additional layers of photovoltaic material can be added to

wafers as well; Twin Creeks has produced heterojunction solar cells, which combine crystalline and amorphous silicon, in its development centre. Over time, the combination of lower cost and lighter packaging will allow Twin Creeks' customers to expand into other markets such as building-integrated photovoltaics (BIPV) and consumer electronics.

In keeping with providing a true manufacturing solution, the company says it has developed intellectual property for creating and handling ultra-thin wafers and producing finished solar cells. This intellectual property can be licensed to Twin Creeks' customers.

The company, in collaboration with the state of Mississippi, has built a commercial demonstration plant in Senatobia, Mississippi where Twin Creeks and its customers can fine-tune processes for generating ultra-thin solar modules and wafers with Hyperion.

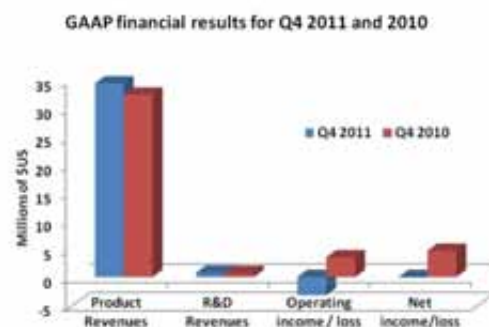
Senatobia is currently capable of producing 25 MW of solar cells a year and will be expanded to 100 MW. The company has obtained UL and TUV certification for heterojunction technology-based panels made at its Senatobia facility.

Kopin incomes dive in the last quarter

Although the firm's income plummeted, III-V revenues rose 6.8 percent to \$66.5 million for fiscal 2011 and overall, Kopin fared better than it did last year

Kopin Corporation has announced financial results for the fourth quarter and 12 months ended December 31, 2011.

Despite the disappointing financial results in the last quarter, the company remains positive.



"We concluded a successful 2011 with strong fourth-quarter growth," says John C.C. Fan, Kopin's President and Chief Executive Officer. "Total revenues for the fourth quarter of 2011 increased 6.3 percent to \$35.2 million from \$33.1 million for the comparable period of 2010."

“Driven by strong global sales of wireless handsets and growing demand for our BiFET and BiHEMT structures as enabling technology for smartphone power amplifiers, III-V product revenues increased 15 percent for the fourth quarter to \$17.4 million from \$15.1 million in the same period in 2010,” Fan continues.

“BiHEMTs deliver the high performance in the small footprints required by next-generation smartphones, and our integrated circuit customers’ BiHEMT qualification and production activities increased significantly in the fourth quarter.”

“Display revenue decreased \$0.3 million to \$17.8 million in the fourth quarter of 2011, reflecting lower R&D and military display revenue, partially offset by higher revenue from consumer electronics applications,” adds Fan. “In addition, development of our Golden-i voice-activated, hands-free, cloud computing and communications technology progressed on schedule.”

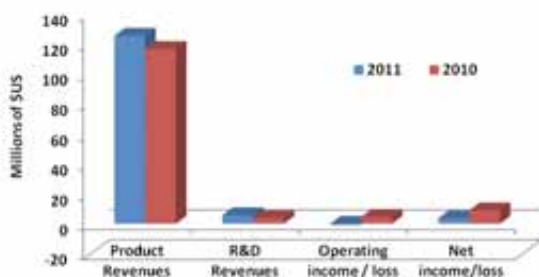
Fourth-quarter 2011 GAAP net loss was \$67,000, or \$0.00 per basic and diluted share, compared with net income of \$4.7 million, or \$0.07 per diluted share, for the fourth quarter of 2010. Results for the fourth quarter of 2011 included a non-cash intangible asset and goodwill impairment charge of \$5.0 million associated with Kopin’s Forth Dimension Displays Ltd (FDD) subsidiary and a non-cash income tax benefit resulting from the release of a deferred tax valuation allowance of \$4.3 million related to its Kopin Taiwan Corporation (KTC) subsidiary.

Results for the fourth quarter of 2010 included gains of \$0.6 million on the sale of patents and the receipt of \$1.4 million of insurance proceeds.

