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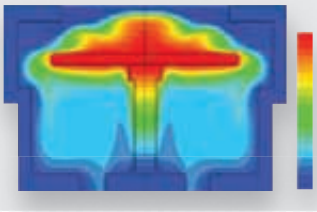

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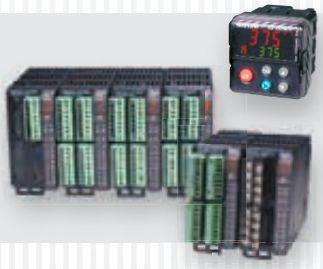

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July 2012
Volume 18 Number 5

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Compound Semiconductor is published eight times a year on a controlled circulation basis. Non-qualifying individuals can subscribe at: £105.00/€158 pa (UK & Europe), £138.00 pa (air mail), $198 pa (USA). Cover price £4.50. All information herein is believed to be correct at time of going to press. The publisher does not accept responsibility for any errors and omissions. The views expressed in this publication are not necessarily those of the publisher. Every effort has been made to obtain copyright permission for the material contained in this publication.
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US mailing information: Compound Semiconductor, ISSN 1096-598X, is published 8 times a year, Jan/Feb, March, April/May, June, July, August/September, October, November/December by Angel Business Communications Ltd, Unit 6, Bow Court, Fletchworth Gate, Burnsall Rd, Coventry CV5 6SP. UK. The 2012 US annual subscription price is $198. Airfreight and mailing in the USA by agent named Air Business Ltd, c/o Worldnet Shipping Inc., 156-15, 146th Avenue, 2nd Floor, Jamaica, NY 11434, USA. Periodicals postage paid at Jamaica NY 11431. US Postmaster: Send address changes to Compound Semiconductor, Air Business Ltd, c/o Worldnet Shipping Inc., 156-15, 146th Avenue, 2nd Floor, Jamaica, NY 11434, USA.

Printed by: Pensord Press.
ISSN 1096-598X (Print)
ISSN 2042-7328 (Online)

Routes to more affordable LED bulbs

I'VE just got back from EuroLEDs, a two-day conference that combines a collection of talks with a fairly large exhibition.

As I walked from booth to booth, I kept my eye out for an attractive 60 W-equivalent LED bulb. When I found one, I enquired of the price: Normally nearly £30, but 30 percent off that figure at the show.

I didn't part with my cash - I'm going to wait for these bulbs to become more affordable, which should happen as reductions in the prices of packaged LEDs are passed on to consumers. LEDs account for the lion's share of the cost of the bulb, and their price will fall, due to severe overcapacity in the market.

For those LED chipmakers caught up in this bloodbath, there are two options for trimming manufacturing costs and maintaining margins: Streamline manufacturing processes; or turning to new, lower-cost technologies.

Speaking at the show, Marco Toja from the consultancy firm Luckygar argued that the focus for LED manufacturers should be on better production processes. He drew parallels with the silicon PV industry, where he says that efforts in China have delivered a six-fold slash in processing costs, enabling sales of $0.3/W panels. In comparison, performance improvement programs in Germany targeting better performance have only led to a halving of the cost-per-Watt.

I've been mulling over what Toja had to say, and I'm not convinced that the best recipe for cost reductions in the silicon PV sector will deliver the best results in the LED industry. In my view, the headroom for improving the cost-per-Watt in silicon PV through technological advances is not that big - the main driver is efficiency, and many panels already deliver over half the theoretical maximum. In contrast, the opportunities to improve the performance of LEDs are massive.

One option is to make the LED much more efficient at high drive currents. Do this and there is less heating, so you can crank even more current through the chip until it finally reaches the temperature limit allowed in the bulb. This means that the operating current rises from hundreds of milliamps to several amps, and it is then possible to slash the number of LEDs in the bulb and its selling price.

The big barrier to driving LEDs harder is droop, a mysterious malady that causes efficiencies to decline as the current is cranked up. Many conjectures have been put forward in the last few years, and Fred Schubert's team from Rensselaer Polytechnic Institute, in partnership with Samsung, Korea, are claiming that they now know the cause: Electron leakage from the active region. Their model can fit experimental data incredibly well (see page 45), and could help to devise droop-combatting LED architectures that will be welcomed by chipmakers. Take them on board and have success, and these chipmakers could help to drive down the price-per-lumen and fulfil my wish for far cheaper LED bulbs.

