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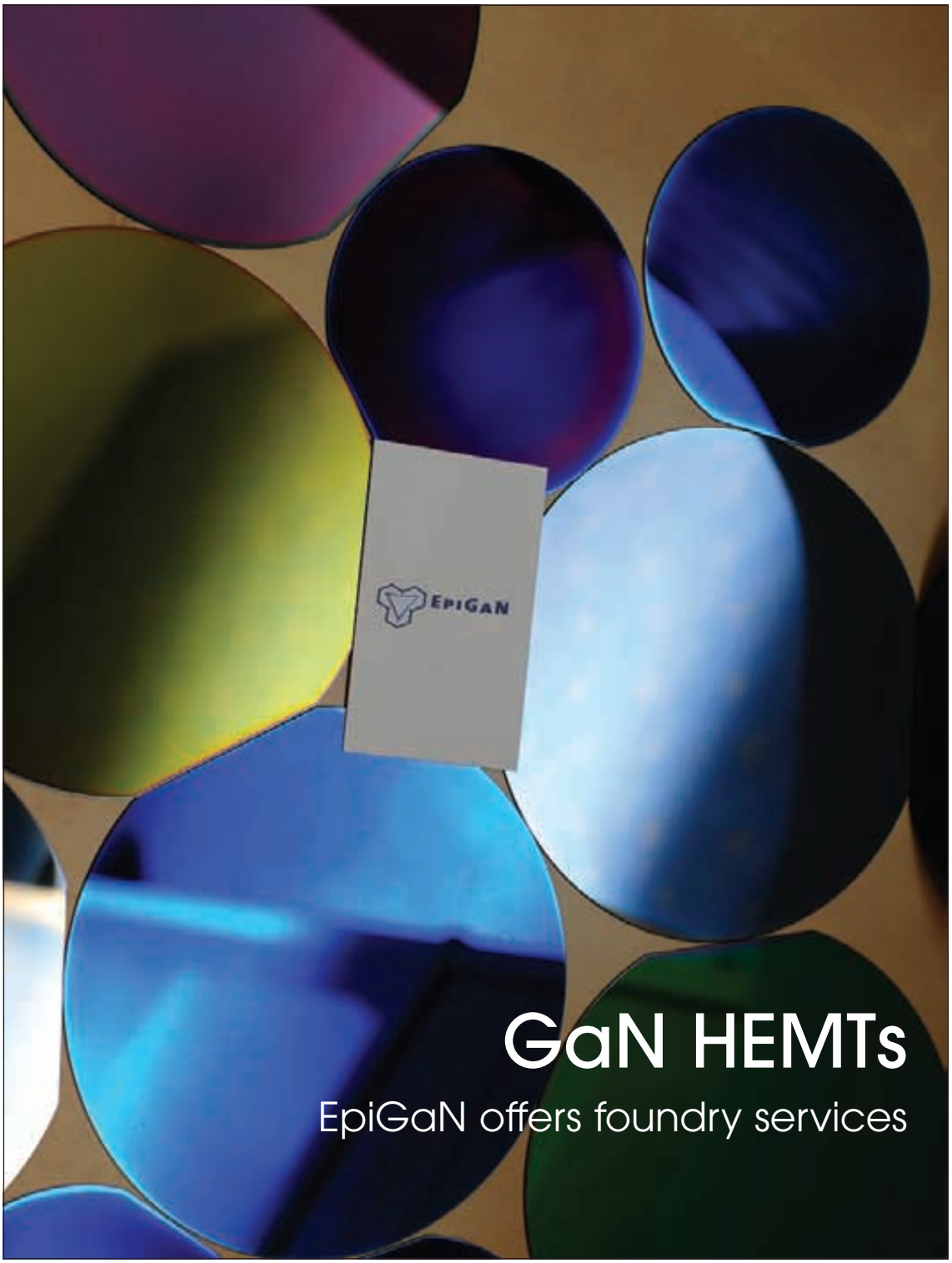

GaN HEMTs

EpiGaN offers foundry services

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LED bulbs: The good, the bad and the ugly

NEW technologies always command high prices. That's partly because a hefty price tag is needed to ensure that the manufacturer claws back some of the money that they invested in bringing their new gizmo to market. But it's also a sensible move from a profit perspective, because a small band of early adopters are generally willing to pay over the odds to get their hands on exciting new products.

Later on prices fall. In an ideal world, that's due to economies of scale. But in some cases its increased competition in the market place, which spurs some firms to cut prices by cutting corners.

In the nascent LED light bulb market, there are fears that attractively priced, poor performing products could put people off this technology. And I have anecdotal evidence to back this up.

Back in late of 2010 I spent £35 on a 40 W replacement, warm-white LED light bulb made by Philips. It's great: It emits a good colour, operates instantly at full brightness and is still going strong. But even if I was willing to use 40 W equivalent bulbs throughout my house, I would not be willing to pay the substantial upfront costs.

LED light bulb prices are falling fast and I've been keeping my eye out for a bargain. So I was delighted when I spotted 60 W equivalent bulbs made by SimplyLED that sell for £14.99 and draws just 5 W. I snapped one up straight away.

But when I plugged it in, my delight turned to anger. The cool-white bulb that I ordered appears to give out less light than the Philips bulb!

Obviously I'm unable to confirm my suspicions because I have no equipment at home for measuring the lumen output. And I may have been unlucky and had a duff bulb. But after paying out £15, surely I have every right to expect a high-quality product every time?

Despite this unfortunate experience, I am still optimistic for the future of LED lighting. For starters, chipmakers are coming out with ever-more-appealing products, such as the high-voltage warm-white LED chipsets made by Epistar, which combine blue and red LEDs in a manner that ensures low colour temperature, high efficacy, and good colour mixing (read more about this on page 38).

What's more, efforts at making LEDs-on-silicon are accelerating, with other companies following in the footsteps of the US trailblazer Bridgelux. Osram has started pilot production of this product on 6-inch silicon, and Epistar and LG Siltron are heading in the same direction by placing orders for Veeco MOCVD tools.

So there's a good chance that LED bulbs can catch on, by combining low cost with high quality. But the road to success could well be a rocky one.

Richard Stevenson PhD
Consultant Editor

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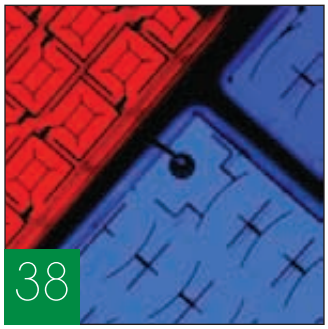
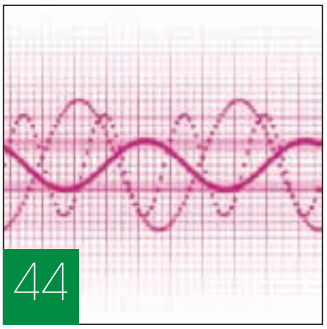
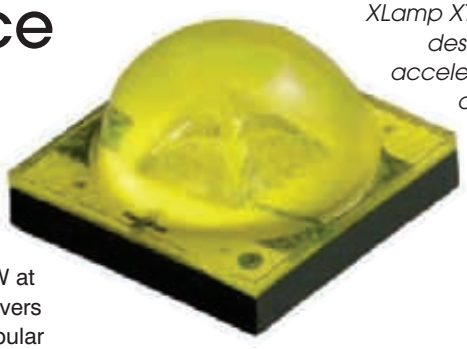




news

SiC makes LED performance better and pricing easier



XLamp XT-E White designed to accelerate LED adoption and lower system cost

CREE says it has made a breakthrough in LED technology that completely redefines the lighting industry and erases old assumptions about up-front LED cost and performance. Based on the new SiC technology platform, the XT-E LED and the recently released XB-D LED represent a change in LED price and performance. Cree's platform addresses the largest obstacle to mass LED lighting adoption, initial cost, and enables LED lighting systems to replace their ancestors.

"Cree has a history of delivering LED solutions," said Fritz Morgan, chief product officer, Digital Lumens. "We are committed to building the most energy-efficient industrial lighting systems and the XT-E LED enables us to do just that with high lumens per watt. The result is an intelligent LED-based lighting system that is driving widespread adoption of LEDs in industrial facilities, with compelling performance and end-user payback."

The XT-E LED more than doubles the lumens per watt of the XLamp XP-E LED family – providing up to 148 LPW at 85°C (or up to 162 LPW at 25°C) at 350mA. The XT-E LED delivers exceptional performance in the popular 3.45mm x 3.45mm XP footprint and can be used for almost all lighting applications.

By leveraging the XP footprint, customers can easily incorporate the XT-E LED in existing XP LED designs to shorten the LED fixture design cycle and improve customer time-to-market.

Additionally, since the XT-E White LED is a successor product to XP-E High Efficiency LED, the application for ENERGY STAR qualification requires only 3000 hours of XT–E LED LM-80 data
.
"Our mission is to drive the LED lighting revolution through our relentless pursuit of innovation and by helping manufacturers bring high-quality, affordable LED lighting to market," said Mike Watson, Cree senior director marketing, LED components. "With the XB-D LED, Cree changed the game and introduced a better price-performance curve. Now, with the XT-E LED, Cree continues to break barriers and extend its leadership on this new trajectory, delivering products that accelerate LED adoption."

Cree says the XT-E White LED delivers up to 148 lumens and 148 lumens per watt in cool white (6000 K) or up to 114 lumens and 114 lumens per watt in warm white (3000 K), both at 350 mA, 85°C.

GaAs device revenue grows a mere six percent in 2011

THE STRATEGY ANALYTICS report, "2011 GaAs Device Revenue Falters after Strong Start," explores GaAs device revenue growth trends in handsets and smartphones. It also explores revenue performance of leading substrate and device manufacturers, like IQE, VPEC, Kopin, RFMD, Skyworks, TriQuint Semiconductor, Avago Technologies and WIN Semiconductor. While growth drivers are still present, the rates are likely to flatten in 2012.

"Tremendous growth in the smartphone segment of the handset market in 2010, and the early part of 2011, had propelled the overall GaAs market to record levels of revenue which are now slowing," commented Eric Higham, Director of the Strategy Analytics GaAs and Compound Semiconductor Technologies Service. "However, increasing GaAs content in handsets and the sheer volume of the handset market should still power GaAs growth."

Asif Anwar, Director, Strategy Analytics Strategic Technologies Practice, added, "There were revenue declines in the second half of 2011 at GaAs substrate manufacturers. Strategy Analytics will continue to monitor these trends throughout 2012, in order to see their effect on the GaAs supply chain."

Veeco K465i is the logical choice according to SemiLEDs

SEMILEDS has recently qualified the TurboDisc K465i GaN MOCVD System for high-volume production of high brightness LEDs at its state-of-the-art manufacturing facility in Taiwan.

"We have placed Veeco's K465i system into our production facility in Taiwan. In addition to their proven MOCVD technology, Veeco's commitment to providing best-in-class LED manufacturing equipment, as well as enhanced local support with their technology centre in Hsinchu, makes the selection of Veeco as our vendor a logical choice," said Chuong A. Tran, President and Chief Operating Officer, of SemiLEDs.

William J. Miller, Veeco's Executive Vice President, Process Equipment, added, "We are very pleased SemiLEDs chose Veeco to be a new supplier of MOCVD equipment. Our TurboDisc K465i platform consistently offers excellent productivity while keeping production costs low. Our Taiwan Technology Centre will help the SemiLEDs Taiwan team learn best practices to maximize the value of their new system and grow as a leader in the energy-efficient lighting market."

SemiLEDs develops and manufactures LED chips and LED components primarily for general lighting applications, including street lights and commercial, industrial and residential lighting.

The firm sells blue, green and ultraviolet LED chips under the MvpLED brand.

LED lighting to boost power supply market to $10 billion

THE global market for power supplies used in LED lighting is forecast to reach a monumental $10 billion in 2016. IMS Research's recent report "Opportunities for Power Components in LED Lighting," reveals that rapid uptake of LED lighting, driven by legislation and rising costs of electricity will result in a potential global market of 4 billion power supply units by 2016.

Report co-author and senior market analyst, Ryan Sanderson, commented, "Demand for LED lighting solutions is increasing rapidly for all applications from low-power residential retrofit LED lamps and bulbs to high-power commercial and industrial LED luminaires for applications such as street lighting."

The report also says that the traditional lamp and luminaire market is well established. Manufacturers are faced with new challenges when it comes to powering LED lamps and luminaires and often require significant power electronics expertise, opening up opportunities for power supply manufacturers.

The requirements to power new LED lighting products varies widely, depending on design factors including power rating, the number of LEDs or LED strings and the environment in which the solution will be placed. Sanderson added, "These design requirements, coupled with the lack of clear standards for LED lighting means that LED lamp and luminaire manufacturers need considerable power electronics expertise, either via employing specialists or from a merchant power supply manufacturer."

Competition in lighting, however, is already fierce and some of the largest manufacturers of LED lamps and luminaires are positioning themselves to cope with these challenges internally.

Report co-author and market analyst, Jonathon Eykyn, commented, "Some of the largest manufacturers of LED lamps and luminaires already have the capability to design and manufacture power circuitry in-house, either via subsidiaries or through the acquisition of power supply providers. Philips Advance is a prime example".

Veeco systems big in Asia for gallium nitride on silicon epitaxy

TAIWAN headquartered Epistar will use the Turbodisc K465i GaN MOCVD reactor to grow LEDs. South Korea's LG Siltron will use the same tool to grow LEDs as well as power devices.

M. J. Jou, President of Epistar, commented, "We are pleased to choose Veeco's K465i as our GaN-on-Si development tool. We are excited about the potential of GaN-on-Si technology as we move to larger wafer sizes. We appreciate the strong support from Veeco, and look forward to this collaboration."

WILLIAM J. MILLER, Veeco's Executive Vice President, Process Equipment, commented, "We are very pleased that Epistar has chosen the K465i, which provides low cost-of-ownership and production worthiness, for its GaN-on-Si LED development. Large diameter Si wafers offer tremendous promise as a low cost alternative to sapphire for volume production of lower cost LEDs."

Epistar manufactures high brightness LEDs of compact size, low power consumption and long life. LG Siltron, a South Korean epi wafer manufacturer, also chose the TurboDisc K465i GaN MOCVD system for production of GaN-on-Silicon wafers for power electronics and LED devices.

As traditional silicon-based power transistors approach their limits, materials such as GaN are gaining popularity to speed energy conversion at lower costs. A wide range of industries, including many in the green-tech space such as wind, solar, smart grid, and hybrid electric vehicles, are driving demand for energy-efficient GaN-based power electronics. GaN-on-Silicon may also offer an alternative approach to LED manufacturing.

Alta Devices GaAs solar panel raises the bar with 23.5% efficiency

ALTA has taken another step toward commercialising its GaAs multi-junction solar technology.

The firm chose to focus on GaAs because of its intrinsic efficiency advantages as well as its ability to generate electricity at high temperatures and in low light. This means that Alta's panels have substantially higher energy density than other technologies, generating more kilowatt-hours of energy over the course of a year in real life conditions.

According to Christopher Norris, Alta president and CEO, "Our goal is to optimise the production economics of solar so that it is competitive with fossil fuels without subsidies, leading to broad adoption of solar generated electricity." In addition to technology advances which push the limits of energy density, Alta is also focused on changing the manufacturing economics of solar and enabling formats and form factors that were previously not possible.

GaAs is known for being expensive to produce, Alta has invented a manufacturing technique that enables extremely thin layers of GaAs that are a fraction of the thickness of earlier GaAs solar cells. Alta's cells are about one micron thick, forty times thinner than a human hair.

In utilising very thin devices that have the highest energy density possible, the cost of the material needed in Alta panels remains low and the potential costs of an entire solar energy system based on Alta's technology could be dramatically reduced.

What's more, because Alta's PV film is thin and flexible, it has the potential to be integrated in wholly unique ways and into a variety of applications – including roof and building materials, and numerous military, consumer, and transportation products.

According to Norris, Alta is making substantial progress on the build-out of its pilot manufacturing line, which uses mostly off-the-shelf equipment with some proprietary optimizations unique to Alta's process. Moreover, Alta is starting to plan for full-scale production, with activities such as building strategic manufacturing partnerships and selecting its first large, commercial manufacturing site.

According to Alta investor, Andy Rappaport of August Capital, "Alta has perfectly and very systematically met its plan for achieving, and then continually improving on record efficiency since the company was first funded. This consistency of technical accomplishment, building on the potential inherent in Alta's core technology, confirms our belief that the company will change the landscape of solar energy deployment."

Cambridge and Plessey all set and ready to glow

A NEW technique for manufacturing gallium nitride LEDs on silicon is to be exploited in the UK, putting mass-produced, energy-efficient lighting within reach. Researchers say that the novel process is paving the way for manufacturing affordable LED lights and could have a dramatic impact on carbon emissions. Plessey, a semiconductor manufacturer based in Plymouth, will use the process, developed at the University of Cambridge. It involves growing GaN crystals on silicon and could drastically reduce the cost of making LEDs for lighting in offices and homes.

Researchers estimate that a worldwide switch to LEDs, which are far more energy-efficient, would enable the closure of 560 power plants and result in annual CO2 savings equivalent to the output of all the cars on the planet.

LEDs are also being designed to give off a more natural quality of light, which will be better for people's health. They could potentially be used as "smart lighting" that can switch itself on or off when a person enters or leaves a room, or adjust its brightness according to the amount of daylight. Now a team led by Colin Humphreys at the Department of Materials Science and Metallurgy, University of Cambridge, says it has developed a new method which will be commercialised by a new arm of Plessey.

Called Plessey Lighting, the division will initially make LEDs on silicon for external manufacturers, but in time hopes to develop its own light bulbs in-house. "We've got higher efficiency for growing gallium nitride on silicon than anyone else we know," Humphreys said. "Potentially this is a deal that puts Britain right at the forefront of LED research."

"LED light bulbs currently cost as much as £40, but we expect to be able to reduce that cost by a factor of five by growing on silicon. Mass manufacturing may reduce the cost further. Eventually I think that we will see LED lighting being fitted throughout the world."

Value for money is high as LEDs last as long as 100,000 hours. Since the average light bulb in Britain is on for four hours a day, LED light bulbs would only have to be changed once in every person's lifetime. LEDs, which require far less energy than conventional bulbs, are currently about 30% efficient and Humphreys hopes to raise that figure to 60% in time.

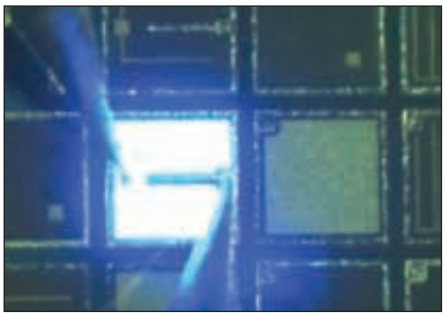
In the UK alone, the researchers estimate that the nationwide use of LEDs would save 15% of the electricity generated by power stations, resulting in a similar reduction in CO2 emissions. There are also potential cost savings, as a (2010) US Department of Energy report estimates that savings of $20 billion per year would result if LED light bulbs became widespread in the US.

The technique developed by Humphreys resolves several problems with trying to grown GaN on silicon. In particular, it addresses difficulties to do with thermal expansion under the growth temperature of 1,0000 C. Gallium nitride expands at a very different rate to silicon and when the two substances cool down, the material tends to crack.

Humphreys' team have been able to introduce layers to the process that put the GaN in a state of compression before it heats up. "This compression balances the tension when it cools down, which allows the material to relax," he said. "As a result, we can grow LED structures which are totally crack-free."

The new process will grow LEDs on 6-inch silicon wafers. Each costs about £20 ; cheaper than the 2-inch sapphire wafers used in the past, and ten times more LEDs can be grown on a 6-inch wafer than on a 2-inch. Plessey was chosen because it already has the equipment to manufacture silicon wafers of this size. What's more, its work in electronics means that, in time, the company may be able to develop "smart lighting" from LED light bulbs as well.

"It's very important to us that this research will be exploited here in the UK," Humphreys added. "If we had stopped at the research stage, our work would probably have been picked up and commercialised overseas. This way, we can create more jobs in a low-employment part of the country and potentially turn Britain into a major centre for better, greener lighting."



An LED emitting light on a 6-inch silicon wafer. (Credit: Colin Humphreys)

Minister for Universities and Science David Willetts said, "Professor Humphreys' work shows the potential of science to drive growth and create the high-tech jobs of the future. Not only could his research result in a highly marketable, low carbon alternative to the everyday light bulb, but he has worked closely with industry to ensure that the commercialisation process also happens in the UK."

There are a number of players developing GaN on silicon technology for LEDs. Osram Opto is marketing InGaN LED chips fabricated on 150 mm (6-inch) silicon wafers. Researchers at the company have succeeded in manufacturing high performance prototypes of blue and white LEDs, in which the light-emitting GaN layers are grown on 150 mm silicon wafers.

German based Azzurro Semiconductors also grows on 150 mm silicon and its patented technology allows the firm to grow GaN epitaxial layers up to 8 μm thick. The firm says the bow of the 150 mm wafers is below 20 μm and allows the use of standard CMOS-fabs for a massive cost breakthrough for LEDs.

Last October, Bridgelux closed an additional $15 million in financing raised specifically to further accelerate research, development, and scaling of the company's position in GaN on silicon LED chip technologies ; it's targeted for commercialisation in 2013.

Siltronic AG and Belgian nano-electronics research institute imec are setting their sights even higher and are developing a process to grow on 200 mm silicon wafers.

They are collaborating on the development of silicon wafers with a GaN layer as partner of imec's GaN on silicon industrial affiliation program (IIAP). The venture aims to enable future production of LEDs and power devices.

600 V gallium nitride device is over 99% efficient

AT the Applied Power Electronics Conference (APEC), Transphorm revealed its newest step to solve the large and growing problem of electrical energy waste in power conversion.

The company announced the qualification of its first products, power diodes based on its patented, high-performance EZ-GaN technology:
TPS2010PK — 600 V, 6 A, GaN diode in the industry standard TO-220 package
TPS2011PK — 600 V, 4 A, GaN diode in the industry standard TO-220 package
TPS2012PK — 600 V, 2 A, GaN diode in the industry standard TO-220 package
These products are now qualified and available for sale through the Transphorm web site to approved customers.

"Our team lays the key first stake in the ground demonstrating that 600V GaN is not just a long-term promise, but today a superior product - an accomplishment made possible by working closely with our customer-partners who deliver the end products for power conversion", said Primit Parikh, President of Transphorm. "For customers looking for a low-risk roadmap to the next generation of power conversion technology, Transphorm's EZ-GaN provides a cost-effective, customizable and easy-to-use solution ready for commercial scale."

Electric power waste that occurs during power conversion is equivalent to the daily output of 318 coal plants, and it costs the U.S. economy $40 billion per year. Transphorm reckons it is the first company to provide a qualified 600 V GaN solution to inefficient power conversion.
The GaN products come in industry-standard packages and are designed for optimum high-frequency switching. Transphorm's proprietary EZ- GaN platform can reduce power system size, increase energy density and deliver high efficiencies across the grid, from HVACs to hybrids, and from servers to solar panels.

TriQuint foundry supports Sarda Tech

TRIQUINT SEMICONDUCTOR has announced that its Foundry Services division is supporting start-up Sarda Technologies to bring a new line of high-efficiency DC-DC converter switches to the global marketplace.

Sarda, a 'clean-tech' company based in Durham, North Carolina in the U.S., plans to offer cost-saving solutions for increasing efficiency and reducing component size in smartphones, mobile PCs and similar applications.

"Sarda Technologies is a good example of the innovative commercial and defence start-ups our Foundry Services division supports. Sarda is developing an impressive family of power semiconductors for high-volume applications," remarked VP and General Manager for Defence Products and Foundry Services, James L. Klein. "We offer a support system that enables a company's first-to-market strategies including best-in-class modelling, program management and applications engineering teams dedicated to customer success."

The global market demand for highly-efficient DC-DC switches for power converters is significant. According to the Darnell Group's December 2011 report, the market is projected to grow from nearly 20 billion units in 2011 to just under 32 billion units in 2016, a 9.7% compound annual growth rate; global revenue is expected to grow to $4.3 billion. Power switching process technology currently utilised in DC-DC converters is not highly efficient. The switch is seen as an increasingly critical consumer electronics design element since power consumption dramatically impacts end-user product experiences. The higher efficiency, reduced size and cost-effectiveness of compound semiconductor-based technologies can be a definitive marketplace advantage.

Jeff Shepard, Darnell Group President said, "Sustained growth built on delivering improved DC-DC converters depends on innovative solutions. Sarda is a good example of a high tech company striving to deliver products that aim to meet these emerging requirements."

ALWAYS ONE STEP AHEAD

HIGHER PRODUCTIVITY // With almost 30 years of experience AIXTRON stands for proven engineering power and dedicated customer support: Our equipment serves a diverse range of customers to manufacture highest LED volumes at lowest cost.

BETTER PERFORMANCE // As the driving force in deposition equipment AIXTRON engineers powerful technology solutions: Our equipment is the best choice available to manufacture the brightest and most efficient LEDs.

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AIXTRON started in 1983 and is today a leading provider of deposition equipment to the semiconductor industry. With our advanced solutions customers worldwide build components for electronic as well as opto-electronic applications. As pacemaker in our line of industry we are keeping always one step ahead.

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Aixtron's new approach to its MOCVD business

A NEW agreement with MSFL , one of China's main non-banking financial institutions, will enable Aixtron to promote the leasing of its MOCVD equipment to customers across China. Minsheng Financial Leasing (MSFL) and Aixtron SE, announced a strategic alliance for joint marketing of leasing options in China. Feng Wang, CPO, President of Finance Leases SBU MSFL, and Wolfgang Breme , CFO Aixtron, signed the Memorandum of Understanding at a ceremony held at MSFL's headquarters in Beijing.

"This exciting strategic cooperation will enable LED manufacturers to draw upon the most appropriate financing opportunities for the acquisition of key-enabling MOCVD equipment," commented Rong Wang, CFO of MSFL.

LED technology plays an important role in the global aspiration to conserve energy and has been defined as one of the key industries (energy conservation/ environmental protection, new materials) in China´s 12th 5-year plan aiming to ensure long-term prosperity.

"Aixtron's role and commitment to China is to deliver the essential key-enabling technology, that the emerging LED lighting market needs, taking full advantage of Aixtron's technology and embedded expertise," Paul Hyland, President and Chief Executive Officer at Aixtron, commented. "Our goal with Minsheng is to facilitate financial instruments to support Chinese manufacturers."

According to Internal Market Research Analysis, GBRA / MBL, China, November 2011 China's LED market showed extensive annual growth of 45% in 20101. It is expected to grow in output value from CNY 120 billion ($19.05 billion) in 2010 to CNY 500 billion ($79.4 billion) during the course of the 12th 5-year plan, representing a total growth of 317%. Aixtron says these significant projections reflect the fact, that in 2011, China was the biggest single regional buyer of MOCVD equipment, accounting for 58% of all global shipments within that period.

MiaSolé CIGS efficiency beats targets for panel production

MIASOLÉ has achieved a 17.3 percent champion device result, while the manufacturing process for 14 percent efficiency is now in production at its facility in Silicon Valley, California. These latest efforts occured ahead of schedule, and represent an increase of more than 30 percent in efficiency from last year.

"The progress in efficiency gains we've demonstrated are proof that we're moving toward a competitive cost structure ," said John Carrington, CEO of MiaSolé.

With increased manufacturing efficiency and investment in research and development, MiaSolé has been able to unlock the vast potential for CIGS thin-film in the solar industry. To date, the firm has shipped over 55MW with its panels being used for a wide range of global projects in North America, Europe and Asia.
The panels have been selected for a range of segments from utility scale fields to rooftops, and unique applications like electric vehicle recharging stations.

"Our ability to deliver 14 percent in production with the capability to achieve efficiency up to 17 percent further emphasises the progress we are continuously making against our roadmap," said Carrington. "Our ultimate goal is to continue scaling innovation and deliver the lowest levelised cost of electricity to our customers."

Astrium GaAs pumps up the power

ASTRIUM has installed the one millionth solar cell from its supplier AZUR Space, a medium-sized supplier of solar cells based in Heilbronn, Germany. The firm delivered its 300th solar array in the presence of the Bavarian State Minister of Economic Affairs, Infrastructure, Transport and Technology, Martin Zeil. Astrium has also signed a long-term cooperation agreement with AZUR Space. The 100-strong Astrium team is currently busy preparing the solar arrays for the European BepiColombo Mercury probe. Astrium is also developing the world's most modern solar array for the new European ALPHABUS telecommunications satellite.

"Weather observation, environmental monitoring, disaster management, navigation, telecommunications from space and numerous scientific missions – all these applications would be impossible without Astrium's particularly reliable solar arrays," said Evert Dudok, CEO of Astrium Satellites. "Today's modern gallium arsenide solar cells, that we install in space, have now reached an efficiency of up to 28 percent, making them more than twice as efficient as the solar cells currently used for roof installations. Space then can contribute to improving conditions on Earth, and, as the number one European company for space technologies, were are acting as an innovation driver for terrestrial applications."

The solar arrays developed and manufactured by Astrium have an output ranging from a few hundred watts up to 26 kilowatts. Featuring some 20,000 solar cells and a wingspan of up to 19 metres (for each panel either side of the spacecraft), a solar array weighs no more than 145 kilograms and is folded during launch to a thickness of 30 centimetres. Once the satellite is in space, two of these solar wings are deployed to the left and right of the satellite to meet its electrical power needs. To date, not a single Astrium solar array has failed while in operation. The production facility features three parallel integration lines, enabling up to nine large arrays to be in production. A cleanroom provides space for production, integration and testing benefiting from the fact that all the development and manufacturing processes are carried out in one single place.

Astrium has developed a patented method of detecting potential breakages and other defects in its solar cells. Solar cells can be operated in reverse – in other words electroluminescence.

Currently, Astrium in Ottobrunn is also developing solar arrays for the European Space Agency's BepiColombo interplanetary probe, which is due to embark on its journey to Mercury, the closest planet to the sun, in 2014.

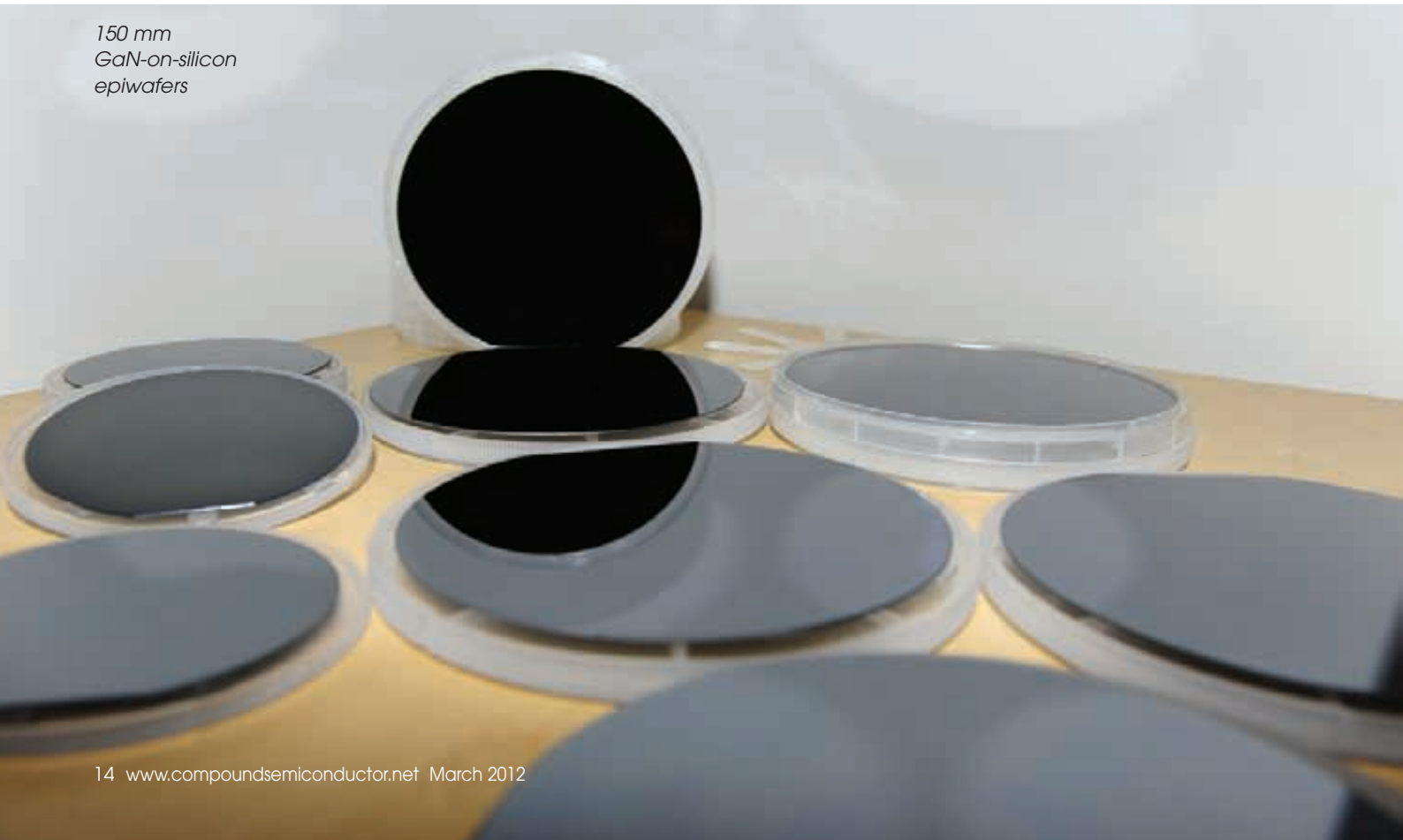
The biggest challenge here is preparing the arrays to withstand temperature fluctuations ranging between -130 and +270 degrees Celsius and to protect them from the sun's intense UV radiation.

Driving widespread deployment of **GaN electronics**

Transistors built from GaN-on-silicon promise to grab a major share of the power device market, thanks to their combination of low cost and high performance. Converting their potential into success hinges on scaling production to large wafer sizes and employing excellent passivation techniques, two areas where they excel, according to **EpiGaN founders Marianne Germain, Joff Derluyn and Stefan Degroote.**

Saving energy is a top priority for many nations. To succeed in this endeavour, they can make greater use of clean technologies that enable efficiency gains in the production of energy, the way it is transported and how it is used.

In this context, one area demanding the utmost attention is that of power conversion. There is still a tremendous opportunity to deliver substantial reductions in energy losses associated with AC-to-DC conversion and DC-to-DC conversion. If a new generation of electronic devices can be unleashed that combine the capability to handle higher powers with lower switching loss and higher operating frequencies, that could boost the efficiency of power inverters, while trimming their size and weight. Benefits that would follow include



150 mm GaN-on-silicon epiwafers

better power supplies for computers and more efficient power conversion in solar converters and hybrid electrical vehicles.

The power electronics market that could underpin this revolution in efficiency savings is growing at more than 8 percent per year, and is worth billions and billions of Euros. Silicon devices dominate this sector. However, the room left for improvement in these devices is vanishing fast, because the best ones are now operating close to limits imposed by their intrinsic characteristics. It is widely accepted that silicon IGBTs deliver a relatively poor performance at high frequencies and MOSFETs struggle to handle high powers.

Fortunately, there is a superior class of materials that can come to the rescue: Wide bandgap semiconductors. This includes GaN-on-silicon devices, which excel at combining affordability with great performance.

One of the biggest attributes of these nitride electronic devices is their high breakdown voltage, which stems from a field strength that is an order of magnitude higher than that of silicon. Thanks to the high mobility and large carrier concentration associated with the two-dimensional electron gas (2DEG) of the AlGaN/GaN heterostructure, nitride devices built for switching applications can also combine a low on-resistance with a high switching speed. What's more, the wide band-gap properties associated with GaN-based devices enable them to operate at high temperatures.

Development of nitride power devices has been underway for more than a decade and progress in this direction has enabled today's switching devices to outperform their silicon rivals. In the performance stakes, SiC is a tougher opponent, but GaN more than holds its own.

Making the nitrides affordable

Great performance is no guarantee of market success: Products must also be affordable. GaN-on-silicon excels in this regard, because it is the most cost-efficient wide bandgap technology. It is already possible to deposit advanced heterostructures on silicon substrates up to 150 mm in diameter, and in the near future this growth process will be extended to 200 mm silicon. There is also an opportunity to develop process compatibility with standard CMOS technology, which would open the door to further cost reduction by enabling these wafers to be put through lines at under-utilized 200 mm silicon fabs that are dotted around the globe.

Given it's potential, it is of no surprise that GaN power electronics technology is attracting more and more interest. But no one is yet to deliver the first big commercial breakthrough – a reliable device operating at 600 V. One of the biggest challenges is to drive the

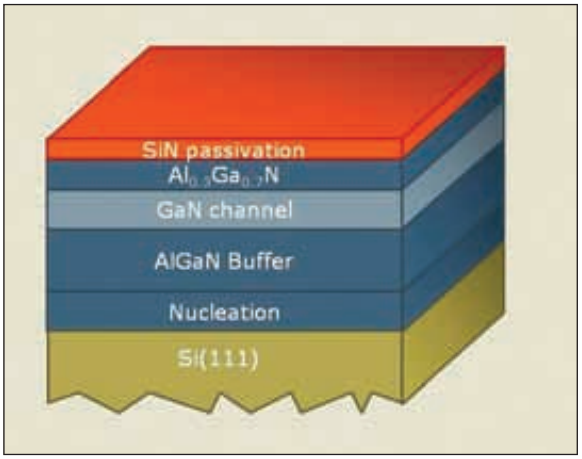


Figure 1. In-situ SiN passivation, a unique concept for controlling surface states filling, enhancing device stability during operation as well as reliability tests

first significant penetration for a compound semiconductor technology of a domain where silicon dominates, and many potential customers have been scarred by the experience of SiC. Although the performance of SiC diodes is attractive for power converter manufacturers, these chips are too pricey. In addition, until recently these diodes couldn't be paired with a SiC transistor, which is detrimental to the uptake of this first-on-the-market wide bandgap solution.

Another reason behind the lack of a commercially attractive, reliable 600 V device is that it is tough to manufacture GaN-on-silicon epitaxial structures, which are the starting point for making power electronics.

This is precisely the challenge that we have picked up at EpiGaN, a spin-off of imec, a large international independent nanoelectronics centre located in Leuven, Belgium. Our start-up, which we co-founded in May 2010, is built on our expertise developed at imec, where we were involved in GaN research from 2001. Key successes during that time included the world's first low-sheet-resistivity 6-inch HEMT structures in 2006, and the first GaN-on-silicon 200 mm epiwafers, a feat achieved in partnership with the MOCVD toolmaker Aixtron.

Our approach differs from that of several players, which employ SiC as the substrate for their nitride devices. We have always focused our efforts on GaN-on-silicon devices, due to their cost advantages. Initially, we developed material for RF devices (we also offer epiwafers for RF applications). However, given the strengths of GaN-on-silicon for power electronics, it was an obvious move for us to switch our focus and target this lucrative market.

During our time at imec advances in device performance governed our development of materials growth. This approach worked effectively and efficiently, thanks to very fast feedback of device performance.

While stress engineering may be the most challenging aspect of forming GaN-on-silicon devices, it is arguably not the hottest topic. That accolade goes to passivation of surface states

Armed with this method of working, we were able to simultaneously improve: Material aspects, such as channel conductivity and defect density; device related aspects, including *in-situ* passivation, dynamic performance, enhancement-mode devices, high-voltage operation, power density and operating frequency; and last, but by no means least, reliability. During this effort we paid careful attention to the reproducibility of the results. This approach brought us much success, including state-of-the-art device performances and the unveiling of a device concept for an enhancement-mode 600 V HEMT.

The commercial promise of these achievements has helped us to attract a strong, balanced consortium of investors. Our vision is shared by Robert Bosch Venture Capital, Capricorn Cleantech fund and LRM. Their funding in 2011 has been used to set-up a new plant for producing GaN epiwafers by MOCVD in Hasselt, Belgium.

Taking the strain

Our growth process deals with the strain that arises when GaN is deposited on silicon. These two materials have significantly different crystalline properties and thermal expansion coefficients. Left unchecked, this can lead to strain in the epilayer and substrate that can ultimately cause the wafer to bow and even crack.

By carefully managing this strain, we can make wafers that are suitable for passing through silicon processing lines. Day-in, day-out, we can manufacture 150 mm epiwafers with a bow well below 50 μm – it is typically 20-30 μm, depending on wafer specs. Uniformity, in terms of standard deviation of either layer thickness or electrical characteristics, is typically better than 3 percent.

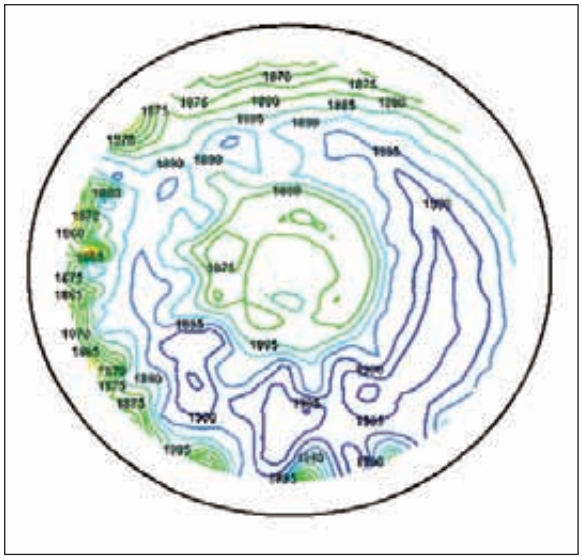


Figure 2. Electrical uniformity mapping of 150 mm GaN-on-silicon wafer, measured contact-less sheet resistivity

These epiwafers are optimized for high voltage/high frequency operation. This requires the formation of a buffer layer that withstands a very high voltage. It is possible to realise this: We have observed that in devices formed with high-quality GaN layers, the upper breakdown voltage is actually limited by the silicon substrate. The epiwafers that we produce for high-voltage devices have a buffer leakage current well below μA/mm at 600 V. Operating frequencies in excess of 100 GHz are also possible with our material, thanks to a reduction of buffer traps.

While stress engineering may be the most challenging aspect of forming GaN-on-silicon devices, it is arguably not the hottest topic. That accolade goes to passivation of surface states. GaN is a piezoelectric material that features an excellent high-electron-concentration – associated with high electron mobility – that is obtained 'for free', without the need for any extra doping. But there is a significant price to pay: An extreme sensitivity governing device characteristics, such as current density and threshold voltage, on the filling of those surface states, which have a density comparable to that found in the channel. If passivation is poor, the device's dynamic behaviour suffers. To combat this so-called dispersion problem, devices must be processed in a carefully controlled manner using high-quality epiwafers, because this leads to optimised buffers and controlled surface states.

Fail to do this, and uncontrolled charging or discharging of these surface states – which can be modified during processing and device operation – can severely degrade the dynamic properties of the device. To prevent this from happening we deposit a unique *in-situ* SiN capping layer, which is grown by MOCVD as part of the epitaxy process, on top of HEMT epiwafers. The interface between this capping layer and the top nitride surface is incredibly smooth, and it enables perfect passivation of surface states (see Figure 1).

We have shown that this capping layer can properly control the filling of the surface states during device operation. In fact, it is believed that SiN can provide enough charge to neutralize the surface charge of the

AlGaN barrier layer so that its surface potential no longer contributes to 2DEG depletion. In addition, we have found that the SiN layer aids device stability at elevated temperatures. Specifically, it significantly enhances device reliability in high-temperature, accelerated-lifetime tests.

These *in-situ* deposited SiN films can also lead to lower channel resistance. This equips engineers with another route to adjusting the top part of the FET so that it can hit particular device specifications. GaN FETs are lateral devices, and optimising their performance demands a trimming of conduction losses. This means that for switching applications, aluminium-rich barriers are preferred in a typical AlGaN/GaN structure, because this leads to a higher piezoelectric field, a higher current density and a lower specific on-resistance.

We have shown that one of the major benefits of the SiN cap layer is that it enables increases in aluminium concentration, which are possible without any significant material degradation. This is not the case in transistor structures with an uncapped or GaN-capped AlGaN/GaN 2DEG, where relaxation of the strained top AlGaN layer typically prevents high aluminium content in the top layer.

It seems that *in-situ* SiN capping layers postpone relaxation of the strained AlGaN layer grown on GaN. This delay of relaxation has enabled us to demonstrate a SiN/$Al_{0.35}Ga_{0.65}N$/GaN/AlGaN FET with sheet resistance (R_{sh}) well below 300 Ω/☐ on 100 mm and 150 mm silicon (111) substrates. As one would expect, our SiN passivation process improves the performance of nitride FETs grown on other types of substrate too, such as SiC.

For our SiN/AlN/AlGaN design that is detailed in Figure 3, sheet resistance falls to 235 Ω/☐ with our passivation technology. In this structure, Hall measurements indicate that the electron sheet concentration is 2.15 x 10^{13} cm^{-2} and electron mobility is 1250 cm^2/Vs. These are very promising values and they enable the fabrication of devices with a high transconductance, even when gate length is relatively large. What's more, they highlight the potential of this device for high-frequency operation.

The neutralization of surface charges provided by the SiN layer also unlocks the door to an innovative approach for making enhancement-mode devices. This form of transistor, which is required for power converters, can be made by combining a thin AlGaN barrier layer with local removal of SiN under the gate.

From 600 V to 1.2 kV

Today we can reproducibly manufacture GaN-on-silicon wafers with a breakdown voltage above 600 V and a very low leakage current. This is by no means the upper limit for the breakdown voltage of our devices – recent work has yielded FETs with a breakdown above 2 kV.

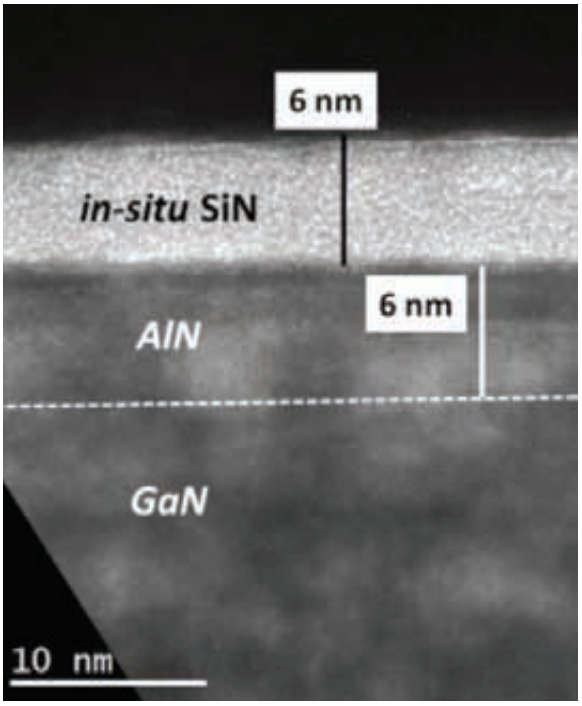


Figure 3. SiN/AlN/GaN heterostructure

In every industry, conversion of hero results in the lab to production processes takes time. However, it is clear from our efforts that GaN can already be used today to make products in the 30 V-200 V and 600 V range, and it will not be long before variants operating at 1200 V can be added to the list.

This will pave the way for the replacement of two silicon MOSFETs with a single GaN HEMT, a move that will trim the cost and weight of a power converter. To make this happen, we are focussing our development on 1200 V epiwafers on 150 mm silicon.

When we release this product, it will be added to our existing range of 4-inch and 150 mm epiwafers for high voltage and/or high-frequency applications. The production capacity for these products is being ramped up at our new site, while in parallel we are developing manufacturing processes for 200 mm GaN epiwafers operating at 600 V and 1200 V.

Although today the demand for these larger epiwafers is weaker than that for those with diameters of 150 mm or less, larger sizes will spur a cost reduction and enable GaN to deliver further success in a field where, up until now, no compound semiconductor has seriously challenged silicon.