Full-year Financial Results

Total revenues for the fiscal year ended December 31, 2011 increased 8.9 percent to \$131.1 million from \$120.4 million a year earlier. III-V revenues rose 6.8 percent to \$66.5 million for fiscal 2011 from \$62.2 million in fiscal 2010. Display product revenue increased 11.2 percent to \$64.7 million from \$58.2 million a year earlier.

GAAP financial results for 2011 and 2010



Gross margin for the 12 months ended December 31, 2011 increased to \$43.4 million, or 34.6 percent of revenues, from \$35.4 million, or 30.4 percent of revenues, for 2010.

Operating loss was \$0.8 million for the year ended December 31, 2011, compared with operating income of \$4.6 million for 2010. Results for fiscal 2011 included impairment charges

associated with FDD of approximately \$5.0 million. Results for fiscal 2010 included gains from insurance proceeds of approximately \$1.5 million.

GAAP net income for fiscal 2011 was \$3.6 million, or \$0.06 per diluted share, compared with GAAP net income of \$8.9 million, or \$0.13 per diluted share, for fiscal 2010. Results for 2011 included a non-cash intangible asset and goodwill impairment charge of \$5.0 million associated with Kopin’s FDD subsidiary and a non-cash income tax benefit of \$4.3 million related to KTC.

Results for 2010 included gains of \$0.8 million on the sale of patents that the Company was no longer using, the receipt of \$1.8 million of insurance proceeds and \$2.6 million from the sale of investments.

The impairment charge for the fourth quarter and fiscal year 2011 reflects the Company’s current estimate of the fair market value of the FDD business. The value of this charge is subject to change.

“During 2011, we maintained a strong financial position while investing for the future. Our 2011 gross margin dollars increased \$8.0 million compared with 2010, which enabled us to increase internal R&D investments in our III-V, display and Golden-i technologies by \$5.1 million,” comments Fan.

“We generated \$18.1 million of cash from operating activities in 2011, which allowed us to spend \$11.0 million for the acquisition of FDD, \$5.9 million for capital expenditures and \$4.4 million for the repurchase of stock while finishing the year with cash and equivalents and marketable securities of \$105.4 million versus \$111 million at December 25, 2010. As of year-end 2011 we continued to have no long-term debt.”

Business Outlook

“We anticipate another strong year of growing global demand for smartphones to drive a solid performance for our III-V business in 2012, and our Golden-i technology is on track for a 2012 launch,” Fan says. “However, we expect Defence Department budget cuts to negatively affect our military display revenue and as a result, for full-year 2012 we expect to generate total revenues in the range of \$110 million to \$120 million.”

“The Defence Department budget cuts were not unexpected and we have been planning for this situation for some time. For example, by the end of this month we anticipate the completion of a plant consolidation project we started more than a year ago. We have consolidated all of our domestic display manufacturing activities into one facility that allowed us to consolidate all of our domestic III-V activities into one facility and we effectively closed our other domestic III-V facility this month.”

“Actions like these will help to generate substantial cost savings, allowing Kopin to remain financially strong and flexible so that we can continue to invest in the future growth of our business. In 2012 we will continue to focus on developing our BiFET and BiHEMT smartphone technologies as well as on working with our partner for the successful launch of our Golden-i technologies. We believe these investments will position us to further capitalize on our leadership position

in III-V technology, as well as on our expertise in advanced display imaging systems for consumer and industrial markets to drive market share gains and longer-term growth for Kopin,” concludes Fan.

Novel Devices

Breaking conventional concepts in SiGe thermoelectric materials

Using a modulation-doping strategy in 3D bulk silicon germanium thermoelectric materials enhances their carrier mobility and hence electrical conductivity by over 50%

Thermoelectric materials switch between heat and electricity in a unique and clean solid-state approach.

In the last couple of decades, thermoelectrics have been drawing more and more research interest due to the limited availability and the negative environmental impact of conventional energy strategies.

In the past, as a measuring stick of the conversion efficiency, the term “dimensionless figure-of-merit,” also referred to as ZT , has been widely used. A high ZT value usually promises high thermoelectric performance. Typically, good thermoelectric materials should simultaneously display low thermal conductivity and good electrical conductivity.