Richard Stevenson PhD
Editor

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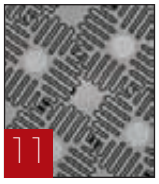

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Speakers

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Novel Solar Cell Technology

Dr Markus Behet
Global Market Segment Manager Electronics Solutions, Dow Corning Corporation
Large Diameter SiC and GaN/Si Substrates for Power Electronic Applications

Dr Schang-jing Hon
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High-Voltage LED Technology in 2013

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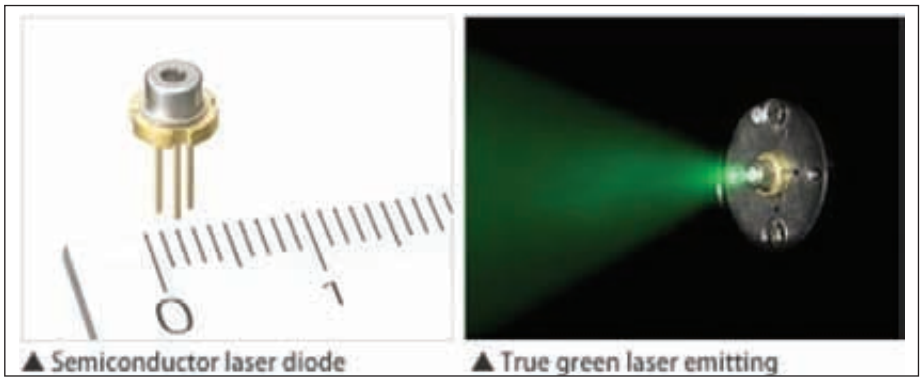
Green laser chips emit over 100 mW

SUMITOMO ELECTRIC and Sony have jointly developed what the firms say is the world's first semiconductor laser diode with an optical output power of over 100mW in the true green region.

At a wavelength of 530 nm, this laser diode (LD) can be mounted on laser projectors and many other display devices. The new device features twice the luminosity of conventional GaN green laser diodes (which are considered to operate at 60mW or less and at 520nm or less), and a colour gamut broadened by 182% based on the NTSC standard (CIE 1976 colour gamut). This standard compares the new true green LD with current red and blue laser diodes.

Red and blue laser diodes have been commercially available among the primary red-green-blue (RGB) colours, and the technology of these LDs is well known. But there has been a far greater need for high output green laser diodes to enhance the overall performance of high laser projectors and display devices which are needed today. Conventional GaN-based green lasers have problems achieving sufficient luminosity as their performance is limited to an output power of several tens of milliwatts at a wavelength of 520nm or less.

To overcome these challenges, Sony and Sumitomo Electric collaborated on the development of a true green semiconductor laser for practical use. The research drew on Sumitomo Electric's semi-polar GaN substrate, crystal growth, and wafer processing technologies and Sony's GaN-based laser technology, acquired through Blu-ray development. By introducing new techniques and improving the entire semiconductor laser production process, the firms were able to develop a true green semiconductor laser with an optical output power of more than 100mW at a wavelength of 530nm. Changes in the process included structural design, crystal growth, wafer processing, and electrode configuration. This true green semiconductor laser diode is claimed to be highly reliable as it has a wall-plug efficiency of over 8%.
The development of the true green semiconductor laser diode completes the three basic colours of the RGB laser light sources. Sumitomo Electric and Sony anticipate a wide variety of applications for this technology such as incorporation into advanced laser projectors with high luminosity and broad colour gamut, as well as compact, light, energy-efficient laser projectors. The device was grown using a semi-polar (20-21} GaN substrate. In this instance, the plane is tilted 75 degrees compared to the conventional GaN crystal c-plane. The semi-polar GaN substrate enables the sustainable production of homogenous indium-based active layers, leading to the successful growth of a high quality light-emitting layer.



▲ Semiconductor laser diode ▲ True green laser emitting

In GaN-based green light-emitting devices, luminous efficiency declines in the green region due to the internal field effects resulting from distortion in the crystal structure and the resultant internal polarisation. It is possible to suppress the internal field effects by adopting semi-polar GaN substrates. However, this isn't enough; it is also necessary to optimise the entire laser production process, and this is exactly what the joint venture did, building on Sony's knowledge.

Sumitomo Electric and Sony managed to reduce the operating current and voltage in the laser through the optimisation of the laser structure, impurity control in crystal, and minimisation of electrode resistance.