Further reading

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J. Derluyn et al. J. Appl. Phys. 98 54501 (2005)

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Defining the next steps for the Compound Semiconductor Industry

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

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

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Topic: Building a successful III-V pure play foundry

Dr. Michael A. Briere
International Rectifier
Job title

Topic: Commercialization of GaN on SI based Power Devices

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

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

Dr. Markus Behet
Dow Corning
Global Market Manager Power Electronics

Topic: Advances in wide bandgap semiconductors for power electronics

Dr. Matty Caymax
Imec
Chief Scientist

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

Asif Anwar
Strategy Analytics
Director – Strategic Technologies Practice

Topic: Compound Semiconductor markets: Current status and future prospects

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Topic: Damage – free deposition on LED devices

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Philip Smallwood
IMS Research
Lighting Market Analyst

Topic: The market for LEDs in lighting

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

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

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

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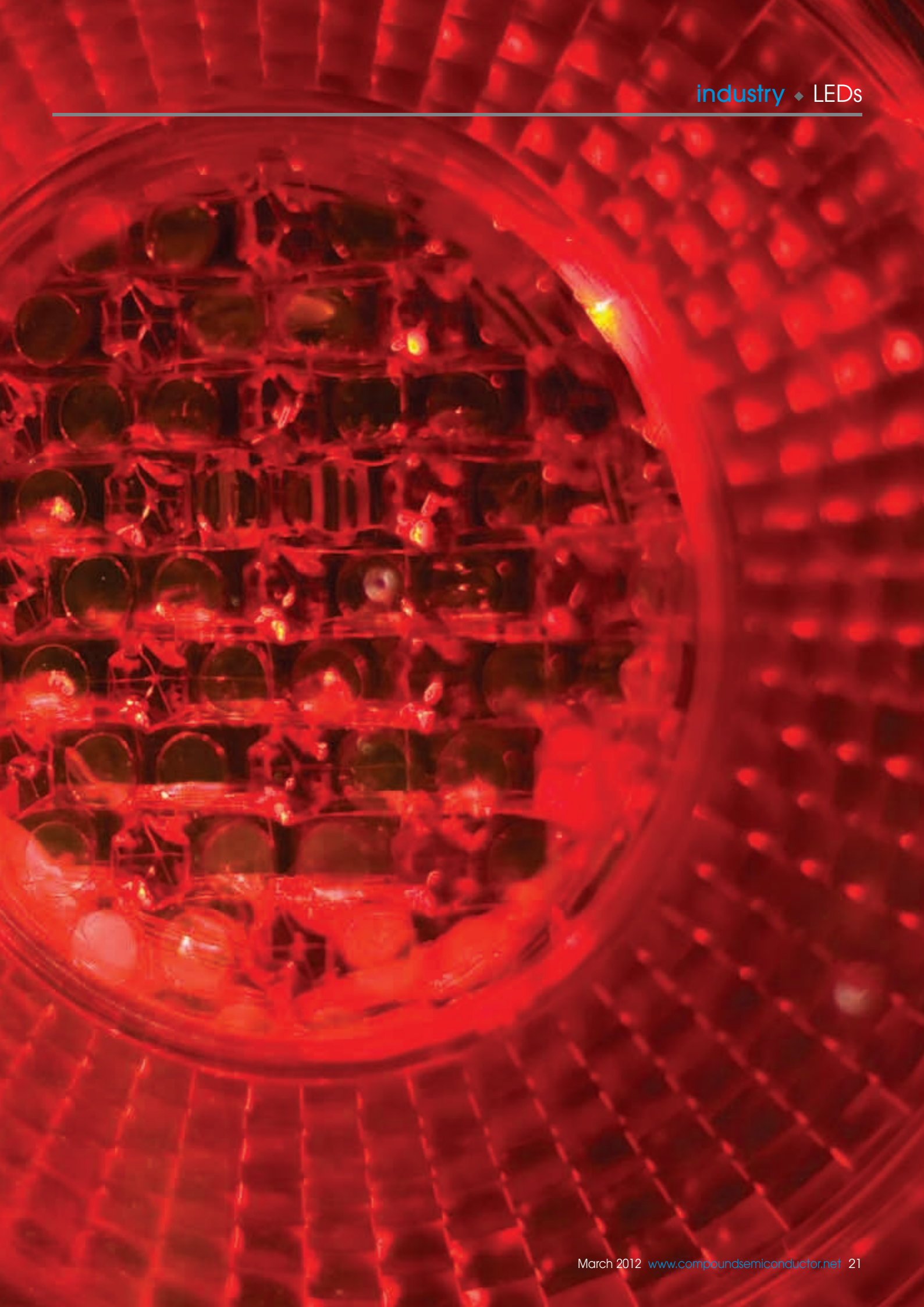
Osram issues a red alert for **solid-state lighting**

Breaking the 200 lm/W barrier for the red LED will do far more than simply increase the efficiency of car brake lights. It will also improve the efficacy and colour quality of solid-state lighting sources as well as pico-projectors and yield a lighting product for greenhouses when combined with blue LEDs, says **Martin Behringer from** Osram Opto Semiconductors.

The term 'solid-state lighting' conjures up images of white emission emanating from streetlights, car headlamps and modern fixtures in subway stations. Anyone standing there and basking in such light will undoubtedly look on in awe at these diminutive illumination sources, but that does not mean that they will be thankful for their pale-looking faces produce by the collections of white-emitting LEDs.

Fortunately, we don't live in a black and white world – we live in one of colour and warm faces. But to do justice to the world's incredibly rich palette requires an illumination source that produces the full gamut of colours, from the deepest reds right through to blues and violets.

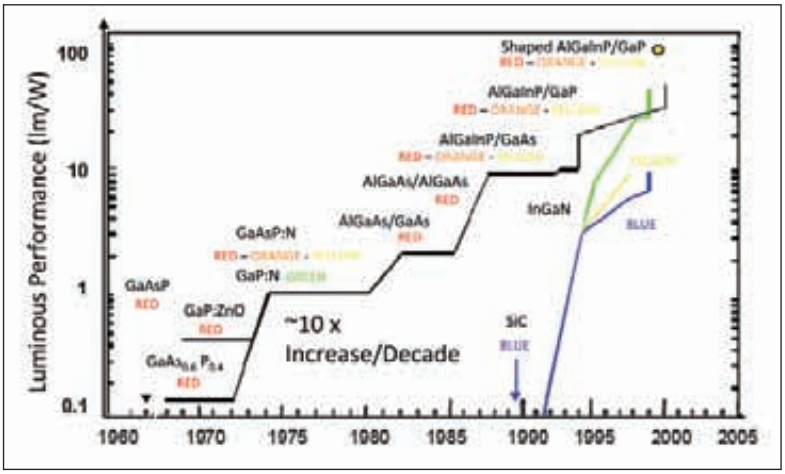
The traditional white LEDs that combine a blue-emitting chip with a yellow phosphor fail in this regard, because they ignore longer wavelengths. Although long-wavelength sources – directly emitting red, yellow and



LEDs are now employed for a wide variety of applications, from solid-state lighting to projectors and green house illumination

infrared LEDs – have been overshadowed by their blue cousins in recent years, their development stretches back far further, to the 1960s. Efforts in this direction are tremendously important, because a vast number of applications require yellow, red or hyper-red illumination: Projectors; colour-mixing systems for warm white illumination; lighting sources for green houses that marry hyper-red and blue light; and closed circuit TV, adaptive cruise control for cars and light curtains in elevators that require high-brightness infrared illumination. Despite common perceptions to the contrary, it is clear that the solid-state lighting requirements of today far transcend 'just white light'.

At Osram Opto Semiconductors, which is based in Regensburg, Germany, we have recently achieved a significant technological breakthrough that will help in this regard, and one that merits a 'red alert': The first red LED with an efficacy exceeding 200 lm/W. This new benchmark for the red LED is a fruit of 12 years of diligent effort associated with our development of thinfilm technology.



A little history

The most widely used material for developing long-wavelength visible LEDs is AlInGaP, which can span 560 nm to 660 nm. The first devices made with this quaternary were homojunction LEDs incorporating a simple pn junction. However, over time this device has evolved from a lab curiosity to a high-performance, commercial product (see Figure 1).

The introduction of mature processes has driven up yield; and efficiency has rocketed, thanks to the introduction of more sophisticated device architectures incorporating carrier capture in quantum wells.

Growth of LED epistructures by MOCVD on high-quality substrates can routinely produce longer-wavelength emitters with internal efficiencies exceeding 90 percent. But the high refractive index of the AlInGaP LED traps most of the light: Only 4 percent leaves the chip directly and can be used for illumination; with the remaining 96 percent either re-absorbed by the material, or reflected at the interface between chip and air, before eventually being absorbed by the device (see Figure 2).

These high levels of absorption held back the performance of red LEDs. Devices with a peak wavelength of 615 nm, for example, produce a peak efficiency of just 40 lm/W (see Figure 3).

To stop wasting so many photons, we have pioneered and developed ThinFilm technology (see Figure 2). With this approach, in contrast to a conventional LED, the

*Figure 1: The performance of red, yellow, green and blue LEDs has come on in leaps and bounds over the last 50 year. Figure adpted from Semiconductors and Semimetals **48** 48 (Publisher: Elsevier/Academic Press)*

growth substrate is removed and the active epilayers are bonded to a carrier. Absorption of light in the substrate is negated by inserting, via deposition, a highly reflecting mirror between the epilayer and carrier. And in addition, the ThinFilm LED features: A thinner active region that reduces absorption; superior light extraction, thanks to surface roughening or the introduction of microprisms; and no shadowing, because the current is directed away from the bondpad.

Our development of ThinFilm LEDs, which began in 1998, has had a tremendous impact on the efficacy of red emitters. Although the technology took some time to master, by 2010 we were able to produce 140 lm/W LEDs.

The high efficiency of our ThinFilm LEDs goes hand-in-hand with other strengths. They are also scalable. This means that, in theory, all chip sizes can be made by similar methods, possess similar characteristics, and deliver a level of performance that just depends on the dimensions of the device.

In addition, these surface-emitting chips deliver a highly desirable Lambertian beam pattern, and can be manufactured in high volumes using cost-efficient design and manufacturing processes.

These results were obtained some time ago, and we believe that our latest generation of ThinFilm die can increase the output power of bare and packaged die by 30-50 percent and 10-30 percent, respectively.

Towards new highs

During the last few years we have made further strides in terms of efficiency, cost and reliability. This has been accomplished by carrying out a detailed investigation of loss mechanisms and introducing new designs to combat these losses.

One aspect of the LED that has been improved is a reduction in its internal absorption. This pays dividends even if light has to travel ten times through the die before escaping the semiconductor. Absorption has been trimmed by increasing the bandgap and adjusting the doping in some layers.

These steps could also drive up operating voltage and ohmic resistance, so to address this we have improved the conductivity in certain layers.

Another of our improvements is optimisation of contact design, which helps to lower the operating voltage. With more current paths spaced closer together, the electrical current can be evenly distributed across the entire chip. Images of 1mm^2 die reveal the dense arrangement of these metals' current paths, and strong electrical performance despite adjusted doping levels.

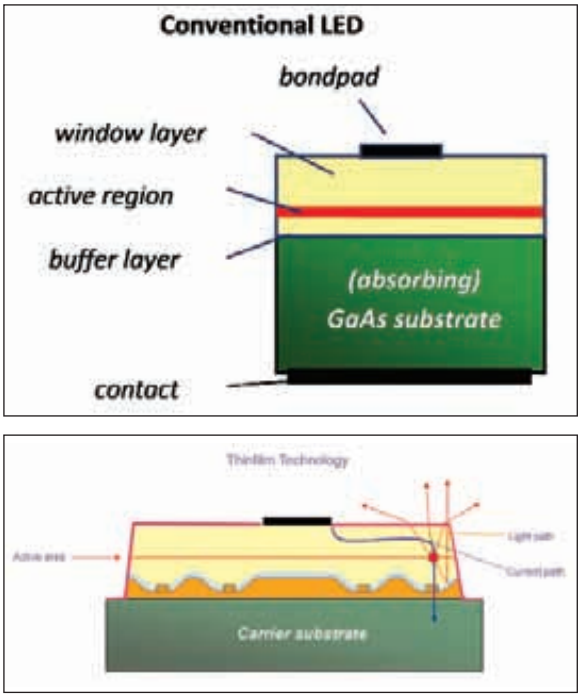


Figure 2: A substantial proportion of the light generated in a conventional LED, which is built on an absorbing substrate, is trapped within the chip (top). Light extraction improves dramatically with a ThinFilm LED architecture incorporating a metal mirror between the active epilayers and carrier (bottom). In this superior device, the current path, depicted by the blue line, is directed away from the bondpad to avoid shadowing. The light path (shown in red) is initially toward the substrate, but changes direction thanks to reflection by the underlying mirror. Light is redirected toward the chip surface, where it can leave the semiconductor die

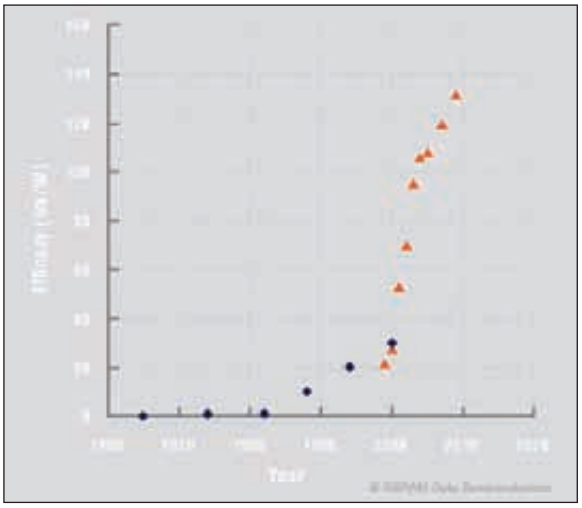
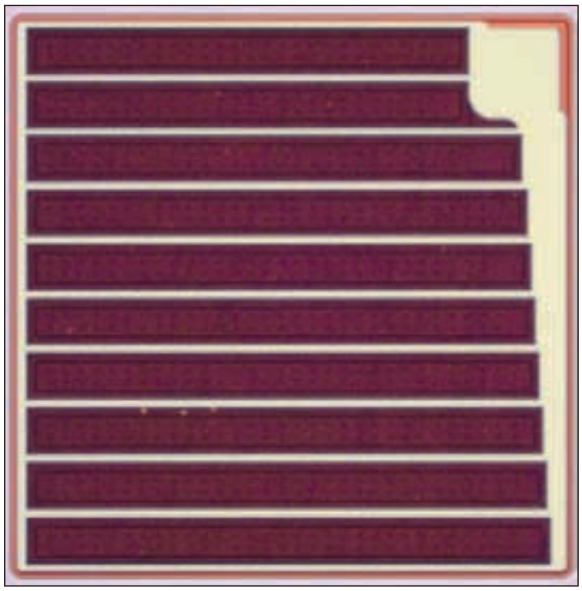
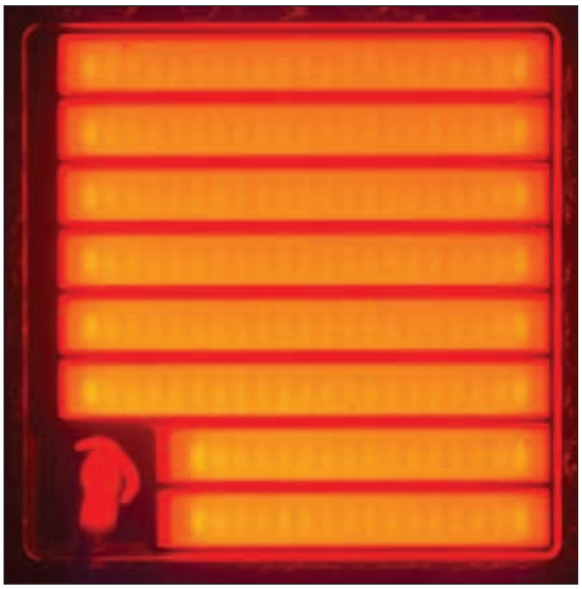


Figure 3: The historic efficiency of red LED brightness. Blue dots indicate volume emitters on an absorbing GaAs substrate and orange triangles indicate the performance of Osram's ThinFilm LED since 1999





1mm² die of latest Osram ThinFilm generation. Surface image (left) and illumination pattern (right)

Thanks to all these enhancements in device design, the latest generation of ThinFilm LEDs set a new performance benchmark. Our 1mm² die, which was mounted into a laboratory package and optimised for efficient out-coupling, produces high levels of efficacy and wall plug efficiency (WPE) over a wide current range (see Figure 4).

Both these characteristics peak at a drive current of 50 mA, hitting 201 lm/W and 61 percent and falling to 168 lm/W and 52 percent at 350 mA. The reason behind these declines in efficacy and WPE is revealed by the orange curve, the plot of external quantum efficiency. This has a very broad maximum, with values of 58 percent at 50 mA and 59 percent at 350 mA.

Since the external quantum efficiency is essentially constant, declines in efficacy and WPE must be attributed to increases in operating voltage, due to ohmic resistances within the die.

Record-breaking efficacies were produced with a red die with a dominant wavelength of 609 nm at room temperature. Realising similarly high efficacies at longer wavelengths is even more challenging, due to declines in eye sensitivity. But, counter-balancing this, high-wall-plug-efficiency values are easier to realize with longer wavelengths.

We have also produced 1mm² die housed in identical laboratory package that have a 645nm dominant wavelength and a peak emission at 660nm (see Figure 5). WPE exceeds 70 percent between 5 mA and 60 mA, and falls to 59 percent at 350 mA. Output power rises linearly with current to reach about 437 mW at 350 mA, using a forward voltage of 2.1 V. Due to reduced eye sensitivity, the lumen output at this drive current is just 21 lm.

The improvements resulting from out latest ThinFilm technology can be implemented with a very broad process window. This allows for high yield, which in turn lowers overall cost. We have already applied this new technology to chip sizes of varying lengths: 250 μm, 300 μm, 500 μm, 750 μm and 1 mm.

Later this year, 150μm and a 2mm² die will be added to our portfolio.

An already-widespread application is the combination of a highly efficient – but aesthetically unpleasant – cold-white LED with an amber or red one, because this lowers the colour temperature to a more visually pleasant and high-quality white. This modification is something of a win-win, because it increases the overall efficiency and the colour-rendering index

The wavelength range, in terms of the dominant wavelength, is currently 590 nm to 645 nm, and 560 nm and 570 nm LEDs will follow in the latter part of 2012.

Commercial opportunities

An already-widespread application is the combination of a highly efficient – but aesthetically unpleasant – cold-white LED with amber or red one, because this lowers the colour temperature to a more visually pleasant and high-quality white. This modification is something of a win-win, because it increases the overall efficiency and the colour-rendering index.

Our breakthrough in red LED efficiency will also aid projection and signalling applications, which value a highly efficient red source. Mobile applications are also set to benefit, with customers enjoying brighter screens, or benefitting from longer battery life. While in industry, lower energy consumption will trim operating expense, and brighter devices will cut the cost of initial installation.

One area where highly efficient LEDs seem assured to make a positive impact is in LED-illuminated green houses. Thanks to incredibly high efficiencies, energy costs can plummet by almost a factor of two compared with conventional lighting; and on top of this, LED-cooling is made easier. For example, our state-of-the-art LEDs can generate 75 percent more light at a given electrical power than a source with 40 percent peak efficiency. And if waste heat is the chief concern, our LEDs can generate two-and-a-half times as much light compared with the present lighting fixtures.

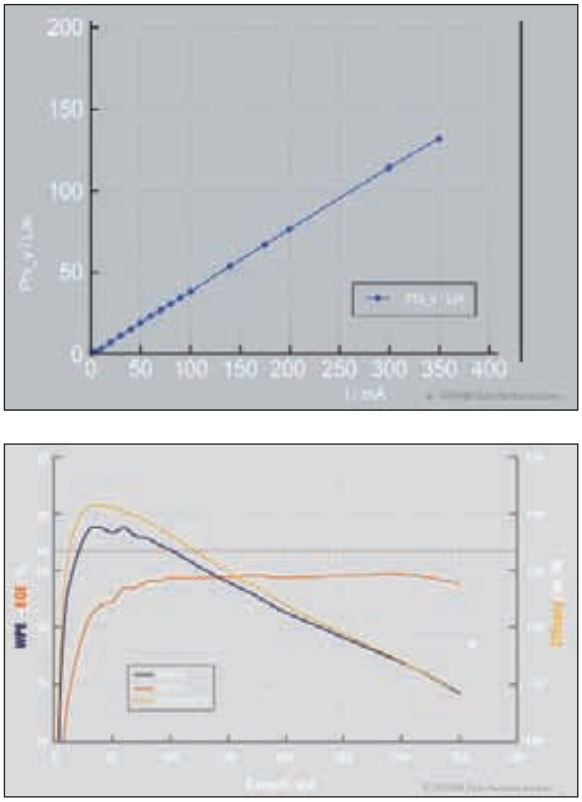


Figure 4: Light current curve (top) and efficiency /efficacy over current (bottom) of 1mm² LED in laboratory package

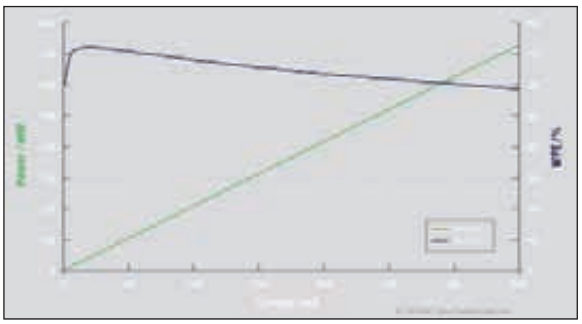


Figure 5: Light output and wall plug efficiency over operating current for a Osram's 1mm² die emitting at a peak wavelength of 660 nm

What next?

Wringing out further improvements in efficiency is increasingly challenging as the devices creep towards the ideal goal of 100 percent. Efforts will undoubtedly continue in this direction, nudging efficiency from 60 to 70 percent, but this will be carried out in conjunction with programmes to improve production and processes.

There is also a need to improve LED performance at high currents and temperatures. Characterizing devices at room temperature is common practice, even though many devices actually operate in far hotter environments, such as 100°C. To address this, we are working to optimise output power at this temperature, as well as reducing the shift in operating parameters with temperature.

Another challenging area, where issues continue to evolve, relates to optimisation of the coupling of light out of the LED. Research is ongoing to extract every generated photon, at both the package and the die level. New die configurations promise to deliver significant progress in this direction.

As we continue to develop and improve our long-wavelength LEDs using the approaches just outlined, our devices will be able to serve an increasing broad portfolio of applications. Further improvements are imminent, so don't be surprised if its soon time for us to issue another 'red alert'! A brighter future surely lies ahead for all of us.

Ultra-fast photodiodes:

The missing link between wireless and optical networks

Wireless-over-fibre systems are needed to increase data rates to the speed demanded by next-generation wireless networks. One key component in these systems is the near-ballistic uni-traveling carrier photodiode, which can operate at ultra-high speeds with the addition of a p-type charge layer inside the collector, says **Jin-Wei Shi from National Central University, Taiwan.**

Nowadays, we rarely make a call on our mobile. Instead, we use it to stream YouTube and Facebook videos, watch Internet TV shows, play video games, download and store songs and movies, and take and share pictures. Unfortunately, all these types of data transmission consume radio bandwidth – lots of it. The reality is that we are in the midst of a famine of the radio spectrum.

The most useful wireless communication occurs between 0.3 to 3.5 GHz, a spectral band that enables compact antenna, produces low propagation loss and allows good penetration through buildings. However, the maximum capacity in these wireless channels is typically just several Mbits/s, way short of the bandwidth

requirements for next-generation Gbit/s wireless networks.

The simplest way to rescue us from this famine is to boost up wireless carrier frequencies. Several currently 'unlicensed' (sub-) millimetre wave (MMW) bands are attracting attention for this purpose, including the V-band (60 GHz), D-band (120 GHz), and bands beyond 300 GHz. However, (sub-) MMW signals suffer substantial propagation loss, both in free-space and in transmission lines. This weakness, and their inherent straight-line path of propagation, hamper connections and synchronization between different parts of the communication system.

A promising way to overcome this problem is the MMW-over-fibre (MOF) technique (see Figure 1 for two examples of MMW over-fibre communication systems). This approach has three key strengths: It employs flexible optical fibre, rather than rigid MMW waveguides; propagation losses fall by several orders of magnitude (in MMW waveguides the loss is typically 0.05 dB/cm at 100 GHz, compared with typically 0.1 dB/km for MMW carrier-wave signal distribution); and network coverage is increased significantly. However, there is a tremendous difference in frequency between the 1.55 μm signals used in optical networks, which have a frequency of 190 THz, and MMW signals that have wavelengths of a few millimetres and frequencies of tens or hundreds of gigahertz.

MMW-over-fibre solutions

The first example provided in Figure 1 shows setups for additional electrical-to-optical and optical-to-electrical conversion in the central office and base station of an MOF system. The electrical-to-optical conversion in the central office usually employs 1.55 μm lasers and optical modulators. To let the optical wave have the desired MMW envelope for remote distribution through a low-loss fibre to several base stations, the electrical MMW is used for the input signal. This approach eliminates the huge propagation loss of the MMW signal that occurs along an electrical transmission line or in free-space. This optical signal is returned to the electrical domain at the base station. Down-conversion of the incoming optical signal extracts the MMW envelope, which is radiated over the last-mile to the end-user through an antenna.

A high-speed photodiode that can operate at the (sub-) MMW regime is the key component for converting the optical MMW envelope into an electrical MMW signal. Ideally this device also has a high output saturation power, so that it can generate high MMW power under intense optical power injection.

When these high-power MMW PDs are used in partnership with a high-power, erbium-doped fibre amplifier (EDFA), it is possible to minimize the burden imposed on the limited gain, noise, and saturation power performance of the next-stage MMW amplifier for wireless data transmission. What's more, the optical signal processing technique can deliver a photo-generated MMW signal of superior quality to that generated from a chain of MMW mixers and amplifiers.

It is also possible to build an MOF system that does not require a MMW photodiode (see Figure 1(b)). In this case, the optical fibre links are used to distribute the optical data signals from the central office to each base station. In the base station, incoming optical data is transformed into electrical MMW signals for radiation to the end-user with an oscillator, mixer, amplifier, and antenna operating in the MMW bands.

With this approach, the photodiode only converts low-frequency optical data; there is no optical MMW signal in this system. However, this benefit has to be weighed against more expensive and complex base stations, which must be synchronized and share the same optical MMW signal. Greater expense stems from the high-cost MMW ICs, which include the elements mentioned above, such as a mixer, oscillator, and amplifier for the MMW bands.

In addition, it is challenging to synchronize the different MMW oscillators at different base stations. This may be an issue for mobile users roaming among different base stations. Given this complexity, it is clearly better to build an MOF system that incorporates a MMW photodiode.

This device can be integrated with a MMW antenna to form a photonic transmitter (PT) at the base station of a high-performance MMW photonic-wireless link that also features a high-quality optical MMW source in the central office.

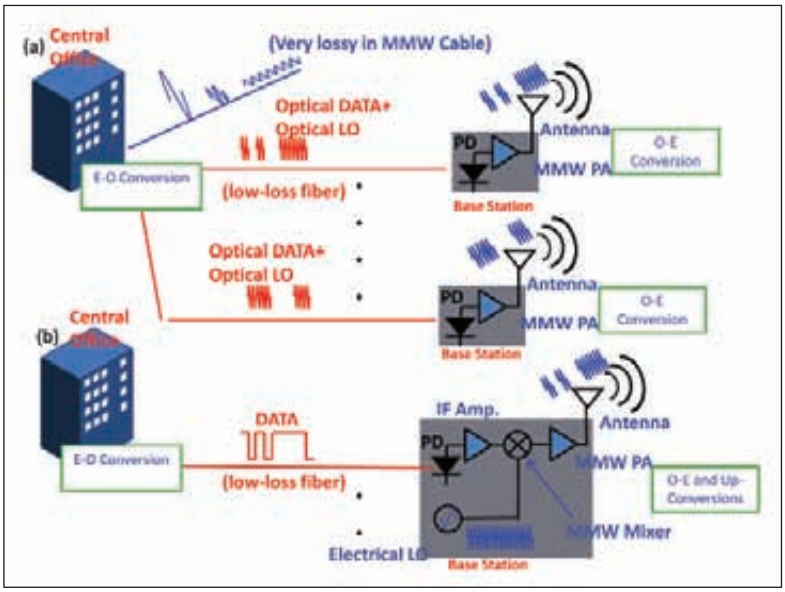


Figure 1. A MMW-over-fibre communication system promises to improve wireless data transfer rates. Such a system can feature a common optical local oscillator MMW source shared by: (a) different base stations and (b) different electrical local oscillator MMW sources installed in each base station

To create such a system, groups around the world have been developing of high-power, ultra-fast photodiodes. This effort had yielded several photodiode architectures, which have been trialled in MOF wireless communication systems deliver data rates exceeding 10 Gbit/s.

Photodiodes serving this application ideally excel in both speed and output power. One way to enhance the photodiode's speed is to reduce its parasitic capacitance, which is possible by trimming the device's absorption volume. However, when the absorption volume falls below about 1 μm^3, the density of photo-generated free carriers is very high, and this increases the space-charge field and photocurrent density, which screen the external applied bias field.
The upshot: A severe degradation in electrical bandwidth due to a reduction in the drift velocity of the photo-generated carriers (see Figure 2 (a) for an illustration of this point).

Researchers have developed two approaches that can produce an increase in power and electrical bandwidth. These methods are based on replacing a single photodiode with several smaller ones, or turning to a superior epitaxial structure.

With the first option, high power of the optical input can be shared between several miniaturized ultra-high-speed photodiodes. The power generated by each of them can then be combined with a low-loss electrical transmission line. This approach, known as the distributed or traveling-wave photodetector (TWPD), was first used in the era of the vacuum tube to improve the bandwidth performance of the vacuum tube amplifier. Parallel connections are the simplest way to combine the photocurrent from these small photodiodes. The major downside of this approach is a serious degradation of the RC-limited bandwidth, which stems from the hike in junction capacitance. But this can be avoided with a distributed structure (Figure 2 c). In this case, the MMW signal generated from each photodiode is coherently combined, leading to minimal broadening and distortion of the resultant signal. In an ideal case, the maximum bandwidth is as high as the bandwidth of each single photodiode.

Modifying the traditional epi-layer structure of the p-i-n photodiode is the other popular approach to improving the device's power and speed. This can combat saturation of the device's speed by quickening the rate at which photo-generated carriers are drained from the photodiode's active layers. With this approach, space-charge density falls, driving down the induced electric field.

One of the best ways to do this is to speed up the carrier drift-velocity inside the photodiode. This is possible by switching to a uni-traveling carrier photodiode (UTC-PD) design (see Figure 3). This swaps an intrinsic photo-absorption layer with a p-type doped epilayer, and modifies carrier transport: Photo-generated holes relax directly into the p-contact metal without drift, diffusion or accumulation in the photo-absorption layer, and only electrons remain in the active carrier. This promises to greatly enhance carrier velocity, by

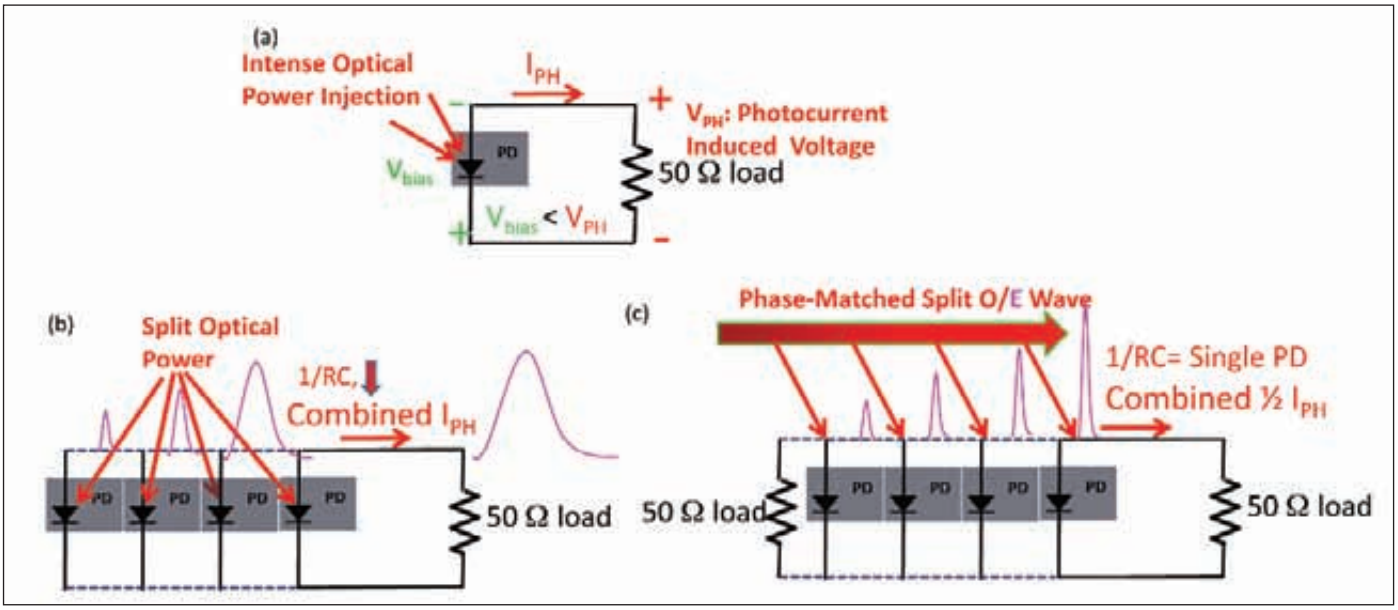


Figure 2. (a) With a single photodiode, intense light injection produces a high-output, photocurrent-induced voltage on the load, which has the opposite polarity to the bias voltage. This reduces the net electric field in the active layer of the device, thereby slowing down the carrier drift-velocity and speed performance. (b) Splitting the optical power between an array of photodiodes that are connected in parallel increases the output saturation current, but severely degrades the RC-limited bandwidth. (c) This restriction is lifted with distributed (travelling-wave) connections, which ensure matching of the velocity and phase of the injected optical wave and the photo-generated carrier wave

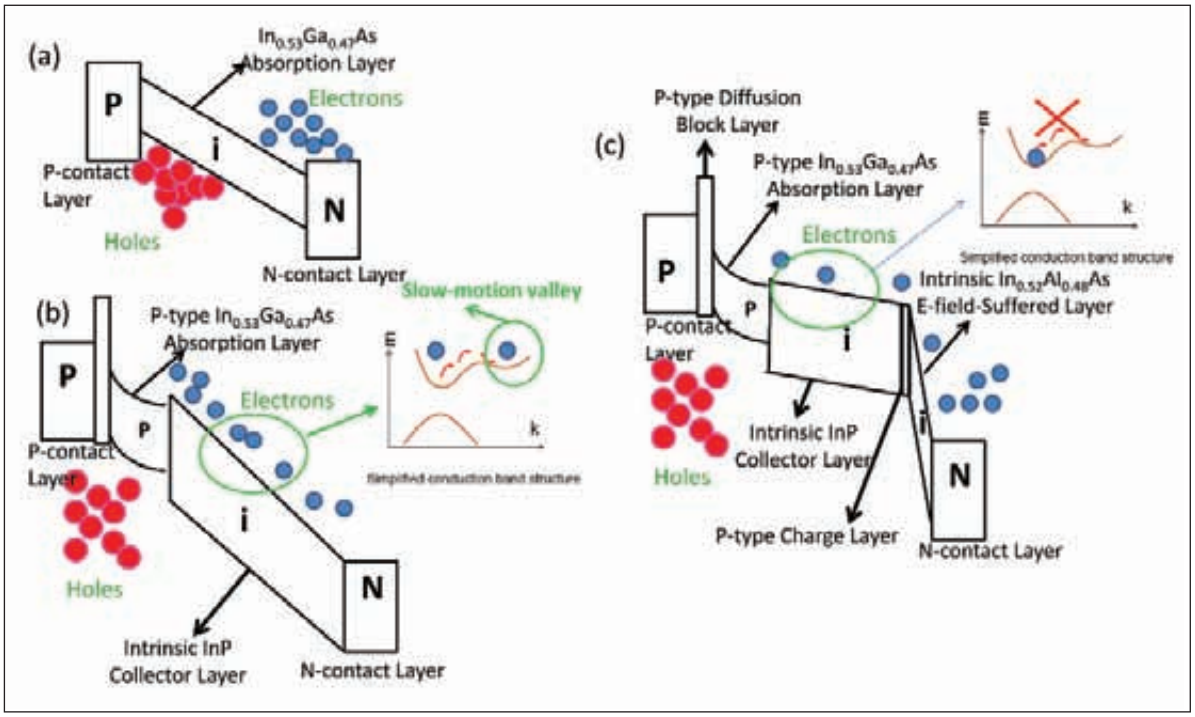


Figure 3. (a) The low mobility of holes limits the speed of conventional p-i-n photodetectors. (b) The UTC photodiode overcomes the limitation of low hole mobility by getting these carriers to relax in the p-contact metal without drift, diffusion or accumulation in the photo-absorption layer. However, if the electron is subjected to a high electric field, it can easily be swept to another electron potential valley with a heavier effective mass and a slower drift-velocity (c) With the NBUTC photodiode, a p-type charge layer is inserted inside the collector to control the distribution of the electrical field and minimize intervalley scattering

eliminating holes, which are far slower at moving through the device than electrons.

Thanks to their superior transport properties, vertical-illuminated type, waveguide type, and distributed type UTC-PDs can all deliver a high power-bandwidth product. However, there are still some weaknesses when the operating frequency of the UTC-PD is in the MMW (sub-THz) regime. In this frequency regime, the internal electron transient time, rather than the RC-limited bandwidth, tends to limit device bandwidth. In these devices the electron drift-velocity can saturate under a high external applied electric field due to intervalley scattering (see Figure 3). To prevent this, a very small reverse bias voltage, such as -0.75 V, can be applied to the thin collector layer (~200 nm thick). This is necessary to maintain the overshoot drift-velocity of the electron and maximise the speed performance of the UTC-PD.

The downside of using a very small reverse bias voltage to realise a high drift-velocity in a sub-MMW UTC-PD is that it tends to be screened by the output AC voltage produced by this device (see Figure 2a). A small load resistance, such as less than 25 Ω can minimize the amplitude of the output AC voltage, but this addition slashes the output power of the photodiode, which normally operates under a standard 50 Ω load.

To overcome such problems, our group at National Central University in Jhungli, Taiwan, has developed a near-ballistic uni-traveling carrier photodiode (NBUTC-PD). This outperforms a UTC-PD in the sub-MMW regime, in terms of the product of saturation current and bandwidth. One key feature of our photodiode is its p-type charge layer inside the collector layer, which can properly control the distribution of the electrical field and minimize intervalley scattering. Near-ballistic transport of electrons in the moderately high optimum reverse bias regime (-2 to -3 V) minimises external saturation. We note that a similar concept has also been reported in the near-ballistic collection HBT by researchers at the Electrical Communication Labs of NTT, Kanagawa.

Photonic transmitters

The backbone of future wireless communication networks operating at Gbit/s speeds will be the optical fibre based network, which connects different base stations, each distributing large volumes of data. Every base station in the MMW wireless network will need many pico-cells (or femto-cells) to radiate the photo-generated MMW power from the photodiode to the last-mile for the end-user.

Each photodiode is integrated with an antenna to form a photonic transmitter that radiates the photo-generated

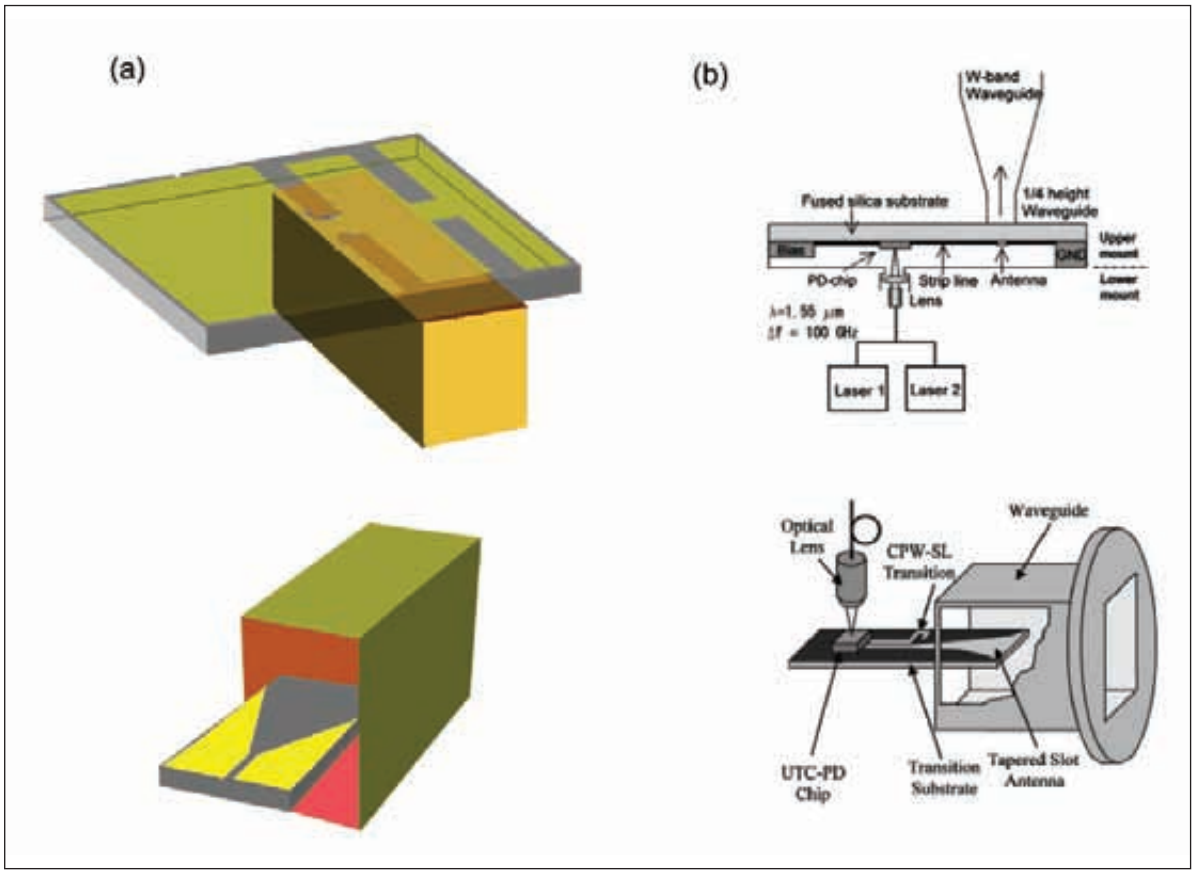


Figure 4. (a) Conceptual diagrams of a broadside patch antenna and an end-fire tapered slot antenna for rectangular waveguide (WR) excitations; and (b) conceptual cross-sectional view of UTC-PD based photomixers with integrated patch antenna and tapered slot antenna for WR-10 and WR-08 waveguide excitations, respectively. (re-printed by permission from A. Ueda, et al., IEEE Trans. Microwave Theory Tech., vol. 51, pp. 1455-1459. May, 2003 © 2003 IEEE and A. Hirata, et al., IEEE Trans. Microwave Theory Tech., vol. 52, pp. 1843-1850, Aug. 2004 © 2004 IEEE)

MMW power. The high speeds and powers of UTC-PDs and NBUTC-PDs enable the construction of photo-transmitters that can produce a range of radiation patterns, operate at 0.1 to 1 THz, and deliver output powers that are typically 20 dB higher than those associated with photo-transmitters based on conventional photodiodes. By pairing the UTC-PD based photo-transmitter with an end-fire taper slot antenna or a broadside patch antenna, researchers have shown that it is possible to excite WR-10, WR-08, and WR-03 rectangular waveguide-based horn antenna (see Figure 4). This has enabled the demonstration of 10 Gbit/s and 16 Gbit/s line-of-sight data transmission using centre frequencies of 120 GHz and 300 GHz by use of the WR-08 and WR-03 waveguides based photonic transmitter, respectively.

Our NBUTC-PD based photo-transmitters have a unique advantage over UTC-PD based photo-transmitters: An ultra-fast switching speed. This means that the photo-generated MMW power from the NBUTC-PD can be shut 'on' and 'off' very fast with a high extinction ratio, simply by switching the bias point. To realise this, we incorporate an additional input port, an intermediate-frequency input, into our device. We use this for injecting high-speed electrical data and for also modulating both the bias point and photo-generated MMW power of our novel photo-diode.

Our device can do more than just convert the incoming optical MMW envelope into electrical data: It can also up-convert incoming electrical data to the MMW regime. The entire device functions as an MMW mixer called the photonic-transmitter-mixer (see Figure 5). The superior modulation speed of our device stems from a combination of bias modulation in only the reverse bias regime, and a high extinction ratio MMW envelope, which predominantly originates from variations in electron drift-velocity in the collector layer under different reverse bias voltages.

However, in order to quench the photo-generated MMW power from the UTC-PD, it is necessary to push the device into near forward bias operation. This induces a

slow minority carrier injection process, which severely degrades the modulation speed and limits the maximum data transmission rate. By use of the ultra-fast switching characteristic of the NBUTC-PD, we have demonstrated the photonic-transmitter-mixer for an MMW-over-fibre communication system operating at 20 Gbit/s (see Figure 6).

In such proposed scheme, it is possible to use another optical wavelength to provide the data signal for bias modulation on our photonic-transmitter-mixer, by converting this to electrical 20 Gbit/s data with another low-speed photo-diode.

Getting commercial traction

Today, the biggest opportunities for MMW wireless linkage in consumer electronics exist at 60 GHz, for indoor linking, and at 100 GHz, for outdoor linking. Applications include wireless HDMI broadcasting and linking, and high-speed data transfer between cell phones and Sony's cyber-shot camera via Transfer Jet, a proximity-based, wireless technology that can transfer images, video, and other files between compatible devices held about an inch apart.

Up until now, photonic technology has not made an impact on these systems. Competition from the all-electronic approach is strong, and the cost of the MMW photonic wireless linking approach must fall. This situation could change, because increasing maturity of CMOS IC technology is making it possible to install MMW CMOS local-oscillator (LO) chips at each base station without using a synchronized LO signal.

However, the MMW wave that is produced above 60 GHz behaves like an optical-wave: Propagation of the signal is in a straight line, and obstacles in the way drive down its intensity. Realising good network coverage for the end-user could require the deployment of numerous remote antenna units, particularly for an outdoor wireless linking system.

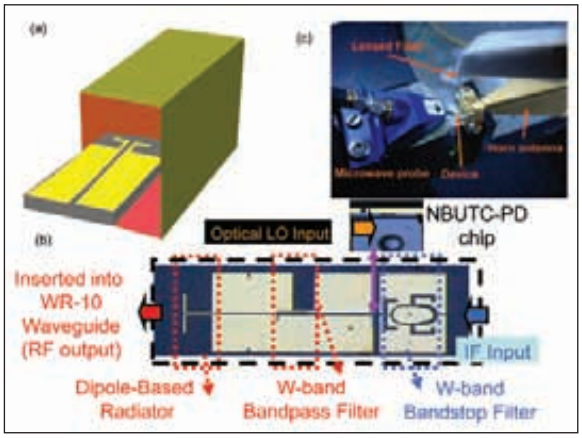


Figure 5. (a) An end-fire quasi-yagi antenna for rectangular waveguide (WR) excitation; (b) top-view of an NBUTC-PD based photonic transmitter with an integrated quasi-yagi antenna for WR-10 waveguide excitation; and (c) the device during measurement

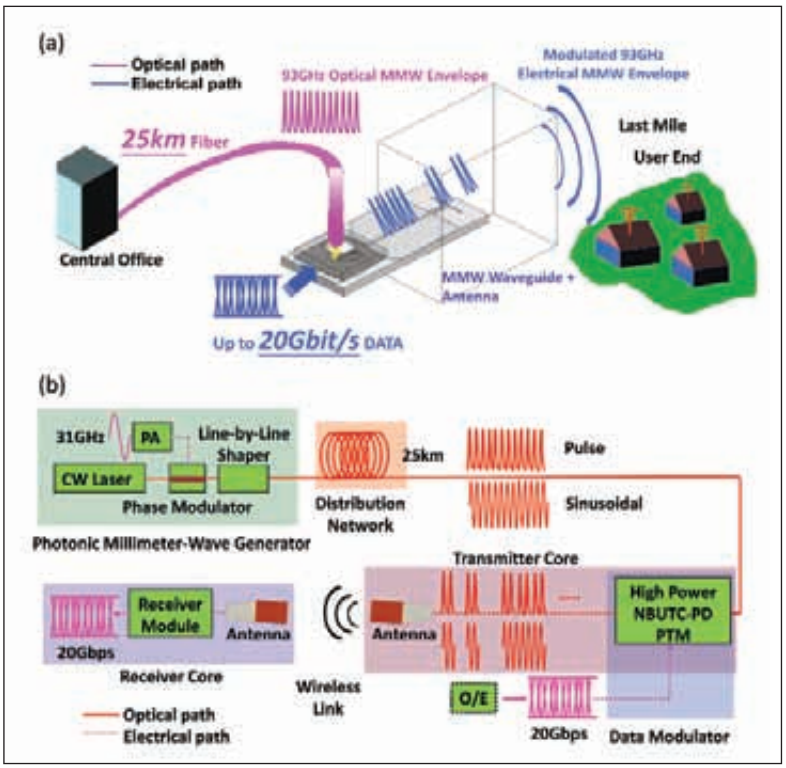


Figure 6. (a) The photonic-transmitter-mixer developed by National Central University, Taiwan, that is used in the last-mile MMW-over-fibre system; and (b) set-up of a photonic wireless linking system for 20 Gbit/s data transmission using a line-by-line pulse shaper with a central frequency around 100 GHz as the photonic MMW source

The biggest advantage of the photonic technique over the all-electronic approach is the use of a fibre backbone to interconnect and synchronize the units. This minimizes interference and multi-path effects between the units. Other merits of the photonic technology include superior immunity to bad weather conditions, plus an improvement in data processing efficiency. However, these benefits will not be enjoyed unless there is widespread availability of ultra-high speed photodiodes and photonic-transmitter (mixer) modules.