Striving to enhance the performance of thermoelectric materials, researchers from Boston College and MIT have recently reported a novel materials design to achieve a 30 to 40% enhancement in the peak ZT value for n -type SiGe semiconducting alloys.

Bo Yu, lead author of a paper describing the recent work, says that SiGe has been almost the exclusive choice for high temperature thermoelectric applications. The material has been used in the radioisotope thermoelectric generators (RTGs) employed by US NASA ever since 1976.

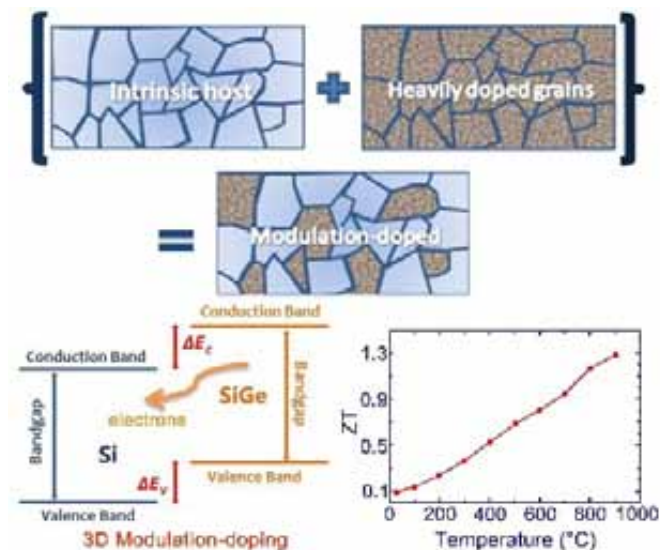
Nevertheless, the broader application of SiGe has been limited by the fact that germanium, which is used to reduce the thermal conductivity in such alloys, is extremely expensive and the cost has to justify the performance.

Bo Yu, is a graduate researcher in the Department of Physics at Boston College working in Zhifeng Ren’s group. He worked on this project with MIT collaborators, Mona Zebajadi, Gang Chen, and Mildred S. Dresselhaus.

The scientists reported that the modulation-doping strategy, conventionally used in the thin-film semiconductor industry, could also be utilised in the 3D bulk thermoelectric materials

to enhance their carrier mobility and therefore the electrical conductivity, by over 50% in this case.

By improving materials design, the team also achieved a simultaneous reduction in the thermal conductivity which combines to provide a high ZT value of about 1.3 at 900 °C.



“To improve materials ZT is extremely challenging because all the internal parameters are closely related to each other. Once you change one of them, the others may most likely change accordingly to the other extreme, leading to no net improvement. As a result, a more popular trend in this field of study is to look into new opportunities, or say new material system. However, our study proved that opportunities are still there for the existing materials, if one could work smartly enough to find some alternative material designs,” explains Bo Yu.

Zhifeng Ren also points out that this reported ZT peak value competes well with the state-of-art n -type SiGe alloy materials while the new material design requires over 30% less of germanium. “That is a significant advantage to cut down the fabrication cost as we want all the materials we studied in the group be really used by people in reality and that is always the goal for our everyday research,” adds Ren.

By using a similar strategy, researchers are also looking into other traditional materials systems trying for more breakthroughs. Actually, this Boston College and MIT team, led by Ren and Chen, has been a pioneer in the clean energy research community for years especially for their contribution in understanding and controlling the phonon and electron transport in bulk thermoelectric composite materials.

Currently, their research is funded by the S3TEC (Solid state solar thermal energy conversion) Centre which is part of the US DOE Energy Frontier Research Centre program, aiming at advancing fundamental science and developing materials to harness heat from the sun and convert this heat into electricity via solid-state thermoelectric and thermophotovoltaic technologies.

This work has been described in more detail in the paper, “Enhancement of Thermoelectric Properties Modulation-Doping

in Silicon Germanium Alloy Nanocomposites” by Bo Yu *et al*, *Nano Letters*, 2012, 12 (4), pp 2077–2082. DOI: 10.1021/nl3003045.

Putting the insulator back into topological insulators

Combining two common topological insulators together reduces the number of defects to produce true insulating topological insulator behaviour

A team of researchers from the UK has shown that anti-site defects are the key to controlling the unwanted bulk conduction that has plagued a new form of material known as a topological insulator.