Cree reveals Verilog-A RF device models to accelerate GaN adoption

CREE is releasing a new suite of Verilog-A proprietary non-linear device models for its GaN RF devices, developed for use with leading RF design platforms from Agilent ADS and AWR Microwave Office. The new device models support more complex circuit simulations including modulation envelope analysis for use in the latest innovative broadband and multi-mode RF power amplifiers for 4G cellular telecommunications.

"The release of this new suite of device models enables RF design engineers to predict non-linear performance using harmonic balance, conduct robust transient analysis as well as use 'real-world' arbitrary modulation signals with envelope simulation for Cree's GaN HEMT devices," says Jim Milligan, director RF and microwave, Cree.

"The Verilog-A models, together with envelope simulators, allow designers to directly investigate higher efficiency circuit approaches, such as Doherty amplifiers, to improve adjacent channel power ratios, spectral re-growth and error vector magnitude, while assessing if amplifier performance meets spectral mask requirements for LTE deployments.

As these models also take advantage of multi-core processors, simulation times can be greatly reduced."

"Transient analysis allows insight into switched-mode power amplifier configurations that may also be driven directly from digital signals," adds Ray Pengelly, RF business development manager, Cree. "Combined with such approaches as Chireix out-phasing, unprecedented efficiencies of greater than 70 percent have been demonstrated."

IQE to buy RFMD MBE manufacturing unit

IQE PLC. has signed a multi-faceted agreement to acquire the entire in-house MBE epi-wafer manufacturing unit of RFMD. The plant contains 16 operational MBE tools. The firm has also secured a seven year wafer supply agreement for exclusive provision of all of RFMD's MBE wafers and for provision of a majority of RFMD's MOCVD wafer requirements.

IQE says this puts it in a powerful position in CPV market with up to $35 million revenue capacity for CPV wafers. The consideration is effectively funded through future wafer discounts.

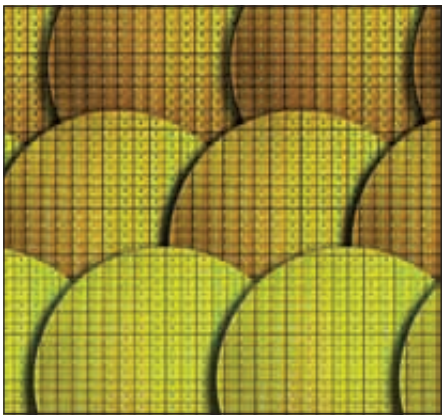
Drew Nelson, President and CEO of IQE, comments, " This landmark agreement with RFMD, one of the true global leaders in the wireless semiconductor industry, provides us with a significant step up in our manufacturing capacity, bringing substantial financial and scale benefits to the Group. This is a clear win-win for both organisations."

"The deal secures IQE world class epi-wafer production assets and staff, together with a long term wafer supply agreement, further strengthening our leadership position in the supply of wafers to the global wireless industry," he continues.

"The spare capacity currently existing within the transferred facilities will be applied to the manufacture of CPV solar wafers, enabling IQE to rapidly build a global leadership position in the supply of wafers for the burgeoning CPV sector as a result of our previously announced agreement and exclusive supply contract with CPV technology partner Solar Junction," concludes Nelson.

The assets being transferred to IQE include a fully fitted clean room of over 90,000 square foot, 16 MBE manufacturing systems and equipment, all housed in a 135,000 square foot stand-alone building in Greensboro, North Carolina. The value of the transferred assets is approximately $27 million. The local management and employees for the unit, consisting of 70 people will also be transferred directly to IQE.

There will be no upfront cash outlay for the transfer of the assets, resulting in no IQE



shareholder dilution. In exchange for the transfer of the assets, the parties have agreed to a long term wafer supply agreement with a minimum purchase commitment of $55 million over the first two years, whereby IQE will supply all MBE wafer requirements and a majority of RFMD's MOCVD wafer requirements under a discounted pricing arrangement.

The transaction will result in major enhancements across all key Group activities, particularly in our products for the wireless sector through increased purchasing power and greater manufacturing efficiencies.

IQE intends to use unallocated capacity from this facility to rapidly accelerate its wafer supply to meet the dramatically growing demand for CPV Solar products in relation to the technology transfer and exclusive wafer supply agreement with Solar Junction, announced earlier this year. This is expected to allow the wafer production of solar products of up to $35 million annually without the need for significant up-front capital expenditures by IQE.