Further reading
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Exploiting the high temperature promise of **SiC**

Replace silicon diodes and transistors with those made from SiC and the operating temperature of power electronics can soar to such an extent that bulky thermal management systems are no longer needed. The upshot: Squeezing grid-scale renewable energy inverters, downhole electronics and aerospace engines and actuators into far smaller spaces, says **Ranbir Singh of GeneSiC.**

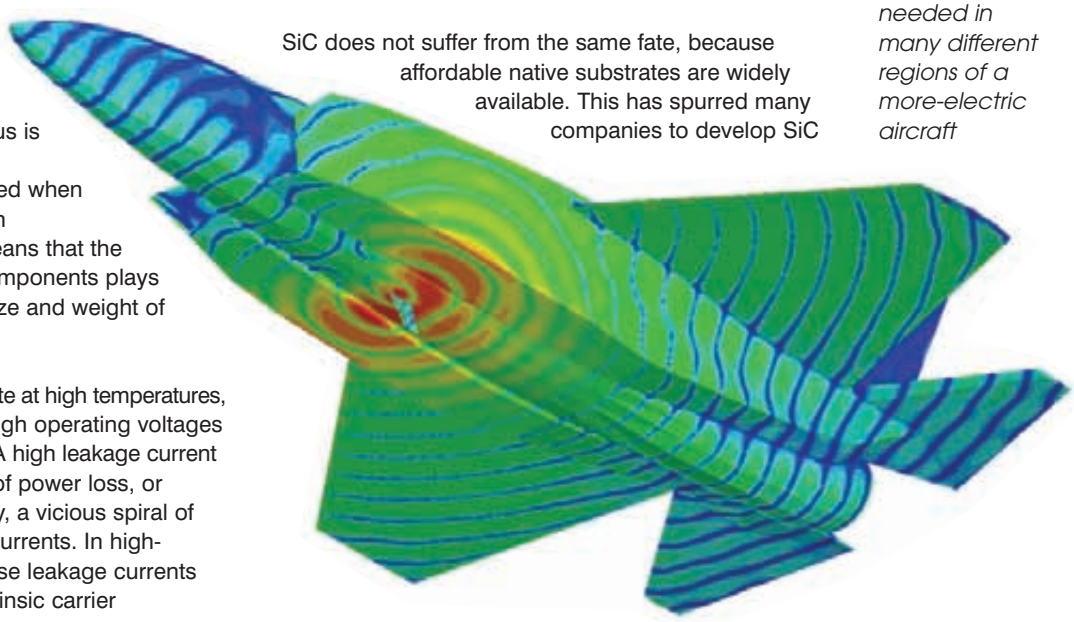
Engineers searching for ever-increasing stealth in fighter jets, greater fuel-efficiency in airliners and vehicles, and compactness in grid scale solar inverters are united in one ambition: To throw out liquid-cooling loops, because this trims the size, weight, volume and cost of the electronic systems.

In all these applications, consumption and generation of electrical power occurs at different voltages and currents. For example, solar panels generate a low-voltage DC output, but this must be transformed into a high-voltage AC output before it is fed into the grid. This conversion process takes place in electronics circuits built from power semiconductors and passive components, such as inductors and capacitors. Electrical conversion is not 100 percent efficient, with losses converted into heat, which must be managed to ensure that these systems function optimally. Often, the thermal management apparatus is bigger than the circuits – and this difference is even more pronounced when the entire circuit operates in a high temperature environment. This means that the temperature tolerance of these components plays a critical role in determining the size and weight of these systems.

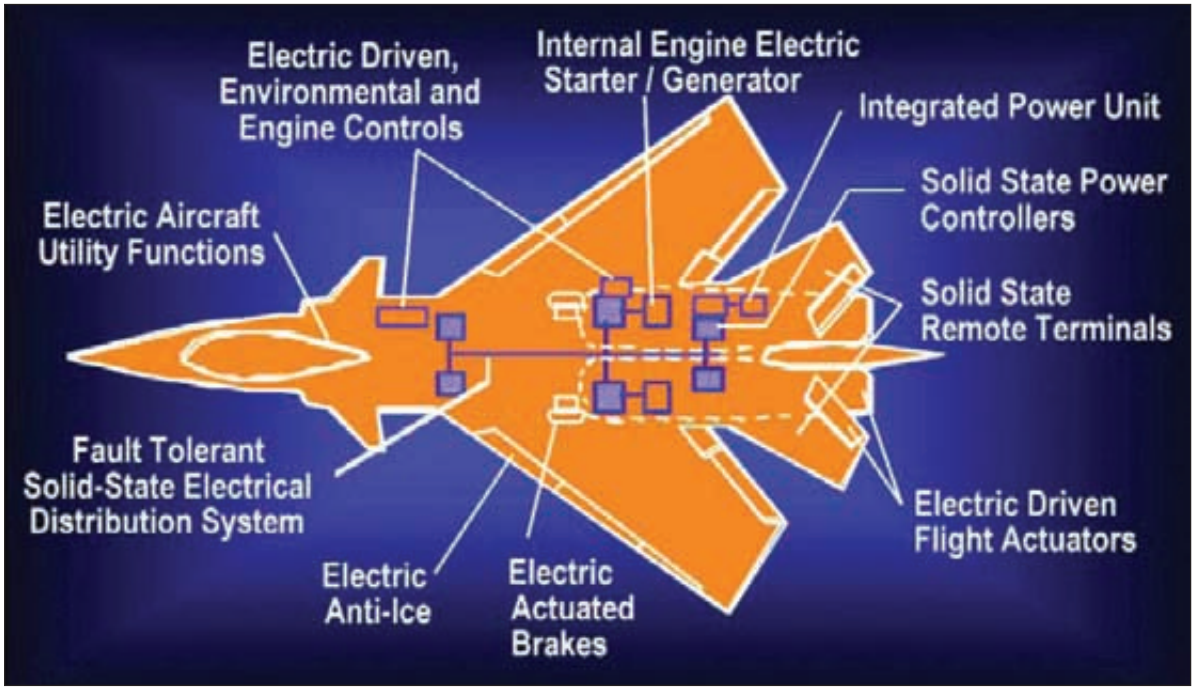
When power semiconductors operate at high temperatures, increases in leakage currents at high operating voltages tend to limit system performance. A high leakage current can result in unacceptable levels of power loss, or device failures by thermal runaway, a vicious spiral of over-heating and higher leakage currents. In high-voltage-blocking pn junctions, these leakage currents are directly proportional to the intrinsic carrier concentration in the semiconductor. This concentration is several orders of magnitude lower in GaN and SiC than it is in silicon, which is why these wide bandgap materials hold tremendous promise for making high-temperature devices with incredibly low leakage currents.

Ideally, GaN power devices would be built on a native substrate. However, GaN substrates are very pricey, so foreign substrates such as sapphire, SiC and silicon must be used instead. Although this trims costs, hetero-epitaxial growth creates high levels of crystal defects, which are to blame for the high leakage currents in devices biased to high voltages. As operating temperatures increase, this leakage current grows exponentially, preventing GaN devices from operating at reasonably high junction temperatures.

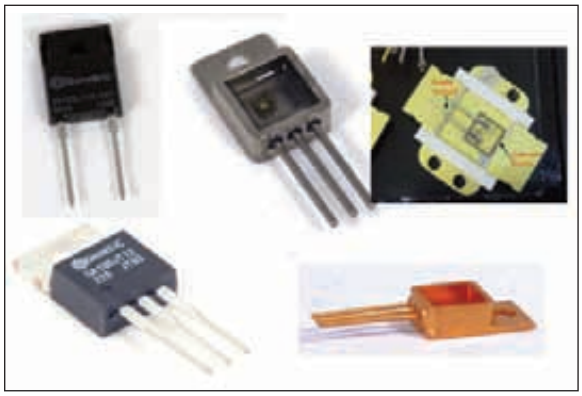
SiC does not suffer from the same fate, because affordable native substrates are widely available. This has spurred many companies to develop SiC



Power electronics is needed in many different regions of a more-electric aircraft



High temperature surfaces on modern aircraft severely burden the electronics required to operate them



GeneSiC offers various packages for its SiC power devices

devices, with attention focused on the development of Schottky barrier diodes. In these devices, leakage currents are governed by design and fabrication processes, rather than the intrinsic properties of the pn junction. Consequently, there is a tremendous variation in the high-temperature performance of Schottky diodes made by different manufacturers.

Slashing leakage currents

At GeneSiC Semiconductor of Dulles, Virginia, we have developed high-temperature Schottky barrier diodes that exhibit the lowest increase in leakage current as the operating temperature is ramped up (see Figure 1). This unprecedented performance stems from our superior designs and processes, including unique expertise in designing, fabricating and characterizing devices at high temperature and high voltages (see Figure 2).

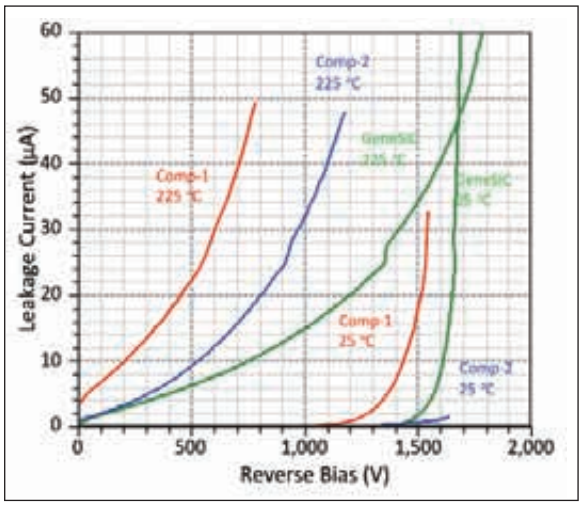


Figure 1: Leakage current comparison for three 1200 V SiC Schottky rectifier technologies at room temperature and elevated temperatures shows the least increase in leakage for GeneSiC's rectifiers

Our device development begins with two-dimensional device design using finite element analysis. Once we have determined the device's architecture with a fundamental physics-based simulation, this is translated into layout designs using a sub-micron mask. These layouts are carefully matched with fabrication techniques. We have unique, world-leading expertise in the specialized nature of fabrication techniques such as: Sidewall etches, double-level, high-temperature metallizations; and implementing involute gate designs. The wafers that we fabricated are tested up to extremely high temperatures using high-temperature chucks. Wafers are diced into individual devices and put into prototype packages for evaluation and optimisation for high temperature operation.

These diodes can be used in power-conversion circuits alongside three-terminal transistors that have the role of

a switch. When the transistor is in its 'off' state it blocks high voltages, and in its 'on' state it delivers high currents with low power losses.

The SiC community has devoted significant effort to the development of SiC power MOSFETs. However, the improvement in high temperature performance of SiC MOSFETs is marginal over a silicon equivalent. That's because the high-temperature limit for operation is determined by the interface between SiO_2 and SiC, rather than the level of current leakage from the pn junction. The conduction band offset between SiO_2 and SiC is quite small, resulting in the degradation of the MOS interface at relatively low temperatures. As a result, as of today, the junction temperature of the only commercially available SiC MOSFE is rated up to a just 125 °C.

To address this weakness and allow this class of transistors to fulfil its full potential, we have developed a high-temperature SiC switch: The 'Super' Junction Transistor (SJT). The hallmark of this gate-oxide free, normally-off, majority carrier device is its incredibly high current gain, which can exceed 88. It also has many other virtues, including a 'square' reverse-biased safe operating area, which allows extremely rugged operation in typical inductive motor and actuator drive applications.

What's more, the temperature co-efficient of on-resistance for this transistor is slightly positive, which is desirable for paralleling multiple devices for high-current configurations; 'turn-on' and 'turn-off' times are less than 20 ns; operating temperature can exceed 250 °C; and the SJT features a low 'on-state' voltage drop and high-current operation, thanks to the absence of a channel region and a near-zero drain-source offset voltage.

Our SJTs combine a near-theoretical breakdown voltage with a temperature-independent, low-reverse-leakage current up to 325 °C. In addition, our SJT displays a distinct lack of a quasi-saturation region, and is notable for the merging of the different gate current I-V curves in the saturation region. The implication of these two features is a lack of charge storage in the drift region of the transistors – this distinguishes it from a 'bipolar' silicon BJT. The resulting benefit is temperature-independent, fast-switching transients. The low, on-state voltage drop stems from appropriate metallization schemes and an optimised epilayer design.

The switching performance of our 4 mm^2 and 16 mm^2 SiC SJTs have been evaluated by pairing them with an inductive load and our 'free-wheeling' 1200 V/ 7 A and 1200 V/30 A SiC Schottky diodes. To drive the SJTs, we used a commercially available IGBT gate driver with an output voltage swing from -8 V to 15 V. For the 4 mm^2 SJTs, a 100 nF dynamic capacitor connected in parallel with the gate resistor can generate high initial dynamic gate currents of 4.5 A and -1 A during turn-on and turn-off switching, respectively. During the turn-on pulse, a constant gate current of 0.52 A was maintained. These large initial dynamic gate currents rapidly charge and discharge the device input capacitance, yielding faster switching performance. We recorded temperature-independent, ultra-low drain current rise and fall times of just 12 ns and 13 ns, respectively, for switching 8 A and 800 V by the 4 mm^2 SJT (see Figure 3).

A realistic assessment of the performance of our SiC transistors and diodes demands a comparison with state-of-the-art silicon devices deployed in real circuits. To do this, we procured three best-in-class 1200 V silicon IGBTs: A NPT1 'non-punch-through' IGBT, which is rated up to 125 °C and 1200 V; a 'non-punch-through' variant rated up to 150 °C and 1200 V, the NPT2; and a trench field stop (TFS) IGBT rated up to 150 °C and 1200 V. All three IGBTs were pre-packaged with silicon fast recovery diodes in anti-parallel configuration. These efforts revealed

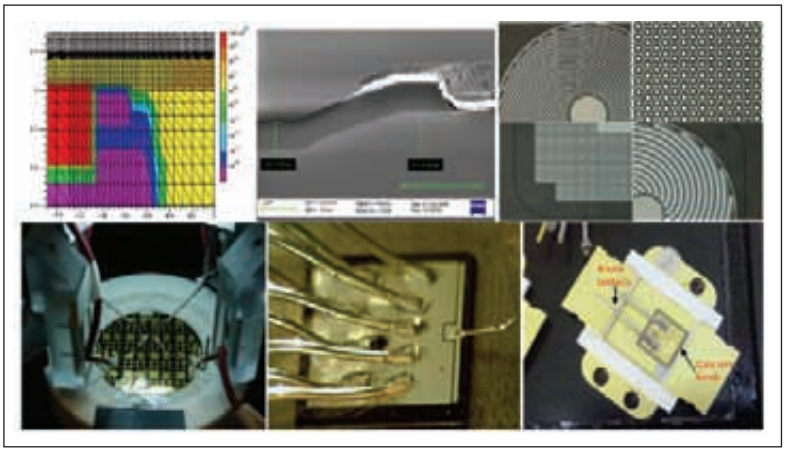


Figure 2. GeneSiC's expertise includes – from left to right (a) two-dimensional device design through computer intensive finite element simulations; (b) Precise sub-micron controlled SiC reactive ion etching; (c) Complex integration of designs to fabrication tools and techniques; (d) high temperature/high voltage on-wafer testing and characterization; (e) die attach and wire bonding; and (f) final high temperature optimized packaged products

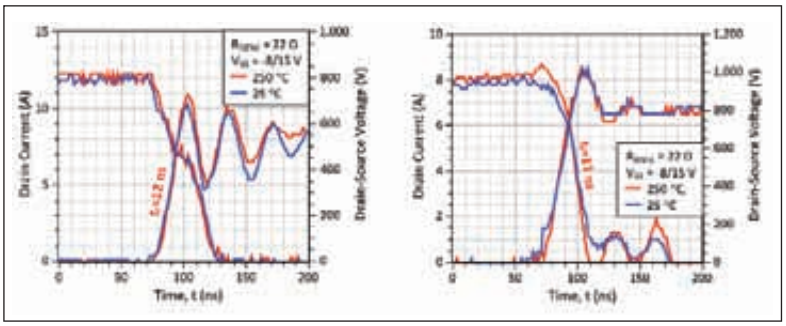


Figure 3: (Left, a) Turn-On and (Right, b) Turn-off drain current and voltage transients recorded for switching 800 V and 8 A through a 4 mm^2 SiC SJT. There is no difference in switching speed between 25 °C and 250 °C, due to the unipolar nature of the SJT device design

that the SiC combination excels over a wide temperature range (see Figure 4). In comparison, when silicon IGBTs are pushed beyond 175 °C their leakage current rockets.

We have also investigated the switching performance of SJTs and silicon IGBTs using an inductively clamped, double-pulse switching setup. This involves using our 1200 V/ 7A Schottky diode and silicon IGBT co-packs as free-wheeling diodes in the switching test circuit. Gate and source terminals of the silicon IGBT co-pack were tied together (V_{GS} = 0 V) to prevent IGBT conduction during dynamic testing. Measurements demonstrated the superiority of SiC devices over a wide temperatures range (see Figure 5). At up to 250 °C, the SiC SJTs displayed temperature-independent drain-current rise and fall times as short as 12 ns and 14 ns, respectively, for switching at 800 V and 7 A. These ultra-short switching times enabled the pair of SiC devices to deliver switching losses that are lower than the all-silicon configurations and those based on a silicon IGBT and a SiC free-wheeling diode.

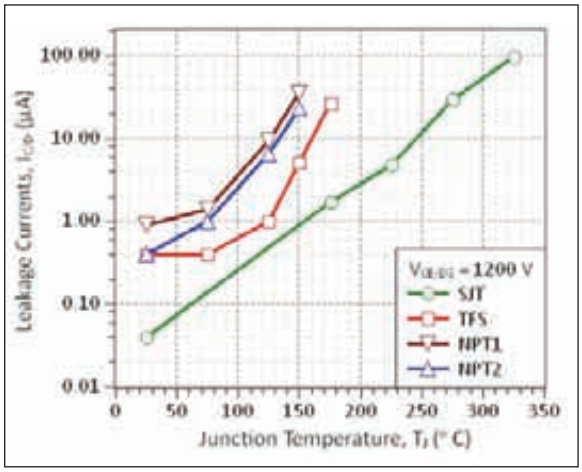


Figure 4: Comparison of leakage currents of SiC SJT and silicon IGBTs as a function of temperature

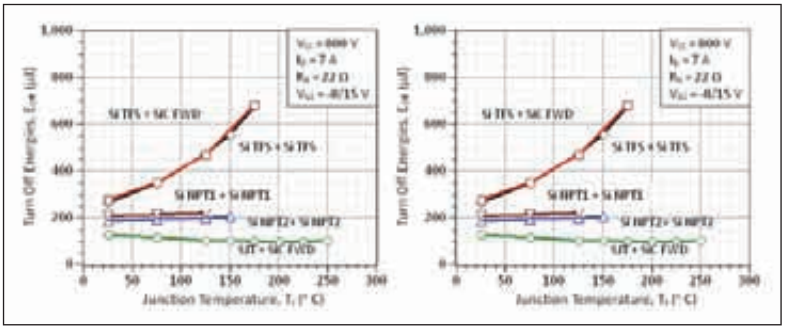


Figure 5: Comparisons of 'turn-off' and 'turn-on' switching energies for SiC SJT and silicon IGBTs at various operating temperatures. "Si TFS + SiC FWD" represents a silicon trench field stop IGBT as the device under test (DUT) and the SiC Schottky diode as free-wheeling diode. In the case of "Si TFS + Si TFS", the silicon TFS IGBT is the DUT, and the silicon TFS IGBT co-pack is the free-wheeling diode. A commercially available IGBT gate driver with an output voltage swing from -8 V to 15 V is used for driving all the devices. While driving the SiC SJT, a 100 nF dynamic capacitor connected in parallel with the gate resistor generated high initial dynamic gate currents of 4.5 A and -1 A during turn-on and turn-off switching, respectively, while maintaining a constant gate current of 0.52 A during its turn-on pulse. These large initial dynamic gate currents charge/discharge the device input capacitance rapidly, yielding a faster switching performance. The testing process also involved a 1 μF charging capacitor, a 150 μH inductor, 22 Ω gate resistor and a supply voltage of 800 V

It is possible to determine the contributions to the power loss of all these devices by considering dynamic and static characteristics for a 100 kHz switching frequency (see Figure 6). At 250 °C, the gate drive, conduction and switching losses of the SJT are 5.25 W, 26.65 W and 20 W, respectively. Note that although the gate driver loss of the SJT is higher than that of the silicon IGBT, its contribution to the overall losses is insignificant. These measurements also take into account the higher conduction losses of the SJT operating at 250 °C.

The measurements show that it is possible to trim overall switching losses by more than 30 percent by simply replacing a silicon fast-recovery epitaxial diode with a SiC Schottky diode for the free-wheeling diode. However, when an all-SiC line-up is employed in the place of silicon IGBTs and pin diodes, power loss reduction is cut by more than 50 percent. These tremendous energy savings show that SiC is well on the way to unlocking its potential at high temperatures.

We are now allowing key potential customers to evaluate the performance of our SJTs and high-temperature Schottky barriers for themselves, while we simultaneously validate our products. These products will expand our portfolio, which also includes SiC Schottky barrier diodes with a more conventional operating range and SiC thyristors.

Figure 6: Overall loss comparison of SJT and silicon IGBTs at their maximum operating temperature. The results are given for a 100 kHz switching frequency

Beating the blues with red-tinted white lighting

Fierce competition in the backlighting market is squeezing the profits of leading LED chipmakers, which are now trying to boost their margins by targeting general lighting. At Epistar, this had led to the development of highly efficient warm-white sources that combine red and blue chips, explains **Epistar's Shao-You Deng, Special Assistant to the company's General Manager, in a interview with Richard Stevenson.**

RS How do sales of LEDs for general lighting and backlighting compare?

SD In 2011, general lighting contributed roughly 25-30 percent of revenue. We are focusing on increasing this at more than 5 percent per year. LED backlighting for LCD displays is around 50 to 60 percent of revenue. This includes small, medium and large-sized backlights – for example, mobile phones, tablets, TVs and monitors.

RS Are you seeing saturation in the global market for LED display backlighting ?

SD No. The emerging markets are still developing, such as those in India and Africa. Even mainland China does not have that high a penetration rate. Although the quantity of LEDs used in one TV will decrease and the average selling price (ASP) will go down, the total quantity will increase. So it will be a slowly growing market.

RS Is Epistar still able to operate profitably in the display business, given the declines in average selling price?

SD This is hard to say, but we think the answer is yes. Our scale of economy helps us to keep a profit, but it will be a decreasing proportion [of overall profit]. We have not only the display business – we have general lighting, general indicators, and so on.

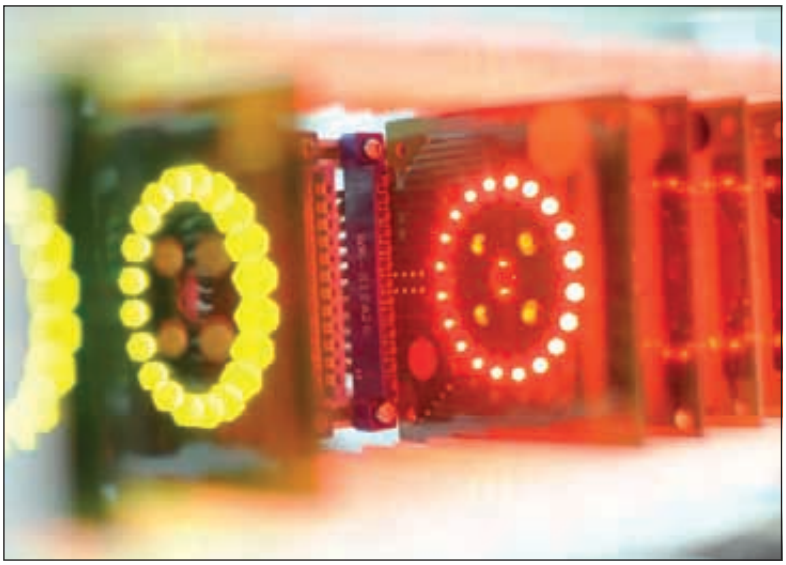
RS You have a strong history in the manufacture of red and yellow LEDs. Are you the world's leading manufacturer, in terms of volume?

SD Yes! We estimate that we have more than 50 percent market share. In terms of the performance of these red and yellow LEDs, which we call four-element-material LEDs, we are number one.

Our red and yellow LEDs are used in outdoor and indoor RGB displays, which differ from LCD displays. This is a major application. Other applications are automotive interior and exterior lighting, and indicators for lighting and consumer electronics.

RS You also use red LEDs with blue ones to create white light sources. How easy is it to deliver good colour mixing with that approach?

SD In many LED packaging houses, they can easily put a phosphor on a blue LED. If you put another red chip beside a blue chip and cover them with a phosphor, the phosphor behaves like a diffuser. That means that the colour mixing will be easier than a pure RGB combination, which does not use a phosphor.



Testing the reliability of Epistar's red and yellow LEDs

RS To make a high-performance white-light source you need good red and blue LEDs. How good are your blue and red LEDs, and what technologies do they employ to deliver those levels of performance?

SD For our red LEDs, the wavelength is around 611 nm. We can deliver about 125 lm/W in mass production with the best bonding and light extraction technologies.

We have different designs. One is the traditional low-voltage LED, and its size is not that large – around 14 mil by 14 mil (350 μm by 350 μm). These can be driven from 20 mA to 40 mA. Our other design is the high-voltage type. This is also 20 mA, but can operate up to 20 V.

Our blue LED can deliver up to 150 lm/W at 5700 K in mass production, by using current spreading and internal quantum efficiency optimization. This LED is also available as a low-voltage and a high-voltage structure.

RS Are there significant advantages in using a red LED, rather than a red phosphor, for making white LEDs?

SD The red LED can significantly boost the CRI (colour rendering index) and the lumen-per-Watt in the region of 2700 K to 3000 K. If you use just a phosphor with a blue chip, efficiency is good at around 5700 K to 4000 K. But below 4000 K, efficiency drops very fast. We have compared these two types of LEDs. Without the red LED, performance drops by 30 percent.

RS Will you take this approach a step further and introduce white-light sources based on red, blue and green LEDs?

SD No. [With our chipsets], the green colour comes from the blue phosphor conversion, rather than a green LED. Green efficiency [with our approach] is now around 90-100 lm/W. The efficiency of a red-green-blue LED would be lower than either a blue LED and just a phosphor, or a blue LED with a phosphor and a red LED. Using a green LED as part of three different chips packaged together also complicates assembly and control.

RS You have developed high-voltage white light sources based on red and blue LEDs. How do these work?

SD The high-voltage LED is a product for the retrofit bulb market. Its voltage is closer to the mains – for example, 120 V, or 110 V. The aim is to bring the LED's voltage to match the mains, and significantly reduce the driver cost and space, especially for the retrofit bulb application, because there is not enough space to put too much circuitry. The high-voltage LED can be a blue chip with phosphor, or blue and red chips plus a phosphor. But our best high-voltage LED combines blue and red chips, and can be introduced into the warm-white market.

RS How do you achieve the high voltage?

SD The voltage for one blue chip is around 3.0 V to 3.3 V. So we put them in series – maybe 10 LEDs, so around 30 V. We are using semiconductor processes to bind them together. Semiconductor technology is well-suited to isolating very small devices and connecting them together.

RS What volumes of these high-voltage white light sources are you shipping today, and how do you project this to increase over the next few years?

Testing blue LEDs for long-term reliability

SD Now it's about 3 million per month, and we are focusing on increasing this to 10 million per month by the end of the year.

RS What are the typical performance figures for these white light sources?

SD So far we have three different sets to provide to our customers for these applications. They all have a CCT of 2700 to 3000 K, and a CRI greater than 85.

Our first is the standard set, around 100 lm/W. Our second is the premium set, around 120 lm/W, and the last is the deluxe set around 150 lm/W.

RS What level of efficacy is required to have success in the LED light bulb market?

SD For LED light bulbs, the main markets are for the 40 W, 60 W and 75 W. For the 40 W replacement, we are using the standard set, with 100 lm/W. The 60W replacement uses 120 lm/W, and if you need to go higher to 75 W, you need 150 lm/W. The bulb doesn't have much space to put the light source and deal with thermal treatment, so efficiency is a big issue.

RS Epistar must have thought about becoming a vertically integrated manufacturer of LED lighting products, such as LED bulbs. Why has

The high-voltage LED is a product for the retrofit bulb market. Its voltage is closer to the mains – for example, 120 V, or 110 V. The aim is to bring the LED's voltage to match the mains, and significantly reduce the driver cost and space, especially for the retrofit bulb application, because there is not enough space to put too much circuitry

the company decided to just be an LED manufacturer?

SD We value our partnership with our downstream customers. We don't want to be in competition with our clients, and would rather have a win-win situation.

We are focusing on our epitaxial wafer technology, our process technology, and we are trying to help our downstream customers. For example, helping them in how to use LED chips to enhance performance, or how to package them.

RS **Has LED lighting made much of an impact in Taiwan?**

SD Yes, but it's not happening fast. The government is placing increasing emphasis on popular LED lighting, and it is changing the streetlights to LED lighting in 2012. A subsidy program for households is also about to launch.

RS **You have a joint venture agreement with Toyoda Gosei. Is this a win-win for both companies. Why?**

An Epistar technician loading and unloading the LED wafers in a tool for the metallization process

SD Toyoda Gosei has comprehensive worldwide patents, but very limited production capacity in Japan. So it's invested in a JV (joint venture) company with Epistar. The JV company inherits TG's patents and is able to use Epistar's production facility for cost-competitive production. Epistar can penetrate some markets that require special patents.

In the Japanese market, these LEDs are sold under the TG brand. We have another JV office, TE with TG, that's based in Taiwan and is for sales outside the Japanese market. Therefore, if we want to deliver these chips to other customers, we are able to sell through the TE with TG brand.

RS **Do you have any joint ventures with Chinese firms?**

SD Yes, we have several JVs with local Chinese firms. This allows us to belong to the downstream of the lighting supply chain. By doing so, we get updates on market demand and the design of lighting products for consumer needs.

RS **How do you view the strong package of incentives provided in China for LED manufacture? Has it helped the global LED industry grow revenues by driving down prices, or has it squeezed profits through an oversupply of chips, and ultimately put the brakes on investment?**

SD We think that the later claim is a more suitable description for the result of China's incentives for progress. The oversupply has really been driven by what has happened in mainland China. There is still a shortage of high-end LED chips, which are bright enough to go into the TV market or high-end lighting. But LED makers will struggle if they cannot catch this high-end market.

RS **What programmes does Epistar have in place to increase yield and cut the cost per lumen?**

SD If you want to get costs down, the best way is to increase your yield. There are two points of view on how to do this: One, to increase your manufacturing efficiency; and two, to increase the efficiency of LED chips.
If you improve the efficiency you improve the lumens. And if you can improve the lumens per area, you can shrink the chip, and that means you can produce more chips with one wafer. So the cost will fall.

RS What do you hope to see from equipment, substrate and materials suppliers in the next year?

SD From equipment makers, we hope to see more customized, consistent equipment to generate more products in the same running time, so our throughput will be higher. For the substrate and materials suppliers, we expect to receive more stable quality, and maybe a more reliable and consistent product.

RS Will Epistar increase its chip capacity this year, and if so, by how much?

SD It's hard to give you a precise answer. We have some JV in mainland China, so we have different ways to develop capacity. In China, for example, one JV has increased MOCVD capacity, and maybe two or three sites have increased their quality.

RS Do you expect average selling prices of LEDs to tumble, or will reductions in price start to slow over the next few years?

SD For high-end LEDs, the demand is still strong. But overall – because of the environment and the application mix – the price reduction will be fast in 2012. But maybe in 2013 there will be a slowing down in price reduction.

RS How will Epistar's business evolve, in terms of revenue and profit, over the next two years?

SD The ASP is going down very fast, making it difficult to deliver a large increase in revenue. This year we hope that revenue will grow by 5-to-10 percent – I think that will be hard work to achieve.

With prices dropping very fast, it is hard to maintain profit and revenue at the same time.

An Epistar technician examines an LED epiwafer

This year we are focusing on how to improve market share in this downturn, and we are hoping to cover different application fields. Maybe pricing will be stable in 2013, or our technology can improve, so we can make a profit in 2013.

Epistar's headquarters are located on the Hsinchu Science Park, Taiwan

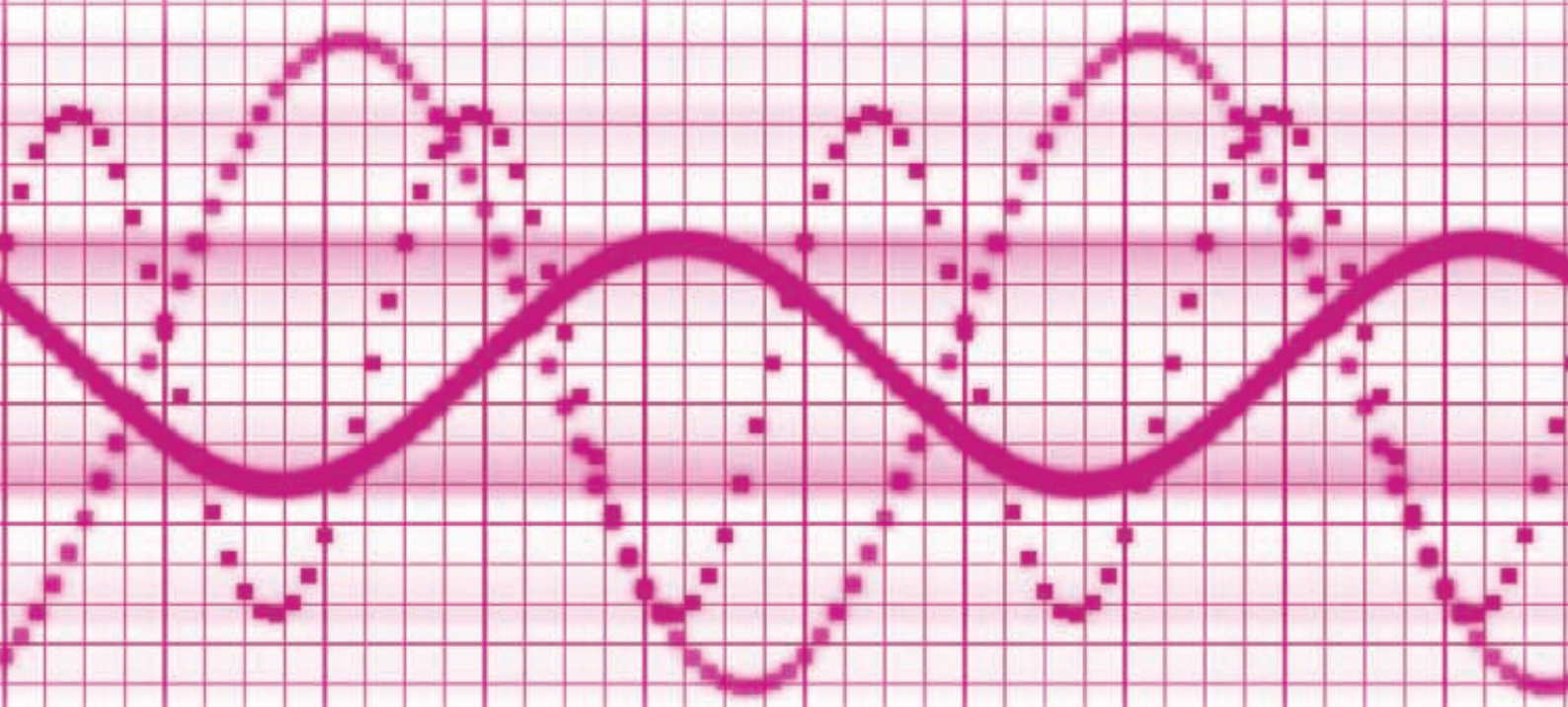
Direct-type LED TVs

One promising market for Epistar is direct-type LED TVs.The majority of LED-backlit LCD TVs on sale today have an array of LEDs at the sides of the screen, and use a lightguide to channel the emission from these chips onto the display. One weakness of this approach is the high cost of the lightguide, which can be avoided by using LEDs in a similar way to the more traditional CCFL sources.

In this case, known as direct-type LED TVs, the screen is illuminated by an LED lightbox. This trims the overall cost of the TV, but there is a downside to pay – a thicker screen, which is needed to accommodate the lightbox. Space is needed to mix the emission from a battalion of very high brightness LEDs, and this leads to increases in the distance from the screen, which reduces the need for lightguides and diffusers.

Greater harmony boosts **amplifier efficiency**

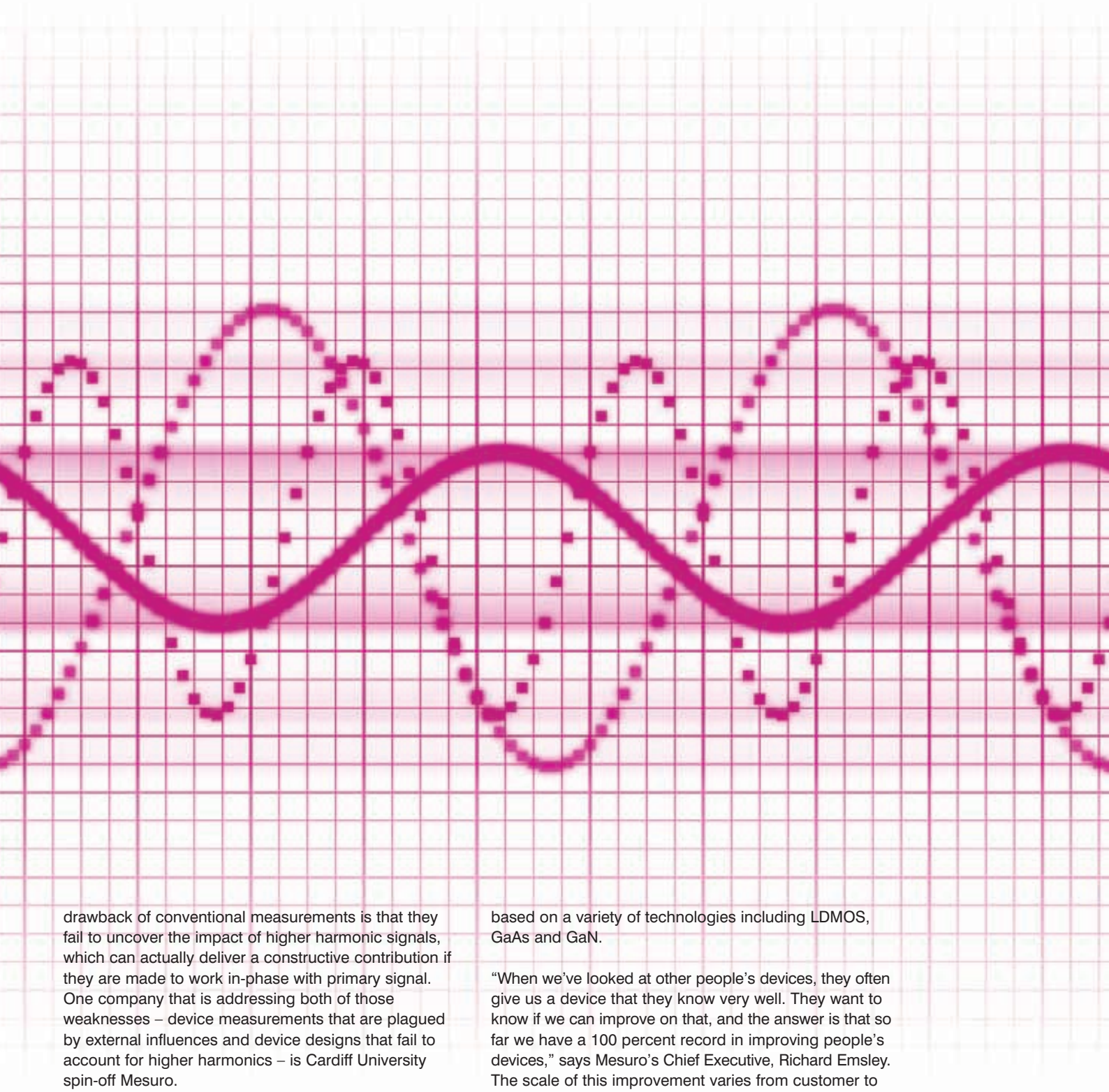
Traditional measurement techniques fail to reveal the harmonic signals in power amplifiers that drag down efficiency. But they can be exposed by Mesuro's novel measurement technology, which can underpin improvements in all forms of non-linear device. **Richard Stevenson reports.**



For many RF engineers, their primary goal is to boost amplifier efficiency. If they can succeed in this regard with a mobile phone power amplifier, they will have extended this handset's battery life, and in turn increased the chances its owner has to get through the day without having to put their phone on charge. And if they are designing an amplifier for a base station, their gains in efficiency will lead to power savings, reduced cooling demands and lower running costs.

The tried and tested route for developing a new amplifier involves building a part, measuring its performance and using this data to uncover areas for improvement, before constructing a better device. Often this process has to be repeated two or three times before a device is good enough to go into production. This makes it an expensive and time-consuming exercise to bring a device to market, because it can take several months to fabricate and test a chip, and the cost of every iteration runs into six figure sums.

Worse still, the final device is unlikely to operate anywhere near to its true potential. That's partly because traditional on-wafer measurement techniques are unable to deliver a true characterization of the device, because they are plagued by influences from the local environment, such as vibrations that shake the testing equipment, including the probes. But the biggest



drawback of conventional measurements is that they fail to uncover the impact of higher harmonic signals, which can actually deliver a constructive contribution if they are made to work in-phase with primary signal. One company that is addressing both of those weaknesses – device measurements that are plagued by external influences and device designs that fail to account for higher harmonics – is Cardiff University spin-off Mesuro.

This start-up, founded in 2008 and located just a stone's throw from Cardiff University's Centre for High Frequency Engineering, has an incredibly strong track record in improving the performance of RF devices based on a variety of technologies including LDMOS, GaAs and GaN.

"When we've looked at other people's devices, they often give us a device that they know very well. They want to know if we can improve on that, and the answer is that so far we have a 100 percent record in improving people's devices," says Mesuro's Chief Executive, Richard Emsley. The scale of this improvement varies from customer to customer, reflecting differences in the lack of device optimization. "In some cases you can make an unbelievable jump," says Emsley. "In fact, sometimes customers don't believe the jump, and you have to go to some lengths to prove the reality."

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Although customers tend to want to keep the details of their improvements under wraps, Mesuro is able to share the results of its efforts at increasing the efficiency of a low-power 900 MHz amplifier made by TriQuint. This device, which was built with a GaAs technology that the US outfit knew very well, initially delivered an efficiency of around 65-70 percent. Following harmonic tuning by Mesuro, efficiency rocketed to over 90 percent.

"I think that's still an industry record," says Emsley, who adds that the engineers at TriQuint were also pleased with the characteristics of the waveforms producing this far higher efficiency, and the mode of operation of the device.

The amplifier required modifications before it could be used in the end application, so the team at Mesuro, in partnership with researchers in Cardiff's Centre for High Frequency Engineering, built a MMIC around this device. It took just one go to build that circuit, which delivered a highly creditable efficiency of 82 to 83 percent.

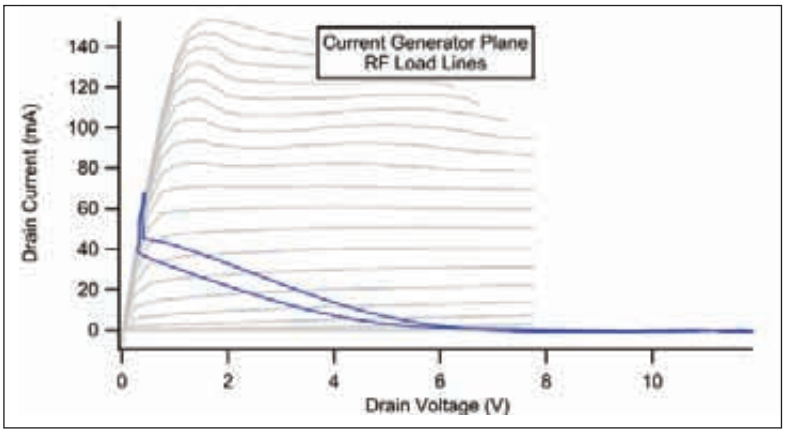
"Bear in mind that it was a student designing the MMIC, and most commercial customers will take two to three goes to get a design correct," says Simon Mathias, Mesuro's Vice President of Sales. "This was a very simple design, but it proved a point: You can get device data, translate it to a usable circuit design, and achieve very good performance."

A different approach

The key to this fast, successful approach for understanding and optimising device performance is that it is the device that is the model. Engineers adopting the Mesuro method run the device under its standard operating conditions and then optimise its performance by adjusting current and voltage waveforms, taking in account the impact of harmonics. "You are not mathematically modelling," explains Emsley. "You are obtaining a complete emulation of the environment in which the device is going to be used."

A more technical description for the measurement technology employed by Mesuro is open-loop, active-harmonic load pull.

The term open loop refers to the architecture of the system: It defines how the load is presented to the device, and how this device is driven. A more stable testing environment results from using an open loop rather than a closed one, according to Emsley: "The device reacts, but only to the instructions that you put in; and because of the open loop architecture, the tendency for the device to oscillate is significantly reduced."



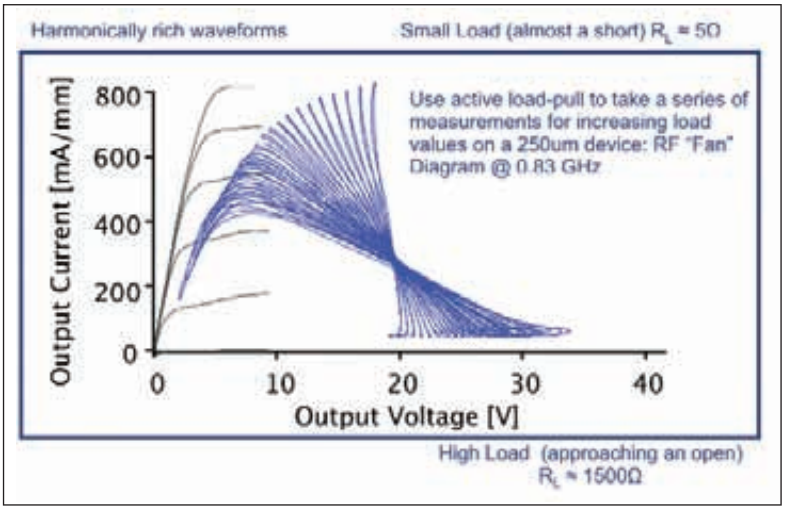
Dynmaic load line measuremnets with Mesro's system

To realise active load pull, the device is driven by an amplifier so it overcomes the losses in the system. In Mesuro's case the approach is also described as 'harmonic', because the first, second and sometimes the third harmonics are controlled in this type of measurement.