Touted as the next silicon, topological insulators are unusual materials which, as the name suggests, should be insulating.

However, unlike familiar insulators such as diamond or quartz, they have surfaces which conduct electricity without the scattering that is a limiting factor in the performance of current electronic devices. This could one day lead to unprecedented advances in computing technology, and the realisation of an entirely new form of electronics known as spintronics.

However, most current examples of this exotic state of matter don't display the insulating bulk suggested in their name.

This causes problems not only for trying to study their intrinsic properties, but also for building a device that exploits the special surface current that sets these materials apart from normal semiconductors.

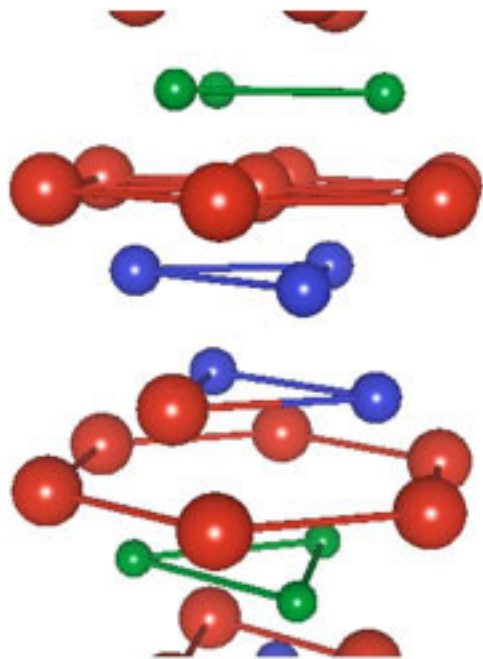


Figure 1: Schematic of the layered tetradymite structure, with Bismuth (red), and the inner and outer chalcogenides marked as green and blue spheres respectively. This schematic indicates a Bismuth on the outer chalcogenide anti-site defect, and a Bismuth vacancy

Now, a team of researchers from University College London and the Universities of St. Andrews and Warwick, all in the UK, have found the imperfections in these materials responsible for their unintentional conductivity, and show ways to manage these in order to realise true topological insulators.

The scientists used theoretical calculations to understand what happens when the crystals grown don't have the perfect textbook structure. They found that the most likely structural imperfections are also ones that cause the high, undesired bulk conduction that is commonly observed in experiment.

However, by combining two common compounds together, these defects can be carefully balanced to encourage the material to become insulating.

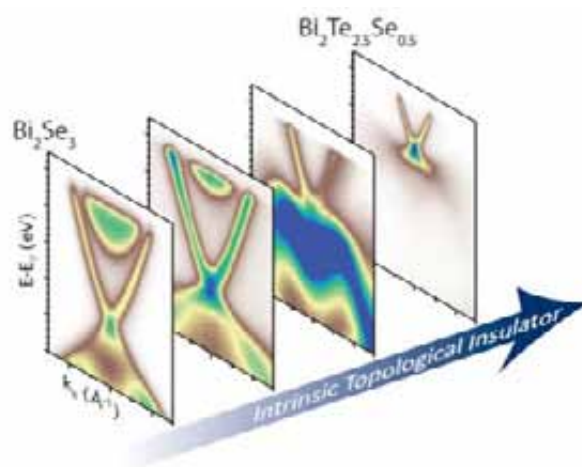


Figure 2: Angle-resolved photoemission measurements confirm that alloying Bi_2Se_3 with Bi_2Te_3 is an effective way to tune bulk conductivity in topological insulators, reaching the desired regime where only the special topological surface state (V-shaped feature) crosses the Fermi level

The researchers show this experimentally, demonstrating an efficient way to tune the topological insulators into exactly the regime desired for exotic future applications. This borrows ideas commonly used to modify conventional semiconductors like Silicon or GaAs.

Applying such tricks to topological insulators could ultimately lead to these semiconductors being superseded in the never ending hunt for faster and smaller electronic devices.

Further details of this work have been published in the paper, “Controlling Bulk Conductivity in Topological Insulators: Key Role of Anti-Site Defects” by D.O. Scanlon *et al* in *Advanced Materials*, published online on 19th March, 2012, DOI: 10.1002/adma.201200187.