The transaction will be immediately revenue and earnings enhancing to IQE, whilst free cash flow generation will reflect the discounted wafer pricing agreed between the parties.

Similarly, RFMD expects the outsourced wafer supply model to improve its operating performance by lowering its manufacturing costs, improving its return on invested capital, and supporting more predictable financial results.

SemiSouth doubles current rating of SiC power diodes to 10A

SEMISOUTH LABORATORIES, a developer of SiC transistor technology for high-power, high-efficiency, harsh-environment power management and conversion applications, has doubled the current rating of its DPAK-packaged SiC diodes from 5A to 10A.

The 1200V/10A SDB10S120 features a positive temperature coefficient for ease of paralleling, and temperature independent switching behavior. Maximum operating temperature is 175^0C.

The devices also exhibit zero forward and reverse recovery current. Total capacitive charge is 40nC. The true two lead DPAK (TO-252-2L) package has a mounted footprint (nominal) of 9.8 x 6.6mm and measures just 2.29mm high.

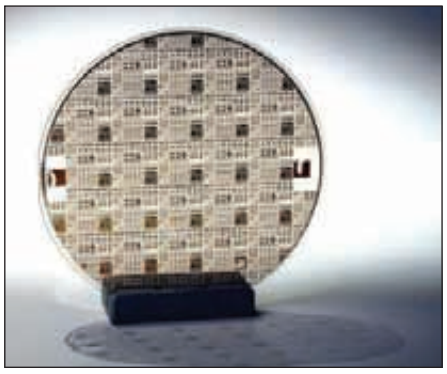
SemiSouth's Senior Vice President of Sales & Marketing, Dieter Liesabeths explains, "By again extending our leadership position in silicon carbide with these new 1200V/10A diodes we are enabling manufacturers of products such as solar inverters, SMPS, induction heaters, UPS and motor drives – and well as anyone building PFC circuits – to benefit from increased performance and reduced space."

NXP GaN development

RECOGNISED as a compelling alternative to silicon for many RF applications, GaN technology has generated significant industry interest due to its performance advantage.

However, this material has faced significant challenges related to cost but according to NXP, this may be a thing of the past. Core to that vision is the concept of "mainstream GaN" – bringing economies of scale and over 30 years of experience in RF power transistors to enable innovation and a secure, reliable supply chain for RF GaN products.

"SINCE announcing our commitment to 'mainstream GaN' last year, we've received a great deal of interest in our GaN offerings and have worked intensively with a handful of key customers to refine our first-generation GaN portfolio," says Mark Murphy, director of marketing, RF power product line, NXP Semiconductors. "By offering our customers a choice between high-performance GaN and LDMOS, we're in the unique position of being able to offer unbiased choices for fully optimised designs, depending on the specific requirements of each application."



NXP currently offers engineering samples of its first-generation GaN products, including the CLF1G0035-50 and CLF1G0035-100 amplifiers for 50W and 100W broadband applications. Based on a 0.5μm gate-length technology developed in collaboration with the Fraunhofer IAF Institute in Freiburg, as well as United Monolithic Semiconductors (UMS) in Ulm, Germany. NXP's collaboration with UMS and Fraunhofer IAF Institute establishes a Europe-based supply chain for GaN technology. NXP will be ramping up for volume production and offering engineering samples of additional amplifiers in Q3 and Q4.

2GHz power amplifier for communications

MITSUBISHI ELECTRIC has developed a prototype high-output, high-efficiency 2GHz power amplifier for mobile communications base stations. The amplifier, which features a GaN transistor on a silicon substrate instead of more costly SiC, achieves a conversion efficiency rating of 70%. This, says the firm, is unprecedented among 2GHz power amplifiers with outputs of 150W or higher.

The amplifier is expected to lead to the development of smaller and more power-efficient base station transmitters. The installation of such equipment in tighter spaces will help expand wireless network coverage to accommodate increasing wireless traffic due to smartphone proliferation.