Benefits associated with measuring the device in this manner extend beyond uncovering pathways to higher efficiency, and include the possibility of improving device reliability. That's because insights provided by the Mesuro's technology can expose overdriving of the device, which can be to blame for its modest efficiency. There are occasions when devices driven at their peak voltages produce current when they should shut it off, and this destroys the device.

This understanding of the relationship between current waveforms, voltage waveforms and reliability comes from the research group led by Paul Tasker, head of the Institute of High Frequency and Communications Engineering at the University of Cardiff. Tasker founded this group when he took up a chair in the department in 1997, motivated by a belief that there was tremendous

The term open loop refers to the architecture of the system: It defines how the load is presented to the device, and how this device is driven. A more stable testing environment results from using an open loop rather than a closed one



An exmaple of how Mesuro's system can be used to map out the boundary conditions of a semiconductor process/ device – the kneee region and the pinch-off region – using multiple bias points

room for improvement in the characterisation of power amplifiers.

Working together with his first student, Johannes Benedikt – now CTO of Mesuro and a professor in Cardiff's Centre for High Frequency Engineering – they spent several years developing and refining the measurement system until it reached a level high enough to attract the attention of industry.

The system that they perfected employed a pair of Tektronix instruments: An arbitrary waveform generator that provides very good control through two channels, and a high-quality sampling oscilloscope. In addition, it featured their own multiplexer system that involved hardware insertions between the Tektronix's instruments and the device, plus homespun software.

Getting off the ground

When Tasker his co-workers went to various tradeshows, they tried to convince employees of Tektronix of the tremendous promise of their measurement technique. Their words initially fell on deaf ears, but they persisted and their efforts were rewarded in 2008 when they were invited to showcase their system on the Tektronix stand at the International Microwave Symposium (IMS) in Atlanta.

Their demonstration at this conference was a big hit, with delegates queuing three or four deep at the Tektronix stand to witness the benefits of this novel, sophisticated measurement technique. The tremendous level of interest convinced Tasker and his colleagues that their technology could have mass industry appeal, and when they returned home they made enquiries within the University on how to exploit the commercial potential of their measurement technique.

These engineers were directed to Fusion IP, which has rights over university-owned IP at Cardiff University. When Fusion looked into the matter, they felt that the prospects for this venture were worth investigating, so they started a due diligence campaign, calling on the services of Emsley.

To gauge support for the innovative measurement technology, Emsley headed to the next big conference in the RF calendar, European Microwave Week. There he talked to most of the big instrument vendors, plus AWR, one of the world's leading providers of software for designing circuits. "AWR's interest and partnership with us extends from that very first meeting. They said 'We want to work with you. When is this going to be ready?' People were pushing for delivery dates."

At that point Emsley realized that if Mesuro launched right away, it could make a splash at a very, very good time for the industry: "There was a lot of pressure within the industry to look at highly non-linear device technologies, and obtain much better results than had been obtained previously."

Shortly after this conference, Emsley switched from a due diligence role to running the company. He then boarded a plane to the US to try and tie up a deal with Tektronix. The trip was highly worthwhile, with the two companies signing a memorandum of understanding.

Following this key milestone, Fusion stumped up £150,000 to get the start-up off the ground. The cash enabled Mesuro to build its first measurement system in time for launch at the IMS meeting in Boston, June 2009. While preparing for this meeting, the company

The benefits associated with Mesuro's measurement techniques are by no means limited to gains in power amplifier efficiency: It can also help optimise the combination of power and efficiency in amplifiers used to make jammers in the defence industry; and it can also enable improvements in other non-linear devices, such as mixers and oscillators

closed a second funding round that netted £1 million, with contributions coming from Fusion, Finance Wales and ERA foundation.

From then on the Cardiff start-up has been working with an increasing large number of customers. Often, relationships begin with what Mesuro describes as 'measurement services', which is essentially device characterization.

"From there, it will develop into demonstration evaluations – that's us providing software and hardware solutions to them," explains Mathias. "We integrate that into the existing equipment that they have in the labs, or new equipment that they are buying in to support this activity." Although Mesuro developed its technology using Tektronix's signal generators and analysers, its hardware and software can work with all the leading brands of instrumentation.

"Recently, we've become technical partners to [instrumentation manufacturers] Rohde and Schwarz, and that has been based on their experience of our engineering team," says Emsley. Market success is also behind this move, with sales of systems made by Mesuro employing Rohde and Schwarz instruments. One attraction of this pairing is that it is possible to build a relatively compact measurement system by selecting a particular Rohde and Schwarz vector network analyser, which also incorporates signal sources.

Mass appeal

The benefits associated with Mesuro's measurement techniques are by no means limited to gains in power amplifier efficiency: It can also help optimise the combination of power and efficiency in amplifiers used to make jammers in the defence industry; and it can also enable improvements in other non-linear devices, such as mixers and oscillators.

What's more, Mesuro's technique can aid the development of semiconductor devices, or play a role in quality control. "We can tell device engineers an awful lot about their device technology – how the currents and voltages and biasing points work together," explains Emsley. Armed with this information, it is possible expose trapping effects, uncover pinch-off effects and also understand how the device really operates.

In addition, this current and voltage data – which is inaccessible with traditional techniques – is a valuable aid to the modelling of semiconductor devices. "In general, a foundry will be providing models of their process for their customers to use in simulations," says Mathias. "If they can improve the accuracy of the information contained in those models, that's valuable to them and their customers. That's another area where our system is used a lot."

The Mesuro MB20 open loop acttive harmonic integrated test system.This features three harmonic load pull over the 0.8-6.0 GHz range and is capable of testing 20 W CW active devices

Emsley says that the customers that have bought a Mesuro measurement system are very enthusiastic about the technology: "[Those] that we had last year will all re-order or have re-ordered."

To spur further growth, Mesuro is going to devote more resources to sales, a move that will be financed through the closing of another funding round this year. Revenue should also increase with a streamlining of its measurement services. "We have a fruitful measurement services pipeline at the moment," explains Emsley, who reveals that many of these requests involve similar types of measurements at similar frequencies and powers. "So we need to establish dedicated systems to enable us to deliver that much more effectively and much more quickly."

With a growing band of loyal customers and a clear vision for the future, Mesuro looks well placed to get through the testing times ahead. And when it does, this Cardiff spin-off should win further plaudits for its key role in driving up the performance of non-linear devices.

Getting to grips with GaN HEMT degradation

Operating a HEMT at a low bias for hours and hours can lead to failure, due to a steady accumulation of defects that eventually create a breakdown path

A partnership between researchers in Italy and Belgium is claiming to have reported the first comprehensive analysis of recoverable and permanent degradation in GaN HEMTs.

The team from imec and a pair of Italian institutions – the University of Padova and the University of Modena and Reggio Emilia – has performed a full electrical and optical characterisation of its HEMTs and put forward a model to explain the mechanisms behind recoverable and permanent transistor degradation.

Findings of this research are at odds with the widely held view that reverse-bias degradation just depends on a threshold process. Instead, it has been shown that transistor performance can deteriorate with time.

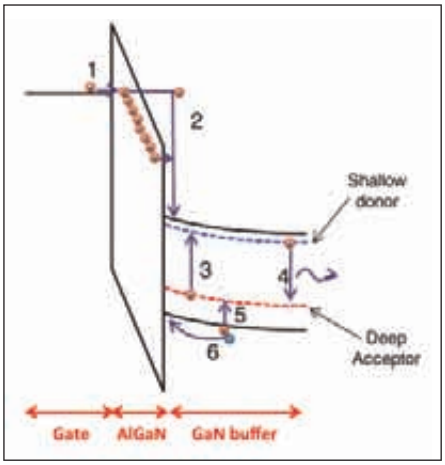
"For this reason, instead of referring to a 'critical voltage', we prefer to define a 'time to breakdown', for a given voltage level," explains Matteo Meneghini from the University of Padova.

The HEMTs investigated by the researchers had a critical voltage of 40 V, but showed degradation after 27 hours of operation at just 15 V. (The critical voltage is defined as the voltage that causes the elastic energy in the barrier to exceed a critical value and lead to the formation of defects that cause a hike in leakage current).

"[Our research] forced us to propose a new hypothesis for explaining the origin of permanent degradation: A time-dependent defect-generation and percolation process," says Meneghini.

He and his co-workers believe that defects are continuously generated within the semiconductor material when the HEMT is under reverse bias. When the number of defects exceeds a certain value, permanent degradation kicks in, with defects creating a conductive path between the gate and channel.

The team investigated the behaviour of



Researchers from imec, the University of Padova and the University of Modena and Reggio Emilia, have propsed a model for explaining HEMT degradation of GaN-on-SiC HEMTs with a GaN buffer. This model that includes several processes: (1) electron injection under a high electric field from the AlGaN layer to the buffer, where electrons can lose excess energy by emitting radiation (2); (3) electron ionization of deep acceptors in the buffer, which leads to generation of yellow emission (4); and (5), the transfer of an electron from the valence band to a deep acceptor, which leads to the generation of free holes (6).

HEMTs with a 22 nm-thick $Al_{0.26}Ga_{0.74}N$ barrier and a Schottky contact made from 40 nm of nickel and 300 nm of gold.

These transistors were passivated with 90 nm of SiN and had a gate length and width of 0.5 μm and 400 μm, respectively. Gate-source and gate-drain distances were 1.15 μm and 2.05 μm, respectively.

HEMTs were subjected to a step-stress test that involved biasing the device to -15 V for 120 s and monitoring the gate current, before repeating the measurement at the same duration for -20 V, -25 V and so on, until results at -50 V were recorded.

At low voltages, the gate current showed a recoverable decrease during stress time. When the device was subjected to a 30 V stress voltage, gate current became noisey, indicating that the transistors would soon undergo permanent damage. And when the HEMT was driven at higher voltages, which exceeded the critical voltage, the transistors showed permanent degradation.

To understand the changes in the device during this testing, the researchers collected electroluminescence produced by the HEMT. The wavelength and spectral shape of this emission enabled the team to identify the processes taking place in the device, and ultimately propose a model to explain recoverable and permanent behaviour of the transistor (see Figure).

Using this model, the researchers carried out a two-dimensional simulation that had good agreement with experimental data. Based on this, the team have put forward an explanation for HEMT degradation under different voltages.

They argued that when the device is under long-term stress, defects can be randomly generated in the AlGaN layer, due to either the converse piezoelectric effect or atom displacement that arises due to the high electric field. As this trap density increases, defects can overlap, probably leading to increased gate noise. Over a lengthy period of time, a conductive path, due to defects, can then form between gate and buffer.

With this model, defect generation and percolation govern device degradation. This implies that devices with higher defects should breakdown faster, a prediction confirmed by experiment.

"Now we plan to study the properties of the defective levels generated as a consequence of reverse-bias stress, and to study the dependence of 'time-to-breakdown' on the epitaxial quality," says Meneghini.

M. Meneghini et al. Appl. Phys. Lett **100** 033505 (2012)

II-VI lasers produce powerful green emission

Combining a GaN pump source with a novel II-VI structure yields a powerful, efficient green laser

An international research team has constructed a very powerful, highly efficient green source that employs a violet nitride laser to optically pump a II-VI heterostructure. The 150 mW, pulse-driven 543 nm laser that results is a very promising candidate for the green source for low-cost, high-resolution pico-projectors that can be incorporated into smartphones, digital cameras and laptops.

The green laser created by researchers from Ioffe Physical-Technical Institute, Russia, the King Abdulaziz City for Science and Technology, Saudi Arabia, and the Institute of Physics of NAS Belarus, produces a conversion efficiency in excess of 25 percent and a wall-plug efficiency (WPE) of 6 percent. This is comparable to the WPE of second harmonic generation (SHG) lasers, which have values of 6-12 percent, and nearly three times that of green InGaN lasers emitting at 523-525 nm.

Sergei Sorokin from Ioffe Physical-Technical Institute says that the design of the II-VI converters is probably simpler than those employed in SHG laser diodes. What's more, he claims that the output power of these II-VI lasers promises to exceed that of their InGaN cousins, which have relatively high threshold current densities when operating in the green spectral range. "Additionally, the lasing wavelength of the III-N/II-VI converters can be varied in the wide green range from 520 to 560 nm," adds Sorokin.

Historically, II-VI lasers have been plagued with short lifetimes. However, Sorokin says that with this wavelength-converting design, device lifetime should be governed by that of the violet nitride laser. "The undoped II-VI optically-pumped laser structures possess long enough lifetime."

The team have been developing lasers incorporating II-VI structures for several years, and in 2007 they reported a source with five electronically coupled CdSe/ZnSe quantum dot planes that delivered a pulsed output of 65 mW. The latest design produces nearly three times this power, thanks to the introduction of a superlattice graded-index waveguide. This introduces an electric field, which sweeps carriers that are optically generated in this waveguide into the quantum dots.

Fabricating this waveguide from II-VI materials is very challenging because minor adjustments to the composition of ZnMgSSe produce large changes in lattice constant. "The superlattice graded-index waveguide allows digital variation of composition profile, keeping all the growth parameters unchanged," says Sorokin. What's more, strain balancing is possible in this structure.

The team forms its Cd(Zn)Se/ZnMgSSe quantum dot structure by MBE on a GaAs buffer layer. Migration enhanced epitaxy, which is similar to atomic layer epitaxy, is employed to deposit the initial ZnSe layer on GaAs. "We deposit only a part of monolayer during one deposition cycle, due to surface reconstruction peculiarities," says Sorokin. "The interruption between zinc and selenium fluxes is necessary to allow efficient redistribution of adatoms at the proper places on the surface."

The team's green source, which employs a ToPGaN 416 nm laser with a 1W output in pulsed mode (pulse duration of 50 ns and frequency of 1 kHz), has a peak room-temperature output of 154 mW.

Sorokin says that pumping must be performed with ultra-violet LEDs, rather than laser diodes, before it will be possible to make cheap, compact devices based on the marriage of II-Vs and III-Vs. "This, in turn, requires further improvements of the threshold and output characteristics of II-VI optically-pumped laser heterostructures, as well as in the converter design as a whole."

The team is addressing this issue, and in addition, it has set itself the goals of: Cutting the density of extended defects in the II-VI laser heterostructure to below 10^4 cm^{-2}; reducing the threshold power density of II-VI laser structures below 1kW/cm^2; and studying device reliability.

S.V. Sorokin et al. Electron. Lett. **48** 189 (2012)

CdSe QDs target neural activation

A new technique holds promise for better understanding of brain disorders.

Researchers at the University of Washington (UW) have developed a new way to stimulate neurons in the brain using quantum dots. Being able to switch neurons on and off and monitor how they communicate with one another is crucial for understanding and treating a host of brain disorders.

Recently a team of Stanford University researchers altered mammalian nerve cells to carry light-sensitive proteins from single-celled algae, allowing the scientists to rapidly flip the cells on and off, just with flashes of light. The problem with this process, however, is that the light-controlled cells must be genetically altered to perform this trick. An alternative, says the UW team, led by electrical engineer Lih Y. Lin and biophysicist Fred Rieke, is to use CdSe quantum dots—tiny semiconductor particles, just a few billionths of a metre across, that confine electrons within three spatial dimensions.

When these otherwise trapped electrons are excited by electricity, they emit light, but at very precise wavelengths, determined both by the size of the quantum dot and the material from which it is made. Because of this, quantum dots are being explored for a variety of applications.

Lin, Rieke and colleagues have extended the use of quantum dots to the targeted activation of cells. In laboratory experiments, the researchers cultured cells on quantum dot films, so that the cell membranes were in close proximity to the quantum-dot coated surfaces.

The electrical behaviour of individual cells was then measured as the cells were exposed to flashes of light of various wavelengths; the light excited electrons within the quantum dots, generating electrical fields that triggered spiking in the cells.

The experiments, says Lin, show that "it is possible to excite neurons and other cells and control their activities remotely using light. This non-invasive method can provide flexibility in probing and controlling cells at different locations while minimising undesirable effects."

So far, the technique has only been applied to cells cultured outside the body; to gain insight into disease processes and be clinically useful, it would need to be performed within living tissue. To do so, Lin says, "we need to modify the surface of the quantum dots so that they can target specific cells when injected into live animals."

Further details of this work have been published in the paper, "Remote switching of cellular activity and cell signalling using light in conjunction with quantum dots," by K. Lugo et al, Biomedical Optics Express, Vol. 3, Issue 3, pp. 447-454 (2012).

http://dx.doi.org/ 10.1364/BOE.3.000447

Uniting GaN and silicon

A silicon dioxide bonding process promises to unlock the door to circuits exploiting the strengths of silicon and GaN

Researchers from MIT have unveiled a new bonding technology for uniting GaN HEMTs and silicon MOSFETs on 4-inch silicon substrates using foundry compatible processes. The team, led by MIT's Tomas Palacios from the Department of Electrical Engineering and Computer Science, have used a thin layer of SiO_2 to bond a silicon-on-insulator (SOI) wafer, which was capped with silicon, to a AlGaN/GaN-on-silicon epiwafer made by US firm Nitronex.

This work will help to support efforts to combine high-quality transistors made from silicon with those built from nitrides, and ultimately pave the way to the fabrication of a range of novel circuits: Power distribution schemes for silicon microsystems; digital-to-analogue converters combining exceptional efficiency with high power; and a range of new optoelectronic devices on a silicon platform, which could potentially cover a wide spectral range.

Palacios says that it is possible to scale the SiO_2 bonding process to larger wafers, which are more attractive from a commercial perspective: "Since we submitted the paper, we have been able to demonstrate 6-inch hybrid wafers in collaboration with [MIT's] Lincoln Laboratory." The team is targeting 8-inch wafers by the end of the year. "It is a very interesting diameter," says Palacios, "because there are many silicon fabs with a good silicon technology that can accept 8-inch wafers."

The most widely used approach for uniting nitrides and silicon is hetero-epitaxy. But this requires thick buffer layers and strain-compensation techniques to address the significant lattice and thermal mismatches between the two types of material. The substantial thickness of this buffer – typically 1.5 μm or more – prevents the use of state-of-the-art lithography in the bottom silicon layer, due to a limited depth of focus.

Wafer bonding with various materials can overcome this issue. Palacois' group has previously used a hydrogen silsequioxane interlayer for bonding, but particles and contamination in this film hamper scaling of the process. Switching the bonding layer to SiO_2 makes a lot of sense. "Silicon dioxide is used in silicon-on-insulator technology all the time," explains Palacois. "It is a material that bonds very well to itself as long as it is atomically smooth."

To fabricate circuits based on silicon and nitride transistors, the researchers clean a Nitronex 4-inch epiwafer and coat its AlGaN surface with a 1 μm-thick film of SiO_2 using CVD. Heating to 950 °C degasses this wafer, and chemical mechanical polishing creates a smooth top surface.

Organic cleaning prepares the top surfaces of the nitride and silicon-on-SOI wafers, which are bonded by contacting the two wafers under vacuum so that they fuse together. Annealing at 900 °C strengthens this bond, before wet etching and chemical mechanical polishing remove the two top layers: That of the silicon substrate and its oxide.

Standard silicon process technology forms MOSFETs from this hybrid wafer. GaN devices are then added following selective removal of the silicon (100) active layer. This involves annealing the wafer to 870 °C, a step that does not impact the dopant diffusion profile in the silicon devices, according to modelling with the Synopsys' TSUPREM4 software.

Uniting silicon and nitride transistors by these processes does not degrade their performance, according to the team. Their silicon pMOSFETs, which have a 3 μm gate length, produce a peak drain current of 42.8 mA/mm at a gate-source voltage of -3 V.

Meanwhile, the HEMTs that have a 3 μm gate length and a 1.5 μm gate-source distance deliver a drain current of 420 mA/mm at a gate-source voltage of 1V, and have a gate leakage current below 10^{-4} mA/mm.

The engineers have also built an AlGaN/GaN HEMT voltage amplifier circuit with a silicon current source. Fed with a 3 V supply, this amplifier delivers a gain of 17.

Goals for the team are to scale the process to 8-inch wafers and work with circuit designers to develop hybrid circuits based on GaN and silicon.

H.-S. Lee et al. Electron Device Lett. 33 200 (2012)

One giant leap for IR technology

Removing gallium from III-V type-II superlattice materials delivers a massive hike in minority carrier lifetime. Thanks to this, these superlattice detectors have the potential to start challenging expensive state-of-the-art HgCdTe infrared imagers.

Researchers have demonstrated that InAs/InAsSb Type-II superlattice (T2SL) materials could be a better alternative to conventional InAs/InGaSb T2SLs. This discovery was made by scientists at Arizona State University and IQE.

Time-resolved photoluminescence of the gallium-free LWIR superlattice exhibited a lower-limit 412 ns minority carrier lifetime at 77 K, more than an order of magnitude increase compared to 30 ns for conventional LWIR InAs/InGaSb T2SL type structures. Researchers at the US Army Research Laboratory say they have, for the first time, measured lifetimes approaching the reported record (~1 μs) for HgCdTe alloys. This, they say, could pose a realistic alternative to HgCdTe for high performance IR detector and focal plane array (FPA) applications. State-of-the-art infrared imagers made using HgCdTe technology suffer from high costs due to expensive substrates, device processing, a decreasing yield with longer cut-off wavelength, and the need for a low-temperature cryogenic dewar. The breakthrough in the minority carrier lifetime demonstrated in an InAs/InAsSb T2SL could eventually enable infrared imagers to be manufactured with much lower costs using commercial III-V processes and the vast resources of MBE foundries.

What's more, T2SL materials have long been predicted to possess longer carrier lifetimes than HgCdTe due to the suppression of Auger recombination. However, Shockley-Read-Hall recombination in the previous III-V T2SL materials prevented the demonstration of the theoretical high performance and limited the minority carrier lifetime to ~30 ns in the LWIR (8-12 μm) range.

With the recent advances in the size and availability of 4 inch GaSb substrates, future infrared FPA assemblies would cost much less and expand commercial applications into new areas such as the automotive, law enforcement, environmental monitoring, and safety surveillance industries. The researchers at Arizona State University and their collaborators are very optimistic about the future of gallium-free T2SL materials and the potential to improve the material with further bandgap engineering and defect reduction. It is worth noting that the carrier lifetime currently observed demonstrates a lower bound as the sample structures in this study have not been optimised. Better understanding of the recombination mechanisms, as well as improved bandgap designs are expected to advance existing gallium-free T2SL performance.

E. H. Steenbergen *et al.* Appl. Phys. Lett. 99 251110 (2011)

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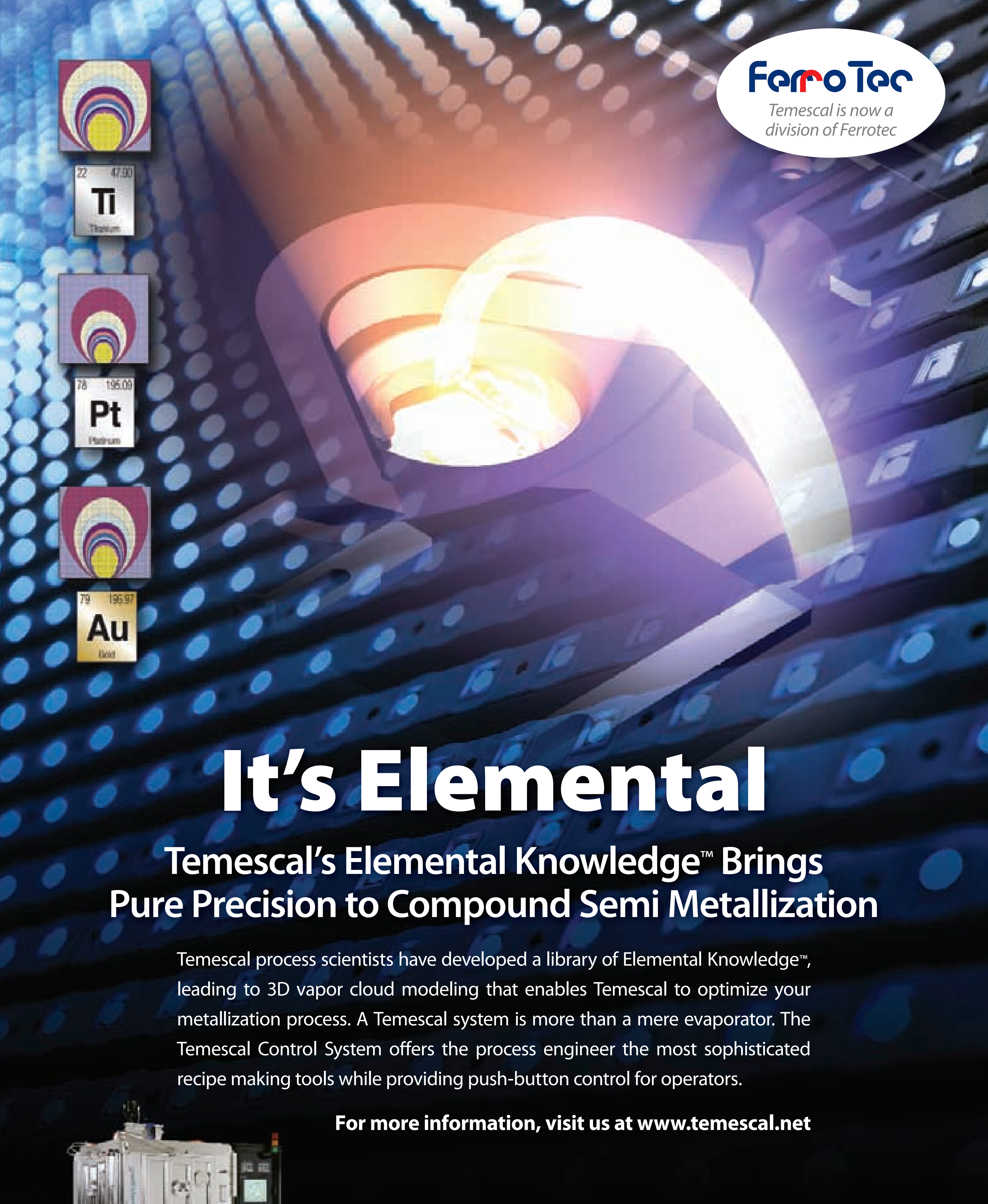
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News Digest Contents

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."

Chevron and Bridgelux brightening up California

The partnership is designed to save tax and increase safety by installing innovative, efficient LED lighting

An alliance between Chevron Energy Solutions and Bridgelux is creating new innovative advancements in LED lighting, enabling cities to significantly reduce utility bills and maintenance costs.

Under the program, Chevron Energy, will upgrade streetlights with LED technology, often at no upfront cost to cities. In many cases, taxpayers should not be impacted except by the dramatic improvement in the lighting of their communities.

Livermore and Dublin, two Northern California cities in Alameda County, are taking part in the demonstration of this unique LED technology and have upgraded several of their streetlights with Bridgelux's technology.

"The pilot installation has been received with great excitement. We are proud to be a part of a significant advancement in lighting innovation," says John Marchand, mayor of Livermore. "We take great pride in seeing our investment in local clean technology companies produce potential fiscal benefits for cities around the world."

Streetlights typically account for 10 to 40 percent of a municipality's energy costs. According to the

Clinton Global Climate Initiative, the energy used by street lights amounts to the third largest use of power by local governments today. Many cities in America could see reductions up to 40 percent or as much as $17 million in yearly energy costs, simply by converting their existing conventional streetlights to the Bridgelux LED.

“All cities are facing a similar fiscal dilemma; they need to upgrade their infrastructure, but lack the capital to move forward,” says Jim Davis, President of Chevron Energy Solutions. “Through this new initiative, we can help cities modernise their infrastructure by financing projects through energy savings. These LED streetlights are making a dramatic difference, but they are just the start of what we can do to help cities save on their energy costs.”

“Our community is excited about the evaluation we are doing with Chevron Energy Solutions and Bridgelux,” adds Tim Sbranti, mayor of Dublin. “All of us in city government look forward to the energy savings and improved street level visibility. We think this could be a successful financing model for many of our infrastructural improvement projects.”

The heart of the streetlight is an LED lighting module designed to be installed or upgraded quickly and easily into the existing streetlight head. Designed by Bridgelux, the module contains the light source and other components most subject to rapid evolution. As the technology advances in energy efficiency and capabilities, it is anticipated that modules could be simply swapped out without having to replace a city’s physical infrastructure.

The module also allows cities the potential of upgrading streetlights in the future to incorporate sensing and networking capabilities, giving city managers tools to control their lights and monitor traffic or remote locations, something impossible with conventional streetlights.

“LED lighting is the biggest advance in lighting since Thomas Edison showed off his bulb in 1879,” said Bill Watkins, CEO of Bridgelux. “But LEDs and solid-state lighting represent more than just a technical advance. They will usher in new business models and capabilities for running our homes, businesses and cities. Lights are going to become more than just something you screw into a socket.”

Oslon stabilises the temperature in its new SSL LED

By reducing the variation of the luminous flux in the LED at elevated temperatures, it is now possible to retain a virtually constant luminous efficacy at high application temperatures

The new generation of high-power Oslon SSL-LEDs by Osram Opto Semiconductors will be appreciated by users for their improved performance, with an efficiency increase of approximately 25 percent.

The new Oslon SSL LEDs by Osram Opto Semiconductors generate a particularly high light output with a long lifetime on a small surface - even at high temperatures

Thanks to this optimisation, the luminaire design is significantly simplified and the new generation of Oslon SSL LEDs, presents a particularly temperature stable light source. The LED provides a luminous flux of typically 98 lm in warm white (3,000 K), with an operating current of 350 mA at an application temperature of 85°C in the chip.

With its typical luminous efficacy of 96 lm/W, referring to the ratio between luminous flux and expended electrical output, it is among the most efficient 1 mm²-Chip-LEDs presently to be found on the market. The combination of higher luminous flux and reduced forward voltage of 3.1 V provides an efficiency increase of approximately 25 percent, when compared with the previous generation.

For manufacturers of lighting solutions, this makes luminaire development much easier: a smaller number of LEDs attains the same luminous flux, as well as the same efficiency as before.

State-of-the-art technology in use The latest developments in chip technology, converters, and package are the secret to the performance optimisation of the Oslon SSL. The higher temperature stability of its luminous flux, even when operating under “hot” application conditions, significantly simplifies thermal management. “This efficiency enhancement not only implies a reduction of the initial costs incurred by our customers, it also makes the development of luminaire solutions so much easier,” says Martin Wittmann, responsible marketing manager at Osram Opto.

Particularly small and bright The new Osram Oslon SSL LEDs are available in the light colour “warm white” (3,000 K), suitable for interior lighting (type EC), for instance in downlights, as well as in “cold white” (5,000 K), for use in exterior lighting (type PC).

Like the previous products of the Oslon SSL-range, the new arrivals are also available in a compact size of 3 mm x 3 mm and offer two different lenses. Thanks to the reflectivity of the package, the light that is irradiated to the side or to the back is reflected and can be used again. “Thus, this LED generation, which combines the converter and reflective package, ensures the best possible light colour homogeneity over angle,” Martin Wittmann adds.

Technical Data (at 350 mA operating current):

Component size		3 mm x 3 mm
Radiation characteristic		80° / 150°
Lifetime		> 50,000 hours (L70/B50 at Tj=125°C)
Light colours and CRI	at 3,000 K	80 minimum
	at 5,000 K	70 typical
Luminous efficacy	at 3,000 K	96 lm/W (Tj = 85°C) typical
	at 5,000 K	111 lm/W (Tj = 85°C) typical
Luminous flux	at 3,000 K	98 lm typical
	5,000 K	113 lm typical
Forward voltage		2.9 V typical

Osram Opto›s product portfolio is continually being expanded by additional colour temperatures.

Epistar welcomes its first Aixtron CRIUS II-XL MOCVD system

The firm will use the system to mass produce ultra-high brightness blue and white LEDs

Aixtron’s existing Taiwanese customer Epistar, a manufacturer of optoelectronic materials and devices, has received its first CRIUS II-XL system in a 19x4-inch wafer configuration.

The CRIUS II-XL system has successfully passed the process demonstration and acceptance test. In line with its usual procedure, Epistar will now further qualify the system in mass production. The company plans to purchase more CRIUS II-XL systems, when expanding its production capacity.

Ming-Jiunn Jou, President of Epistar, comments, “Looking at this first tool, I can see that the CRIUS II-XL will make a huge difference to our productivity. Epistar has always had great confidence in Aixtron technology and, thanks to its seamless process compatibility with our earlier generation reactors, the latest CRIUS technology is set to rapidly and efficiently drive forward future capacity expansion and technology advances.”

COO of Aixtron, Bernd Schulte, adds, “With the purchase of our latest system, the CRIUS II-XL, Epistar continues to pursue its cutting-edge production and engineering innovation in epitaxial growth. The CRIUS II-XL design concept offers the largest productivity with best-in-class uniformities, which massively increases yield and directly translates into enhanced competitiveness for Epistar’s products in an ever demanding marketplace.”

Located at the Hsinchu Science-based Industrial Park in Taiwan, Epistar Corporation has for over a decade been focused on the development, manufacture and marketing of UHB LED products. Employing its proprietary MOCVD process technology, Epistar continues to successfully commercialize a full range of UHB LEDs worldwide, featuring low power consumption and long operation life.

Introduced in November 2011, the Aixtron CRIUS

II-XL configuration offers an outstanding reactor capacity as high as 19 x 4 inch, which represents a capacity increase of 46% compared to the original CRIUS II. Aixtron reckons this gives it the highest throughput and lowest cost of ownership in the whole LED industry.

Optogan takes lean to the extreme with 500W COB LED platform

The firm's X10 offers a modular approach for luminaire designs from 1,100 lumens to 55,000 lumens and can be used in a variety of different shapes and sizes

Optogan's new X10 Chip-on-Board module (COB) is based on the vision of scaleability and lean processing for luminaire manufacturing.

The modules can be used in applications for LED-retrofits, downlights, industrial and street lighting as well as flood and stage lights as they come in various sizes and forms.

The X10 COB-block consists of 50 segments which can easily be divided into LED elements of smaller sizes and power, and each of these can be used in separate light fittings. The smallest segment of Optogan´s "single X10" consists of a 1cm² ceramic board and consumes 10 W (1 A, 10 V), with efficacy levels currently exceeding 100 lm/W.

The product's ceramic base and the materials used are optimised for long life performance. The new technology incorporates smart binning and uses the firm's lean in-house production.

Optogan says the COB was designed for direct mounting on heat sinks and offers a smaller footprint than conventional solutions. The firm is also offering an X10 system specific accessory, which is a universal connector providing both electrical and mechanical interfaces for assembly and optics.

The multinational engineering team achieved the requested target to develop a unified COB module portfolio for simplified application, handling, increased performance and lifetime at a universal level.

"X10 represents Optogan's new flagship, offering modular solutions, economical and simple to use, for that additional degree of freedom in lighting design. Coupled with state of the art module efficiency exceeding 100 lm/W, the X10 provides our clients the maximum possible variety in steps of 10W reaching up to 500W. The positive feedback from our key customers confirms, that our latest development is covering the missing white spot in LED landscape", says Markus Zeiler General Manager Global Sales & Marketing at Optogan GmbH in Germany.

The company says it is currently ramping up pre-series production of the X10.

Toyoda Gosei less than impressed with Formosa Epitaxy

Another lawsuit alleges that Forepi is infringing Toyoda Gosei's patents regarding gallium nitride-based LED chips. Toyoda Gosei is seeking damages and an injunction against a plurality of Forepi LED products

On February 24, 2012, Toyoda Gosei Co., Ltd. filed a patent infringement lawsuit in Taoyuan District Court in Taiwan against Formosa Epitaxy (Forepi), a Taiwanese LED chip manufacturer.

Prior to this, Toyoda Gosei filed a patent infringement lawsuit in the United States District Court, Northern District of California on February 21, 2012 against Forepi's infringement of its LED chip patents.

Japanese head-quartered Toyoda Gosei, says it was one of the first to develop LED chips and has also obtained a number of LED-related intellectual property rights worldwide.

A spokesperson from Toyoda Gosei said, "We have respected others' and our own intellectual

property rights in Japan and other countries, and have made our best efforts to further develop the market. Particularly in Taiwan, we have not only manufactured and sold our products and procured parts, but we have also established cooperative relationships with our partner firms with regards to manufacturing."

League of Green Embassies to push energy savings with Cree LED lighting

Five European installations contribute up to 76 percent in savings. The completed installations which will showcase sustainable U.S. building products are expected to be unveiled throughout 2012

Cree is participating in a series of energy efficiency renovations across U.S. Embassies in Vienna, Rome, Berlin, Madrid and Lisbon.

The installation of energy-efficient interior and exterior LED lighting by Cree is part of a visionary program spearheaded by the Alliance to Save Energy and The League of Green Embassies, a U.S. Department of State initiative to promote international cooperation in energy efficiency and clean technology.

The range of LED lighting products being installed at each residence varies according to its unique needs. The energy savings for these installations as compared to the old lighting ranges from 45 percent to 76 percent, which can have significant economic impact due to the cost of electricity in these locations. Older, energy-wasting lighting is being replaced with energy-efficient LED lighting in security lighting, indoor lighting, area lighting, walkway lighting and parking lot and roadway lighting.

"The goal of the League of Green Embassies is to make each participating embassy as energy efficient as possible and to use these embassies as platforms for showcasing U.S. energy innovation technologies and products," said Bruce J. Oreck, U.S. Ambassador to Finland. "We want to encourage companies to create and showcase for a global market the latest technologies that reduce energy waste and lower costs."

The League of Green Embassies was established to advance the 2007 Presidential mandate to reduce greenhouse gas emissions in U.S. government buildings; to demonstrate the capabilities of U.S. products and technologies to the world market; and to increase the exports of U.S. products and services in line with the National Export Initiative.

"Embassies are a great vehicle to showcase U.S. innovation and influence global commercial and industrial organizations to take action, consume less energy and advance energy efficiency," said Greg Merritt, vice president corporate marketing, Cree. "Cree is excited to be part of the League's initiative and to provide the embassies with Cree high-performance, energy-efficient interior and exterior LED lighting."

The embassies will host a VIP and press reception and exhibition to provide guests a firsthand look at recent upgrades in the embassy.

About Cree

Cree is leading the LED lighting revolution and making energy-wasting traditional lighting technologies obsolete through the use of energy-efficient, mercury-free LED lighting. Cree is a market-leading innovator of lighting-class LEDs, LED lighting, and semiconductor products for power and radio frequency (RF) applications.

Cree's product families include LED fixtures and bulbs, blue and green LED chips, high-brightness LEDs, lighting-class power LEDs, power-switching devices and RF devices. Cree products are driving improvements in applications such as general illumination, backlighting, electronic signs and signals, power suppliers and solar inverters.

For additional product and company information, please refer to www.cree.com. To learn more about the LED Lighting Revolution, please visit www.creeledrevolution.com.

Can you easily improve the reliability of High Brightness LEDs?

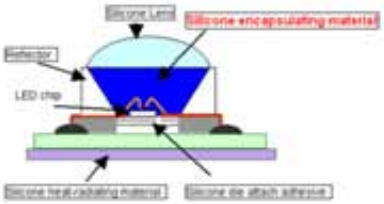
Apparently, yes. A new low refractive index silicone encapsulating material improves the efficiency of LED light transmission by greatly reducing gas permeability

Shin-Etsu Chemical has developed a new silicone encapsulating material product for applications in packaging materials for HB-LEDs.

The "KER-7000 Series," which is a low refractive index (RI)-type greatly reduces gas permeability.

The company is beginning sample shipments, mainly for applications in LED lighting.

Low gas permeability is one of the important characteristics sought in LED encapsulating material, along with superb photo-thermal stability in withstanding high temperatures and excellent retention of its initial optical transparency throughout the lifetime of the device.



With an encapsulating material that has high gas permeability, gases such as oxygen can easily permeate and cause oxidation and sulphuration to occur. This can lead to degradation in light intensity.

Up to now, Shin-Etsu Chemical has been developing many silicone encapsulating materials that have various characteristics, such as methyl-group material that is superior in heat resistance and phenyl-group material that has a low gas permeability.

The newly developed silicone encapsulating product succeeds in greatly reducing the level of gas permeability by 1/10 while maintaining heat resistance at the same level as that of the methyl-group.

What's more, when compared with the phenyl group, this new product has the same level of gas permeability and much higher resistance to high temperatures. LED packaging materials that apply this product will achieve dramatically improved reliability of LED lighting because of its effectiveness in preventing the degradation of light intensify caused by the corrosion of the peripheral materials.

As this new product has a refractive index of 1.38, which is lower than that of the methyl-group material, and is superior in transparency, it is a particularly attractive encapsulating material for flat-package HBLEDs. There are two types of products in this new series that are formulated based on different hardness properties: "KER-7080 A/B" has a hardness level of (Durometer A) 80, and "KER-7030 A/B" has a hardness level of (Durometer A) 30.

Shin-Etsu Chemical has a group of other diverse silicone encapsulating materials for HBLED applications. Representative products in the "SCR Series" are increasingly being adopted for backlighting applications in mobile phones and notebook PCs, and products in the "ASP Series," which have excellent characteristics with regard to long-term reliability and possess greatly reduced gas permeability, also are being increasingly adopted, mainly for applications in backlighting for LCDs.

Cree ups the voltage with LMH2 LED modules for Europe and Asia

The firm's next-generation LED module family supports 230 V input

To support the growing global demand for its LMH2

module, Cree has announced the module is now available to lighting manufacturers based in Europe and Asia.

Cree LMH2 LED module

The LMH2 is designed to speed time-to-market and Cree says it is the only LED module delivering 80 lumens-per-watt system efficacy combined with CRI greater than 90. The modules feature Cree TrueWhite Technology, a revolutionary way to generate white light with LEDs.

"Cree modules let us quickly and easily create high-performance lighting solutions for our customers," said Miroslav Masar, SSL director, OMS. "The LMH2 delivers the perfect combination of efficacy, colour consistency and cost management."

The compact, two-piece module gives lighting manufacturers the flexibility needed for rapid LED luminaire design and development. LMH2 also features primary thermal management – potentially eliminating the need for costly secondary thermal management systems.

The LMH2 is designed for many lighting applications, including wall sconces, pendant lights, ceiling fans and many other common luminaires in commercial, retail, museums, residential, hospitality and restaurant environments.

"The LMH2 is designed with the needs of the 230-volt European and Asian lighting markets in mind," said Mike Watson, Cree senior director marketing, LED components. "One of the major barriers to LED lighting adoption and design remains upfront cost. The new Cree LMH2 modules can reduce initial luminaire cost and accelerate time-to-market for OEMs."

The LMH2 is available with 90 CRI at 850 and 1250 lumens and in colour temperatures of 2700 K, 3000 K, 3500 K and 4000 K. Designed for 50,000 hours of operation and dimmable to five percent, the LMH2 comes with a Cree warranty.

The LMH2 is also UL-recognised and complies with multiple international regulatory and safety standards. Luminaire makers seeking ENERGY STAR qualification will have access to specification and performance data, including LM-80 reports, which can speed regulatory approvals.

Sample and production quantities are available with standard lead times from both Cree and Cree distributors.

Chevron goes green with Cree LEDs

The LED upgrade is estimated to deliver 70 percent in energy savings

Beaverton, Oregon's Highland Chevron gas station and ExtraMile food market recently underwent extensive eco-renovations.

These include the installation of energy-efficient interior and exterior LED lighting provided by Cree. The addition of Cree LED fixtures supports Highland Chevron's mission of becoming a zero-energy establishment.

Rebuilt from the ground up, the Highland Chevron store is fully lit with Cree LED luminaires under the exterior canopy and inside the convenience store—delivering energy savings estimated at nearly 70 percent over the old non-LED fixtures.

According to Bob Barman, owner of the Highland Chevron, the indoor and outdoor LED lighting allows the station to consume a third less energy than typical 24-hour c-stores and petroleum stations. Barman estimates that the new Cree luminaires should provide payback in 2.5 years and the financial savings just add-up after that. The Beaverton Chevron anticipates more than a decade of virtually maintenance-free operation.

"The payoff is more than what is saved in energy consumption and cost," said Barman. "The payoff is also intangible – it's what your customers think of you as a leader in sustainability and how you think

of yourself – it's just the right thing to do."

"The only time I'm going to think about my lighting is when I'm showing it off," said Barman. "The high-quality LED light makes everything appear brighter and safer—and that translates into a better customer experience."

304 series Canopy luminaire

Twenty-four Cree 304 Series recessed canopy luminaires with petroleum symmetric optics replaced the original 368-W metal halide fixtures on the fuelling canopy. Based on BetaLED Technology, the 105-watt 304 Series luminaires provide superior NanoOptic lighting control with little to no spill-off into neighbouring areas, helping Highland Chevron comply with local light pollution ordinances. In addition, 330-watt fluorescent fixtures were replaced by 27 Cree 304 Series pendant-mount luminaires in the ExtraMile food market.

Other green features of the gas station and convenience store include 180 solar panels on the fuelling canopy and store rooftop, capable of delivering nearly one-third of a typical gas station's electricity needs. Highland Chevron also installed a geothermal well that exchanges heat through groundwater to naturally cool water for the store's refrigeration cases, while water pipes store heat from cooling units underground for hot water usage.

"Energy efficient and near maintenance-free LED lighting is ideal for the 7/24 operations of gas stations and convenience stores," said Andy Strickland, Cree vice president, petroleum lighting. "Cree's LED products offer the Beaverton Chevron early payback and financial savings over their lifetime – they are the best choice for c-stores and gas stations."

Cree scientific advisor Steven P. DenBaars elected to NAE

DenBaars has been recognised for his contributions to gallium nitride-based materials and devices for solid state lighting and displays

Steven P. DenBaars is a prominent faculty member in the College of Engineering at UC Santa Barbara and a professor of electrical and computer engineering and of materials.

Steven P. DenBaars (Credit: Randy Lamb, UCSB)

Election to the Academy is among the highest professional distinctions accorded to an engineer. Membership honours those who have made outstanding contributions to "engineering research, practice, or education, including, where appropriate, significant contributions to the engineering literature," and to the "pioneering of new and developing fields of technology, making major advancements in traditional fields of engineering, or developing/implementing innovative approaches to engineering education."

"I am absolutely thrilled by this news, which not

only recognises Professor DenBaars's pioneering research in the area of solid state lighting and displays, but also his commitment to applying this research in order to improve the lives of people around the world," said Chancellor Henry T. Yang.

"Election by one's peers to the National Academy of Engineering is a very important and meaningful affirmation of years of innovation, creativity, and hard work. Our entire campus community proudly congratulates Professor DenBaars on his outstanding achievement."

DenBaars, who joined the UCSB faculty in 1991 as an assistant professor of materials, is the Mitsubishi Chemical Professor in Solid State Lighting and Displays. He is also co-director of the campus's Solid-State Lighting and Energy Centre. The author or co-author of more than 600 technical publications, his specific research interests include the growth of wide-bandgap GaN-based semiconductors, and their applications to Blue LED's and lasers, and high-power electronic devices. UCSB says this research led to the first U.S. university demonstration of a Blue GaN laser diode.

DenBaars received a National Science Foundation Young Investigator Award in 1994, and the IEEE Fellow award in 2005. He has made over 250 invited conference presentations and has been awarded over 30 patents. His election brings to 25 the number of current UCSB faculty members in the National Academy of Engineering.

Before joining the faculty at UCSB, DenBaars was a member of the technical staff at Hewlett-Packard's Optoelectronics Division, involved in the growth and fabrication of visible LED's. He is currently a scientific advisor for Cree Lighting. Among his many honours and awards are the 2010 Aron Kressel Award from the IEEE Photonics Society, the 2008 Japanese Science of Applied Physics Outstanding Paper Award, and the 2007 Viterbi Award and Distinguished Alumni Award from the University of Southern California.

Kaistar lights up Bridgelux with $25 million investment

The LED developer will use the cash to accelerate research, development, and production of LED chip and packaging technology for general illumination applications

"The market for solid-state lighting is expected to grow from $3 billion in 2011 to more than $25 billion in 2015," said Bill Watkins, Bridgelux's Chief Executive Officer. "This investment marks the beginning of our cooperation with Kaistar to lead the transition to solid-state lighting. Kaistar's cost-competitive manufacturing capabilities combined with Bridgelux's high performance packaging solutions will continue to drive down the cost of solid-state technology for general lighting, helping to more rapidly expand the market for LED."

Kaistar Lighting (Xiamen) Co., Ltd. is a China-based firm.

Verticle's Honeycomb InGaN LED chip in mass production

The indium gallium nitride LED chip, developed with Verticle's patented copper substrate and chemical chip separation technology, is optimised for light extraction efficiency

Verticle, Inc. is announcing the mass production of a hexagonal-shaped LED chip called "Honeycomb".