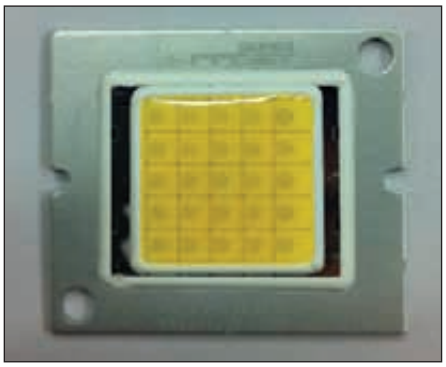
While amplifiers that use GaN transistors consume less power and have a higher output than amplifiers made with silicon transistors, they typically require a more robust substrate made SiC, which elevates the cost. Initial efforts to develop a GaN transistor using a silicon substrate were hampered by deformation between the GaN layer and Si substrate, which led to increased loss and decreased power conversion efficiency. Eventually the company designed a high-performance transistor by optimising the GaN crystal structure and inserting a buffer layer between the GaN layer and Si substrate.

Could this buffer be aluminium nitride?

Mitsubishi has remained tight-lipped about this but it is known from literature that using this material as a buffer layer can minimise wafer bow and strain in the full structure of GaN-on silicon devices.

Mitsubishi Electric's new GaN power amplifiers made with cheap silicon substrates achieve a power conversion efficiency of 70% at 2.1GHz, largely improving upon the 58% conversion efficiency of silicon transistor amplifiers currently available commercially.

Silicon substrate LED arrays delivering best thermal dissipation performance



KOREAN spin-off, Daewon Innost has revealed the "Glaxum" LED Array family of Chip-On Board modules. Using proprietary Nano-Pore Silicon Substrate (NPSS) technology, Glaxum arrays are claimed to provide the industry's best thermal dissipation performance with thermal impedance of only 0.41^{0}C / W. They are built using some of the highest efficacy, commercially available 1 WLED chips.

Daewon Innost developed the NPSS technology for LED modules specifically to provide the best thermal dissipation performance available today.

The LED substrate is created by applying semiconductor lithography to silicon wafers allowing for fine pitch interconnection between GaN LED chips, providing a pitch spacing of 50 μm as compared to over 300 μm with current Metal Core Printed Circuit Board (MCPCB). NPSS offers several advantages over MCPCB including superior thermal performance, higher levels of integration, and favourable scaling which will offer lower system costs as power levels increase.

"We are delighted with the test results of our LED modules as independently tested by a leading LED chip supplier. The results demonstrate that we have surpassed the thermal performance of the best performing chip on board (COB) technology to date," says Sungyuk 'Stephen' Won, CEO of Daewon Innost.

"Our Glaxum module runs over 12 degrees centigrade cooler than the previous top performing COB module. The industry rule of thumb is that each degree centigrade you can lower operating temperature translates to an extra 1000 hours of lifetime, so our cooler temperatures will provide longer life for LED arrays."

"Our business success directly depends on the reliability of our products, and thermal performance is critical for lumen maintenance. AlterLume sees the introduction of Daewon Innost's NPSS array packages as a seminal moment in LED lighting technology, and we are proud to be part of its advance in both technology improvements and cost reduction," concludes Brent.

Lattice Power first to volume production of high-power GaN-on-Si LEDs

LATTICE POWER CORPORATION has announced the start of volume production of its new generation GaN-based high powered LEDs on silicon substrates.

Lattice Power claims to be the first and only company in volume production of GaN-on-Silicon LED chips, with products that are comparable to high-end chips that rely on conventional sapphire substrates.

Operating at a current of 350mA, the 45 mm product is capable of producing 130 lumen cool white with an efficiency of 120 lumens for each watt consumed. What's more, silicon substrates are readily available in larger diameters and come at a fraction of the cost of sapphire substrates resulting in substantial cost reductions for downstream manufacturers.

Twenty strategic customers have received the LEDs and will incorporate them into indoor and outdoor lighting applications.

Lattice Power's silicon LED series encompasses four different chip sizes. Chip power ranges from 0.5W to 2W.

Lattice Power has always invested heavily in research and development in silicon substrate-based LED technology. The commercialisation of its silicon substrate based power chip series represents a second milestone for Lattice Power after the launch and volume production of its smaller size silicon substrate-based LED chips used in display and signage.

Using GaN-on-Silicon technology to make commercial grade LEDs in the United States and Europe has shown promising laboratory results.

While moving towards mass production, Lattice Power says it has filed more than 200 innovative international and domestic patents in this field.

"Lattice Power not only has the state-of-the-art silicon substrate-based LED technology, but also a world class technical and management team," says Sonny Wu, the managing director of GSR Ventures and chairman of Lattice Power. "With the big growth of solid state lighting and Lattice Power's introduction of high power LED product family into the lighting market, the company has once again proven its cutting-edge development and manufacturing capabilities. I'm highly confident that Lattice Power will grow into a world class solid state lighting company."

"Since its birth, Lattice Power has focused on high efficiency, low cost and high reliability LEDs on silicon. To get to where it is now, Lattice Power has faced lots of hurdles and challenges and overcome many obstacles and heart-breaks," adds Wang Min, the co-founder and CEO of Lattice Power. "But we have persevered and gained enormous traction with customers. Our silicon-based LED technology will finally open the door for LED bulbs to be used in millions of households."

Leading industry experts now predict that future LED chip cost savings could be as much as 70% greater than with the current mainstream products when manufactured on larger diameter silicon substrates.

Lattice Power is actively working on 150mm GaN-on-silicon technology and is expecting to transfer its production to even larger diameter silicon substrates in 2013.

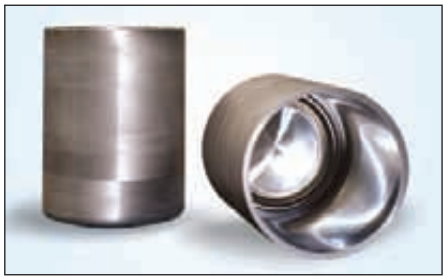
Super smooth sapphire growth

PLANSEE says its new tungsten crucibles make growing sapphire in a crucible much easier. The firm says their very smooth surface gives the crucibles a longer service life and reduces costs.

Ultra-pure sapphire is used in the production of LEDs. The Kyropoulos method, which involves melting a sapphire crystal in a heat-resistant crucible made from molybdenum or tungsten, is in widespread use. One particularly critical stage during this production process is when the sapphire crystal is extracted from the crucible.

The easier it is to release the sapphire from the crucible, the greater the yield and quality of the sapphire. If the surface of the crucible is too rough, the sapphire cannot be released or can only be partially released from the wall of the crucible. This results in cracks and faults in the crystal. Not only that, the crucible itself is also damaged in the process and has to be reworked or replaced earlier than planned. A fully automated manufacturing process coupled with more than 90 years of experience in the field of powder metallurgy allow Plansee to exercise precise control over the material properties of refractory metals such as tungsten and molybdenum.

In order to reduce the costs of sapphire growth, the materials experts developed a



special pressed-sintered tungsten crucible with an ultra-smooth surface. With its surface roughness of less than 0.8 μm, sapphire growth is now a smooth operation: The sapphire can be extracted from the crucible without difficulty and without damaging the surface of the crucible.

For sapphire manufacturers, this results in less complex and expensive reworking of the surface of the crucible. Plansee says the cycles run smoothly and deliver high-quality ingots. What's more, the smooth surface is less susceptible to corrosion caused by the aggressive melted sapphire. This increases the service life of the reusable tungsten crucibles.

Plansee's tungsten crucibles also score well in terms of density. You may wonder why is this important. Crucibles with a low density and a large number of porous areas can shrink under the high process temperatures. This means that they become denser in use and can thus become seriously deformed or even break.

The company has fine tuned its sintering process for the crucibles. Sintering is performed at very high temperatures and a uniform temperature distribution. This gives the tungsten crucibles a very high material density of 93 % coupled with an extremely homogeneous density distribution. Even under high temperatures and rapid changes of temperature, the crucible is guaranteed to retain its shape.

So what about purity? Contaminants in the plant components can be transferred to the sapphire in a way that is detrimental to its quality. Iron, titanium and chromium are particularly critical in this respect.

To ensure that only flawless sapphire comes out of the crucible, Plansee has adopted an ultra-clean process. Everything from the metal powder to the finished crucibles is manufactured in-house. This allows every step to be carefully monitored, and the resulting crucibles have a purity of over 99.97 %.

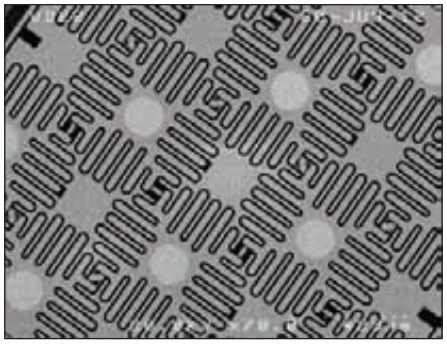
Nowadays, crucibles large enough for 35 kg up to 100 kg of sapphire are commonplace. And yet the industry is already considering a new generation for up to 200 kg of sapphire. Plansee says its extremely large sintering plants and processing machines mean that it is already geared up to take this step.