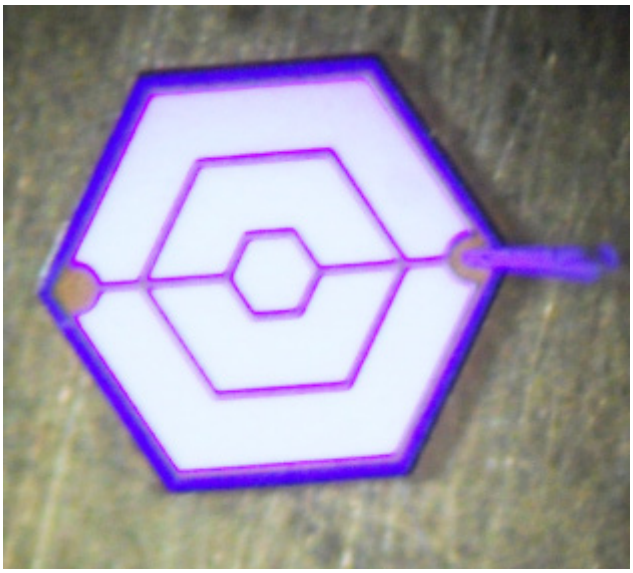
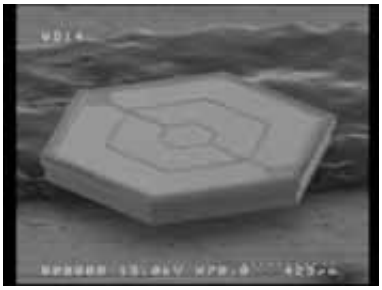


Photo of Honeycomb LED chip

" This vertically structured LED chip features significant benefits that include higher light extraction and amore uniform beam profile than conventional square or rectangular LED chips based on sapphire or silicon substrates," says Mike (M.C.) Yoo, Verticle's CEO.



SEM Image ofSeparated Honeycomb Chip

There have been many attempts to fabricate various shapes of LED chip with conventional laser scribing or dicing. However, according to Verticle, only a few shapes, like diamond or triangular-shaped LED chips, were possible to fabricate on an R&D level. And these could not be made on a production scale.

Verticle says its unique chemical chip separation technology makes this step much easier and quicker than conventional chip separation techniques. The process enables the fabrication of any shape of chip, even circular ones.

What's more, Honeycomb delivers an improvement in diode performance when compared to square or rectangular type LEDs. The optical efficiency of an LED chip depends on the effective current density in the active region. The hexagonal architecture of the InGaN Honeycomb allows better control of current spreading, enabling the chip to operate at high currents and achieve higher brightness than conventional chips.

Standard square and rectangular LED chips have a distorted beam profile when packaged with a typically circular lens. However, a hexagonal-shaped LED chip, which is more similar to a circular chip, generates a much less distorted beam profile and a very small dark spot.

Hence, after packaging with a circular lens, a hexagonal chip will achieve a higher lumen per Watt as compared to conventional square or rectangular chips having similar electro-optical properties. The Honeycomb chip can also be packaged in flat form like square or rectangular chips, meaning there is no additional cost or system modification needed.

Additionally, Verticle says the Honeycomb, with its copper substrate, has an excellent thermal and electrical conductivity, crucial for both long life and good thermal behaviour of the LED.

The main optical power range of the Honeycomb is between 370 - 420 mW at 350mA with a forward voltage range between 3.1 - 3.4V.

The mass production level Honeycomb chip will be showcased and available for sale at LED China 2012. The conference is taking place between 20 and 23 Feb 2012 at the China Import & Export Fair Pazhou Complex, Area B in Guangzhou.

Rubicon signs $20 million contract to supply sapphire substrates

The new agreement is with the firm's largest customer for large-diameter (classed as 6- and 8-inch) wafers

The contract represents a baseline level of shipments that will be made from June through December 2012. The previous contract expired at the end of December.

"We are pleased that we will continue as a key supplier to our valued six-inch wafer customer in 2012," said Raja Parvez, President and Chief Executive Officer of Rubicon. "As other LED chip manufacturers make the transition to large-diameter substrates in pursuit of greater efficiency, Rubicon—the world's largest, most experienced and most reliable provider of large-diameter sapphire wafers—stands to benefit greatly. However, with LED chip capacity presently not fully utilized, the inflection point in demand for large-diameter sapphire wafers for LEDs is still some months in the future."

In light of current market conditions and in the interest of further establishing a long-term customer relationship with our prominent customer, Rubicon

granted adjustments to fourth-quarter 2011 price and volume requirements under the expiring six-inch contract, as management had indicated was likely in remarks made November 8.

As a result, Rubicon's revenue for the fourth quarter ended December 31, 2011, was between $19 and $20 million, slightly below its previous guidance of $20 to $23 million. The Company expects to release complete results for the fourth quarter on February 23, after the market closes.

In another matter, but also related to the current market conditions, Rubicon disclosed that the Company, as an accommodation to certain key customers of its small-diameter sapphire ingots (cores), wrote off $1.8 million of accounts receivable in the fourth quarter.

"The fourth quarter of 2011 was a period of limited demand for sapphire substrates resulting from the accumulation of excess inventory in the LED supply chain," Parvez said. "This temporary decline in channel demand in turn resulted in sapphire prices falling sharply in the second half of 2011. Out of consideration for our important customer relationships, we made certain concessions that we deemed to be in the best long-term interest of our company."

"The near-term demand from the LED market continues to be limited, as inventory adjusts throughout the supply chain, but orders for two-inch and four-inch cores have begun to recover somewhat in the first quarter of 2012, and demand for large-diameter wafers for the Silicon on Sapphire (SoS) RFIC market is growing. As the channel inventory situation improves, and as LED technology further penetrates both the backlighting market and the general lighting market, we expect significant strengthening of the market for sapphire substrates later this year," he said.

"We remain optimistic on the long-term outlook for the LED market and Rubicon's positioning to capitalise on the opportunity. To date, Rubicon has shipped more than 230,000 six-inch sapphire wafers to the LED manufacturing and RFIC industries. This has provided us with the experience and scale to drive process and cost efficiencies throughout our system while maintaining our industry leading quality and service. Cost and quality leadership are instrumental to the acceleration of LED adoption in the marketplace and, as such, are strategic priorities for Rubicon," Parvez concluded.

SemiLEDs' nitride UV LED chips hit 40% EQE

The firm hopes its chips, some of which incorporate indium gallium nitride layers, to advance UV LED technology for the curing industry and provide cost-effective solutions

SemiLEDs Corporation says its latest ultraviolet LED chips are capable of emitting radiation at a wavelength of 390-420 nm with 40% external quantum efficiencies (EQEs).

The EQE is an LED's ability to convert electrons into photons. The devices have been tested at 350 mA and up to an output power of 500 mW and a typical 3.3V forward voltage. The exact output power depends on the wavelength.

"Our patented structure and metal alloy substrate allow us to produce and supply to the industrial curing market UV LEDs that are capable of operating at high current with high output power density," says Chuong Tran, COO and President of SemiLEDs.

"We are proud to be able to advance the UV LED technology for the curing industry and to provide cost-effective solutions to our customers thanks to our proprietary MvpLED technology."

The present SemiLEDs UV LED products are available in wavelengths ranging from 365nm-420nm, in chip sizes of 1.07 mm x 1.07 mm and 0.3 mm x 0.3 mm, and are immediately available for sampling and order.

GTAT to provide large diameter sapphire cores to Chongqing Silian

The firm will to supply 500,000 TIE (2-inch equivalent) of 6-inch diameter c-plane sapphire cores, which will be used to produce high quality sapphire substrates for the HB-LED industry

GT Advanced Technologies has announced that

its subsidiary, GT Crystal Systems, has entered into a purchase agreement with Chongqing Silian Optoelectronics Science & Technology.

GT's ASF furnaces produce high quality sapphire crystal material that is well suited for LED manufacturing

«We are pleased to announce this important agreement for large diameter sapphire cores and to continue our long and successful relationship with Silian,» said Cheryl Diuguid, GT Advanced Technologies› vice president and general manager of its Sapphire Equipment and Materials Group.

«Silian has an outstanding reputation for providing high quality substrates to some of the most advanced LED producers in the industry. This contract further validates that sapphire material produced in our ASF furnaces is well suited for use in the LED supply chain.»

«ASF-grown sapphire has helped Silian and our customers to achieve the high yields necessary for the maturing LED industry,» said David Reid, COO and general manager, Chongqing Silian Optoelectronics Science & Technology. «The consistency and quality of ASF-grown sapphire has served our business well and we look forward to continued collaboration with GT Crystal Systems.»

The ability to produce LED-grade sapphire at diameters of six inches and larger helps to accelerate the transition to next generation MOCVD production tools capable of handling the larger diameter wafers.

Larger substrates allow more efficient MOCVD production processes than current generation MOCVD tools processing two- and four-inch wafers. The large diameter cores will be produced from boules grown in GT›s ASF sapphire growth furnaces installed in the company›s newly expanded sapphire manufacturing facility in Salem, Massachusetts. This is the same technology which has been sold commercially to GT›s ASF equipment customers.

Soraa reveals its disruptive LED 2.0 technology

The firm's LED MR16, built on its breakthrough gallium nitride on gallium nitride technology, is superior to halogen

Soraa, a developer of GaN on GaN solid-state lighting technology, is launching its flagship product, the Soraa LED MR16 lamp.

The firm says this new product is the first LED lamp to provide superior performance to a traditional halogen MR16. It is also claimed to be the first LED lamp to provide halogen-equivalent brightness without requiring a mechanical fan and payback within months, not years.

The Soraa LED MR16 lamp based on GaN on GaN technology represents a revolutionary breakthrough in lighting technology: LED 2.0.

Founded by Shuji Nakamura, Steve DenBaars, and James Speck, Soraa leverages decades of expertise from the father of modern LED lighting, Shuji Nakamura, and preeminent solid-state lighting experts from the University of California, Santa Barbara. The company is headquartered in Fremont, California, where it houses the world's first GaN on GaN light-chip fabrication facility and their lighting products design lab.

Soraa says its pure GaN crystal is up to one thousand times purer than GaN on sapphire or GaN on SiC substrates, the platforms other LED lighting technologies rely upon today.

"Our technological foundation enables Soraa products to emit more light per LED material and handle more electric current per area than competitors, providing the highest quality light that makes for a perfect, more energy efficient

replacement for traditional halogen lamps," said Soraa CEO Eric Kim.

The company's flagship product, the Soraa LED MR16 lamp, available first to commercial customers, is priced to achieve less than one-year payback. The company chose the MR16 format because it has been the most difficult LED lamp to do correctly, given its small size and intense, high quality brightness requirements. Soraa's GaN on GaN MR16 is the first LED to rival the traditional 50W halogen. Its perfect crystal structure delivers a bright, highly-focused, controlled beam with the ability to produce a high colour rendering index and centre beam candle-power to match a standard halogen lamp.

Soraa's efficient thermal design also delivers halogen-equivalent performance without requiring a mechanical fan. The lamp's elegant, single-source LED design provides crisp object definition with solo shadow, uniform colour and a perfect beam pattern. Additionally, the Soraa LED MR16 lamp features optimised electrical design for total compatibility, making it suitable for use with all common transformers and dimmers, both indoors and outdoors.

"I've been searching for a long time for a quality LED to replace an MR16 halogen. Soraa's lamp is a quantum leap over what is currently on the market, offering brighter light, dimmability, long lamp life, as well as dramatically improved energy efficiency," said Randall Whitehead, a leading U.S. lighting designer. "Soraa's is not only the first LED MR16 I've found that outperforms halogen lamps, it's simply a best of breed product."

Led by CEO Eric Kim, who brings deep technology and brand development leadership from his tenure at Intel and Samsung, Soraa is backed by over $100 million in funding from Khosla Ventures, NEA, and NGEN Partners.

"Lighting affects the way we see the world, and good light can make anything more compelling," said Co-Founder Shuji Nakamura. "At Soraa, we are proud to create efficient lighting products that do not compromise on performance, offer the highest quality available and greatly reduce energy waste. We believe that with GaN on GaN, we have truly entered the next chapter in LED technology: LED 2.0."

Seoul Semi launches linear AC-power LED modules

The firm's latest Acrich2 will enable customers to lower carbon dioxide emissions whilst reducing their electricity bills

Seoul Semiconductor is releasing a new AC-powered LED product in its Acrich2 family.

The Acrich2 Linear Module exhibits efficacies, light output levels, and power factors comparable to DC LED solutions while eliminating the AC to DC power supply. The solution is on exhibit at the Strategies in Light conference this week in Santa Clara, California.

Acriche 2 modules

Compared with the existing linear modules driven by direct current, the main feature of the Acrich2 Linear Module is the removal of AC/DC converter and the consequent optimized form factor. This type of solution increases the reliability by removing many of the components which cause early lifetime failures of other fluorescent replacement solutions. The design also provides more flexibility and space to work inside the fixture since the large ballast (power supply) does not have to be accommodated.

AC solutions of the past have required a sacrifice in power line performance such as power factor and total harmonic distortion (THD). Acrich2 solves this issue and provides power factor increases to 97%, power efficiencies up to 90% and THD approaching 10%. In addition, the Acrich2 Linear Module will be available with LM-80 and UL testing data.

"Let's plant two trees," proposed Sunghun Bae, vice president of Seoul Semiconductor. His argument is based upon the adoption of Acrich2 bringing similar effects of planting two trees compared with the use of the LEDs driven by a direct current. "Armed with optimised and simplistic system design," says Bae, "the Acrich2 Linear Module is a state-of-the-art product that outperforms existing

non-environmentally friendly fluorescent lamps and direct current LED fluorescent lamps." He added, "With the doubly long life span and lower carbon dioxide emission, customers will be able to actualise eco-friendly lighting while paying lower electricity bills."

The Acrich2 Linear Module comes in 220V, 120V, 100V variants. Samples will be available from the local sales force, manufacturer representatives, and distributors. Earlier this year, the company announced a family of similar Acrich2 modules targeted at the replacement lamp market which allows easy bulb design of A19, PAR, MR16 and other form factors.

Rubicon aspires to move to large diameter sapphire

The firm is already producing 6-inch and 8-inch sapphire wafers, which set the stage to support the manufacture of LED-based general lighting

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Rubicon says that in order to support mass adoption of solid state lighting, a shift to larger diameter sapphire substrates must happen. Manufacturing efficiencies and cost reductions inherent in the large diameter platform set the stage for scaling up of the entire LED supply chain to meet the growing demand for LED chips. Rubicon›s presentation will review why a large diameter wafer is essential to driving down costs and increasing yields to support aggressive cost targets of SSL, and will address trends that are on the horizon.

Having said that, 4, 6 and 8-inch silicon substrates are also being explored as an LED platform by a number of companies and R & D institutions. Although silicon substrates are far cheaper than sapphire, finding a stable process to make GaN on silicon epiwafers in volume, particularly for 8-inch wafers, could take some time.

As a vertically integrated supplier of sapphire substrates and products for the LED industry, Rubicon is one of the major sapphire wafer producers in the production of high yield, large diameter wafers. Upto now, Rubicon has shipped more than 230,000 large diameter wafers, produced from the raw material, through cutting and finishing polished wafers.

Bringing down the overall price of LEDs is a key element in supporting the worldwide commercial adoption of solid state lighting based on LEDs as a light source. According to market research firm DisplaySearch, the total average LED penetration in lighting was 1.4% in 2010 and is forecast to reach 9.3% in 2014. Government entities around the world including China, European Union, Australia, Canada and the United States have introduced legislation to require energy efficient lighting.

Who knows what material will dominate the LED substrate market, sapphire, silicon carbide or silicon? Or maybe something else?

An updated mask alignment system for LED manufacturing improves COO

The new tool also optimises footprint in the fab and is claimed to deliver 55 percent higher wafer output for every square metre of cleanroom space compared to competitive offerings

EV Group (EVG), a supplier of wafer-bonding and lithography equipment for various markets including advanced compound semiconductors, has unveiled the EVG620HBL Gen II.

This is a second generation fully automated mask alignment system for the volume manufacturing of HB-LEDs.

EVG620HBL Gen II

Introduced one year after the launch of the first-generation EVG620HBL, the Gen II delivers a tool platform tailored to address HB-LED customer-specific needs and the ongoing demand of total cost-of-ownership reduction.

Thomas Uhrmann, business development manager for EV Group, noted, "The HB-LED market is dynamic and fast changing, and our customers constantly need innovative solutions to ensure their output and capital investments are being maximised. The EVG620HBL Gen II is a great example of how EVG quickly responds to its customers' needs by leveraging its expertise in HB-LED manufacturing to deliver an effective solution."

"Having already built a proven platform that is now a de-facto industry standard with our first-generation mask alignment tool, we expect the EVG620HBL Gen II will further widen the economical gap over competitive offerings," he continued.

EVG says that currently, its bonders and mask aligners are being deployed by four of the top five major HB-LED manufacturers.

Escalating demands for cost reductions and yield enhancements require that equipment providers rethink what they bring to the table in terms of total cost of ownership. This is particularly true with mask alignment for lithography where maximising yield is critical to fulfilling the long-term growth potential of LED technology.

The EVG620HBL Gen II is outfitted with a host of new features aimed at satisfying high-volume manufacturing (HVM) customers' specific demands:

• Enhanced microscope supporting automated mask pattern search, which further reduces mask setup and change time—both of which are critical to enabling continuous device production in HVM environments;

• Updated robotic handling layout with wafer mapping capability, which supports the demand for wafer traceability;

• Improved alignment capability (line alignment), which leverages the grids that mark single LEDs for orientation instead of requiring alignment marks that take up valuable space on the wafer;

• Reduced system footprint, which optimises total cost of ownership for operation and increases the wafer per footprint index.

Together, EVG says these key enhancements enable a 20-percent reduction in cost-per-processed wafer compared to competitive offerings.

Built on EVG's field-proven mask aligner platform, the EVG620HBL series features a high-intensity ultraviolet light source and an optional filter fan unit to maximize yield and enable the industry's highest wafer throughput of up to 165 six-inch wafers per hour (up to 220 wafers per hour in first print mode).

Another key feature of the EVG620HBL is the availability of special recipe-controlled microscopes whose illumination spectrum can be varied and optimised to ensure the best pattern contrast with various wafer and layer materials, including such advanced substrate materials as sapphire, SiC, AlN, metal and ceramic. The EVG620HBL series processes 2- to 6-inch wafers.

The EVG620HBL Gen II is available for purchase immediately.

Aixtron slashes revenue expectations by 25 percent

Despite generally positive results and continuing development activities in the optoelectronics industry, the LED market slowed down towards the end of 2011

Marketing firm Strategy Analytics says that the LED segment has adversely affected the semiconductor market.

The firm's report, "Compound Semiconductor Industry Review July-September 2011: Optoelectronics," captures product, technology, contract and financial announcements for companies such as Aixtron, IQE, Kopin, Soitec, Oclaro, GigOptix, Cree, JDSU, Avago Technologies, Finisar and Osram.

"When a leading equipment manufacturer in the very front end of the supply chain revises revenue and backlog expectations substantially downward, the entire segment takes notice," observed Eric Higham, Director of the Strategy Analytics GaAs and Compound Semiconductor Technologies Service. "Mid- to long-term prospects for the LED market remain positive, but continuing economic turmoil and rapidly dropping prices have manufacturers in the LED supply chain on edge."

Asif Anwar, Director, Strategy Analytics Strategic Technologies Practice added, "The optoelectronics market appears poised for growth. Optical device and network manufacturers are targeting 40 and 100 Gbps systems, a number of new LED products have been introduced and the US Department of Energy continues to make large investments in solar energy."

Holophane introduces outdoor LED luminaires

The new LED fixtures offer efficiency in new or installed applications

Architectural appearance combined with sustainability and a high level of performance characterise new GranVille II LED luminaires from Holophane.

The fixtures offer the same timeless housing choices that made Holophane's GranVille HID line popular and are offered with Classic or Premier prismatic borosilicate glass optics to facilitate use of new or installed pieces.

GranVille II LED luminaires

The GranVille II LED luminaires feature a new optical design that provides HID light levels while creating a comfortable wholly luminous appearance with low glare, less uplight and less light trespass. Multiple lumen packages are available and fixtures may be ordered with asymmetric or symmetric distributions. The luminaires are optimised to meet existing light standards.

"GranVille II LED luminaires represent the latest generation in the Granville family, which has become the benchmark for decorative acorn-style lanterns," said Ben Prichard, Holophane Senior Product Manager, Outdoor. "The period style fixtures are highly efficient and provide significantly greater lumens per watt. Depending on the application, they also use less energy than traditional lamp technologies."

Like most LED sources, GranVille II LED luminaires offer long life with reduced maintenance. A dedicated thermal management system maximizes

performance and reliability. The fixtures are also designed for easy access to the electronic driver to simplify maintenance.

GranVille II LED luminaires include cast aluminium housing available in multiple styles, including two utility series and four standard housings. The fixtures are offered with traditional GranVille trim options and mount to industry standard pole tenons and existing locations.

“New GranVille II LED luminaires provide present customers the cost effective option of retaining their pole, housing, glass globe, accessories and trim and simply replacing the light source and internal electronic components,” Prichard said. “The luminaires are suited to a range of environments, from parks and city streets to campuses, walkways and parking lots.”

GranVille II LED luminaires are OEM certified for retrofit of existing models. The new product family is pending regulatory listing and will be suitable for up to 400 C ambient temperature, depending on the selected wattage and options.

Headquartered in Granville, Ohio, Holophane provides energy efficient lighting systems for a range of commercial, industrial and outdoor applications.

Lumileds brings some sparkle to lighting

The new LUXEON H makes it possible to develop cost effective, compact LED bulb solutions for space constrained bulbs like GU10s and candelabra bulbs

Philips Lumileds is launching its next generation high-voltage LED, LUXEON H.

LUXEON H LED

With significant performance enhancements, LUXEON H enables the broadest range of retrofit bulbs and space constrained applications while providing the light output, efficacy, and quality of light required to meet ENERGY STAR specifications.

With a CCT of 2700K and 3000K with minimum 80 CRI, the LUXEON H has Freedom From Binning and a single 3-step MacAdam Ellipse colour space. With no flux bins and no Vf bins, the colour over angle is specified at a low 0.02 du’v. The device is hot tested and has a typical efficacy of 90 lm/W at 40 mA, 100V at Tj of 85°C.

The 100V / 200V package is rated for 4W – 8W. The typical flux is 320 – 660 lumens at 20 – 90 mA and 100V or 200V.

“LUXEON H is a major advancement that delivers unsurpassed quality of light in a package that’s easy to implement,” says Rahul Bammi, VP Marketing at Philips Lumileds. For the first time there is a practical solution for GU10 and other small form factor bulbs. Compared to other high-voltage or AC LEDs, LUXEON H delivers more light, better light, and better efficacy in a more cost effective package with proven LUXEON reliability.”

Compact and dimmable drivers are already available and LUXEON H is being designed into bulbs as a single LED solution which offers significant advantages over the multi-source designs previously required. The ease of solderless assembly reduces fixture manufacturing costs. Complementary components including drivers, optics, and clamps will be available through Future Lighting Solutions. The high volume release of LUXEON H will be in March.

Optogan reveals world class 500W LED lighting module

The X10 module delivers up to 50000 lumens from one component

Optogan’s new high power Chip-on-Board (COB) module, X10, is based on the vision of scalability and lean processing for luminaire manufacturing.

X10

The X10 is a COB-block, consisting of 50 segments, and can be easily divided into LED elements of smaller sizes and power, and each of them can be used in separate light fittings. The smallest segment of Optogan´s X10 consists of a 1cm² ceramic board and consumes 10 W (1 A, 10 V), with efficacy levels already exceeding 100 lm/W.

The connections of the sub-modules are opened, where required, either by industrial means, or a simple mechanical operation. Due to various sizes and forms of the elements, they can be used in halogen lamp analogues, light fittings, fixtures with reflectors, as well as in industrial or street lights. The ceramic base and product material selection is based on long life performance by design.

"X10 represents Optogan's new flagship, offering modular solutions, economical and simple to use, for that additional degree of freedom in lighting design. Coupled with state of the art module efficiency over 100lm/W, the X10 provides our clients the maximum possible variety in steps of 10 W reaching up to 500W", says Markus Zeiler General Manager of Business Unit International at Optogan GmbH in Germany.

Palomar Tech has a wire-bond-free direct attach for LEDs

The provider of microelectronics and optoelectronic packaging systems has developed a precision eutectic process for these devices

Donald Beck, General Manager of Palomar Technologies Assembly Services, says, "Direct-attach LEDs are the next generation of solid-state LED emitters that deliver superior value for consumer products and markets that include TV backlighting, camera flash and a variety of general illumination needs."

"Assembly Services is supporting more than 390 700µm LEDs that are attached with an Au/Sn solder to a single 50mm metal core carrier. Palomar Technologies' Pulsed Heat System is a major contributor to this development, allowing our precision die attach systems to control LED exposure much more effectively than most other processes. The bondpad-down design of direct-attach LEDs eliminates the need for wire bonds, yet improves the thermal management", he continues.

Cree faces margin pressure as LED prices deteriorate

It's a good thing then, that the firm has not put all its egg in one basket, as it is also investing in silicon carbide power devices

Companies focused on the manufacturing of LEDs have struggled in the New Year as an influx of Chinese companies has boosted competition in the industry.

The fierce competition has cut prices, squeezed profit margins and inflated supplies, Reuters reports. Five Star Equities has examined the outlook for companies in the Semiconductor LED Industry and provides equity research on Cree and Universal Display Corporation.

The LED industry is expected to be a "low margin business," Wunderlich Securities analyst Theodore O'Neil explains. "Demand is going to be awesome," O'Neill said, pointing to the 50 percent drop in prices on LED light bulbs at home improvement retailers like Home Depot and Lowe's.

VantagePoint Capital Partners expects prices for LEDs to plummet within three years as competition intensifies to satisfy surging demand for energy-efficient lights. Prices for LEDs may fall 90 percent by 2015, said Alan Salzman, chief executive officer of VantagePoint Capital Partners.

Last month Cree reported fiscal second quarter net income of $28.7 million, or 25 cents per share, after excluding stock-based compensation and amortized goodwill -- down 53 percent from a year ago. Revenue rose 18 percent to $304.1 million but was below analysts' expectations of $309.85 million. For the third quarter, Cree expects revenue

of $290 million to $310 million, well below analysts' estimates of $320.87 million, according to Thomson Reuters.

Telecoms

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.

HRL's GaN transistor technology available commercially

The company's gallium nitride technology provides significant advantages for high-data-rate wireless links, radars and active sensors over other conventional products

HRL Laboratories is offering products in its GaN high electron mobility transistor (HEMT) technology range to commercial customers in select markets.

HRL has been investing in GaN transistor development since the late 1990s, reporting the first Ka-band GaN power amplifier at the 2004 IEEE International Microwave Symposium and the first W-band GaN power amplifier at the 2006 International Electron Devices Meeting.

The HRL GaN amplifiers offer more than five times improvement in E and W-band output power compared to current state-of-the-art commercial solid-state technologies. This high power output reduces the need for power combining multiple amplifiers and minimises the power module assembly complexity. What's more, the intrinsic higher linearity of GaN allows the transmission of modulation schemes with higher spectral efficiency, increasing the potential data throughput for wireless links.

HRL is offering wideband 70 to 100 GHz GaN power amplifiers as well as a family of application-specific E and W-band power amplifiers covering the 71 to 76 GHz, 81 to 86 GHz and 90 to 96 GHz bands.

HRL will be showcasing its GaN products at the 2012 GomacTech conference (Booth # 305) taking place from March 19-22, 2012 in Las Vegas, Nevada. The company will also exhibit its GaN products at the International Microwave Symposium (Booth # 203) from June 17-22 in Montréal, Canada.

HRL Laboratories, LLC, Malibu, California is a corporate research-and-development laboratory owned by The Boeing Company and General Motors. It specialises in research into sensors and materials, information and systems sciences, applied electromagnetics, and microelectronics. HRL provides custom research and development and performs additional R&D contract services for its LLC member companies, the U.S. government, and other commercial companies.

Infinera ranked number one in 2011 North American long haul WDM market

The indium phosphide PIC provider held the number one market share position in this sector

According to ACG Research, a market analysis firm delivering telecom market share and forecast reports globally, the global Long Haul WDM market increased 15% in 2011 from 2010.

The North American Long Haul WDM saw a healthy increase of 9.1% quarter over quarter in 2011. In fourth quarter 2011 alone, the overall worldwide Long Haul WDM market was up 20% from its previous quarter, exemplifying a strong growth in this market.

"Our reports indicate the Long Haul market is experiencing another growing cycle and we expect this market to continue to expand over a couple of years," said Eve Griliches, Principal Analyst at ACG Research. "Infinera is well positioned to sustain its number one rank in this market, especially with the Infinera DTN-X platform coming to the market."

In 2011, Infinera experienced growth globally, adding 16 new customers for a total of 98 customers worldwide during this period. In addition to new customers, Infinera's customers purchased multiple products across multiple applications.

"We are pleased to see further evidence validating Infinera's strategy of focusing on our customers' success," said Tom Fallon, Infinera CEO. "Infinera's Digital Optical Network solution enables multi-Terabit optical networks solutions that are simple, scalable and efficient. These results reflect the trust our customers continue to place in us."

New promise for gallium manganese arsenide in spintronics

The material properties, which arise from holes in an impurity band, created by manganese doping, depletes the valence band and shifts the Fermi level . This should enable a boost in the materials' spintronics performance

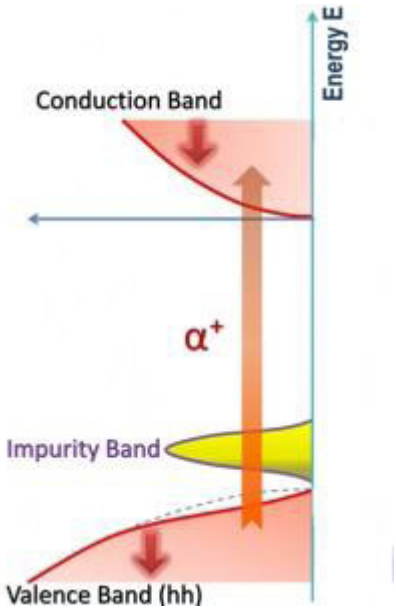
Scientists say they have solved a long-standing controversy regarding gallium manganese arsenide ((Ga,Mn)As)), a material which shows great potential for spintronic applications.

Researchers at the U.S. DOE's Lawrence Berkeley

National Laboratory and the University of Notre Dame have determined the origin of the charge-carriers responsible for the ferromagnetic properties that make (Ga,Mn)As such a hot commodity in spintronics. Such devices utilise electron spin rather than charge to read and write data, resulting in smaller, faster and much cheaper data storage and processing.

Wladek Walukiewicz, a physicist with Berkeley Lab's Materials Sciences Division and Margaret Dobrowolska, a physicist at Notre Dame, led a study that showed that the holes (positively-charged energy spaces) in (Ga,Mn)As control the Curie temperature.

This is the temperature at which magnetism is lost, and located in an impurity energy band rather than a valence energy band, as many scientists have argued. This finding opens up the possibility of fabricating (Ga,Mn)As so as to expand the width and occupation of the impurity band and thereby boost the Curie temperature to improve spintronic potential.



Schematic illustrating the presence of the impurity band between the valence and conduction band

"Our results challenge the valence band picture for gallium manganese arsenide and point to the existence of an impurity band, created by even moderate to high doping levels of manganese," Walukiewicz says. "It is the location and partially localised nature of holes within this impurity band that drives the value of the Curie temperature."

As a commercial semiconductor, GaAs is second only to silicon. Substitute some of the gallium atoms with atoms of manganese and you get a ferromagnetic semiconductor that is well-suited for spintronic devices. While it has been established that the ferromagnetism of (Ga,Mn)As is hole-mediated, the nature of the hole-states, which has a direct and crucial bearing on its Curie temperature, has been vigorously debated.

In semiconductors and other solid-state materials, the valence band is the range of energies in which the movement of charge is determined by availability of holes. Doping gallium arsenide with manganese can create an impurity band that depletes the valence band and shifts the Fermi level, the energy level at which the electronic states below are filled and those states above are empty.

"The question has been whether the holes mediating the interactions of manganese spins reside in a delocalised valence band, or in a manganese-derived partially localised impurity band," Walukiewicz says. "The valence band model assumes that a separate impurity band does not exist for manganese concentrations higher than about two-percent."

Walukiewicz and his co-authors addressed the issue through channelling experiments that measured the concentrations of manganese atoms and holes relevant to the ferromagnetic order in (Ga,Mn)As. These experiments were carried out at Berkeley Lab's Rutherford Backscattering facility, which is operated under the direction of co-author Kin Man Yu. The results of these experiments were then combined with magnetisation, transport and magneto-optical data performed at the University of Notre Dame.

Wladek Walukiewicz and Kin Man Yu at Berkeley Lab's Rutherford Backscattering Spectrometry laboratory

"We were able to determine where the manganese atoms were located, what fraction of this total replaced gallium and acted as electron acceptors (meaning they created ferromagnetic-mediating holes), and what fraction was in the interstitial sites, acting as positively-charged double donors compensating for a fraction of manganese acceptors," Walukiewicz says.

"Taking all our data together, we find that the Curie temperature of gallium manganese arsenide can be understood only by assuming that its ferromagnetism is mediated by holes residing in the impurity band, and that it is the location of the Fermi level within the impurity band that determines the Curie temperature."

Electron spin is a quantum mechanical property arising from the magnetic moment of a spinning electron. Spin carries a directional value of either "up" or "down" and can be used to encode data in the 0s and 1s of the binary system. Walukiewicz says that understanding the factors that control the Curie temperature can serve as a guide for strategies to optimise ferromagnetic materials for spintronic applications.

"For example, with appropriate control of the manganese ions, either co-doping with donor ions, or modulation doping, we can engineer the location of the Fermi level within the impurity band to best the advantage," he points out.

Walukiewicz says the findings of this study further suggest that it should be possible to optimise magnetic coupling and the Curie temperature for the whole family of ferromagnetic semiconductors by tuning the binding energy of the acceptor ions.

The results of this study have been published in the paper, "Controlling the Curie temperature in (Ga,Mn)As through location of the Fermi level within the impurity band" by M. Dobrowolska *et al* in *Nature Materials*, published online on 19 Feb 2012. DOIi:10.1038/nmat3250

This research was supported in part by the DOE Office of Science, and by grants from the National Science Foundation, the Natural Sciences and Engineering Research Council of Canada, and the Canadian Institute for Advanced Research.

Infinera boosts its customer support with a new VP

Todd Hanson has joined indium phosphide PIC innovator Infinera as the vice president of Global Professional Services

Hanson brings deep experience having worked in operations executive roles with high profile cable and service provider companies.

Infinera's Professional Services team supports customers with deployment, technical support, training, maintenance and consulting services worldwide. These include network migrations from legacy equipment to photonic integrated circuits (PIC) based systems.

Todd Hanson brings to Infinera experience from a customer perspective. Having worked in engineering and operations, management, and executive roles at Sprint, AT&T Canada, Qwest, Frontier, and Time Warner Cable, Hanson is familiar with Infinera's solutions and the benefits of Infinera's services.

"As a former Infinera customer on several occasions, I personally experienced Infinera's advanced solutions and services and quickly recognised the operational benefits in terms of simplicity and lower overall life cycle costs Infinera delivered to our network compared with others," said Hanson. "I look forward to working with our customers to improve their networks, demonstrating the ease of operation on Infinera's platforms and the capex and opex improvements."

"Infinera has grown rapidly, expanding our worldwide footprint," said Lonny Orona, Senior Vice President, customer services/product support. "Todd brings a wealth of operational experience from his leadership roles with world-class service providers that will serve our customers well. We are excited to have Todd on our team."

GaAs TRITIUM Duo family is the tiniest for dual-band power

TriQuint says it's gallium arsenide based amplifiers offer mix-and-match two-band combinations. This gives mobile device manufacturers a flexible, high-performance platform that speeds up time to market

TriQuint's new TRITIUM Duo family combines two band-specific power amplifiers (PAs) and two duplexers in a single compact module, effectively replacing up to twelve discrete components.

The company says it is the smallest dual-band PA duplexer (PAD) for global 3G and 4G smartphones.

TriQuint's TRITIUM Duo™: Industry's First Dual-Band Power Amplifier Module

Source: TriQuint, 2012

"We've powered the world's top smartphones with over a half billion of our single-band TRITIUM modules, and now the TRITIUM Duo is being evaluated by customers for use in next generation smartphones," said Ralph Quinsey, president and chief executive officer of TriQuint. "Our broad technology portfolio has enabled us to integrate two commonly used bands in one small footprint. Not only have we simplified the RF front-end for phone designers, we have also increased performance and flexibility."

The TRITIUM Duo family shares a common 6 x 4.5mm footprint, giving designers the flexibility to support multi-band, multi-mode operations across multiple platforms. Mobile device manufacturers can capitalise on the large size reductions to include more features or larger batteries in thinner, lighter form factors with all the performance needed for CDMA, 3G, and 4G networks.

At about 50 mm2,, roughlyhalf the footprint of a comparable discrete solution, they offer improved manufacturing and supply chain efficiency. Optimised for each of its two bands, no switching is required after amplification, unlike configurable architectures.

The new dual-band TRITIUM Duo implements proprietary TriQuint CuFlip technology to replace wire bonds with copper bumps; this saves board real estate and enables superior system performance by eliminating noise-radiating wires.

The copper bumps also dissipate heat better than traditional interconnect techniques. The integrated Flip Chip BiHEMT power amplifier die achieves industry leading current consumption to provide maximum talk-time and thermal efficiency critical for smartphone applications.

The TRITIUM Duo also employs a wafer level packaging technique to provide hermetic filter encapsulation for improved performance and a reduced size. In addition, the modules integrate high-performance BAW and SAW duplexer capabilities.

TRITIUM Duo Product Family

Band Pairs	Part #	Geographies Served
Bands 1 & 4	TQM6M6214	U.S., Europe, Africa & Asia
Bands 1 & 9	TQM6M6218	Europe, Africa & Asia
Bands 2 & 5	TQM6M6225	North America

The TRITIUM Duo is currently sampling, with volume production is planned in June.

TriQuint speeds up the smallest phones

The firm's devices incorporating gallium arsenide HBTs, deliver design flexibility for 2G, 3G and 4G mobile devices

TriQuint Semiconductor is now offering two QUANTUM Tx modules that are 40% smaller than the previous generation.

These transmit modules integrate TriQuint's new

ultra-small GSM core, and enable more flexibility for smartphones, feature phones and low-cost voice-only phones.

"Design innovations have enabled cost and size breakthroughs without compromising performance," said Shane Smith, Vice President of Global Marketing for Mobile Devices. "Our 2G QUANTUM Tx module has already made significant inroads in the GSM market. Our new 3G/4G QUANTUM Tx module pairs with our new TRITIUM Duo family of dual-band PA-duplexer modules to create the industry's smallest, high-performance RF solution for global 3G/4G wireless devices."

Leading mobile handset manufacturers Samsung, Huawei and ZTE have selected TriQuint's new QUANTUM Tx modules. TriQuint has seen success with previous generations of its QUANTUM Tx modules; to date, more than 150 million units have shipped.

"We expect to ship more than 100 million QUANTUM Tx modules in the next 18 months alone, making it one of the highest volume product lines in our factory," Smith added.

TriQuint increased manufacturing capacity by 40 percent in 2011 to support customer demand for its growing mobile device portfolio.

Shipping in volume since mid-2011, TriQuint's 2G (GSM) QUANTUM Tx module, TQM6M4068, offers phone designers full GaAs HBT performance and a small size to enable flexible designs. At 5 x 6 x 1 mm, the TQM6M4068 is one of the industry's smallest Tx modules and has won "Best Product" in the 2011 EDN China Innovation Award program for the communications and networks front-end category.

Approved for MediaTek's chipset reference design, the new product has been chosen for many new 2G phone platforms. "Close to 1.5 billion GSM based phones will be produced this year," said Neil Shah, an analyst from research firm Strategy Analytics. "Virtually all 3G and 4G capable phones incorporate 2G access technology, and 2G remains the dominant wireless communication technology in many areas of the world."

Shipping in volume since January 2012, TriQuint's TQM6M9069 QUANTUM Tx module features the same small 5 x 6 mm footprint, making it one of the smallest 3G/4G transmit modules on the market. This new part simplifies mobile device design and includes a GSM/GPRS power amplifier and WCDMA antenna switch. TriQuint plans to expand the QUANTUM Tx module family in the months ahead with product solutions that incorporate additional switch ports to support more frequency bands.

The QUANTUM Tx transmit modules implement TriQuint's proprietary CuFlip technology to replace wire bonds with copper bumps. This saves board space and enables superior system performance by eliminating noise-radiating wires. The copper bumps also dissipate heat better than traditional interconnect techniques. The QUANTUM Tx modules offer improved system efficiency and full RF transmit functionality in a compact 30 mm² package.

Manganese doped ZnS is not a dilute magnetic semiconductor

Results indicate that manganese doped zinc sulphide is paramagnetic, meaning it is only attracted when in the presence of an externally applied magnetic field

Dilute magnetic semiconductors (DMS) have recently been a major focus of magnetic semiconductor research.

Magnetic semiconductors exhibit both ferromagnetism (or a similar response) and useful semiconductor properties.

These materials when implemented in devices, could provide a new type of control of conduction. Whilst traditional electronics are based on control of charge carriers (*n*- or *p*-type), practical magnetic semiconductors would also allow control of quantum spin state (up or down). This would theoretically provide near-total spin polarisation (as opposed to iron and other metals, which provide only about 50% polarisation). This is an important property for spintronics applications such as spin transistors.

Now a laboratory from the University of Science and Technology of China has reported the feasibility of doping manganese into zinc sulphide (ZnS) to produce magnetic semiconductors.

Hideo Ohno and his group at the Tohoku University, Japan, say they were the first to measure ferromagnetism in transition metal-doped semiconductors such as InAs and manganese doped GaAs. Since then, researchers have attempted to obtain semiconductor hosts doped with different transition metals that exhibit ferromagnetic properties.

A team of researchers from Hefei National Laboratory for Physical Sciences at the Microscale, University of Science and Technology of China, discovered that manganese-doped ZnS (ZnS : Mn) shows paramagnetic behaviour and is not suitable for use as a DMS.

Electron spin resonance (ESR) spectra (Figure 1(a)) of nanocrystalline ZnS : Mn show that at lower concentrations of manganese, a typical sextet centred at a g-value of 2 is associated with the allowed (Δms = ±1, Δml = 0) magnetic dipole transitions between the hyperfine-split Zeeman levels of the 6S5/2 ground state of the Mn2+ 3d electrons.

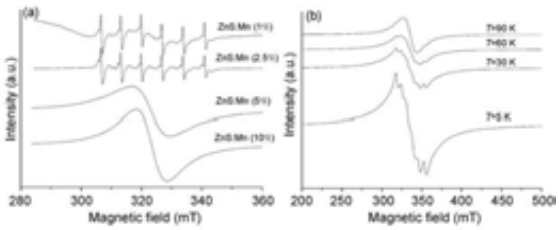


Figure:1 (a) Room temperature ESR spectra of ZnS : Mn; and (b) Low temperature ESR spectra of ZnS : Mn (20%)

The hyperfine structure arises from the interaction between the S = 5/2 spin of the unpaired 3d electrons with I = 5/2 spin of the 55 Mn nucleus. This indicates that managnese ions are distributed in the ZnS nanocrystalline lattice so that they are isolated from each other.

At higher manganese concentrations, the ions assemble together and are localised in the ZnS crystal lattice, decreasing the Mn - Mn atomic distance and increasing the dipole-dipole interaction. This causes the hyperfine structure to merge into one broad resonance.

Further ESR experiments (Figure 1(b)) at low temperature also suggested that the sample was not ferromagnetic. All of the results indicated that ZnS : Mn is paramagnetic and not suitable for DMS.

Further details of this work have been published in the paper, " Structure characterization, magnetic and photoluminescence properties of Mn doped ZnS nanocrystalline" by Zuo M, Tan S, Li G P, *et al.*., SCIENCE CHINA Physics, Mechanics & Astronomy,2012, Vol. 55, p 219-223.

DOI: 10.1007/s11433-011-4595-3

Anadigics introduces InGaP Multimode Multiband PAs

These compact and efficient indium gallium phosphide MMPAs are suited to Quad-Band GSM/EDGE and dual-band WCDMA/LTE applications

Anadigics says its new PAs reduce RF space requirements in handsets, smart phones, tablets, netbooks, and notebooks.

"Mobile devices continue to evolve in both form and function, creating performance and size constraint challenges on the RF front-end," said John van Saders, senior vice president of RF products at Anadigics.

"Anadigics has responded to these challenges by continuously improving power amplifier performance and integration. The introduction of our new multimode multiband power amplifiers extends our high performance RF integration. By delivering a converged solution with industry-leading performance, we are able to provide manufacturers with greater design flexibility to enable the next-generation of mobile devices."

Anadigics multimode multiband power amplifiers are optimised to deliver compelling performance under LTE, WCDMA and CDMA signal modulations for bands 1,5,6,18,19 and 26. Efficiency, current consumption and linearity specifications have been enhanced for all modulations, while ensuring that critical harmonic, noise and intermodulation performance results in superior phone level performance.

Anadigics' MMPA solution uses the Company's exclusive InGaP-*Plus* technology and HELP architecture to achieve optimal efficiency across low-range and mid-range output power levels, without the use of a DC-DC converter. When paired with a DC-DC convertor, the MMPA can deliver additional performance benefits.

The compact 5 mm by 7.5 mm MMPA features an integrated voltage regulator and separate single-ended RF chains. The inclusion of high directivity couplers also ensures optimum system performance. The GSM performance of the MMPA is characterised by high efficiencies at all power levels, while the EDGE performance meets all stringent modulation mask requirements under all conditions.

Engineering samples of the ALT6181 are available now.

Cellular PA market to reach $4 billion in 2016 with the help of GaAs

The market for gallium arsenide-based PAs will continue to grow in more demanding applications and more sophisticated smartphones

The cellular power amplifier (PA) market grew 19 percent, to more than $3.3 billion in 2011, driven by the growth of cellular terminal shipments to an estimated 2.3 billion units.

The Excel-based report, "Cellular PA Forecast 2012," from the Strategy Analytics RF & Wireless Components (RFWC) service covers the market for PAs and PA-front-end modules in dollars and units through 2016.

According to Christopher Taylor, Director, Strategy Analytics RF & Wireless Components, "Grey market (illegal, or shanzhai) handsets grew, as did smartphones, cellular-enabled notebooks, netbooks, tablets, USB dongles and M2M devices. The average number of bands and modes supported by cellular devices also grew, which slightly increased the average number of PAs per cellular device 2011. Strategy Analytics expects the non-handset segments of this market to contribute

more than 40 percent of the demand in 2016."

Eric Higham, Director of the Strategy Analytics GaAs and Compound Semiconductor market research service, added, "GaAs-based PAs make up about 95 percent of the market, however W-CDMA PAs fabricated in monolithic CMOS will capture a small but growing share in low-cost 3G devices over the next five years. Even so, the market for GaAs-based PAs will continue to grow in more demanding applications and in the form of complex modules for multiband smartphones."

GaAs propels NASA with a quantum leap forward in detector technology

A new Thermal Infrared Sensor (TIRS), which incorporates gallium arsenide chips, will take the Earth's temperature with a new technology that applies quantum physics to detect heat

The TIRS is part of a new Landsat satellite instrument which has arrived at Orbital Sciences in Gilbert, Arizona.

There it will be integrated into the next Landsat satellite, the Landsat Data Continuity Mission (LDCM).

The engineering team at NASA's Goddard Space Flight Centre in Greenbelt, Maryland, completed TIRS on an accelerated schedule, going from plans on paper to building the instrument in only 43 months.

"That's a full year ahead of a typical schedule for a new space borne instrument," says Betsy Forsbacka, TIRS instrument manager.

Aleksandra Bogunovic reaches across the instrument to affix the corners of a Multi-Layer Insulation blanket to the TIRS instrument (Credit: NASA Goddard/Rebecca Roth)

"Two things made this remarkable achievement possible," says James Irons, LDCM project scientist. "The dedication of the TIRS team working nearly around-the-clock and the use of advanced detector arrays we had on-hand because Goddard played a major role in developing the technology. TIRS will be the first time this technology is used in space."