GaN Systems beats own development targets

GaN SYSTEMS has closed a Series B financing round with existing investors Chrysalix Energy Venture Capital and RockPort Capital, two cleantech venture capital firms. This funding comes six months after the closing of GaN Systems' Series A round.

"This significant financing round is a stamp of approval from our existing investors which validates our engineering excellence," says Girvan Patterson, CEO of GaN Systems. "It enables us now to accelerate commercialisation of the gallium nitride power devices that we have developed on our breakthrough island technology platform.

Mike Sherman, Managing Director at Chrysalix, adds, "Since the Company's Series A round, the market momentum for



GaN as a credible alternative to silicon for power devices has grown significantly, with devices becoming mainstream faster than we anticipated. This means commercial reality is closer and more tangible than expected.

GaN Systems' gallium nitride transistors are targeted at the next generation of highly efficient power conversion applications, the fastest growing segment of the $14 billion-a-year power devices market. This includes high growth applications such as solar inverters, server farms, and hybrid vehicles. Beyond the inherent advantages of GaN in efficiency, speed and temperature, GaN Systems' Cool Switching technology enables extremely compact, low cost designs. It also provides a seamless transition to foundry-independent GaN-on-silicon fabrication for flexible access to high volume production resources.

"With these advantages, GaN Systems is uniquely positioned to drive broad adoption of gallium nitride as a superior alternative to conventional silicon power devices," remarks Daniel Hullah, Partner at RockPort Capital.

NXP enhance GPS signal reception

NXP SEMICONDUCTORS N.V. has unveiled the BGU8006 low-noise amplifier. The firm reckons it is the tiniest GPS LNA on the market today designed for very small portable devices.

Available in a compact WLCSP (wafer-level chip-scale package), measuring just 0.65 x 0.44 x 0.2mm, the latest GPS LNAs require only two external components, saving 38 percent in PCB space compared to what NXP says is the smallest solution on the market today.

Also featuring an extremely low noise figure of 0.60 dB, the LNAs offer superb reception for weak GPS signals by dynamically suppressing strong cellular and WLAN transmit signals.

"Smartphones, tablets, personal navigation devices and automotive telematics applications all suffer from communication delays when network reception is poor, and have to wait for data to refresh as the GPS searches for satellite signal. Our new BGU8006 LNA helps to maintain optimal GPS signal reception for as long as possible – on a chip that is so small, it isn't even visible to the naked eye," explains Erick Olsen, marketing director, RF small signal product line, NXP Semiconductors. "As GPS functionality becomes ubiquitous, the ability to deliver better accuracy and faster Time to First Fix will vastly improve user experience and enable operators to provide more sophisticated Location Based Services down the line," he continues.

The new BGU8006 LNA uses adaptive biasing techniques – enabled by NXP's QuBIC4Xi SiGe:C BiCMOS process technology – to instantly detect any output power from jammers, and compensate by temporarily increasing the current. Adaptive biasing dynamically suppresses strong cellular, WLAN and Bluetooth signals, which can drive typical GPS LNAs into compression, lowering gain, generating intermodulation and harmonics that can overpower weak signals, and causing poor GPS reception. With the BGU8006, adaptive biasing improves linearity with a 10 dB better IP3 under -40 to -20 dBm jamming conditions and provides effective GPS output with jammer power up to -15 dBm.

The BGU8006 LNA uses wafer-level chip-scale package (WLCSP) technology, which is ideal for space-constrained applications. WLCSP minimises parasitic inductance because there are no leads, bond wires or interposer connections, and optimises package size, cost and thermal characteristics. In addition to the BGU8006, NXP also offers the BGU8007 LNA in a 1.45 x 1.0 x 0.5 mm 6-pin leadless SOT886 package. Both LNAs require only one external matching inductor and one external decoupling capacitor for easy design-in and savings in component costs and PCB area.

NXP's BGU800x series LNAs are ideally suited for a wide range of applications using GPS technology.