TIRS uses Quantum Well Infrared Photodetectors (QWIPs) to detect long wavelengths of light emitted by the Earth with an intensity depending on surface temperature. These wavelengths, called thermal infrared, are well beyond the range of human vision. While devices for thermal infrared night 'vision' have long been available, QWIPs offered a new lower-cost alternative to conventional infrared technology. QWIP arrays are designed for sensitivity to specific wavelengths.

The QWIP design operates on the complex principles of quantum mechanics. GaAs semiconductor chips trap electrons in an energy state 'well' until the electrons are elevated to a higher state by thermal infrared light of a certain wavelength. The elevated electrons create an electrical signal that can be read out and recorded to create a digital image. The QWIPs' TIRS uses are sensitive to two thermal infrared wavelength bands, helping it separate the temperature of the Earth's surface from that of the atmosphere.

TIRS was added to the satellite mission when it became clear that state water resource managers rely on the highly accurate measurements of Earth's thermal energy obtained by NASA satellites like LDCM's predecessors, Landsat 5 and Landsat 7, to

track how land and water are being used.

"For example, irrigated fields are cooler than those suffering from a lack of moisture," says Veronica Otero, TIRS thermal engineer.

With nearly 80 percent of the fresh water in the Western U.S. being used to irrigate crops, TIRS will become an invaluable tool for managing water consumption, says Rick Allen, director of water resources research at the University of Idaho, in Kimberly, Idaho.

LDCM is scheduled to launch in January 2013 from Vandenberg Air Force Base in California. Aboard LDCM are two instruments, TIRS and an imaging sensor called the Operational Land Imager (OLI) built by Ball Aerospace & Technologies Corporation, Boulder, Colorado. OLI collects data in the visible, near infrared and short wave infrared spectrum.

LDCM is the eighth satellite in the Landsat series, which began in 1972 with the launch of Landsat 1, and extends the world's longest-running satellite program for global land observations. NASA and the U.S. Department of the Interior through the U.S. Geological Survey (USGS) jointly manage Landsat and the USGS preserves a 40-year archive of Landsat images with free distribution of data over the Internet.

Because of this freely available data of more than three million current and archived images of Earth, Landsat data is the basis for thousands of university research papers, the foundation for commercial innovations like Google Earth, and a cornerstone of U.S. space cooperation with foreign nations. More than 20 nations on six continents operate local receiving stations for Landsat data.

Anadigics' new InGaP family supports E-UTRA Band

The devices are manufactured using the firm's advanced indium gallium phosphide HBT MMIC technology

The company's small-cell wireless infrastructure PA family delivers a combination of high output power, efficiency, and linearity and are optimised for the rapidly growing class of small-cell base stations.

The two new power amplifiers (PAs), the AWB7128 and AWB7228, are optimised for WCDMA, HSPA, and LTE base stations.

"The continual increase in consumer demand for wireless data is fuelling the rapid deployment of small-cell wireless infrastructure devices, such as picocells and femtocells," said Glenn Eswein, director of product marketing for broadband RF products at Anadigics.

"Anadigics' small-cell power amplifier family delivers the highest output power, power-added efficiency, and linearity in its class, enabling manufacturers to develop compact, aesthetic, high throughput devices that offer service providers an economical path to expand broadband network coverage. Working closely with device manufacturers, we are expanding this family to help bring the same performance and design flexibility to additional frequency bands."

The AWB7128 and AWB7228 wireless infrastructure PAs are optimised for WCDMA, HSPA, and LTE small-cell base stations operating in the 2620 MHz to 2690 MHz frequency band.

The AWB7128 provides +24.5 dBm linear output power, while the AWB7228 delivers +27 dBm linear output power. These power amplifiers use Anadigics' InGaP-Plus technology to achieve best-in-class efficiency and linearity at these output power levels, enabling small-cell wireless infrastructure solutions that are more thermally-efficient, consume less power, and provide a greater range.

Anadigics' AWB7128 and AWB7228 PAs have a linearity of -47 dBc ACPR @ +/- 10 MHz offset (10 MHz channel bandwidth).

The modules, which come in a 7 mm x 7 mm x 1.3 mm surface mount package are optimised for operation in a 50 Ω system.

Sofradir beats the US to it in supplying IR products to military and space

The French firm has been assessed the global number one for supplying the military with cooled MCT infrared detectors, critical scanning and staring arrays

Sofradir has secured more than 25 per cent market share in volume for supplying second generation Mercury Cadmium Telluride (MCT/HgCdTe) infrared detectors to the military and space sectors.

This is what Maxtech International report, "The World Market for Military Infrared Imaging Detectors and Systems," says.

Sofradir's infrared detectors are used in thermal imagers, missile seekers, Infantry Fighting Vehicles (IFVs), such as those used by the French army in Afghanistan, other surveillance, targeting and homing infrared equipment and space-borne observation satellites.

In 2011, Sofradir delivered 5,000 units. This is up from the 4,400 units it delivered in 2010, enabling Sofradir to tip the scales and eclipse its predecessor.

Compared to the manufacture of components in other industries, volumes for cooled MCT IR detectors may appear small. However, system integrators in the defence industry are well aware of the extreme complexity of producing cooled MCT IR detectors, with only a handful of IR manufacturers able to produce more than 2,000 units per year.

Sofradir credits its increased market share to its longevity in meeting customer demands for cutting edge and innovative products, its capacity to run a safe and reliable production line and to anticipate market needs for new standards, such as the 15 micron pitch.

"Sofradir has been making and selling infrared detectors since 1986, so we are very proud to have climbed to the leading market position. It acknowledges the robustness of our business strategy and technological choices. It is recognition that we have been carrying out the right analysis on the problems customer face and bringing them winning solutions. I'd like to express our gratitude to all of our customers for their continuous confidence in Sofradir," said Philippe Bensussan, chairman and CEO of Sofradir. "In addition, with the recent strengthening of our shareholder structure, new assets from Safran and Thales will broaden our IR technology portfolio and this will further reinforce Sofradir's world leadership position."

Sofradir's market achievement comes on the heels of an announcement by its defence group shareholders Thales SA and Safran SA that they have increased their shareholdings in Sofradir from 40 per cent to 50 per cent each, through the purchase of the 20 per cent holding from Areva, a nuclear energy group.

JDSU highlights collaborative innovation with indium phosphide technologists Infinera

The firm is launching a new video segment as part of its Different View campaign on JDSU.tv.

The segment highlights how JDSU collaborates closely with customers to provide innovative solutions that help advance the optical communications market.

The main video features leading optical manufacturer Infinera and covers how the company works closely with JDSU to bring forth new optical communications solutions that enable faster and more reliable connectivity in response to growing demand for voice, video, and wireless applications among consumers.

Three supporting videos on JDSU.tv highlight

various aspects of JDSU culture that foster both innovation and collaboration at the company. Topics include the JDSU Innovation Council, JDSU customer service and employee culture at the company.

"Collaboration with suppliers like JDSU provides a strategic advantage to Infinera," said Tom Fallon, CEO at Infinera."Together we bring innovative solutions to market that unleash the market potential of optical transport networks for global network operators."

"At JDSU, collaborative innovation starts with understanding our customers' needs and working together on a daily basis to create successful solutions," said Alan Lowe, president of the CCOP business segment at JDSU. "Infinera is an important customer for JDSU because they help us drive innovation and stay ahead the curve in terms of what the optical communications industry needs now and in the future."

Silicon Valley Bank increases credit facility to Advanced Photonix

The new facility is initially comprised of a three year term note of $1 million, and a two year $5 million revolving line of credit

As part of this new banking relationship, Advanced Photonix has repaid the short term note and line of credit previously held by The PrivateBank and Trust.

Richard Kurtz, President and CEO commented, "We are pleased to have established this new relationship with Silicon Valley Bank, a strong bank with a rich history of working with growing high technology businesses like API. I would also like to thank The PrivateBank and Trust for their support over the past four years. This new credit facility makes possible an increase in foreign receivable coverage up to $3 million as part of the $5 million total line. This increase in total credit facility will help us fund our growth, including our international revenue growth. We are very pleased with our new relationship with Silicon Valley bank, both for their commitment to API in particular and deep understanding of the high technology market."

"We aim to increase the probability of our clients' success and we're looking forward to working closely with the Advanced Photonix team as they continue to grow," said Mike Kohnen, Senior Relationship Manager, Silicon Valley Bank. "Since we are focused on technology innovators like API, we are able to provide them with the services and financing they need to expand internationally and tackle their ambitious goals."

Advanced Photonix is a supplier of optoelectronic products including high-speed optical receivers and terahertz instrumentation for telecom, homeland security, military, medical and industrial markets.

Infinera net losses swell from $2.7 million to $19.4 million

Development of its recently launched indium phosphide based DTN-X remains on track with trials in Q1 and volume production expected to start in Q2 2012

Infinera Corporation, a provider of InP based digital optical communications systems, has released financial results for the fourth quarter and fiscal year ended December 31, 2011.

GAAP revenues for the quarter were $112.0 million compared to $117.1 million in the fourth quarter of 2010. GAAP gross margins for the quarter were 40% compared to 49% in the fourth quarter of 2010.

GAAP net loss for the quarter was $(19.4) million, or $(0.18) per share, compared to a net loss of $(2.7) million, or $(0.03) per share, in the fourth quarter of 2010. GAAP revenues for the year were $404.9 million compared to $454.4 million in 2010.

GAAP gross margins for the year were 41% compared to 45% in 2010. GAAP net loss for the year was $(81.7) million, or $(0.78) per share compared to $(27.9) million, or $(0.28) per share in 2010.

"Our fourth quarter revenue performance was higher than our expectations, and reflects continued solid demand from customers for Infinera's unique digital optical networks including cable, Tier One

and bandwidth wholesale service providers," said Tom Fallon, president and chief executive officer. "We benefitted from unanticipated year-end budget spending by a number of customers and were able to execute to our disaster recovery process following the historic flooding in Thailand."

The company indicated that the development of its recently launched DTN-X remains on track with trials in Q1, expected volume production starting in Q2 and initial revenue recognition expected for the second half of calendar year 2012. Four lab trials with Tier One carriers have been scheduled in Q1 2012, and the company is in the process of preparing for the production ramp of the product.

"Customer interest in our new DTN-X since its launch has been very strong," said Fallon. "We believe this interest is in recognition of the unique advantage that Infinera's integrated platform brings to market – the only platform offering integrated DWDM and OTN switching functionality without compromise."

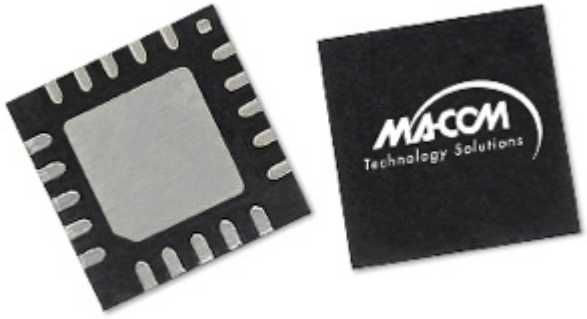
Infinera hosted a conference call for analysts and investors to discuss its fourth quarter and fiscal year 2011 results and first quarter. An archived version will be available on the website for 90 days. To hear the replay, parties in the United States and Canada should call 1-800-925-5459. International parties can access the replay at 1-203-369-3851.

M/A-COM Tech makes a point with its new GaAs PA

The supplier of high performance analogue semiconductor solutions is launching a new 1.2 W gallium arsenide power amplifier which boasts high linearity

M/A-COM Technology Solutions (M/A-COM Tech) has revealed a new power amplifier (PA) for point-to-point radio applications.

The MAAP-008924 is a 3-stage, high linearity 1.2 W GaAs PA. Packaged in a 5 mm, 20-Lead PQFN, the amplifier is fully matched to 50 Ω on both the input and output.



MAAP-008924

"The MAAP-008924 provides a high output IP3 while maintaining low DC power consumption", said Jack Redus, Product Manager. "This power amplifier is an excellent choice for 10, 11, and 13 GHz point-to-point radio transceivers for cellular backhaul applications."

Operating between the 10 GHz to 13.3 GHz frequency range, the MAAP-008924, can be used as a power amplifier stage, or as a driver stage in high power applications. Fabricated using M/A-COM Tech's high linearity MESFET Process, the amplifier features 20 dB Gain and 44 dBm OIP3.

The table below outlines typical part number performance:

Parameters	Units	MAAP-008924
Frequency	GHz	10 – 13.3
Input Return Loss	dB	12
Output Return Loss	dB	10
Gain	dB	20
P1dB	dBm	31
IP3	dBm	44
Quiescent Current	mA	1000

Production quantities and samples of MAAP-008924 are available from stock and additional product information can be obtained from the M/A-COM Tech website at www.macomtech.com

Ford Tamer replaces Young Sohn as Inphi CEO

Tamer brings to the communications specialist, which uses indium phosphide, gallium arsenide, silicon germanium and CMOS technology, over 20 years of experience. He has previously been involved in building successful technology businesses, and has particular expertise in the

semiconductor sector

Inphi Corporation has appointed Ford Tamer as Chief Executive Officer for Inphi effective immediately.

Prior to joining Inphi, Tamer served as CEO of Telegent Systems, Senior VP and General Manager of Broadcom's Infrastructure Networking Group, which he grew to $1.2 billion in revenue in five years. He was also CEO of Agere, which was acquired by Lucent Microelectronics, and VP at Agere Systems. Tamer was also a partner at Khosla Ventures, where he assisted in the growth of cleantech and IT businesses. Tamer holds an M.S. and Ph.D. in engineering from MIT. He serves as Chairman of Senton.

"I look forward to working with the Inphi team, and leverage Inphi's position in computing and networking, to drive the next stage of the company's growth," said Tamer. "Inphi's core competencies in advanced analogue circuit design, signal integrity, power management, packaging, and process technologies should bolster the company's ability to pursue solid growth in the years ahead."

Tamer succeeds Young K. Sohn, President and CEO, who will stay on as a senior adviser to the company during this transition. Sohn, who is retiring from Inphi, will not seek re-election as a director at Inphi's forthcoming 2011 AGM of stockholders that is expected to take place in May 2012.

"I am proud to have been so closely involved in building Inphi's position as a leading provider of high-speed interface products that enable cloud infrastructure, and I'm confident in Ford's ability to take the company to the next level," said Young Sohn. "Ford's expertise in the semiconductor space makes him well suited to take over the leadership position at Inphi and drive long-term growth to improve shareholder value."

"Young has played a significant role in the creation and successful development of Inphi over the past five years, resulting in its successful initial public offering in November 2010 and the company's strong competitive market position today," said Dado Banatao, Chairman of Inphi. "We thank him for his leadership and years of service to Inphi and wish him well in his retirement."

RF Electronics

RFMD to expand PowerSmart family for a top customer

The next-generation devices include a highly anticipated LTE smartphone that will feature multiple variants of RFMD's family of ultra-high efficiency WCDMA and 4G LTE power amplifiers

RFMD is currently supporting multiple devices for this top-tier smartphone manufacturer with a broad range of high-performance products. These include the PowerSmart power platforms, ultra-high efficiency 3G/4G power amplifiers, and multiple switch-based components.

Eric Creviston, president of RFMD's Cellular Products Group, said, "RFMD continues to increase our exposure to the world's leading smartphone manufacturers. With these wins, we expand our participation in a growing family of highly popular smartphones and bolster our position in the high-growth LTE category. We look forward to expanding our content opportunity in future devices as new programs ramp and as new product families are introduced."

RFMD's 3G and 4G LTE PAs extend battery life and reduce 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-based applications, such as web surfing, video calls and internet radio services.

Anadigics' InGaP PA awarded 2012 ACE award from China

The firm's ALT6738 HELP4 power amplifier, which features the firm's indium gallium phosphide technology, was selected as RF/Wireless Product of the Year

Anadigics has received the 2012 China Annual Creativity in Electronics (ACE) Award, presented during a reception held in conjunction with the 17th International IC-China Conference & Exhibition(IIC-China).

The company received the 2012 China ACE RF/Wireless Product of the Year Award for the ALT6738 fourth generation High-Efficiency-at-Low-Power (HELP4)power amplifier (PA).

The China ACE RF/Wireless Product of the Year Award recognises solutions that offer significant design and technical benefits, provide engineers new and compelling capabilities, and deliver significant resource savings, including time, cost, and space. The award also acknowledges products that are likely to have a significant impact in mainland China.

"Anadigics is honoured to be recognised by both the editors and readers of Global Sources China" said Jerry Miller, vice president of business development and marketing at Anadigics. "By combining technological prowess with innovative designs, our HELP4 power amplifiers continue to set the standard for RF efficiency. This level of performance helps designers and manufacturers deliver mobile devices with greater battery-life without the additional system cost of a DC-DC converter."

Anadigics' ALT6738 HELP4 power amplifiers use the Company's exclusive InGaP-Plus technology to achieve optimal efficiency across low-range and mid-range output power levels with thelowest quiescent current. These power amplifiers extend battery life in handsets, smart phones, tablets, netbooks, and notebooks.

The company's HELP4 PAs offer an average current consumption reduction of 30%, compared with previous generation PAs. The devices have three mode states to achieve exceptional power-added efficiencies at low-range and mid-range output power levels and a quiescent current of less than 4 mA.

The highly integrated modules and are claimed to have best-in-class linearity at maximum output power and feature internal voltage regulation. With an integrated "daisy chainable" directional RF coupler with 20dB directivity, they come in a 3 mm by 3 mm package.

RFMD reveals new 3G/4G antenna control solutions

The designer and manufacturer of high-performance RF components and compound semiconductor technologies is broadening its portfolio

The high-performance antenna control products are optimised to solve the complex RF requirements of 3G/4G smartphones related to high band count and signal integrity in an extremely compact form factor.

Eric Creviston, president of RFMD's Cellular Products Group, said, "RFMD's antenna control solutions are securing key design activity at leading smartphone manufacturers by solving the increasingly complex challenges in multimode, multi-band front ends. By optimising antenna performance across modes and bands, RFMD's antenna control solutions improve call quality, extend battery life and enhance the smartphone consumer experience. We expect RFMD's 3G/4G antenna control solutions will begin to achieve broad customer adoption this calendar year."

RFMD's new antenna control solutions expand the Company's switch and signal conditioning product portfolio, which also includes antenna switch modules, switch filter modules, switch duplexer modules, RF power management components, and low noise amplifiers. The product portfolio has grown rapidly since its launch, with more than $25 million in sales in the December 2011 quarter.

Skyworks honours TowerJazz for its innovation

The firm has been recognised for innovations in technology and cost improvement that enable Skyworks to exceed its customer expectations

TowerJazz, a foundry service provider, has received the 2011 Innovation Award from Skyworks Solutions.

This is the first time TowerJazz has won this particular award; the Company was previously recognised as the Foundry Supplier of the Year for three consecutive years for providing excellent quality, performance and solid alignment with Skyworks' supply chain requirements.

Skyworks utilises a broad range of TowerJazz's specialty process offerings including mixed-signal CMOS, RFCMOS, BiCMOS, SOI and SiGe BiCMOS, to develop a variety of products such as transmit/receive modules, power amplifier controllers, switch controllers, linear devices, and wireless LAN solutions.

"Skyworks has been a long time customer of TowerJazz and we are extremely pleased to continue addressing their next-generation technology needs year after year to manufacture their leading-edge devices," said David Postula, TowerJazz Vice President of Sales. "This award demonstrates our commitment to partnering with our customers in helping reduce their costs through joint value-engineering projects that deliver economic benefits not only to existing but also new products. We truly appreciate the validation we consistently receive from Skyworks for our proven technology platforms and design enablement solutions as well as excellence in customer service and support."

Samsung Galaxy Note powered by Anadigics' InGaP PAs

The firm is shipping production volumes of its indium gallium phosphide fourth generation HELP4 modules and dual-band third generation HELP3E power amplifiers to Samsung Electronics

The AWT6621 powers the Galaxy Note I9228 (TD-SCDMA) and the AWC6323, a dual band HELP3E power amplifier, is used in the Galaxy Note I889 (CDMA), both available in China.

The ALT6705, AWT6621, and AWT6624 are the company's fourth generation High-Efficiency-at-Low-Power (HELP4) power amplifiers (PAs) and power the Galaxy Note SHV-E160L available in Korea.

The Samsung Galaxy Note features an impressive 5.3 inch high-definition super AMOLED screen and is capable of displaying movies at full 1080p. What's more, the slim Galaxy Note provides an 8 megapixel camera, 1.4 GHz dual-core processor, and Android 2.3 Gingerbread operating system.

"The new Samsung Galaxy Note represents an advanced convergence device that merges the impressive multimedia features of a tablet with the versatility and functionality of a smartphone," said Michael Canonico, senior vice president of worldwide sales at Anadigics.

"Anadigics' power amplifiers continue to provide an RF advantage by helping to extend battery-life in power hungry multimedia-rich devices. We look forward to continue working closely with Samsung to help innovate and evolve the mobile user experience."

Anadigics' HELP4 and HELP3E PAs use the Company's proprietary InGaP-Plus technology. They achieve optimal efficiency across low-range and mid-range output power levels and provide

low quiescent currents. The ALT6705, AWT6621, AWT6624, and AWC6323 power amplifiers deliver efficiency to extend battery life in handsets, smart phones, tablets, netbooks, and notebooks.

The company's HELP4 PAs offer an average current consumption reduction of 30%, compared with previous generation PAs.

Both the HELP4 and HELP3E devices have three mode states to achieve exceptional power-added efficiencies at low-range and mid-range output power levels and a quiescent current of 4 mA or less.

Both families of devices are highly integrated and are claimed to have best-in-class linearity at maximum output power and both feature internal voltage regulation.

The HELP4 PAs have an integrated "daisy chainable" directional RF coupler with 20dB directivity.

The HELP3E modules have two independent PAs in a single package and an integrated RF coupler.

The HELP4 PAs come in a 3 mm by 3 mm package while the HELP3E PAs have a 3 mm by 5 mm footprint.

SkyHi family raises the bar for power added efficiency

A new range of power amplifiers are claimed to achieve performance breakthrough in support of data intensive mobile platforms

Skyworks Solutions is marketing several new 3G and 4G high-efficiency front-end solutions, collectively known as "SkyHi", for smartphones, tablets and wireless data modules.

All modules in the series incorporate Skyworks' GaAs/InGaP die, GaAs MMIC and/or InGaP HBT technology.

Skyworks says its SkyHi products extend battery life, reducing the radio footprint, and simplify calibration for manufacturers.

"Today's applications and devices require improved efficiency at high power," says Thomas J. Richter, senior marketing director of front-end solutions at Skyworks. "Skyworks' new family of SkyHi amplifiers and front-end modules deliver close to 50 percent power-added efficiency, and offer a path to even higher efficiency when utilised in an envelope tracking system."

According to Ericsson, a global provider of telecommunications equipment and services, mobile broadband connections, which provide the means to connect to the Internet and download data or other content, are exploding. It estimates that there were more than 500 million mobile broadband subscribers globally in 2010 with subscriptions expected to grow to more than 2.5 billion subscribers in 2014 ;a compounded annual growth rate of 44 percent.

The SKY77619 (Bands I, II, III, IV, V and VIII) is a multimode, multiband power amplifier module (PAM) that supports 2.5G/3G and 4G handsets and operate efficiently in GSM, EGPRS, EDGE, WCDMA and LTE modes. The InGaP/GaAs die are mounted on a multilayer laminate substrate and the assembly encapsulated in plastic overmold.

The SKY77733 (Bands XIII/XIV) and SKY77737 (Bands XII/XVII) are fully matched surface mount modules PAMs developed for LTE applications. The single GaAs MMICs in both devices contain all active circuitry in the modules, including the PA, input, and interstage matching.

The SKY77761 is a PAM that is a fully matched 10-pad surface mount module developed for WCDMA applications. This module also has a single GaAs MMIC similar to the SKY77733 and SKY77737 and also incorporates Skyworks' InGaP HBT technology.

The SKY77751 and SKY77752 are dual band power amplifiers supporting either Bands I and VIII or II and V. They come in a 3 x 4 mm package and have either a single RF input or dual RF input for CDMA and WCDMA applications.

The SKY77762, SKY77764, SKY77765 and SKY77768 are PAMs supporting Band I, II, IV, V and VIII, respectively, developed for CDMA, WCDMA and LTE applications.

RF power management to accelerate with RFMD

The company is developing average power tracking- (APT-) and envelope tracking- (ET-) based solutions for power amplifiers using compound semiconductor technology

RFMD has shipped tens of millions of power management integrated circuits (PMICs), mostly within the RF Configurable Power Core based on in its PowerSmart power platform.

The firm has also sold hundreds of millions of PowerStar PAs and transmit modules which have integrated power control.

RFMD forecasts the combination of envelope tracking (ET-) technology and its GaAs device expertise will be a disruptive combination that raises the bar significantly in RF performance.

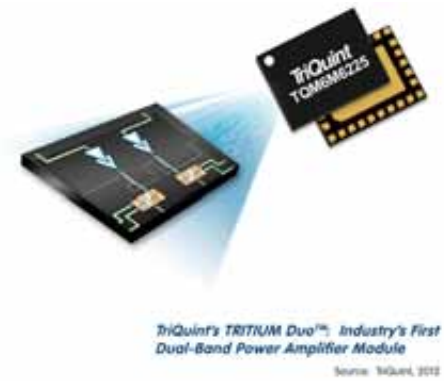
Eric Creviston, president of RFMD's Cellular Products Group said, "RFMD is at the forefront of technology development in RF power management, and we are enthusiastic about the deployment of APT- and ET-based solutions. We believe the importance of power management technologies such as average power tracking and envelope tracking will continue to expand in smartphones, enabling RFMD to leverage our combined leadership in power amplifiers and RF power management and increase our RF content opportunity."

GaAs TRITIUM Duo family is the tiniest for dual-band power

TriQuint says it's gallium arsenide based amplifiers offer mix-and-match two-band combinations. This gives mobile device manufacturers a flexible, high-performance platform that speeds up time to market

TriQuint's new TRITIUM Duo family combines two band-specific power amplifiers (PAs) and two duplexers in a single compact module, effectively replacing up to twelve discrete components.

The company says it is the smallest dual-band PA duplexer (PAD) for global 3G and 4G smartphones.



TriQuint's TRITIUM Duo™: Industry's First Dual-Band Power Amplifier Module

Source: TriQuint, 2012

"We've powered the world's top smartphones with over a half billion of our single-band TRITIUM modules, and now the TRITIUM Duo is being evaluated by customers for use in next generation smartphones," said Ralph Quinsey, president and chief executive officer of TriQuint. "Our broad technology portfolio has enabled us to integrate two commonly used bands in one small footprint. Not only have we simplified the RF front-end for phone designers, we have also increased performance and flexibility."

The TRITIUM Duo family shares a common 6 x 4.5mm footprint, giving designers the flexibility to support multi-band, multi-mode operations across multiple platforms. Mobile device manufacturers can capitalise on the large size reductions to include more features or larger batteries in thinner, lighter form factors with all the performance needed for CDMA, 3G, and 4G networks.

At about 50 mm2,, roughlyhalf the footprint of a comparable discrete solution, they offer improved manufacturing and supply chain efficiency. Optimised for each of its two bands, no switching is required after amplification, unlike configurable architectures.

The new dual-band TRITIUM Duo implements proprietary TriQuint CuFlip technology to replace wire bonds with copper bumps; this saves board real estate and enables superior system performance by eliminating noise-radiating wires.

The copper bumps also dissipate heat better than traditional interconnect techniques. The integrated Flip Chip BiHEMT power amplifier die achieves industry leading current consumption to provide

maximum talk-time and thermal efficiency critical for smartphone applications.

The TRITIUM Duo also employs a wafer level packaging technique to provide hermetic filter encapsulation for improved performance and a reduced size. In addition, the modules integrate high-performance BAW and SAW duplexer capabilities.

TriQuint will showcase its mobile device platform solutions, including the new TRITIUM Duo family, at the GSMA Mobile World Congress in Barcelona, Spain, between February 27 and March 1, 2012.

TRITIUM Duo Product Family

Band Pairs	Part #	Geographies Served
Bands 1 & 4	TQM6M6714	U.S., Europe, Africa & Asia
Bands 1 & 8	TQM6M6718	Europe, Africa & Asia
Bands 2 & 5	TQM6M6225	North America

The TRITIUM Duo is currently sampling, with volume production is planned in June.

TriQuint speeds up the smallest phones

The firm's devices incorporating gallium arsenide HBTs, deliver design flexibility for 2G, 3G and 4G mobile devices

TriQuint Semiconductor is now offering two QUANTUM Tx modules that are 40% smaller than the previous generation.

These transmit modules integrate TriQuint's new ultra-small GSM core, and enable more flexibility for smartphones, feature phones and low-cost voice-only phones.

"Design innovations have enabled cost and size breakthroughs without compromising performance," said Shane Smith, Vice President of Global Marketing for Mobile Devices. "Our 2G QUANTUM Tx module has already made significant inroads in the GSM market. Our new 3G/4G QUANTUM Tx module pairs with our new TRITIUM Duo family of dual-band PA-duplexer modules to create the industry's smallest, high-performance RF solution for global 3G/4G wireless devices."

Leading mobile handset manufacturers Samsung, Huawei and ZTE have selected TriQuint's new QUANTUM Tx modules. TriQuint has seen success with previous generations of its QUANTUM Tx modules; to date, more than 150 million units have shipped.

"We expect to ship more than 100 million QUANTUM Tx modules in the next 18 months alone, making it one of the highest volume product lines in our factory," Smith added.

TriQuint increased manufacturing capacity by 40 percent in 2011 to support customer demand for its growing mobile device portfolio.

Shipping in volume since mid-2011, TriQuint's 2G (GSM) QUANTUM Tx module, TQM6M4068, offers phone designers full GaAs HBT performance and a small size to enable flexible designs. At 5 x 6 x 1 mm, the TQM6M4068 is one of the industry's smallest Tx modules and has won "Best Product" in the 2011 EDN China Innovation Award program for the communications and networks front-end category.

Approved for MediaTek's chipset reference design, the new product has been chosen for many new 2G phone platforms. "Close to 1.5 billion GSM

based phones will be produced this year," said Neil Shah, an analyst from research firm Strategy Analytics. "Virtually all 3G and 4G capable phones incorporate 2G access technology, and 2G remains the dominant wireless communication technology in many areas of the world."

Shipping in volume since January 2012, TriQuint's TQM6M9069 QUANTUM Tx module features the same small 5 x 6 mm footprint, making it one of the smallest 3G/4G transmit modules on the market. This new part simplifies mobile device design and includes a GSM/GPRS power amplifier and WCDMA antenna switch. TriQuint plans to expand the QUANTUM Tx module family in the months ahead with product solutions that incorporate additional switch ports to support more frequency bands.

The QUANTUM Tx transmit modules implement TriQuint's proprietary CuFlip technology to replace wire bonds with copper bumps. This saves board space and enables superior system performance by eliminating noise-radiating wires. The copper bumps also dissipate heat better than traditional interconnect techniques. The QUANTUM Tx modules offer improved system efficiency and full RF transmit functionality in a compact 30 mm² package.

Quad-band modules enhance performance

The RF3235 and 3237 are GSM/GPRS transmit modules employ RFMD's gallium arsenide HBT and silicon CMOS technology

The company says that when paired with one or more discrete 3G power amplifiers such as RF722x or RF724x, the devices enable best-in-class performance at the lowest total solution cost for 3G entry platforms.

Both modules incorporate four (RF3237) to six (RF3235) high linearity UMTS transmit/receive ports. These also serve as GSM Rx ports and are pin-to-pin compatible.

Both devices are built on RFMD's PowerStar integrated power control technology, SOI (silicon-on-insulator) switch technology, and integrated transmit filtering.

These devices are designed for use as the final portion of the transmitter section in a GSM850/EGSM900/DCS1800/PCS1900/UMTS handset and eliminate the need for a PA-to-antenna switch module-matching network. The 50 Ω matched input and output ports require no external matching components and no external DC blocking on TRx ports.

RF3235 *RF3237*

The modules have a high efficiency at rated output power (POUT) and operate at a 3.5 V (VBATT).

For GSM850/EGSM900 applications, efficiency is 43%, while for DCS1800/PCS1900, it is 36%.

Isolation for most port combinations is greater than 35 dB and the TRx insertion loss for low band is 0.6 db and 0.8 db for high band applications. This boosts 3G efficiency and Rx sensitivity.

The devices are suited for single through quad-band UMTS handsets and connected devices including TDSCDMA and CDMA. The GPRS class 12 compliant modules can also be incorporated in

GSM850/EGSM900/DCS1800/PCS1900 products and in 3V multimode mobile applications.

The RF3235 and RF3237 are currently available in production quantities.

Pricing for RF3235 begins at $2.70 each for 100 pieces. Pricing for RF3237 begins at $2.47 each for 100 pieces.

RFMD reveals 1W linear high power amplifier

The firm's latest module uses the firm's indium gallium phosphide HBT technology

The RF5652 High Power Amplifier addresses IEEE 802.11b/g/n WiFi (2.4GHz to 2.5GHz) for customer premises equipment (CPE) applications also supports IEEE 802.16e WiMAX (2.5 GHz to 2.7 GHz) CPE applications.

Other applications include picocells and femtocells, spread-spectrum and MMDS systems as well as long term evolution (LTE) applications.

It integrates a three-stage linear Power Amplifier (PA) with 30 dBm (1 W) linear power at PA output, along with power detection, in a 5 mm x 5 mm QFN package.

RF6514

With a POUT of 30dBm, the module has an EVM of less than 3% at 5 V and a gain of 34dB.

This product is now available in production quantities. Pricing begins at $6.15 each for 100 pieces.

RFMD says farewell to Robert Van Buskirk

The corporate vice president of RFMD's Compound Semiconductor Group (CSG) is retiring

Bob Van Buskirk has been a member of the RFMD executive staff since 2007. Van Buskirk joined RFMD with the acquisition of Sirenza Microdevices, where he had been president and CEO.

He led the integration of Sirenza and was instrumental in the formation of CSG and RFMD's Multi-Market Products Group (MPG).

"I consider myself fortunate to have been a part of the formation of both MPG and CSG and to have worked at RFMD with many of the most talented professionals in the RF industry," said Bob Van Buskirk. He added, "I am looking forward to transitioning to a new phase of my career where I will look to serve on boards of technology-oriented companies and enjoy spending more time with family and friends."

Bob Bruggeworth, president and CEO of RFMD, said, "As a member of the executive staff, Bob has been a key contributor in the overall management of the Company, in setting the strategic direction of the Company and in communicating this direction to customers and shareholders. On behalf of the entire RFMD team, I would like to recognise and congratulate Bob on his many contributions to RFMD and wish him well in his retirement."

Anadigics' new InGaP family supports E-UTRA Band

The devices are manufactured using the firm's advanced indium gallium phosphide HBT MMIC technology

The company's small-cell wireless infrastructure PA family delivers a combination of high output power, efficiency, and linearity and are optimised for the rapidly growing class of small-cell base stations.

The two new power amplifiers (PAs), the AWB7128 and AWB7228, are optimised for WCDMA, HSPA, and LTE base stations.

"The continual increase in consumer demand for wireless data is fuelling the rapid deployment of small-cell wireless infrastructure devices, such as picocells and femtocells," said Glenn Eswein, director of product marketing for broadband RF products at Anadigics.

"Anadigics' small-cell power amplifier family delivers the highest output power, power-added efficiency, and linearity in its class, enabling manufacturers to develop compact, aesthetic, high throughput devices that offer service providers an economical path to expand broadband network coverage. Working closely with device manufacturers, we are expanding this family to help bring the same performance and design flexibility to additional frequency bands."

The AWB7128 and AWB7228 wireless infrastructure PAs are optimised for WCDMA, HSPA, and LTE small-cell base stations operating in the 2620 MHz to 2690 MHz frequency band.

The AWB7128 provides +24.5 dBm linear output power, while the AWB7228 delivers +27 dBm linear output power. These power amplifiers use Anadigics' InGaP-Plus technology to achieve best-in-class efficiency and linearity at these output power levels, enabling small-cell wireless infrastructure solutions that are more thermally-efficient, consume less power, and provide a greater range.

Anadigics' AWB7128 and AWB7228 PAs have a linearity of -47 dBc ACPR @ +/- 10 MHz offset (10 MHz channel bandwidth).

The modules, which come in a 7 mm x 7 mm x 1.3 mm surface mount package are optimised for operation in a 50 Ω system.

Triquint annual net income plummets 75%

The firm has suffered from reduced "Defence and Aerospace" and the "Networks" product demand. Revenues for these sectors were down 9% and 4% respectively from 2010 to 2011

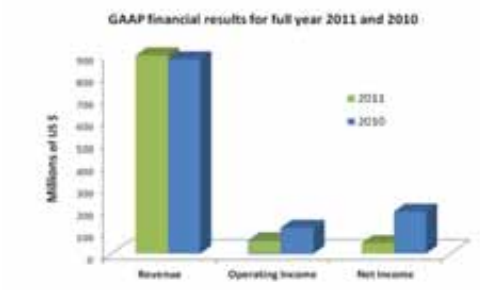
RF product innovator TriQuint Semiconductor has announced its financial results for the quarter and year ended December 31, 2011.

Revenue for the fourth quarter of 2011 was $227.0 million, down 10% from the fourth quarter of 2010 and up 5% sequentially. Revenue for 2011 was $896.1 million, up 2% from 2010. Mobile Devices revenue grew 7% sequentially and 6% for 2011 compared to 2010.

GAAP gross margin for the fourth quarter of 2011 was 29.5%, down from 34.9% in the prior quarter. Gross margin for the year ended December 31,

2011 was 35.9%, down from 39.9% for 2010.

Operating expenses for the fourth quarter of 2011 were $61.6 million, or 27% of revenue, down from $63.3 million in the prior quarter primarily due to lower litigation expense. Operating expenses for 2011 were $262.9 million.



Net income for the fourth quarter of 2011 was $4.3 million, or $0.03 per diluted share. Net income for 2011 was $48.2 million or $0.28 per diluted share.

Commenting on the company's financial results, Ralph Quinsey, President and Chief Executive Officer, stated "TriQuint has grown revenue for six consecutive years and in 2011, we expanded our capacity to serve our customers' rising demand. The proliferation of smartphones and emergence of 4G is driving exciting growth in the markets we serve. As a leader in integrated RF solutions, we have both the products and capacity to deliver on the opportunities in front of us. We see solid prospects for growth in the second half of the year."

In the last year, the firm's GaN NEXT program has moved to Phase II and the DARPA R&D program is ahead of schedule. The firm has also been honoured by Sony Ericsson and Raytheon Space & Airborne Systems for its supply services. China has also recognised the firm for RF Leadership ; the company has received several industry awards and recognition from key customers in China.

Outlook:

The Company believes first quarter 2012 revenue will be between $210 million and $220 million. First quarter 2012 non-GAAP net income is expected to be between $0.01 and $0.03 per share as compared to $0.08 for Q4 2011 and $0.25 for Q4 2010. The Company is fully booked to the midpoint of revenue guidance.

RFMD introduces FEM for 433MHz to 470MHz AMI/AMR systems

The device incorporates the firm's gallium arsenide pHEMT and indium gallium phosphide HBT technology

The Tx port on RFMD's latest device provides a PA with nominal output power of 30dBm and a gain of 15dB. The Rx passthrough port is on a separate path. Both are combined with a single antenna port and SP2T switch, all in a 5.5mm x 5.0mm, 28-pin package. There is a separate 50Ω Tx/Rx transceiver and interface Rx insertion loss of 1dB .

RF6504

Applications in which the device can be used in are

Wireless Automated Metering
Wireless Alarm Systems
Portable Battery Powered Equipment
Smart Energy
433MHz/450MHz to 470MHz ISM Band Applications
Single-Chip RF Front End Modules

Lasers

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.

New amplifiers accelerate high speed networks

Oclaro’s new family of intra-node amplifiers use the firm’s uncooled compact pumps and dual-chip 980 nm pump lasers based on III-V compound semiconductors

Oclaro says its family of amplifiers is the industry’s first targeted directly at off-setting losses inside the nodes of next generation ROADM network architectures that will carry 100 Gbps, 400 Gbps and 1 Tbps channels.

ROADMs (reconfigurable optical add/drop multiplexers) add the ability to remotely switch traffic from a WDM (Wavelength-division multiplexing) system at the wavelength layer.

Off-setting losses in the node while maintaining

space and power requirements is critical for maintaining the performance of high speed networks.

Losses inside the node have steadily increased as node architectures have evolved in complexity, and Oclaro says it is the first company to target this problem with a family of intra-node amplifiers. These are all built on its successful OASIS platform. These amplifiers are aimed at maximising the overall network performance while also meeting the stringent space and power constraints of next generation node designs.

Next generation networks will bring increased agility and asset utilisation through architectures that enable high degrees of colourless, directionless and contentionless routing of wavelengths in the optical domain. These increased demands on optical routing and connectivity within the node are creating losses that affect the overall network performance and can lead to significant limitations in the size of the optical network that can be supported without regeneration.

By utilising Oclaro's new intra-node amplifiers, network equipment manufacturers can maintain the network performance and allow installation on existing fibre plants while minimising footprint, power consumption and heat dissipation.

"With the broadest portfolio of products targeted directly at the core optical network, Oclaro is able to leverage its expertise to address critical design challenges posed by the more complex node architectures required for higher bit rate networks," said Terry Unter, President and General Manager of the Oclaro Optical Networks Solutions Business Unit. "By using these new amplifiers, our customers can now integrate amplification within the node, where space and power are at a premium, to enable higher bit rate wavelengths without compromising overall network performance."

"Oclaro continues to deliver the technology innovation for the core optical network that will help drive the growth of the 100 Gbps market, which we expect to be a nearly $2 billion market by 2016," said Daryl Inniss, Vice President and Practice Leader of Components Telecoms at Ovum.

"These higher bit rate networks have become increasingly complex as manufacturers continue to add more features while expanding the capacity. Such complexity results in higher node losses, which limit the network performance and may prevent installation on existing fibre plants. We think these amplifiers will be important tools to offset these higher losses while fitting onto the very dense line cards that we see today."

Oclaro's new family of intra-node amplifiers is leveraging its vertical integration strategy by using the firm's recently announced uncooled compact pumps and dual-chip 980 nm pump lasers.

The uncooled 980 nm pumps offer up to 500 mW of output power from a 10-pin butterfly package. The dual-chip pumps feature a single 14-pin package that replaces two 600 mW discrete pumps, which significantly lowers the total module power consumption. These pump lasers therefore allow for simplified control electronics and reduced component count, while also reducing the space and power required by the optical amplifiers.

About the OASIS Intra-Node Amplifier Family

Oclaro's first two family members, a small form factor single-channel amplifier and a compact arrayed multi-channel amplifier, are built on the company's OASIS platform that has been deployed in volume with customers around the globe.

The single-channel amplifier is a very small form factor booster or pre-amplifier designed specifically for transponder applications. Pre-amplifier features include expanded input power ranges and ultrafast optical transient control, which enhance the robustness and performance of high bit rate direct detection and coherent receivers.

Booster amplifiers are optimised for single-wavelength amplification of amplitude and/or phase modulated signals. The arrayed amplifier is a space and power efficient amplifier targeted at off-setting losses of multiple parallel connections in add/drop cards or between line interface cards.

Unleashing next-generation technologies with electron-detection

Visible red light can be produced when applying a voltage across gallium arsenide crystals whilst simultaneously illuminating the material with an invisible infrared laser pulse

Physicists at the University of Kansas have discovered a new method of detecting electric currents.

The process is based on “second-harmonic generation,” and is similar to the process taking place in a radar gun for electrons that can remotely detect their speed.

The researchers say this new idea could improve many present-day renewable-energy technologies, like solar cells and batteries, which all rely on detection of electric currents. In the future, sensors that better read the motion of electrons could underpin next-generation cell phones and computers.

“So far, most techniques to detect electric currents are very much like measuring the speed of a car by tracking it with a camera, and later analysing how the position changes with time,” said Hui Zhao, assistant professor of physics at the University of Kansas (KU). “But for moving cars, a radar gun is a much better tool, since radar allows us to instantaneously measure the speed. Yet, for electrons, there has been no tool available that allows us to directly ‘see’ the motion like this.”

Zhao collaborated on the research at KU’s Ultrafast Laser Lab with Judy Wu, University Distinguished Professor of Physics, and graduate students Brian Ruzicka, Lalani Werake, Guowei Xu.

The researchers discovered that by shining light from a high-power laser onto a material that contains moving electrons, light of a different colour is generated.

By applying a voltage across thin GaAs crystals, they set electrons to move through it with a specified speed. When illuminating the crystal with an infrared laser pulse, invisible to the human eye, they found that visible red light was produced — a signature of the second-harmonic generation process.

What’s more, they observed that the brightness of the red-light increases with the speed of the electrons. In other words, when the electrons have no directional motion, no red light comes out.

“By detecting the red light, one can accurately determine the speed of electrons without making any contact with the sample and without disturbing the electrons,” Zhao said. “Before this study, it was generally known that an electric current has three effects: It can charge the system, change its temperature and produce a magnetic field. As a result, all experimental techniques of current detection were based on these effects. This newly discovered optical effect of currents opens up a new way of using lasers to study currents.”

The KU researchers’ experimental results are consistent with theoretical studies performed by professors Jacob Khurgin of John Hopkins University and Eugene Sherman from Spain.

This research was jointly funded by a five-year CAREER award from NSF and the NSF EPSCoR Kansas Centre for Solar Energy Research. The experimental equipment was developed under support of the KU College of Liberal Arts and Sciences new faculty start-up funds.

Further details of this research are detailed in a recent paper published in Physical Review Letters.

Laser innovator IPG to offer up to 3 million shares

The offering will consist of 2,800,000 shares to be sold by the Company and up to 200,000 shares to be sold by the Company's chairman and CEO, Valentin P. Gapontsev

IPG Photonics Corporation has commenced a public offering of up to 3,000,000 shares of its common stock.

The Company intends to grant to the underwriters a 30-day option to purchase up to an additional 450,000 shares of the Company's common stock.

The Company plans to use the net proceeds of the offering for general corporate purposes and to fund capital expenditures and working capital requirements. The Company may also use some of the net proceeds for acquisitions of complementary businesses and technologies, although no such acquisitions are currently pending.

BofA Merrill Lynch will be the sole book-running manager for this offering and Needham & Company, LLC and Stifel Nicolaus Weisel will act as co-managers.

An automatic shelf registration statement relating to the securities to be offered in this offering was filed with the Securities and Exchange Commission (the "SEC") on February 27, 2012. The offering of these securities will be made pursuant to a prospectus supplement to the prospectus contained in the shelf registration statement, which prospectus supplement will be filed with the SEC.

The prospectus and prospectus supplement will be available at no charge on the SEC's Web site at www.sec.gov. When available, copies of the prospectus and prospectus supplement also may be obtained from BofA Merrill Lynch, 4 World Financial Centre, New York, NY 10080, Attention: Prospectus Department, or by emailing a request to dg.prospectus_requests@baml.com.

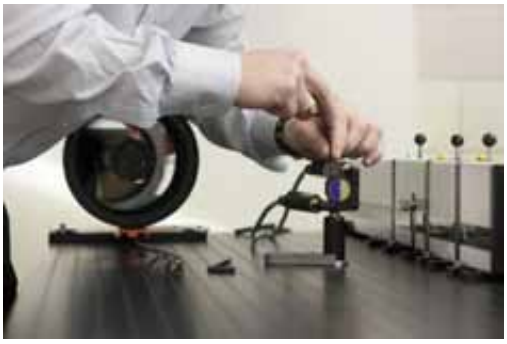
Locating explosives with laser beams

Scientists have found a way to detect chemicals over long distances, even when they are enclosed in containers

Most of us like to keep a safe distance from explosive substances, but in order to analyse them, close contact is usually inevitable.

Now, scientists at the Vienna University of Technology (TU Vienna) have developed a new way to detect chemicals inside a container over a distance of more than a hundred metres.

Laser light is scattered in a very specific way by different substances. Using this light, the contents of a non-transparent container can be analysed without opening it.



A bright laser beam hits the sample, the scattered light is collected by a telescope

"The method we are using is Raman-spectroscopy," says Bernhard Lendl, a Professor at TU Vienna. The sample is irradiated with a laser beam. When the light is scattered by the molecules of the sample, it can change its energy. For example, the photons can transfer energy to the molecules by exciting molecular vibrations. This changes the wavelength of the light, and thus its colour. By analysing the colour spectrum of the scattered light, scientists can determine by what kind of molecules it must have been scattered."

"Until now, the sample had to be placed very close to the laser and the light detector for this kind of Raman-spectroscopy", says Bernard Zachhuber, one of the researchers. Due to his technological advancements, measurements can now be made

over long distances. “Among hundreds of millions of photons, only a few trigger a Raman-scattering process in the sample”, continues Zachhuber.

These scattered particles of light are scattered uniformly in all directions. Only a tiny fraction travel back to the light detector. From this very weak signal, as much information as possible has to be extracted. This can be done using a highly efficient telescope and extremely sensitive light detectors.

In this project, funded by the EU, the researchers at TU Vienna collaborated with private companies and with partners in public safety, including The Spanish Guardia Civil who are extremely interested in the new technology.

During the project, the Austrian military was also involved. On their testing grounds the researchers from TU Vienna could put their method to the extreme. They tested frequently used explosives, such as TNT, ANFO or RDX. The tests were highly successful: “Even at a distance of more than a hundred metres, the substances could be detected reliably,” concludes Engelene Chrysostom of TU Vienna.

Bernhard Zachhuber, adjusting the spectrometer

Raman spectroscopy over long distances even works if the sample is hidden in a non-transparent container. The laser beam is scattered by the container wall, but a small portion of the beam penetrates the box. There, in the sample, it can still excite Raman-scattering processes.

“The challenge is to distinguish the container’s light signal from the sample signal”, says Bernhard Lendl. This can be done using a simple geometric trick: The laser beam hits the container on a small, well-defined spot. Therefore, the light signal emitted by the container stems from a very small region. The light which enters the container, on the other hand, is scattered into a much larger region. If the detector telescope is not exactly aimed at the point at which the laser hits the container but at a region just a few centimetres away, the characteristic light signal of the contents can be measured instead of the signal coming from the container.

The new method could make security checks at the airport a lot easier – but the area of application is much wider. The method could be used wherever it is hard to get close to the subject of investigation. It could be just as useful for studying icebergs as for geological analysis on a Mars mission. In the chemical industry, a broad range of possible applications could be opened up.

Laser manufacturer Thorlabs completes new headquarters

Subsequent construction phases are planned for the next 7-10 years and will ultimately expand the company’s space to include approximately 300,000 square foot

Thorlabs, a global provider of photonics equipment, has completed its new three-story, 120,000 square foot facility, located at 56 Sparta Avenue, in Newton, New Jersey.

The new site will serve as the central hub for Thorlabs’ sales, service, R&D, and manufacturing operations.

The company, still privately held by its founder and CEO, Alex Cable, has consistently experienced double-digit growth since its founding in 1989. Although Sussex County has always been home to the New Jersey-based manufacturer, the company has expanded geographically over the years to include 12 sales, manufacturing, and R&D offices in eight countries.

During that time, the need for more space also led Thorlabs to expand its footprint in Sussex County, eventually purchasing 87,800 square feet of space, spread out over five different locations.

Today, Thorlabs employs approximately 700 people

(350 in Sussex County) and manufactures 95% of its product offerings (70% domestically, 25% internationally), which now number over 15,000.

"After many years of planning, I am thrilled to have an additional space that supports Thorlabs' continued growth and desire to bring products to market quickly," commented Cable. With the addition of the new building, Thorlabs intends to expand its machine shop at its 40,000-square-foot facility located two miles away from the new site on state Route 206 in Andover Township.

"Currently, the same equipment is shared for prototyping and production," said Cable. "By expanding our machine shop's footprint, we will be able to allocate specific resources and equipment to the creation of prototypes. In addition, the expansion will support faster turnarounds on special customer requests for small modifications to our stocked products."

The new manufacturing, R&D, and administrative facility is built on a 5.6 acre former brownfield that had been vacant and in need of environmental remediation since 1993. The location, in the Newton downtown area, had been earmarked by the town for redevelopment.

The Town of Newton grew up in the 1800's as a manufacturing and railroad town, and Thorlabs is excited to be leading a major redevelopment effort that will result in a cleaner, more energy efficient, high tech production facility that employs hundreds of individuals within walking distance of the downtown shops and eateries.

Thorlabs, a member of the Photonics community for over 20 years, manufactures equipment for the photonics industry, including optomechanics, optics, laser diodes, tuneable lasers, fibre optics, optical detectors, motion control equipment, and vibration isolation systems. The firm also provides system-level solutions such as our complete OCT, confocal, and multiphoton imaging systems.

QD Laser acquires ISO 9001:2008 certification

The new accreditation will leverage the firm's ability to provide higher quality lasers which are mainly based on a gallium arsenide platform

QD Laser acquired the international quality management standard on January 25, 2012.

The firm is a provider of highly efficient semiconductor laser solutions for Telecom/ Datacom, consumer electronics, and industrial use. QD Laser provides finely tuned products ranging from wavelengths of 532, 1064 to 1310nm. The company helps its customers create new laser light products in a variety of applications such as LAN/ FTTH, optical interconnection, material processing, sensing and laser projection.

The firm has also developed and marketed high-performance optical semiconductor devices such as quantum-dot lasers.

By running and continuously improving the certificated quality management system, QD Laser says it will provide higher-quality semiconductor laser solutions to its customers.

Opnext AlInGaP laser diode joins the ProPhotonix portfolio

The new aluminium indium gallium phosphide LD provides high power single-mode 660nm output with a built-in photodiode for use by system designers and OEMs

ProPhotonix says the module is the highest power single-mode laser on the market at this wavelength in a package that includes an integrated monitor photodiode.

With continuous wave output power up to 120mW at 660nm, the single mode HL65051DG laser diode is well suited for a range of applications including medical, sensing and LIDAR systems.

Its monitor photodiode allows for a continuous

feedback in the system, ensuring constant optical power output from the laser diode. It is temperature rated from -10 to +600 C, allowing for operation in harsh environments. With low operating current and voltage of 175mA and 2.5V, respectively, the HL65051DG is easy to integrate into a range of systems.

Opnext offers laser diodes, ranging from 404nm to 852nm.

David McGuinness, Europe, Middle East and Africa (EMEA) Sales Director, commented, "as an Opnext distributor and laser module manufacturer, we're delighted Opnext has developed this device. The ability to achieve high optical power with a stable output will allow us to address our customers increasingly demanding applications such as low-level laser therapy and 3-D imaging."

"ProPhotonix is a key partner in selling and supporting Opnext laser diodes into strategic accounts," said Wolf-Rudiger Gaepel, Opnext EMEA account manager. "This newest red laser diode opens up multiple opportunities across a range of applications."

Laser manufacturer opens sales offices in Germany

The global developer and manufacturer of industrial lasers is expanding its business

JK Lasers' new sales offices, based in Munich and close to Hamburg, complement the firm's existing support network.

Providing specialist advice and technical support at a local level, the strategic location of these premises will help JK Lasers serve other German-speaking countries.

Mark Greenwood, General Manager for JK Lasers, said, "JK Lasers plans to expand in Germany because it represents an important market for us. The country accounts for a large percentage of the worldwide photonics trade and is home to leading manufacturers who could benefit from our products and services."

JK Lasers, which is part of the GSI Group, offers a high performance range of Watt to kiloWatt fibre lasers, Nd:YAG lasers and process tools, which are designed to operate 24/7.

A new range of powerful kiloWatt class fibre lasers will be added to the company's portfolio later this year. Easy to use, with next to no maintenance or set up times, JK Fiber Lasers says it can simplify the most demanding welding, cutting and drilling requirements.

Photonics pioneer James J. Coleman honoured by NAE

He has been elected to membership in the National Academy of Engineering. He oversees research using MOCVD of III-V semiconductors to explore applications in lasers, quantum dots and other optical structures

Professor of materials science and engineering at the University of Illinois, Coleman, is also the Intel Alumni Endowed Chair in Electrical and Computer Engineering.

He is among 66 new members and 10 foreign associates credited by the NAE.

Election to the NAE is one of the highest professional honours an engineer can garner. The 2,254 members and 206 foreign associates are an elite group distinguished by their outstanding contributions to the fields of technology and engineering.

James Coleman, a pioneer of photonics and semiconductor lasers, elected to the National Academy of Engineering

Coleman was cited for his work in semiconductor lasers and photonic materials. His research focuses on materials for optoelectronics – devices that convert electricity into light or vice-versa, such as lasers, light sensors, solar cells and fibre optics. He helped to develop the MOCVD growth method and is director of the Semiconductor Laser Laboratory at the U. of I.

"This is a significant recognition and prestigious honour for one of our distinguished faculty," said Ilesanmi Adesida, the dean of the College of Engineering. "Dr. Coleman's research has added considerable knowledge to the field of semiconductor lasers and photonic devices, and his many successful patents and contributions to the engineering literature remain a testament of those achievements. He is also an Illinois alumnus, so we are doubly proud of his achievements."

Coleman earned his bachelor's, master's and doctoral degrees in electrical engineering from the U. of I. He worked at Bell Laboratories and Rockwell International before joining the faculty in 1982. He has published more than 400 scholarly journal articles and holds seven patents. He is a fellow of the Institute of Electrical and Electronics Engineers, the Optical Society of America, SPIE (the international society for optics and photonics), the American Association for the Advancement of Science and the American Physical Society.

NeoPhotonics steps up its tuneable laser production

The NLW-TL lasers, made of III-V compound semiconductors, are critical to high speed 40 and 100 Gbps coherent systems used for metro and long-haul optical networks

The firm has completed the first phase in its plan to significantly increase production capacity of narrow line-width tuneable lasers (NLW-TL) in support of rapidly growing demand.

The company has doubled NLW-TL output since initiating the production plan in the fourth calendar quarter of 2011. Demand for these products has outstripped industry capacity due to the rapid uptake of coherent optical technology coupled with industry supply constraints attributable to the flooding in Thailand in 2011.

Narrow Line-width, High Power Integrated Tuneable Laser Assembly

"With the flooding in Thailand, the supply of Narrow Line-width Tuneable Lasers has become a limiting factor in the shipment of 40 and 100 Gbps coherent optical transport systems," said Tim Jenks, Chairman and CEO of NeoPhotonics.

"Accordingly, we have stepped up our production to help satisfy this critical need. Since we first announced our expansion plans, we have added seven additional customers and are engaged with several more. Our first phase capacity expansion is now full and we are again expanding to help meet industry requirements. We expect the growth in demand for NLW-TLs to continue for the next several years in concert with the rapid adoption of coherent transport technology."

NeoPhotonics NLW-TLs are compact, widely-tuneable and narrow line-width assemblies with up to 35mW launch power in the C band and 20mW in the L band. Narrow line-widths are designed to facilitate digital signal processing, which is used in coherent optical transmission to analyse the incoming signal when it is mixed with a local oscillator laser in a coherent receiver.

With wavelengths spanning 1528 to 1608nm, the lasers incorporate compound semiconductors.

Coherent transmission is capable of increasing the bandwidth of an optical channel from 10 Gbps to 100Gbps, and is designed to enable carriers to add "backbone" network capacity economically and accommodate the surge of wireline and wireless broadband services hitting the network. The narrow line-width and frequency stability of the NeoPhotonics NLW-TL are enabled by a phase-

shifted DFB laser chip and proprietary packaging technology, and the laser assembly includes an integrated wavelength locker as well as electrical and firmware interfaces.

Solar

Suncore JV commences production of 50 MW plant in China

The partnership involves the use of Emcore's III-V multi-junction solar cells. Suncore has begun production of the modules for the solar farm

The joint venture between Emcore Corporation and San'an Optoelectronics, known as Suncore Photovoltaics, has begun production of CPV modules in its facility located in Huainan, China.

To celebrate the completion of the Phase-I construction, a grand opening ceremony was held on February 21, 2012.

Suncore was founded in July 2010, and broke ground to start construction of the current facility in February 2011. The current production facility in Huainan is the first phase of its three-phase construction and business growth plan. Now with Phase I having been completed, Suncore has an annual production capacity of 200 MW CPV modules using a highly automated production line.

Suncore has begun production against its 50 MW purchase order for an installation in Golmud, China. Once completed, this project will be the largest CPV installation in the world.

"Given the current macroeconomic environment for photovoltaics, we believe China is emerging as the most promising market for CPV solar power in the world," says Christopher Larocca, Chief Operating Officer of Emcore.

Larocca adds, "Suncore's initial 50 MW purchase order is a testament to the demand for CPV in China, and we firmly believe that Suncore's cost model will allow Suncore to aggressively compete in the photovoltaic market there and around the world. Emcore is very proud to be supplying the highest efficiency terrestrial solar cells currently in production for this milestone project."

"This is an exciting milestone for Emcore Corporation, San'an Optoelectronics and Suncore. With the strong support from San'an, Emcore, and the local regional government, Suncore completed the facility construction and commenced production at its new state-of-the-art manufacturing facility in one year," comments Charlie Wang, President and CEO of Suncore Photovoltaics.

"Suncore has also made tremendous progress developing solar projects in China. Through close collaboration with our business partners, Suncore is well positioned to be the dominant CPV supplier in China for commercial and power utility applications by offering a long-term cost-effective product to our customers," concludes Wang.

BMW and Honda next in line to employ CIGS PV solar power

The two automotive giants are fitting CIGS solar panels at their car factories

Two of the big guns in the automobile industry are looking to start incorporating more on-site solar electricity generation.

Honda has been installing solar power generation systems at its plants all over Japan which have so far reached a total combined capacity of 3.3 MW.

Honda's own solar power branch is Honda Soltec and it is using its own solar panels, the "Honda Soltec CIGS thin-film solar cells" in all of its branches. Recent installations by Honda include a 9 kW solar power system fitted at the Honda Cars Tokyo Chuo dealership. This installation marks the beginning of a solar power initiative from Honda that will see over 100 dealerships fitted with similar solar panels.

BMW has been pulled over to the 'green side' after having just recently finished installing 400

solar modules that each has a 240 W capacity. They have been installed at BMW Manufacturing's heritage museum and visitor centre which is situated next to their South Carolina plant, in America.

According to an article on Energy Matters, the half a million dollar solar power system provides all of the electricity that is needed for BMW to power the Zentrum Museum. It is hoped that it will eventually be powering three new electric vehicle charging stations throughout the company's main facility.

New JV to propel III-V multi-junction solar cell technology

Southwest Solar Technologies and MaxQ Power Conversion LLC are collaborating to drive the commercialisation of SST's compound semiconductor solar power technology

Southwest Solar's CPV product combines advanced high efficiency multi-junction solar cells with innovative approaches in concentrator optics, power electronics, and efficient manufacturing.

The design incorporates a unique solar flux management capability that enables non-uniform light intensity to be used. This makes it possible to use the CPV product with either dish or heliostat collectors designed for concentrated solar power.

Under the Agreement, the parties will cooperate to develop and manufacture Southwest Solar's patent pending dense array CPV module that packages numerous multi-junction photovoltaic cells into a compact, high concentration, solar power generation module where a solar concentration ratio of 1200-times is achieved.

Extremely high energy flows from this concentration can cause heating that can reduce solar cell performance. To manage this thermal intensity, the system utilises a closed loop liquid cooling system in the form of an advanced cold plate technology developed by MaxQ. This MaxQ cold plate technology is currently successfully used in high power electronic conversion systems in the electric vehicle and inverter industries.

Unique internal fin construction and manufacturing methods provide efficient cooling for the solar cells. The cold plates are manufactured using the Friction Stir Welding process and a patent pending design which allows Max Q to incorporate unique structures with high thermal performance, low pressure drops, and very high reliability. Minimal material is used to achieve light weight at low cost.

This CPV advancement is part of Southwest Solar's integrated development plan centred on the Company's solar dish concentrator, one of the largest commercial solar dishes in North America. The Company previously announced the successful proof of concept testing of its integrated Dish concentrator and air-based open cycle turbine to produce electricity.

Southwest Solar's new patent pending design utilises currently available multi-junction solar cells combined with innovative approaches to concentrator optics, thermal management, power electronics, and manufacturing processes. In addition to leveraging the advantages of concentrated photovoltaic technology our Dish-CPV has a lower cost and higher performance than other CPV technologies.

The firm's product development and testing is conducted at its headquarters and operations facility at Southwest Solar Research Park in Phoenix, Arizona. Max Q Technology provides a number of solutions for the power electronics industry from its operations in Tempe, Arizona.

A new member joins CIGS developer DayStar's Board of Directors

Entrepreneur Daniel Germain has a proven track record of starting and running a large organisation

DayStar Technologies has appointed Germain as an independent Director of the Board of Directors of the company.

He will serve both the Audit and Compensation Committees, as well as the broader Board, effective immediately.

"I am very pleased to welcome Daniel to the

DayStar Board of Directors," said Peter Lacey, Chairman of the Board. "He brings invaluable experience as an entrepreneur and leader as President and Founder of Breakfast Clubs of Canada. Daniel's proven track record of starting and running a large organisation serving breakfast to over one hundred thousand school children a day shows his creativity and execution ability. In addition, he brings relationships and support from multi-nationals including Coca-Cola, McDonalds, Pratt and Whitney, and Wal-Mart."

"I am pleased to join DayStar's Board of Directors and I look forward to working with Peter and the management team to contribute to the company's next stage of growth," said Germain. "I hope to use my entrepreneurial background and contacts to help the company explore new opportunities and leverage DayStar's existing technology base into new markets."

Daniel Germain started Club des petits dejeuners du Quebec (Quebec Breakfast Club) in November 1994, with a grant from the Pratt & Whitney Canada Employee Charitable Fund, and built it into a charitable organisation which now serves more than 2.5 million breakfasts to Quebec schoolchildren annually. The Quebec Breakfast Club program was recognised by the United Nations World Food Programme. It is the model Breakfast Clubs of Canada promotes for other programs elsewhere in Canada. Using his proven Quebec model, Daniel founded Breakfast Clubs of Canada in 2005 in order to reach and help serve children breakfast all across Canada.

In recognition of his work in Quebec and across Canada, Daniel has most recently been appointed the Order of Canada, has received the Medal of the Quebec National Assembly, the Meritorious Service Decoration (civil division) from the Governor-General, and the Queen Elizabeth II Jubilee medal among others.

Opel awarded for a second year as member of the 2012 TSX Venture 50

This ranks the firm, which incorporates Opel Solar which manufactures III-V multi-junction solar cells, in the top 50 for a number of criteria. These include share price appreciation, trading volume, market capitalisation growth and analyst coverage.

The 2012 TSX Venture 50 is a ranking of strong performing companies listed on TSX Venture Exchange.

It is comprised of ten companies from each of five sectors: Clean Technology, Mining, Oil & Gas, Diversified Industries, and Technology & Life Sciences.

"As a technology Company that consistently advances its solar and semiconductor businesses, Opel is proud to again be a member of this elite group of companies on the TSX Venture Exchange," said Leon M. Pierhal, CEO of Opel Technologies. "Capitalising on innovation and new market opportunities for solar technology and our state of the art semiconductor POET process continues to drive our success at Opel. We look forward to persistently growing our offerings."

In a summary statement, Pierhal added, "As technological strides and economic developments in both businesses continue to be achieved, we will proceed to quantify and verify each breakthrough or event. Once we are able to do so, we will disseminate the material information on a timely basis."

Opel Solar, through Odis Inc., a U.S. company, designs III-V semiconductor devices for military, industrial and commercial applications, including infrared sensor arrays and ultra-low-power random access memory. The Company has 35 patents issued and 16 patents pending in PV systems technologies and for its semiconductor POET process. The POET process enables the monolithic fabrication of integrated circuits containing both electronic and optical elements, with potential high- speed and power-efficient applications in devices such as servers, tablet computers and smartphones.

Abound Solar to concentrate on 85 W CdTe modules

The firm is ceasing production of its first-generation CdTe solar modules and 180 jobs will be temporarily slashed. This is in order to accelerate the changes needed for the production launch of its next generation high-efficiency module

Abound Solar's new high efficiency "AB2" 85 W module represents a 12.5 percent solar efficiency as verified by the U.S. Department of Energy's National Renewable Energy Lab (NREL). Several-hundred AB2 modules were produced in early January 2012 on commercial production equipment.

The suspension of first generation module production will result in the temporary reduction of approximately 180 permanent jobs from its Colorado facilities. Once manufacturing equipment has been modified and performance tested, Abound Solar expects to resume mass production with a 12.5-13 percent efficiency module by the end of 2012.

"While this is a difficult move with regards to temporarily reducing our workforce, we know that accelerating the introduction of our next generation module will bring significant benefits to our customers and allow us to create even more jobs in the future," said Craig Witsoe, president and CEO of Abound Solar.

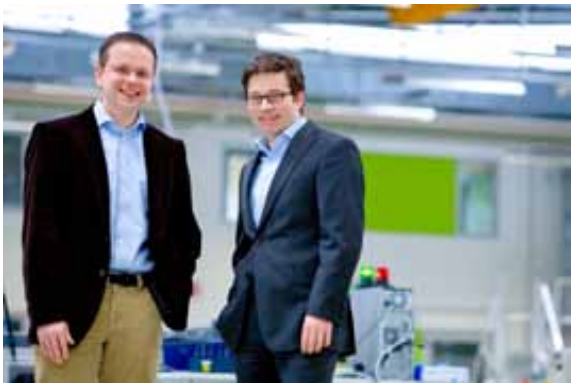
"Current market conditions are challenging for all U.S. solar manufacturers, but the long-term winners will be manufacturers of the lowest cost per watt, most reliable systems. By focusing our resources to accelerate scale-up of our next generation high efficiency technology, we will sustainably lower total system costs for our customers, increase our own profitability and grow U.S. jobs and energy security."

Calyxo makes headway on cost competitive solar power

The CdTe thin-film producer has manufactured a module with an efficiency of 13.4 percent and has secured financing for the year 2012

Calyxo GmbH confirms, with its innovative thin-film module, the huge performance potential of photovoltaic modules based on cadmium telluride technology.

The Calyxo module has an output of 88.7 W at an efficiency of 13.4 % measured on aperture area. Based on these results, owner Solar Fields, LLC, Toledo, Ohio, U.S.A. has decided to fund the company for the some years.



On the left is Michael Bauer, CTO of Calyxo and on the right is Calyxo CEO, Florian Holzapfel

Calyxo GmbH, founded in 2005, produces thin-film solar modules based on cadmium telluride (CdTe) technology. After the company split from Q-Cells in February of 2011, the former technology provider Solar Fields took over Calyxo and invested in a second production line with a capacity of approximately 120 MWp, which will commence production in 2012.

Calyxo currently manufactures a module volume representing an annual power generation capacity of 25 MWp at their production facilities Bitterfeld/ Wolfen-Thalheim, in the so-called "Solar Valley" in Saxony-Anhalt, Germany. All Calyxo modules are thus "Made and Developed in Germany".

Research and rapid further development of the Calyxo CdTe modules is constantly being driven ahead, in collaboration with the American parent company Calyxo USA Inc. Thin-film solar cells are economic to manufacture and can convert solar energy to electricity under the most unfavourable weather conditions. The modules still operate efficiently on roofs that are not directly aligned to the south.

The production process used for Calyxo CdTe thin-film modules also helps to reduce environmental

contamination. The cadmium used for the CdTe modules is a waste product from the mining industry that must otherwise be expensively stored to prevent environmental damage.

Calyxo says CdTe technology refines the cadmium and tellurium to a water-insoluble semiconductor to form the basis of the Calyxo thin-film module. The cadmium telluride is then safely bonded between two glass plates to provide a reliable source of solar power for decades. Calyxo says CdTe modules also offer a small energy payback time of about 1.5 years.

First Solar CdTe modules to energise Taliesin West Initiative

The firm will build a 250kW solar energy system as part of "net-zero" initiative at the National Historic Landmark in Arizona

The Frank Lloyd Wright Foundation, and energy efficiency consultant Big Green Zero, have launched Energising Taliesin West.

This is a pioneering initiative integrating sustainable energy at Frank Lloyd Wright's Taliesin West in Scottsdale, Arizona.

To kick off the initiative, the Frank Lloyd Wright Foundation has partnered with First Solar to install a 250 kW (AC) solar PV array at Taliesin West.

Frank Lloyd Wright's Taliesin West launches a "net-zero" initiative by partnering with First Solar to build a 250kW solar array on the property grounds

The groundbreaking effort will transform the entire National Historic Landmark Taliesin West site into a "net zero" energy customer. In other words the site will produce as much energy as it consumes annually, while maintaining the historic and architectural integrity of the site.

The comprehensive endeavour will focus on the twin goals of maximising Taliesin West's energy efficiency (through improved lighting, insulation, climate controls and other techniques) while also generating clean renewable energy on-site.

Approximately 4,000 of Arizona-based First Solar's sleek, black solar modules will generate clean electricity for Taliesin West. As part of its commitment to the local communities where it operates, First Solar, with help from several key suppliers, is donating the complete custom-designed ground-mounted solar PV system.

The panels will not be visible from anywhere in the historic core of Taliesin West, nor will tour guests be able to see the panels from any location during their entire tour experience. This will maintain the historic integrity of Frank Lloyd Wright's desert home and studio.

However, intentionally, guests will be able to see the impressive solar array from the road before they arrive at Taliesin West to take their tour, celebrating the Frank Lloyd Wright Foundation's commitment to sustainable energy. Every year, more than 100,000 tourists come to Scottsdale to experience Taliesin West, which also houses the Frank Lloyd Wright School of Architecture.

"I couldn't be more excited about this partnership with Big Green Zero and First Solar," said Sean Malone, CEO of the Frank Lloyd Wright Foundation. "This is an extraordinary opportunity; the goal of making a world-famous National Historic Landmark site entirely self-sustaining is unprecedented. And we're going to make it happen. The endeavour will have a broad and deep impact for sustainability efforts throughout America and across the globe. And, importantly, the initiative is entirely consistent with the values of Taliesin West: innovation, an evolving site, embracing new technology, celebrating nature and strategic use of resources."

"Frank Lloyd Wright is synonymous with innovation in architecture and design, and we share the Frank

Lloyd Wright Foundation's passion to forward his legacy — by integrating sustainable energy into his work," said Larry Whittet, First Solar project manager for the Taliesin West solar project. "Taliesin West is a global architectural landmark that has captivated the imagination of visitors for 75 years, and we are proud to be part of this historic undertaking,"

The Energizing Taliesin West program was initiated after a recent energy assessment by Big Green Zero. The assessment indicated that Taliesin West's energy bills could be reduced by as much as 51 percent through simple conservation methods.

"The Foundation is proud to announce First Solar as a partner in achieving our sustainability goals," said Robert Roth, CEO of Big Green Zero. "As a local company focused on harnessing Arizona's most abundant natural energy source — the sun — First Solar will provide Taliesin West with state-of-the-art solar panels in order to reach the property's goal of producing as much energy as it consumes."

"This year marks the 75th anniversary of Taliesin West," adds Malone, "a perfect time to focus on the future. Energizing Taliesin West does just that — it celebrates the future of the Frank Lloyd Wright Foundation, and our future as a society."

Solar Frontier CIS module breaks efficiency world record

Together with Japan's New Energy and Industrial Technology Development Organisation (NEDO) the firm has achieved 17.8% aperture area efficiency on a 30cm x 30cm CPV submodule

This new record for thin-film CIS technology was accomplished at Atsugi Research Centre (ARC), Solar Frontier's dedicated research laboratory in Japan.

This facility is the cornerstone of the company's integrated research and production framework. After a string of major deals and production milestones unveiled in the past few months, the latest announcement underlines the company's fundamental capability in R&D with focus on practical commercial applications.

"I would like to emphasize as we have before that this efficiency is on a fully integrated submodule, which our laboratory produces with processes very similar to what is in place in our factories at commercial production scale," said Satoru Kuriyagawa, Chief Technology Officer at Solar Frontier. "Even higher efficiencies can be achieved by using a device with a very small surface area, but the reason we prefer to focus on the submodule level is that the path to commercial production is more practical. This achievement confirms that we are on track to achieve the higher module efficiencies we are targeting in our commercial production efficiency roadmap."

"This latest efficiency achievement demonstrates Solar Frontier's continued leadership not only in the mass production of CIS thin-film solar modules but also in the technology's fundamental advancement, where our company's roots lie as a pioneer of CIS," said Solar Frontier's Senior Vice President, Atsuhiko Hirano. "ARC is one of the most advanced solar R&D labs in the world. Its achievements include pioneering work in the zinc oxide buffer compound that eliminates the need for cadmium. The work done here is the foundation on which our products are able to achieve more kilowatt hours under actual operating conditions, meeting the needs of residential, commercial and utility customers worldwide."

This new record surpasses Solar Frontier's previous world record of 17.2% set in March 2011.

Solar Frontier's CIS modules are manufactured at its Kunitomi plant, which started full commercial operations last year. The technological advances made at ARC are applied to mass production through Solar Frontier's integrated research and production framework, which includes a pilot plant equipped with the machines on which the GW-scale Kunitomi plant's machinery is based.

The Kunitomi plant recently produced a champion module at 14.5% aperture efficiency (13.38% module efficiency), achieving a 164W rating.

About Solar Frontier

Solar Frontier K.K., a 100% subsidiary of Showa Shell Sekiyu K.K. (TYO:5002) ("Solar Frontier"),

has a mission to create the most economical, ecological solar energy solutions on Earth. Building on a legacy of work in solar energy since the 1970s, Solar Frontier today develops and manufactures CIS (denoting copper, indium, selenium) thin-film solar modules for customers in all sectors around the world. Solar Frontier's gigawatt-scale production facilities in Miyazaki, Japan, integrate compelling economical and ecological advantages into every module: from lower energy requirements in manufacturing to the higher overall output (kWh) of CIS in real operating conditions. Solar Frontier is headquartered in Tokyo, with offices in Europe, the U.S.A., and the Middle East. Visit www.solar-frontier.com for more information.

First Solar 2011 awarded Safety Partner of the Year

CLP Resources honoured cadmium telluride manufacturer First Solar for the company's commitment to safety, extraordinary safety record and safety partnership efforts

CLP recognised eighteen customers across the country as its 2011 Safety Partners from among the thousands it worked with last year and First Solar ranked number 1 nationally.

The award took into account hours worked, hours between incidents, overall safety performance of CLP's employees on the customer's jobsite, and safety culture.

"Having a workforce that is knowledgeable and safe is imperative, and something we take very seriously," said Eric Feinberg, vice president of strategic markets at CLP. "First Solar joins us in our commitment to safe workplaces and has consistently proven that safety is one of their highest priorities. We're proud to do business with a company so dedicated to the safety of all its employees."

"'Safety First' tops the list of First Solar's core values, so we're proud to be recognised for what we have achieved," said Jim Lamon, senior vice president of engineering, procurement and construction at First Solar. "We are fanatics about safety, so it's great to work with firms like CLP that share our uncompromising commitment to safety in everything we do."

CLP Resources, Inc. is celebrating its 25th year as one of the nation's leading suppliers of reliable skilled trades people to commercial, industrial and institutional building contractors. Headquartered in Reno, CLP is a wholly-owned subsidiary of TrueBlue, Inc.

First Solar and Sonnedix complete 7.5 MW CdTe solar farm in Thailand

The plant, based on First Solar's cadmium telluride modules, will meet the annual electricity needs of more than 5,100 homes

Sonnedix Group and First Solar have announced the completion of the Nakhon Ratchasima Solar Farm in the Khorat region of north eastern Thailand

The 7.5 MW (DC) solar power plant-one of the biggest to-date in Thailand was built by Sonnedix with support of Assyce Fotovoltaica and Ch. Karnchang Group using around 95,000 of First Solar's innovative CdTe thin-film solar modules.

Nakhon Ratchasima Solar Farm

"As a global solar independent power producer whose management has an extensive track record of more than fifteen years in Asia," said Sonnedix Chairman Franck Constant. "We are confident that this project, our first to become operational in Thailand, will serve as a strong base for our strategy of developing and building utility-size world-class solar farms and large rooftop solar power plants. It is our view that solar PV should be a mainstream power source in Thailand."

"The completion of the Nakhon Ratchasima Solar Farm is a considerable achievement and supports our commitment, shared with the Thai government, of reducing fossil fuel dependence and greenhouse

gas emissions," said Jack Curtis, First Solar Vice President, Sales and Business Development. "We believe that this project and others like it in Thailand will greatly benefit from our low-cost, environmentally leading technology, which has the smallest carbon footprint of any current PV technology."

"We are delighted to have partnered with the Sonnedix Group on this project in Thailand and to be working with Thai authorities as they increasingly adopt utility-scale PV solar as a clean, affordable source of renewable energy," said Kevin Berkemeyer, First Solar Senior Manager, Business Development. "We look forward to helping Thailand meet its energy needs and enhancing its energy security."

Covering around 20 hectares, the Nakhon Ratchasima Solar Farm can supply enough electricity to meet the annual needs of about 5,100 average Thai homes. It is expected to generate more than 10,500 MW hours of clean, green electricity per year, offsetting carbon dioxide emissions of more than 6,500 tons a year. A Buddhist inauguration ceremony took place at the power plant last week.

The modules in the project are covered by First Solar's prefunded module and recycling program.

Twisting the growth of III-V nanowires

MIT researchers say they can control the composition and structure of tiny indium nitride and indium gallium nitride wires as they grow

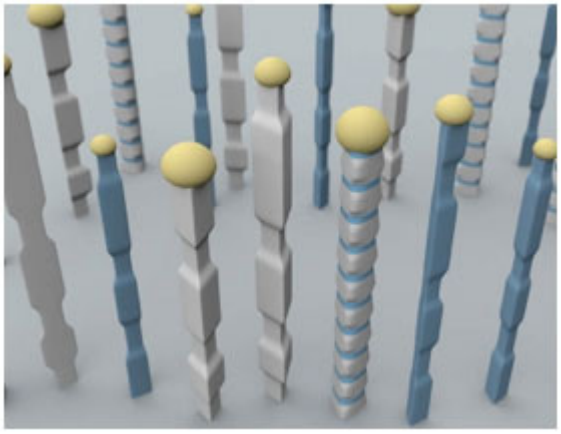
Nanowires, microscopic fibres that can be grown in the lab are a hot research topic, with a variety of potential applications including LEDs and sensors.

Now, a team of MIT researchers has found a way of precisely controlling the width and composition of these tiny strands as they grow, making it possible to grow complex structures that are optimised for specific applications.

Nanowires have been of great interest because structures with such tiny dimensions, typically just a few tens of nanometres in diameter, can have very different properties than the same materials have in bulk.

That's partly because on such a minuscule scale, quantum confinement effects come in to play. The behaviour of electrons and phonons within the material contribute a considerable amount to its properties. This can affect how it conducts electricity and heat or interacts with light.

What's more, because nanowires have a significantly large amount of surface area in relation to their volume, they are particularly well-suited for use as sensors, points out Silvija Gradečak,who heads the research team at MIT.



Nanowires fabricated using the new techniques developed by Silvija Gradečak and her team can have varying widths, profiles and composition along their lengths, as illustrated here, where different colours are used to indicate compositional variations (Image courtesy of the Gradečak laboratory)

Nanowires are grown by using "seed" particles, metal nanoparticles that determine the size and composition of the nanowire. By adjusting the amount of gases used in growing the nanowires, Gradečak and her team were able to control the size and composition of the seed particles and the nanowires as they grew. "We're able to control both of these properties simultaneously," she says.

While the researchers carried out their nanowire-growth experiments with InN and InGaN, they say the same technique could be applied to a variety of different materials.

The scientists observed the nanowires using electron microscopy and made adjustments to the growth process based on the results. Electron tomography also enabled them to reconstruct the three-dimensional shape of individual nanoscale wires.

The team has also published work regarding the use of electron-microscopy cathodoluminescence to observe what wavelengths of light are emitted from different regions of individual nanowires.

Precisely structured nanowires could facilitate a new generation of semiconductor devices, says Gradečak. Such control of nanowire geometry and composition could enable devices with better functionality than conventional thin-film devices made of the same materials, she says.

One likely application of the materials developed by Gradečak and her team is in LED light bulbs, which have far greater durability and are more energy-efficient than other lighting alternatives. The most important colours of light to produce from LEDs are in the blue and ultraviolet range; ZnO and GaN nanowires produced by the MIT group can potentially produce these colours very efficiently and at low cost, she says.

While LED light bulbs are available today, they are relatively expensive. “For everyday applications, the high cost is a barrier,” Gradečak says. One big advantage of this new approach is that it could enable the use of much less expensive substrate materials, a major part of the cost of such devices, which today typically use sapphire or SiC substrates. The nanowire devices have the potential to be more efficient as well, she says.

Such nanowires could also find applications in solar-energy collectors for lower-cost solar panels. Being able to control the shape and composition of the wires as they grow could make it possible to produce very efficient collectors.

The individual wires form defect-free single crystals, reducing the energy lost due to flaws in the structure of conventional solar cells. Also, by controlling the exact dimensions of the nanowires, it’s possible to control which wavelengths of light they are “tuned” to, either for producing light in an LED or for collecting light in a solar panel.

Complex structures made of nanowires with varying diameters could also be useful in new thermoelectric devices to capture waste heat and turn it into useful electric power. By varying the composition and diameter of the wires along their length, it’s possible to produce wires that conduct electricity well but heat poorly. This combination is hard to achieve in most materials, but is key to efficient thermoelectric generating systems.

The nanowires can be produced using tools already in use by the semiconductor industry, so the devices should be relatively easy to gear up for mass production, the team says.

Zhong Lin Wang, the Regents’ Professor and Hightower Chair in Materials Science and Engineering at the Georgia Institute of Technology, says that being able to control the structure and composition of nanowires is vitally important for controlling their nanoscale properties. The fine-tuning in the growth behaviour of these materials opens up the possibilities for fabricating new optoelectronic devices that are likely to have superior performance.

Isofoton & Mercedes AMG Petronas partnership gets the green light

The agreement sees an Isofoton logo on the helmet visors of the Mercedes AMG Petronas drivers Michael Schumacher and Nico Rosberg

Isofoton and the Mercedes AMG Petronas Formula 1 Team are in an exciting new partnership, as the team debuts its F1 W03 car for the 2012 season today.

Malaga based company Isofoton began operations in 1981 producing photovoltaic cells based on silicon wafers. The company is now also involved in the development and manufacture of HCPV technology which uses high efficiency III-V semiconductor materials. These cover a small part of the module’s surface yet allow for the production of nearly double the energy obtained from conventional photovoltaic systems. Thirty years on and now employing close to 800 people, the company expects to increase its manufacturing

capacity to 1 GW over the next three years.

The company's range of products include solutions for the automotive industry such as electric vehicle solar charging stations and batteries.

Ángel Luis Serrano, President of Isofoton commented, "This strategic partnership between Isofoton and the Mercedes AMG Petronas Formula One Team was formed through values shared by both organisations; a commitment to high quality, cutting-edge technology, and environmental sustainability. Isofoton is a pioneer in the PV sector and has been at the forefront of solar innovation for over 30 years, and we look forward to entering Formula One with Mercedes AMG Petronas as the sport enters an era of improved environmental efficiency."

Ross Brawn, Team Principal of Mercedes AMG Petronas added, "We are very pleased to confirm our new partnership with Isofoton and to welcome them to the Mercedes AMG Petronas team. Formula One is frequently the proving ground for new technologies, both automotive and on a wider scale, and we are always pleased to partner with companies who share our innovative approach and excitement about revolutionary technologies. Isofoton, at the forefront of solar energy solutions, provides the perfect match at a time when the Formula One community, including Mercedes AMG Petronas, are working to make our sport more environmentally efficient and socially relevant."

Ceres obtains CIGS technology assets from Veeco

The firm now has the right to manufacture, support and advance the CIGS equipment technology previously sold by Veeco

Ceres Technologies, a global provider of branded process critical support equipment to the semiconductor and solar industries, has expanded its position in the photovoltaic equipment manufacturing supply chain.

The firm has recently purchased certain technology and product assets of the CIGS system business formerly operated by Veeco Instruments.

The CIGS product line acquisition adds to Ceres Technologies' growing portfolio of products and services in the renewable energy space with production-ready CIGS deposition tool sets, including machines for Molybdenum back contact, CIGS absorber layer and Transparent Conductive Oxide (TCO) layers.

The current product offering allows for roll to roll deposition on Stainless Steel substrates at 0.3, 0.6 and 1.0 metre widths. In addition, a production scale CIGS glass process tool is in development. As part of the technology purchase, Ceres Technologies obtained the right to manufacture, support and further develop the CIGS equipment technology previously sold by Veeco.

According to Kevin Brady, President and CEO of Ceres Technologies, "Ceres intends to selectively collaborate with PV Equipment suppliers, CIGS cell and Module manufacturers and state and federal agencies with the intent of expanding production worthy CIGS manufacturing tool sets to the PV market place."

"Ceres is well-positioned to facilitate near term and future CIGS module production capacity growth. Our business model fosters strategic partnership with our customers to develop and fulfil pilot line and production scale requirements. Our CIGS equipment platforms, together with our full portfolio of gas and chemical handling products provide our customers with a production worthy supply of equipment infrastructure."

According to Frank Reilly, Vice President of the Ceres Technologies Solar Group, "Ceres Technologies' "adaptive (CIGS) platform architecture is designed to provide readily available process tool sets to PV companies, allowing them to focus on development of their core IP by deploying it on a proven platform. Cell and module manufacturing companies can also rely on Ceres' engineering and equipment manufacturing expertise to realize scaling of their unique development or pilot line methods and recipes."

Ceres Technologies is a global outsource manufacturing provider of state of the art process equipment for the world's leading Semiconductor, Solar and Life Science production equipment

suppliers. The company also offers ultra high purity specialty gas and chemical handling products and measurement and metrology systems for these process critical applications.

Nanosolar nets $20 million in funding

The investment will fuel new CIGS solar plants and the growth follows on the heels of recent projects and milestones

Thin film solar printing manufacturer Nanosolar, has closed $20 million to fund continued expansion as well as newly committed projects.

Current investors Mohr Davidow Ventures and OnPoint Technologies, participated in the round with new investor aeris CAPITAL.

“We are excited to renew our investment and strongly believe in Nanosolar’s technology and the team’s ability to compete with current market leaders by delivering on its low cost promise,” said Erik Straser of Mohr Davidow Ventures.

“We believe solar printing is the future of low cost harvesting of solar energy,” said Erik Oldekop of aeris CAPITAL. “We are eager to be a part of Nanosolar’s growth and validation.”

Within the last six months, Nanosolar has announced a number of milestones and projects that have helped strengthen its position as the thin film solar cost leader. The firm appointed Eugenia Corrales to CEO as part of a planned transition. The firm also announced a production expansion to a 115 MW capacity. Also, NREL certified the firm’s thin film solar cell had an aperture efficiency of 17.1%.

The firm also announced two new projects with EDF EN in Oregon totaling 3 MW and another two projects totaling 1.5 MW at National Guard Bases in Ohio and California.

“This represents the beginning of an exciting new period of growth for Nanosolar,” said Nanosolar CEO Eugenia Corrales. “With our team firmly entrenched, we will be unveiling new projects and new partners as part of our commitment to deliver the industry’s lowest cost thin film solar solution.”

Nanosolar combines proprietary technology with advanced system design and manufacturing processes to reduce both panel and balance of system costs. Together, these advantages drive Nanosolar’s mission to be the low cost solar provider, independent of subsidies.

NRG Solar looks to Solar Frontier for its CIS modules

This marks the first agreement between the two companies and the first purchase of thin film CIS technology in NRG Solar’s history

Solar Frontier has signed a module supply agreement with NRG Solar, one of the largest solar developers in the United States.

Solar Frontier’s CIS thin-film solar modules, capable of supplying 13.2 MW, were shipped and delivered to NRG this month.

NRG Solar owns and operates some of the largest solar power plants in the U.S., and has more than 2,000 MW of solar projects under development or in construction across the southwest.

NRG Solar is one of the market leaders in the expansion of solar equipment implementation throughout North America. Though the purchase is not set for a specific project, the transaction demonstrates the confidence NRG Solar has in CIS technology for future installations.

“We are proud to have been chosen by NRG Solar for this purchase,” said Gregory Ashley, chief operating office of Solar Frontier Americas. “NRG Solar’s leadership in the industry makes them an extremely valuable long-term customer of Solar Frontier.”

The modules are produced at Solar Frontier’s gigawatt-scale Kunitomi factory, a production facility unparalleled for its combination of advanced automation, scale, and low-energy, end-to-end processing of CIS modules. Solar Frontier’s modules deliver compelling economics, energy conversion efficiency, and overall power output (kWh) in real-world operating conditions.

The "light soaking" effect of CIS modules significantly increases output from initial values, while a lower temperature coefficient than crystalline silicon means more kWh produced under real conditions in hotter climates. Solar Frontier says its modules also lower overall energy consumption in the manufacturing process to yield one of the fastest energy payback times in the solar industry.

O'Donnell joins Opel as director

The recent appointment of John F. O'Donnell will enable Opel to comply with the 25% Canadian residency requirement for the Board of Directors

Opel Technologies and Opel Solar has announced the appointment of John F. O'Donnell to the Board of Directors of the Company to fill the vacancy created by the resignation of Samuel Peralta.

O'Donnell has practiced law in the City of Toronto since 1973 and is counsel to Stikeman Keeley Spiegel Pasternack LLP. His practice is primarily in the field of corporate and securities law and, as such, he is and has been counsel to several publicly traded companies.

John F. O'Donnell is currently also a director of RX Gold & Silver Inc. and Nerium Biotechnology, Inc. With his vast experience and expertise in Canadian securities legislation, corporate governance, private placements and prospectus financings, Opel believes he will be a valuable addition to the Board of Directors.

Having served legal counsel to the company and its predecessor companies for over 20 years, O'Donnell will continue to act as legal counsel to Opel and may also serve on other board committees of the firm.

Opel says that O'Donnell was always available to the Board when needed and his presence on the Board and its committees will be very useful. Especially in these times of increasing compliance requirements and the demand by shareholders for more transparency.

"The Board is honoured to welcome Mr. O'Donnell as a director of the Company." said Lawrence Kunkel, Chairman of the Board. "His appointment exemplifies the Company's commitment to enhancing shareholder value, and his well known integrity and experience will be invaluable to the strategic growth of Opel on a going forward basis and should assist in elevating Opel's stature and credibility. With his increased responsibilities, he will surely provide a strong and solid support to the directors and management team of the Company while Opel continues to expand its Solar sales and to develop its POET technology with a view to monetizing its semi-conductor division."

The Company will continue to seek to recruit other qualified candidates for appointment to the Board, particularly those with industry specific experience and expertise.

Opel Solar through Odis Inc., a U.S. company, designs III-V semiconductor devices for military, industrial and commercial applications, including infrared sensor arrays and ultra-low-power random access memory. The Company has 35 patents issued and 16 patents pending in PV systems technologies and for its semiconductor POET process.

The POET process enables the monolithic fabrication of integrated circuits containing both electronic and optical elements, with potential high-speed and power-efficient applications in devices such as servers, tablet computers and smartphones.

$19.2 million to see Solar Junction move into high volume manufacturing

The developer of high efficiency III-V multi-junction cells has closed a Series D financial round from current investors with an additional strategic investment and partnership from IQE

The investment and partnership is to scale up manufacturing of Solar Junction's exceptional record cell which achieves 43.5% efficiency.

"I am ecstatic about the partnership with IQE and the closing of this current round," said Jim Weldon,

Solar Junction founder and CEO. “In the face of all the externalities hindering solar – pricing, overseas competition, financial markets – Solar Junction has multi-megawatt orders, the financing, the manufacturing capacity and the world record for cell efficiency that will catapult CPV into newer and bigger markets.”

San Jose based Solar Junction closes its largest round to date with investments from New Enterprise Associates (NEA), Advanced Technology Ventures (ATV), Draper Fidher Jurvetson (DFJ) and IQE. With the strategic partnership, Solar Junction is now able to meet demand and fulfil current and future orders with a number of CPV companies.

Solar Junction will continue to engage with additional module manufacturers to further technological advances within the CPV market. Solar Junction’s world record efficiency and sustainable efficiency roadmap exceeding 50% within the decade is a key enabler to reduce CPV module costs to meet the U.S. Department of Energy’s $ / 1 watt objective.

Solar Junction is currently manufacturing CPV cells at a multi-point production efficiency advantage over current market leaders.

“This is a potentially transformational opportunity. The CPV market has reached an inflection point in terms of cost comparisons with fossil fuels and is promising impressive growth potential,” said Drew Nelson, CEO of IQE. “A combination of Solar Junction’s core materials IP and technology, together with our own IP and manufacturing capabilities, provides a compelling route to significantly higher cell efficiency and cost effective, high volume production.”

Solar Junction sought a strategic epi partner, and selected IQE due to its proven expertise in high volume epitaxy, its established reputation in the CPV market and IP, complements Solar Junction’s own technology roadmap to higher efficiencies. IQE is investing $5 mil and receives an exclusive multi-year epi wafer supply contract with Solar Junction.

“Another Silicon Valley success story and it couldn’t come at a better time,” said Silicon Valley Leadership Group CEO Carl Guardino. “Jim Weldon and his team at Solar Junction are leading the U.S. in innovating our way out of the cost per megawatt wars in solar.”

Solar Junction’s cells incorporate the company’s proprietary adjustable spectrum lattice-matched, A-SLAM technology. This financing and partnership enables Solar Junction to scale to high volume manufacturing of its world record efficiency cells for the benefit of its customers, while continuing to manufacture in the U.S.

IQE has its fingers in a lot of pies. These include the manufacture of compound semiconductor substrates, III-V MOCVD, MBE and III-nitride growth to name but a few. This latest venture could see it as a big player in the CPV solar market.

Photonics pioneer James J. Coleman honoured by NAE

He has been elected to membership in the National Academy of Engineering. He oversees research using MOCVD of III-V semiconductors to explore applications in lasers, quantum dots and other optical structures

Professor of materials science and engineering at the University of Illinois, Coleman, is also the Intel Alumni Endowed Chair in Electrical and Computer Engineering.

He is among 66 new members and 10 foreign associates credited by the NAE.

Election to the NAE is one of the highest professional honours an engineer can garner. The 2,254 members and 206 foreign associates are an elite group distinguished by their outstanding contributions to the fields of technology and engineering.

James Coleman, a pioneer of photonics and semiconductor lasers, elected to the National Academy of Engineering

Coleman was cited for his work in semiconductor lasers and photonic materials. His research focuses on materials for optoelectronics – devices that convert electricity into light or vice-versa, such as lasers, light sensors, solar cells and fibre optics. He helped to develop the MOCVD growth method and is director of the Semiconductor Laser Laboratory at the U. of I.

"This is a significant recognition and prestigious honour for one of our distinguished faculty," said Ilesanmi Adesida, the dean of the College of Engineering. "Dr. Coleman's research has added considerable knowledge to the field of semiconductor lasers and photonic devices, and his many successful patents and contributions to the engineering literature remain a testament of those achievements. He is also an Illinois alumnus, so we are doubly proud of his achievements."

Coleman earned his bachelor's, master's and doctoral degrees in electrical engineering from the U. of I. He worked at Bell Laboratories and Rockwell International before joining the faculty in 1982. He has published more than 400 scholarly journal articles and holds seven patents. He is a fellow of the Institute of Electrical and Electronics Engineers, the Optical Society of America, SPIE (the international society for optics and photonics), the American Association for the Advancement of Science and the American Physical Society.

Soitec secures financing for South African 50-MW peaksolar power plant

The plant will use Soitec's Concentrix fifth-generation III-V multi-junction CPV systems

Soitec has obtained financing from Investec , one of the leading investment banks in Africa, to build the company's planned plant in Touwsrivier, Western Cape, South Africa.

All financial arrangements are expected to be finalised by the end of the second quarter of 2012.

In December 2011, Soitec was selected by South Africa's Department of Energy as one of the preferred bidders under the country's independent power producer (IPP) program. Soitec's initial project in this program is the solar plant in Touwsrivier, near the Aquila Private Game Reserve where Soitec has already installed a pilot facility.

According to South Africa's Department of Energy, the country's goal is that 42 percent of all newly installed capacity in the next 20 years will be based on renewable-energy sources.

"With financing now in place, we are moving forward to provide South Africa with its first large-scale CPV renewable-energy plant," said André Jacques Auberton-Hervé, chairman and CEO of Soitec. "Following our previous construction of a pilot facility at Aquila and the 500-kw CPV plant near Durban that helped to power the United Nation's recent conference on global climate change, Soitec is helping South Africa to realize its ambitious renewable-energy objectives."

Soitec's durable, high-efficiency Concentrix systems are well suited for installation in South Africa and other sites with high direct solar radiation. The systems produce a high, constant power output curve throughout the day and are able to match peak-load demands.

Founded in South Africa in 1974, Investec is a specialist bank and asset manager which provides

a diverse range of financial products and services. Its principal markets are South Africa, the United Kingdom and Australia. Investec's strategic goal is to develop business on an international scale.

Opel Technologies restructures its board

On an interim basis, CEO Leon M. Pierhal will direct Opel Solar's marketing activities with the support of the sales and marketing staff

Opel Technologies and Opel Solar, a supplier of HCPV solar panels and solar tracker systems and a semiconductor device and process developer, has made changes to its Management Team.

Francisco ("Frank") Middleton, Chief Operating Officer, has retired from the Company.

Middleton came out of retirement to join Opel six years ago to develop the Company's HCPV technology and universal solar tracking systems.

Over the years, Middleton has seen the rise of Opel's worldwide acceptance within the CPV and tracker businesses. Now that Opel is enjoying market-leading success and continuing growth, especially with its solar trackers, he believes it is a perfect time for his transition back into retirement.

The Company's Management and the Board remains optimistic that the Company's efforts will result in strong growth in both its solar and semiconductor lines of business.

"The businesses of Opel retain great potential," said Leon M. Pierhal, Chief Executive Officer of Opel Technologies. "We are experiencing tremendous sales momentum in the area of our universal solar tracking systems. At the Annual General Meeting, I discussed refocusing Opel Solar to meet the increasing worldwide demand for tracking systems. Over the recent months, Opel has been actively responding to numerous proposal requests for utility scale projects requiring solar trackers for different types of PV technologies. In fact, our pivot to tracking systems has generated such activity that to meet the demand, Opel has shifted resources from our CPV business in order to devote the required attention to solar trackers," Pierhal stated.

In addition, the ODIS group continues to grow to meet its goals. "ODIS continues to successfully forge ahead in its POET development program to achieve its expected milestones," added Pierhal.

Javier Berrios is taking on an expanded role as Vice President of Engineering and New Product Development. He will continue in his current engineering capacity within the solar business. Berrios' deep background in photonics will be of strategic importance to support the ongoing compound semiconductor multi-junction POET development and ODIS's semiconductor business plan.

Abound Solar comes on leaps and bounds with 82.8W CdTe modules

The manufacturer of thin-film cadmium telluride solar cells says its module represents a 12.2 percent aperture efficiency and is being verified by the U.S. Department of Energy's NREL

Photovoltaic module manufacturer Abound Solar is producing 82.8W modules at its Longmont, Colorado, USA factory.

The first 82W module was produced in early January 2012 on existing production equipment, and several hundred modules reaching that wattage have been manufactured thus far. Abound Solar expects to begin mass production of 82W modules in the second half of 2012 and 85W modules in the first half of 2013.

"We are very proud of this achievement and I think it underscores the tremendous capabilities of CdTe thin-film technology as a leading solution for competitive, reliable solar power made in the U.S.A.," said Craig Witsoe, President and CEO of Abound Solar. "Abound's R&D team continues to innovate, and we expect to continue increasing our module efficiency and performance. We believe thin-film will soon outpace other forms of PV in regards to cost-efficiency."

Abound Solar produced its one-millionth module in December 2011. Expansion of the Longmont, Colorado factory is currently underway, with further

expansion efforts within the U.S. coming in 2013.

Power Electronics

Renesas enhances services in Brazil to service South America

The new subsidiary will provide technical product support and regional systems solution development expertise in a number of areas including silicon carbide based power devices

Renesas has celebrated the opening of Renesas Electronics Brasil-Servicos Ltda., a wholly owned subsidiary of Renesas Electronics America located in Sao Paolo, Brazil.

Company representatives from Japan and the United States and customers and industry partners were in attendance at the opening ceremony. This new company will bolster Renesas' support and services for the South America region by providing local sales promotion and technical product support, as well as regional systems solution development expertise.

The firm recently released two series of SiC power semiconductor products SiC, intended for use in home appliances such as air conditioners, PC servers, and power electronics products such as solar power generation systems.

Recently, efforts to reduce the power consumption of electric devices have progressed to address considerations such as environmental protection, and demand has increased for higher efficiency in a variety of electrical products.

Over the past 10 years, working along with its local sales representative and distributors, Renesas has experienced strong adoption of its signal chain solutions in Brazil, especially from the automotive and industrial markets. Renesas has a strong desire to expand its global footprint to pursue growth outside Japan. With this expanded investment in the Brazilian market, a richer relationship with customers and partners in the region.

By providing local support via the new company, Renesas aims to increase its MCU market share in Brazil, as well as increasing its share of the power device market by offering a rich line-up for integrated MCU kit-solutions.

"We are pleased to expand our operations into South America with our new subsidiary. We have seen great promise in this market and we believe that this new investment demonstrates our commitment to customers and partners in Brazil," said Tetsuro Kitano, senior vice president, Renesas Electronics Corporation. "Going forward, we plan to deliver increased benefits and resources to our customers in Brazil by expanding our ecosystem and building partnerships with local independent design houses, contract manufacturers, universities and R&D centres."

"I have long been impressed with the innovations being developed by the engineering community in Brazil, especially the areas of automotive, home appliances, motor control and smart metering," said Ali Sebt, CEO, Renesas Electronics America. "It is an honour to provide MCUs and power semiconductor solutions for products that will enable people to interact with their electronics more efficiently, more conveniently, more safely and with greater intelligence and intuition."

SemiSouth showcases demo board for SiC JFET evaluation

The SSJHB12R085-1 board shows the operation of the firm's silicon carbide JFETs in a cascode half-bridge configuration

Enabling a quick evaluation of the SJDP120R085 JFET, the demo board platform is suitable for many applications including boost, buck, inverter and PSU half-bridge power stage designs. In the cascode configuration, the JFET is driven via a source-connected MOSFET, allowing existing, commercially available MOSFET drivers to be used.

SSJHB12R085-1

Normally-on SJDP120R085 1200 V power JFETs enable high-speed switching, are compatible with standard gate drive circuitry, and feature a positive temperature coefficient for ease of paralleling. The JFETs have a high saturation current (27 A), low on-resistance per unit area (85 mΩ max), and improved switching performance.

The demo board comes complete with Gerber files and a BOM to allow users to build their own circuits. Dieter Liesabeths, VP of Sales and Marketing, comments, “Our SiC JFETs have industry-leading performance and we are committed to supporting them with the best available design tools.”

Normally-On SiC JFETs with ultra low switching losses

Key applications of the silicon carbide power devices include photovoltaic microinverters, SMPS and UPS, motor drives, and induction heating

SemiSouth Laboratories is launching the SJDP120R340, a normally on SiC trench JFET that, when compared with silicon MOSFETs, enables higher switching speeds and substantially lower losses.

S***JDP120R340 JFET***

Rated at 1200V with a maximum on-state resistance of 340 mΩ (typical RDS,on of 270 mΩ), these new devices feature a positive temperature coefficient for ease of paralleling and extremely fast switching with no tail current at 150 °C.

Dieter Liesabeths, SemiSouth’s Director of Sales, explains, “Because of the small die size and our compact device design, the new SJDP120R340 normally on SiC trench JFETs are very cost-effective. Samples are available today; with volume production set to begin in Q2 2012 with pricing below $7 in quantities of 1000.”

Cree spices up support of SiC power MOSFET design

The behaviour-based model enables power electronic design engineers to quantify the benefits of silicon carbide MOSFETs in board-level circuit simulation

Cree has expanded its design-in support for one of the industry’s first commercially available SiC MOSFET power devices with a fully-qualified SPICE model.

Cree Z-FET 1200V SiC MOSFET

Using the new SPICE model, circuit designers can easily evaluate the benefits Cree’s SiC Z-FET MOSFETs provide for achieving a higher level of efficiency than is possible with conventional silicon power switching devices for comparably-rated devices.

SiC MOSFETs havevery different characteristics

to silicon devices and therefore require a SiC-specific model for accurate circuit simulations. Cree's behaviour-based, temperature-dependent SPICE model is compatible with the LT spice simulation program and enables power electronics design engineers to reliably simulate the advanced switching performance of Cree CMF10120D and CMF20120D Z-FETs in board-level circuit designs.

Cree SiC MOSFETs are capable of delivering switching frequencies that are up to 10 times higher than IGBT-based solutions. Their higher switching frequencies can enable smaller magnetic and capacitive elements, thereby shrinking the overall size, weight and cost of power electronics systems.

This SiC MOSFET SPICE model adds to Cree's comprehensive suite of design-in support tools, technical documentation, and reliability information to provide power electronics engineers with the design resources necessary to implement SiC power devices into the next generation of power systems.

Equipment and Materials

New EVG wafer cleaning system installed at Tokyo Tech

The EVG 301 will be used to remove particles from the surfaces of pre-bonded III-V compound semiconductors including gallium indium arsenide phosphide on silicon wafers for use in ICs

EV Group (EVG) has shipped an EVG301 semi-automated single-wafer cleaning system to Tokyo Institute of Technology (Tokyo Tech).

The EVG301 has already been installed at Tokyo Tech's Arai-Nishiyama Lab, and is being used in the research and development of advanced optical communication ICs.

EVG 301 Semi-automated Single Wafer Cleaning System

As network traffic continues to rise dramatically, the need for higher levels of integration in optical communication ICs, including the use of optical routers and wave division multiplexing (WDM) transceivers, is needed to keep transmission rates of each channel at manageable levels.

In response to this need, Tokyo Tech's Arai-Nishiyama lab initiated work to develop compound semiconductor-based optical transceiver components on silicon, which enables higher levels of circuit integration. EVG's EVG301 megasonic wafer cleaning system was accepted and installed by Tokyo Tech to help accelerate this project.

Nobuhiko Nishiyama, associate professor at Arai-Nishiyama Lab, comments, "When you build optical circuits on a silicon platform, creating high-quality luminescent components is essential, and improving wafer bond quality plays an important role in making this happen. The existence of even very small particles creates voids on the wafer bonding interface, and such voids prohibit the normal performance of luminescent components.

The EVG301 megasonic wafer cleaning system by EV Group completely removes such particles and enables perfect bonding results. I am confident our research will show significant progress with the use of this technology."

Today's electronics industry is built on high-speed/high-integration silicon devices. Integration of optical circuits on silicon not only improves network speed, but also increases the functionality of IC devices, including membrane photonic integrated circuits.

Effective stacking of III-V compound semiconductors, such as InP and GaInAsP, to create high-performance optical ICs on silicon is essential to enabling such higher integration and functionality. Wafer cleaning removes voids caused by particles during the wafer bonding process.

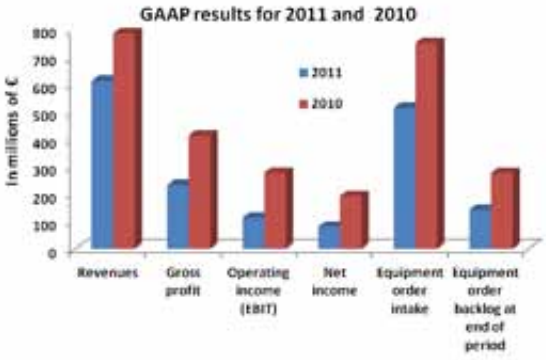
"It is our pleasure to have our EVG301 accepted by Tokyo Tech, which leads optical communication IC research and development," says Yuichi Otsuka, representative director of EV Group Japan KK.

"The EVG301 is widely used in research organisations as the de facto standard for wafer cleaning for various wafer bonding processes—and it is offered as a standard component to EVG's leading-edge, fully integrated wafer bonding systems. Tokyo Tech's selection of the EVG301 for use in their Arai-Nishiyama Lab for advanced research in high-performance semiconductor lasers and highly integrated optical ICs reaffirms the system's status as the tool of record in this field of research."

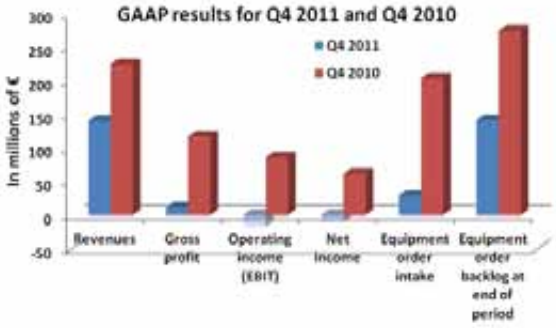
Poor market slashes Aixtron quarterly profit 90%

2011 revenues of the semiconductor deposition equipment maker also declined 22% over 2010

Despite poor market conditions in the second half of 2011 Aixtron SE had revenues of € 611.0 million of revenues and a 18% EBIT margin for 2011.



Although 2012 is expected to be a transitional year between two LED investment cycles with potentially lower revenues, the firm's management anticipates that the Company will remain EBIT profitable for the year.



Total order intake for Aixtron in 2011 was € 513.4 million, 31% down compared to 2010 (€748.3 million) with order intake dramatically slowing down in the second half of the year. The year end order backlog stood at € 141.0 million on December 31, 2011, 49% lower than at the same time in 2010 (December 31, 2010: € 274.8 million).

For the full year 2011, Aixtron recorded revenues of € 611.0 million. While representing a decrease of € 172.8 million, or 22%, compared to € 783.8 million in 2010, 2011 still turned out to be Aixtron's second best year in terms of revenues.

Following an assessment of the market outlook for Aixtron's specific industry and the company's currently limited visibility, Management concluded the likelihood of a continuation of the low level market activity seen towards the end of 2011 into the first half of 2012. In view of this and the consequent likely reduction in inventory turnover, combined with the timing of new product developments in the pipeline, Management decided to make a provision against the potential risk of unsold excess inventories of approximately € 40 million, resulting in a reduced year end total inventory figure of € 184.6 million.

However, Aixtron was able to quickly adapt to the deteriorating business environment during the second half of the year, and consequently still delivered reasonable profit margins for the year, with a gross margin of 38% (2010: 53%) and an EBIT margin of 18% (2010: 35%). Seven percentage points of the gross margin decline as well as of the EBIT-Margin decline were attributable to the inventory provision mentioned above.

The 2011 net profit was € 79.5 million (13% of revenues), 59% down from the € 192.5 million (25% of revenues) in 2010 resulting in basic earnings per

share of € 0.79 (2010: € 1.93).

Dividend proposal

Aixtron's Executive and Supervisory Boards will propose to the shareholders' meeting in May 2012 that a dividend of € 25.4 million or € 0.25 per share (€ 60.7 million or € 0.60 in 2010) will be distributed for the fiscal year 2011. This would result in a pay-out ratio of 32% based on the group net income (2010: 32%), leaving the previous dividend policy unchanged.

Management Review

Despite the current market conditions, Aixtron Management remains convinced that the development of a sustainable LED lighting industry will follow this temporary period of uncertainty.

Paul Hyland, President & Chief Executive Officer at Aixtron, comments, "However we look at 2011, it was certainly an extraordinary year by any standard. We were still delivering strong revenues in the first half of the year, whereas in the second half, the market environment changed dramatically, resulting in a abrupt reduction in demand for MOCVD systems. We have made the necessary adjustments to our order book and inventory and executed immediate cost saving measures, including headcount reductions, without jeopardising our ability to quickly respond to an uptick of demand or diluting our R&D focus."

Commenting on the quality of Aixtron's ability to cope with such volatility and to remain a leading player in the industry, Hyland continues, "Our 2011 full year result still underlines the benefit of the Company's flexible business model and stable financial position which has enabled us to effectively cope with these severe market fluctuations, whilst maintaining our commitment to strategic investments in research and development. Our substantial multi-year investment program is not exclusively limited to the development of next generation LED manufacturing tools. We are also focusing on the development of new technologies for other end markets we believe we can address with the expertise that we have within Aixtron."

In summary, Hyland says, "In the short term, we believe that the next substantial investment cycle will be triggered by MOCVD demand from the emerging LED lighting market. We continue to see very encouraging signals in the form of increasingly proactive governmental engagement and clear market preparation and positioning activities from significant industry players, specifically targeting the LED lighting opportunity. The mid- to long-term prospects for the LED industry remain excellent, particularly in view of the increasing worldwide acceptance of the environmental and cost benefits that come with using LED technology for general lighting applications."

Outlook

With currently very limited order visibility, it is far more difficult than in previous years to provide a full year guidance. However, Management believes that 2012 looks set to be a transitional year between LED investment cycles with potentially lower revenues. Consequently, although unable to offer a precise revenue and EBIT margin guidance at this point in time, Management anticipates remaining EBIT profitable in 2012. Aixtron Management will present a full year revenue and EBIT forecast as and when visibility improves.

A conference call audio replay or a transcript of the conference call will be available at http://www.aixtron.com, section "Investors, Reports/Presentations", following the conference call on March 1st 2012.

Keith Jackson joins Veeco's Board of Directors

The semiconductor industry veteran has previously worked for Fairchild Semiconductor and Tritech Microelectronics

Keith Jackson, 56, currently serves as President, Chief Executive Officer (CEO) and Director of ON Semiconductor, a global supplier of high performance silicon solutions for energy-efficient electronics.

ON Semiconductor recently reported annual revenues of approximately $3.4 billion, and has 20,000 worldwide employees.

John R. Peeler, Veeco's Chief Executive Officer, commented, "Keith brings a strong technology

background to Veeco's Board that includes more than 30 years in the semiconductor industry. His leadership experience and dedication to the markets he serves make Keith an ideal board member. We welcome Keith and believe he will quickly become a valued advisor and partner in Veeco's future growth."

Jackson joined ON Semiconductor in 2002. During his tenure, the Company has successfully completed nine corporate acquisitions and increased revenue by more than $2 billion annually. Before joining ON Semiconductor, he served as Executive Vice President and General Manager, Analogue, Mixed Signal and Configurable Products Groups at Fairchild Semiconductor Corporation, a company that delivers energy-efficient semiconductor solutions for power and mobile designs.

From 1996-1998, Jackson served as President and was a member of the board of directors of TriTech Microelectronics in Singapore, a manufacturer of analogue and mixed signal products. Jackson has served on the board of directors of the Semiconductor Industry Association since 2008. He received his B.S. degree in Electrical Engineering and his M.S. in Electrical Engineering from Southern Methodist University.

BridgeWave to advance wireless market with IBM SiGe technology

IBM's silicon germanium chipset expertise will enable low cost, high-performance 70/80 GHz transmission products

BridgeWave Communications will use IBM's technology to help close the cost gap between millimetre wave high capacity backhaul solutions and traditional microwave solutions.

This will allow mobile operators and wireless carriers to cost effectively deal with growing bandwidth demands.

Recent reports show wireless data traffic, videos, audio and e-mails sent via laptops, smart phones and tablets rose 133 percent in 2011. With many consumers also migrating to 4G networks, this has put a significant strain on global wireless networks, particularly in dense urban cities.

Growing data consumption rates are causing a reduced range of wireless network coverage, raising investment costs for building infrastructure with access points to cover service areas. Alternative approaches, such as integrating backhaul and small cell technology, can reduce these bandwidth bottlenecks and spotty service while increasing speeds over a larger network.

The collaboration between the companies should provide the extremely high silicon integration with GaAs equivalent RF performance, across the entire 71-86 GHz spectrum. BridgeWave says these devices yield ultra-low phase noise performance, enabling the very high spectral efficiencies and system gain for millimetre wave backhaul solutions required by next-generation 4G/LTE networks.

As part of the integration process, BridgeWave will assimilate its proprietary micro-coax mQFN (micro-coax Quad-Flat No-leads) packaging technology along with the IBM designed devices to create high-performance, integrated, low-cost millimetre wave chipsets.

"Until now, the eco-system for millimetre wave components was very limited compared to their microwave counterparts," said Amir Makleff, CEO at BridgeWave. "IBM's research and development efforts in the area of millimetre wave SiGe, along with BridgeWave's proprietary mQFN micro-coax interconnect technologies will allow us to bring cost effective, high performance, carrier-grade solutions to market that operators require as they build out their 4G/LTE networks."

"BridgeWave Communications' use of IBM's silicon germanium technology as the basis for their backhaul network solutions will provide their customers with a platform that can scale to meet the exploding data growth rates of today and tomorrow," said Danny Elad, Manager, Analogue & Mixed Signal, IBM Research-Haifa.

"We are extremely excited that initial sampling results of these designs are exceeding expectations and will enable BridgeWave to start integration into products in 2012," added Idan Bar-Sade, senior vice president of engineering and product

management at BridgeWave.

AXT quarterly revenues boosted by raw materials market

A weak GaAs substrate market has affected the manufacturer of gallium arsenide, indium phosphide and germanium substrates although yearly results are up 9% over last year

AXT, has reported financial results for the fourth quarter and fiscal year ended December 31, 2011.

Fourth Quarter 2011 results revenue for the fourth quarter of 2011 was $21.2 million compared with $28.3 million in the third quarter of 2011.

The graphs below show how each sector contributed to the company's quarterly results for the same quarter last year and the previous quarter of 2011.

Gross margin was 36.9 percent of revenue for the fourth quarter of 2011. By comparison, gross margin in the third quarter of 2011 was 43.2 percent of revenue.

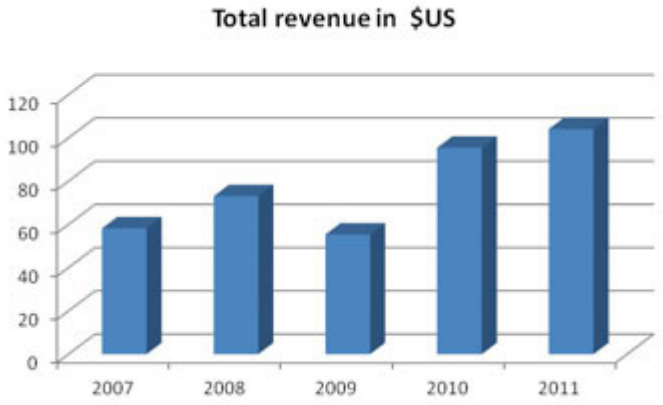
Operating expenses were $4.5 million in the fourth quarter of 2011, compared with $4.2 million in the third quarter of 2011.

Income from operations for the fourth quarter of 2011 was $3.3 million compared with income from operations of $8.1 million in the third quarter of 2011.

Net interest and other income for the fourth quarter of 2011 was $443,000, which included a foreign exchange loss of $150,000. This compares with net interest and other income of $459,000 in the third quarter of 2011, which included a foreign exchange gain of $180,000.

Net income in the fourth quarter of 2011 was $2.6 million or $0.08 per diluted share compared with net income of $6.5 million or $0.19 per diluted share in the third quarter of 2011.

Revenue for the fiscal year 2011 was $104.1 million, a 9 percent increase from $95.5 million in fiscal year 2010. Gross margin for fiscal year 2011 was 43.0 percent of revenue compared with 38.2 percent of revenue for fiscal year 2010.



Net income for fiscal year 2011 was $20.3 million or $0.61 per diluted share compared with net income of $18.7 million or $0.57 per diluted share for fiscal year 2010.

"Our fourth quarter results came in sequentially lower and within the guidance range we provided in October," said Morris Young, chief executive officer. "However, despite near-term challenges, for 2011 as a whole, we posted the strongest fiscal year results in more than 10 years. Revenue for the year was up 9 percent from the prior year, gross margin increased by nearly four hundred basis points and net income rose by approximately 9 percent."

"In addition, we laid important groundwork to prepare our company for growth as we enter the next semiconductor cycle as well as increasing demand relating to a number of key secular trends that we play into. Across our business, we placed great emphasis on diversification of our customer base with notable success in every product category. We strengthened our sales presence and product specifications to enhance our participation in key geographic areas, such as China, Japan and Taiwan," he added.

"Further, we took a critical, measured step to ensure

that we have the appropriate level of capacity at the right time to meet market demand as it increases over the next several years. Throughout 2011, we carefully managed our expense levels and further improved our manufacturing and operating efficiency to keep pace with the pricing requirements of our customers and the sizeable fluctuations in raw materials costs. I am pleased by the way our team executed on its mission in 2011 and believe that we are well positioned for continued growth in 2012," concluded Young.

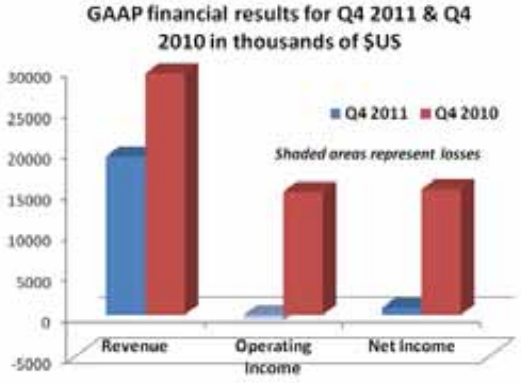
AXT estimates revenue for the first quarter for 2012 will be between $21 million and $24 million and that net income per share will be between $0.07 and $0.11. This takes into account the weighted average share count of approximately 33.2 million shares.

LED excess inventory affects Rubicon's quarter

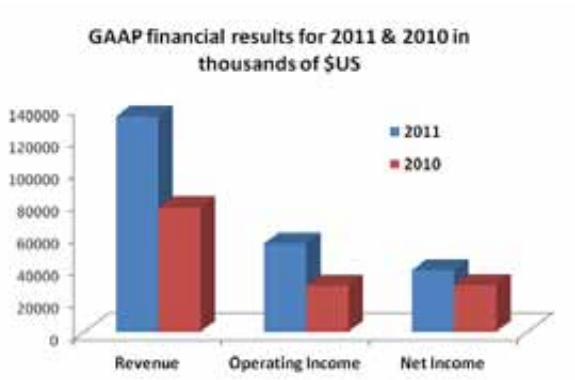
Revenue decreased both year-over-year and sequentially, largely as a result of weak demand from the LED market

Rubicon Technology, a provider of sapphire substrates and products to the LED, RFIC, semiconductor, and optical industries, has reported financial results for its fourth quarter ended December 31, 2011.

Fourth quarter revenue was $19.4 million, slightly below the range of its management's November guidance.



Gross margin in the fourth quarter was 12.1 percent, which was impacted by reductions in pricing and by lower utilisation of the Company's fabrication and polishing operations. Operating loss was $0.7 million, offset by a reduction of the full year tax rate to 30.3 percent, resulting in fourth-quarter earnings of $0.04 per diluted share.



Raja Parvez, President and CEO of Rubicon Technologies, commented, "Market conditions were very challenging in the fourth quarter. Demand was limited, for both sapphire wafers and cores, because of excess inventory in the LED supply chain. We are now beginning to see some improvement, however, with orders for two through four inch cores increasing in the first quarter. We have continued to maintain high utilisation of our crystal growth facilities throughout this slowdown because we are confident that demand will be strong in the second half of 2012. The LED industry's largest potential market, general lighting, is in its infancy, and the more established markets for LEDs such as consumer electronics and the automotive industry have plenty of growth opportunities as well."

Rubicon previously disclosed that it signed a new agreement with its key customer for six inch polished wafers which outlines a base level of shipments from June through December 2012. The Company's previous agreement with this customer expired in December 2011. Due to the challenging market conditions, the Company gave certain concessions to this customer in the fourth quarter by reducing the volumes and pricing requirements under the previous contract. Rubicon also provided accommodations to certain other key customers of its two through four inch cores and consequently wrote off $1.7 million of accounts receivable in the fourth quarter.

"We have worked very closely with our major customers to help them through this challenging period and to ensure that our relationships

remain strong and mutually beneficial," Parvez continued. "We are pleased to have signed a 2012 contract with our foremost large-diameter substrate customer. The use of large diameter sapphire substrates is expected to grow significantly in coming years as LED chip manufacturers continue to look for ways to drive greater efficiency throughout the supply chain. As the most experienced and reliable supplier of large-diameter sapphire substrates, Rubicon is well positioned to benefit from this trend. "

"We are moving steadily forward on the initiatives that will further extend our cost leadership," continued Parvez. "We are increasing our vertical integration by deploying our internally developed raw material processing capability, which we expect will decrease our raw material costs by at least 20 percent when fully implemented. We are relocating much of our slicing and polishing capacity in Illinois to our new facility in Malaysia which will be our primary finishing location as the market improves and will provide state-of-the-art capability in a low-cost environment."

The Company ended the fourth quarter with $55.0 million in cash and short-term investments and no debt.

First Quarter 2012 Guidance

Commenting on the outlook for the first quarter of 2012, Parvez said, "We are seeing signs of improvement in the LED market in the first quarter. Orders for two-inch through four-inch cores have begun to recover somewhat but, given that it is early in the recovery, prices remain low. Our LED customers have substantial inventory of 6 inch polished wafers, and we expect few orders from that market segment in the quarter. In the Silicon on Sapphire (SoS) market, demand for large-diameter wafers continues to grow, but this is a smaller market. As a result, we expect that total revenue for the first quarter of 2012 will be between $8 and $12 million. At this level of revenue, and with further reduced utilisation in our fabrication and polishing operations this quarter, we anticipate a loss of between $0.10 and $0.14 per share in the first quarter. I believe that as pricing and utilisation improve we will gradually move back to our targeted gross margin of over 40 percent."

"We expect capacity utilisation among the LED chip makers to continue to improve throughout the first half of this year," Parvez added.

"Looking beyond the first half of 2012, the outlook for sapphire substrates is for very strong growth, as LEDs gain momentum in the general lighting market, where LED penetration presently is only in the single digits, and as LED penetration into the auto market continues and the backlighting market strengthens. Rubicon continues to be the market leader in terms of capability and cost, and we are well positioned for the market rebound," he concluded.

Oxford Instruments plasma tools impress Lancaster University

The Lancaster Quantum Technology Centre (LQTC) will use the tools for nano-patterning of antimonides and nitrides for mid-infrared light sources and detectors. They will also be used for solar cells and quantum dot memories development

As part of its strategy for the development of physical sciences, the PlasmaPro NGP80 and PlasmaPro System100 ICP Etch systems were chosen for their flexibility; they will enable many applications that the multi-user LQTC wishes to run in its cleanrooms.

Oxford Instruments PlasmaPro System100 ICP Etch tool

Oxford Instruments says LQTC chose its systems as it has an extensive process library of over 6,000 recipes and provides excellent customer support, service and training packages.

Head of the Semiconductor Physics & Nanostructures Research Group at Lancaster University, Tony Krier, comments, "These new Oxford Instruments etch tools will enable us to run dry plasma etching and nano-patterning on a range of semiconductors including narrow gap antimonides and dilute nitrides for mid-infrared light sources and detectors. They will also be used for development of novel solar cells, quantum dot memories, nano-electronic structures, and much more."

Krier continues, "The new clean room facility provides a focus for industrial and academic researchers with interests in fabricating nanoscale structures to enable them to investigate quantum phenomena. We chose Oxford Instruments because of the excellent technical specification and well founded reputation of the processing tools backed up by expert specialist support."

"Oxford Instruments was founded as a result of the pull-through of science into the marketplace, and we are delighted to be part of this significant development in UK scientific research capabilities", says Mark Vosloo, Sales & Customer Support Director at Oxford Instruments Plasma Technology, "Like the LQTC, Oxford Instruments uses innovation to turn smart science into world class products, meeting the needs of the 21st century and beyond."

Rubicon signs $20 million contract to supply sapphire substrates

The new agreement is with the firm's largest customer for large-diameter (classed as 6- and 8-inch) wafers

The contract represents a baseline level of shipments that will be made from June through December 2012. The previous contract expired at the end of December.

"We are pleased that we will continue as a key supplier to our valued six-inch wafer customer in 2012," said Raja Parvez, President and Chief Executive Officer of Rubicon. "As other LED chip manufacturers make the transition to large-diameter substrates in pursuit of greater efficiency, Rubicon—the world's largest, most experienced and most reliable provider of large-diameter sapphire wafers—stands to benefit greatly. However, with LED chip capacity presently not fully utilized, the inflection point in demand for large-diameter sapphire wafers for LEDs is still some months in the future."

In light of current market conditions and in the interest of further establishing a long-term customer relationship with our prominent customer, Rubicon granted adjustments to fourth-quarter 2011 price and volume requirements under the expiring six-inch contract, as management had indicated was likely in remarks made November 8.

As a result, Rubicon's revenue for the fourth quarter ended December 31, 2011, was between $19 and $20 million, slightly below its previous guidance of $20 to $23 million. The Company expects to release complete results for the fourth quarter on February 23, after the market closes.

In another matter, but also related to the current market conditions, Rubicon disclosed that the Company, as an accommodation to certain key customers of its small-diameter sapphire ingots (cores), wrote off $1.8 million of accounts receivable in the fourth quarter.

"The fourth quarter of 2011 was a period of limited demand for sapphire substrates resulting from the accumulation of excess inventory in the LED supply chain," Parvez said. "This temporary decline in channel demand in turn resulted in sapphire prices falling sharply in the second half of 2011. Out of consideration for our important customer relationships, we made certain concessions that we deemed to be in the best long-term interest of our company."

"The near-term demand from the LED market continues to be limited, as inventory adjusts throughout the supply chain, but orders for two-inch and four-inch cores have begun to recover somewhat in the first quarter of 2012, and demand for large-diameter wafers for the Silicon on Sapphire (SoS) RFIC market is growing. As the

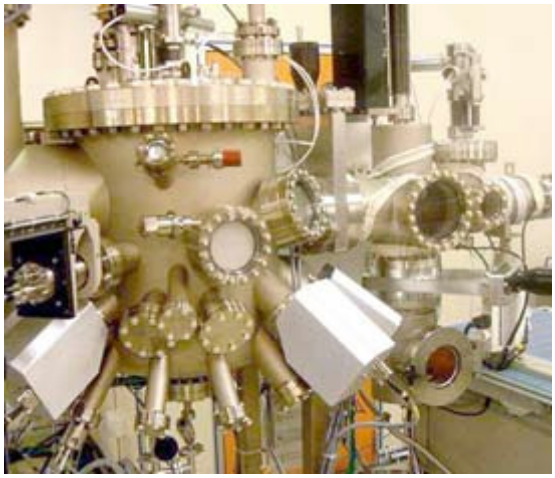
channel inventory situation improves, and as LED technology further penetrates both the backlighting market and the general lighting market, we expect significant strengthening of the market for sapphire substrates later this year," he said.

"We remain optimistic on the long-term outlook for the LED market and Rubicon's positioning to capitalise on the opportunity. To date, Rubicon has shipped more than 230,000 six-inch sapphire wafers to the LED manufacturing and RFIC industries. This has provided us with the experience and scale to drive process and cost efficiencies throughout our system while maintaining our industry leading quality and service. Cost and quality leadership are instrumental to the acceleration of LED adoption in the marketplace and, as such, are strategic priorities for Rubicon," Parvez concluded.

Riber receives order for MBE research system in Argentina

The machine will be used for designing III-V component-based semiconductor devices

MBE equipment maker Riber is selling one of its Compact21 research systems in Argentina. This is the firm's first sale in Argentina.



Riber Compact 21 MBE research system

The machine will be set up in the Institute of Nanosciences and Nanotechnologies of Bariloche in Argentina. It will enable the laboratory strengthen its development capacities for designing III-V component-based semiconductor systems.

The Compact21 MBE systems are one of the world's top-selling research systems. They offer flexibility and can meet the most demanding expectations for applied research on compound semiconductor materials.

GTAT to provide large diameter sapphire cores to Chongqing Silian

The firm will to supply 500,000 TIE (2-inch equivalent) of 6-inch diameter c-plane sapphire cores, which will be used to produce high quality sapphire substrates for the HB-LED industry

GT Advanced Technologies has announced that its subsidiary, GT Crystal Systems, has entered into a purchase agreement with Chongqing Silian Optoelectronics Science & Technology.

GT's ASF furnaces produce high quality sapphire crystal material that is well suited for LED manufacturing

«We are pleased to announce this important agreement for large diameter sapphire cores and to continue our long and successful relationship with Silian,» said Cheryl Diuguid, GT Advanced Technologies› vice president and general manager of its Sapphire Equipment and Materials Group.

«Silian has an outstanding reputation for providing high quality substrates to some of the most advanced LED producers in the industry. This contract further validates that sapphire material produced in our ASF furnaces is well suited for use in the LED supply chain.»

«ASF-grown sapphire has helped Silian and our customers to achieve the high yields necessary for the maturing LED industry,» said David Reid, COO and general manager, Chongqing Silian Optoelectronics Science & Technology. «The consistency and quality of ASF-grown sapphire has served our business well and we look forward to continued collaboration with GT Crystal Systems.»

The ability to produce LED-grade sapphire at diameters of six inches and larger helps to accelerate the transition to next generation MOCVD production tools capable of handling the larger diameter wafers.

Larger substrates allow more efficient MOCVD production processes than current generation MOCVD tools processing two- and four-inch wafers. The large diameter cores will be produced from boules grown in GT›s ASF sapphire growth furnaces installed in the company›s newly expanded sapphire manufacturing facility in Salem, Massachusetts. This is the same technology which has been sold commercially to GT›s ASF equipment customers.

Oxford Instruments secures ISO14001 certification

The firm says this certification reinforces its strong commitment and support from its management and its staff to minimising environmental impact

Oxford Instruments Plasma Technology's Bristol, UK headquarters has received accreditation to the international environmental management standard, ISO14001.

"This accreditation from our certification body, Det Norske Veritas (DNV), means that we have achieved an important business objective", comments Dan Ayres, General Manager of Oxford Instruments Plasma Technology, "The certification provides us with a platform for improved environmental management. It demonstrates to customers, shareholders and investors our commitment to achieving high environmental standards, and it will assist in supporting our continued growth."

Ayres continues, "In addition to the formal business requirements of the certification, we have put in place an extensive awareness-raising program to encourage our employees to participate, and car share, recycle waste and to rationalise the use of other resources. We actively encourage everyone in the business to participate and continuously improve our performance."

Oxford Instruments Plasma Technology's accreditation recognises the company's determination to manage the ecological impact of its business through tangible measures and a dedication to exceed the expectations of its customers and the community at large.

Part of the Oxford Instruments Group, the company is dedicated to improving and contributing to a sustainable world. Recently the first league table of company performance under the UK Government's Department of Energy and Climate Change 'Carbon Reduction Commitment (CRC) Energy Efficiency Scheme' was published, with Oxford Instruments finishing in the top 7% of companies.

SSEC adds David Lam to its Board of Directors

Lam introduced one of the first fully-automated plasma etching systems for semiconductor manufacturing in 1981

The manufacturer of single wafer wet processing equipment for the semiconductor industry, Solid State Equipment LLC has appointed industry veteran David K. Lam to its Board of Directors.

A pioneer in semiconductor manufacturing, Lam now consults and invests in the industry. According to Herman Itzkowitz, President and Chief Technical Officer of SSEC, "We are excited to have Dr. Lam on board to help our company grow. A visionary in the semiconductor industry with extensive technological knowledge and demonstrated business acumen, he will help to focus our efforts and direction in a rapidly-evolving environment."

Under his guidance as CEO, the company in 1982 established a strong presence in Japan through a marketing partnership. Lam Research went public in 1984 and remains a perennial leader in semiconductor process equipment.

Today, Lam uses his experience and expertise to provide guidance to emerging technology enterprises in sectors that include semiconductor and semiconductor equipment, micro- and nano-device manufacturing, computer hardware and software, medical devices, and energy infrastructure. Among the companies he also serves as a Board member are Multibeam Corporation, Xradia and MicroProbe.

Lam stated, "SSEC has demonstrated an exceptional track record in developing semiconductor capital equipment and advanced packaging processes, and the high efficiency in its operations. I am excited about the opportunity to further its success in the fast-growing advanced packaging market."

Novel Devices

Twisting the growth of III-V nanowires

MIT researchers say they can control the composition and structure of tiny indium nitride and indium gallium nitride wires as they grow

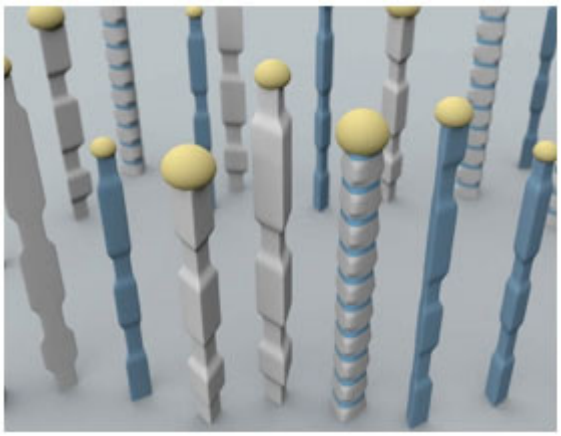
Nanowires, microscopic fibres that can be grown in the lab are a hot research topic, with a variety of potential applications including LEDs and sensors.

Now, a team of MIT researchers has found a way of precisely controlling the width and composition of these tiny strands as they grow, making it possible to grow complex structures that are optimised for specific applications.

Nanowires have been of great interest because structures with such tiny dimensions, typically just a few tens of nanometres in diameter, can have very different properties than the same materials have in bulk.

That's partly because on such a minuscule scale, quantum confinement effects come in to play. The behaviour of electrons and phonons within the material contribute a considerable amount to its properties. This can affect how it conducts electricity and heat or interacts with light.

What's more, because nanowires have a significantly large amount of surface area in relation to their volume, they are particularly well-suited for use as sensors, points out Silvija Gradečak,who heads the research team at MIT.



Nanowires fabricated using the new techniques developed by Silvija Gradečak and her team can have varying widths, profiles and composition along their lengths, as illustrated here, where different colours are used to indicate compositional variations (Image courtesy of the Gradečak laboratory)

Nanowires are grown by using "seed" particles, metal nanoparticles that determine the size and composition of the nanowire. By adjusting the amount of gases used in growing the nanowires, Gradečak and her team were able to control the size and composition of the seed particles and the nanowires as they grew. "We're able to control both of these properties simultaneously," she says.

While the researchers carried out their nanowire-growth experiments with InN and InGaN, they say the same technique could be applied to a variety of different materials.

The scientists observed the nanowires using electron microscopy and made adjustments to the growth process based on the results. Electron tomography also enabled them to reconstruct the three-dimensional shape of individual nanoscale wires.

The team has also published work regarding the use of electron-microscopy cathodoluminescence to observe what wavelengths of light are emitted from different regions of individual nanowires.

Precisely structured nanowires could facilitate a new generation of semiconductor devices, says Gradečak. Such control of nanowire geometry and composition could enable devices with better functionality than conventional thin-film devices made of the same materials, she says.

One likely application of the materials developed by Gradečak and her team is in LED light bulbs, which have far greater durability and are more energy-efficient than other lighting alternatives. The most important colours of light to produce from LEDs are in the blue and ultraviolet range; ZnO and GaN nanowires produced by the MIT group can potentially produce these colours very efficiently and at low cost, she says.

While LED light bulbs are available today, they are relatively expensive. "For everyday applications, the high cost is a barrier," Gradečak says. One big advantage of this new approach is that it could enable the use of much less expensive substrate materials, a major part of the cost of such devices, which today typically use sapphire or SiC substrates. The nanowire devices have the potential to be more efficient as well, she says.

Such nanowires could also find applications in solar-energy collectors for lower-cost solar panels. Being able to control the shape and composition of the wires as they grow could make it possible to produce very efficient collectors.

The individual wires form defect-free single crystals, reducing the energy lost due to flaws in the structure of conventional solar cells. Also, by controlling the exact dimensions of the nanowires, it's possible to control which wavelengths of light they are "tuned" to, either for producing light in an LED or for collecting light in a solar panel.

Complex structures made of nanowires with varying diameters could also be useful in new thermoelectric devices to capture waste heat and turn it into useful electric power. By varying the composition and diameter of the wires along their length, it's possible to produce wires that conduct electricity well but heat poorly. This combination is hard to achieve in most materials, but is key to efficient thermoelectric generating systems.

The nanowires can be produced using tools already in use by the semiconductor industry, so the devices should be relatively easy to gear up for mass production, the team says.

Zhong Lin Wang, the Regents' Professor and Hightower Chair in Materials Science and Engineering at the Georgia Institute of Technology, says that being able to control the structure and composition of nanowires is vitally important for controlling their nanoscale properties. The fine-tuning in the growth behaviour of these materials opens up the possibilities for fabricating new optoelectronic devices that are likely to have superior performance.

More details of this work have been published in the paper, " Controlled Modulation of Diameter and Composition along Individual III–V Nitride Nanowires" by Sung Keun Lim *et al, in Nanoletters,* published online on 7 February 2012. DOI: 10.1021/

nl300121p

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