Shifting landscapes in the GaAs industry

Swings in market share for the leading GaAs chipmakers, a rise in outsourcing, the introduction of new BiHEMT and HBT processes and bleak prospects for pHEMTs featured at this year's CS Mantech. **Richard Stevenson reports.**

It's tricky to accurately describe the mood at this year's CS Mantech. Quiet optimism is probably the best phrase to capture the feeling of the delegates that made their way to Boston between 23 and 26 April. They knew that the incredibly strong, recent growth in GaAs device sales is over, but they could take comfort from the steady, slight increase in shipments that should continue for the next few years. Figures supporting these views were provided by Eric Higham from the Newton, Massachusetts' office of Strategy Analytics. According to him, the GaAs device market leapt in value by a staggering 35 percent in 2010 to almost $5 billion. Such a large hike in global sales of GaAs chips has not been witnessed since 2000, and back then trouble followed. Revenues tumbled when the Internet bubble burst at the turn of the millennium, excess inventory

went through the roof and it took until 2008 for global GaAs device revenues to return to similar levels to those of the 2000 peak.

This time round, however, boom is unlikely to be followed by bust. Healthy handset sales that account for the majority of GaAs device revenues are tipped to rise, and the content of this class of chip in the phones is predicted to increase. These conditions have led Higham and his colleagues to produce a preliminary forecast that suggests that GaAs device revenues will increase at a compound annual growth rate of 6 percent through to 2015 from a starting point of $5.2 billion in 2011.

For many years, RFMD and Skyworks have been vying for the top spot for GaAs device revenues. Previous data from Strategy Analytics suggested that Skyworks pushed ahead in 2008, and recent figures revealed by Higham in his talk indicate that this chipmaker now has a significant lead. According to him, in 2010 Skyworks had 19.1 percent of the market, compared to 16.3 percent for RFMD (see Figure 1). Fast-forward to last year and there are significant changes on this leadership board. Skyworks has surged to 22 percent, while TriQuint has overtaken RFMD, grabbing a 15.1 percent share of the market, compared to just 12.4 percent for the Greensboro headquartered outfit. During his talk, Higham also highlighted the growing trend for outsourcing epiwafer production. In 2011, this market, which is now dominated by WIN Semiconductors, grew to $600 million.

Within the handset sector, by far the biggest change has been the phenomenal growth of smartphone sales. In 2010 and in 201, shipment of these advanced handsets leapt by 68 percent, with quarter-over-quarter changes varying significantly.

“In 2011, it was really 80 percent growth in the first half, dropping to only 40 percent in the second half,” explained Higham. Although such rapid growth is unsustainable, Higham expects double-digit percentage gains in smartphone shipments to continue through to 2014. A year after that, these sophisticated handsets will account for more than half of all mobile phone sales. Wireless infrastructure offers another opportunity for the growth of GaAs device sales. Higham and his colleagues have tracked a rise in the deployment of micro- and pico-cells, which have transmit powers ranging from 0.25 W to 10 W. Silicon LDMOS dominates the traditional base station market, which uses transmitters with an output of 40 W to 80 W. However, at

lower powers, Higham claims that GaAs devices are more attractive.

Cramming it all in

President and CEO of Skyworks, David Aldrich, offered his perspective on the handset market at CS Mantech. He agrees with Higham that the average GaAs content in handsets is increasing - a 2G 'feature' phone can have less than $1 of GaAs content, while a smartphone can feature more than $10 of GaAs chips. According to Aldrich, increasing uptake of the latter class of handset is driving up the total addressable market for the RF content at a rate of 15 percent per year.

This growth in the market is not fueling any convergence in standards. "Each baseband partner has a different view of what they want the front-end to look like," explained Aldrich.

Handset makers, meanwhile, want what they've always wanted: Products with more functions that take up smaller footprints. And they seem to have been getting their wish, according to figures presented by Aldrich and produced by Prismark Partners. The PA footprint for a 3G handset has shrunk by a compound annual rate of 13 percent since it was launched 8 years' ago, while the size of the based band has diminished even faster – falling by 16 percent per year.

Aldrich argued that one of the products that we will see more and more in smartphones is the multi-band, multi-mode PA. Skyworks' has developed one of these that can work with up to 17 bands and support new features, such as envelope tracking. This technology, which can boost battery life, involves the application of dynamic adjustments to the voltage supplied to the final RF stage of a power transistor, so that it tracks the signal envelope. Battery power savings of 200 mW to 500 mW are expected, plus lower heat dissipation and improved 3G/4G coverage per base station.

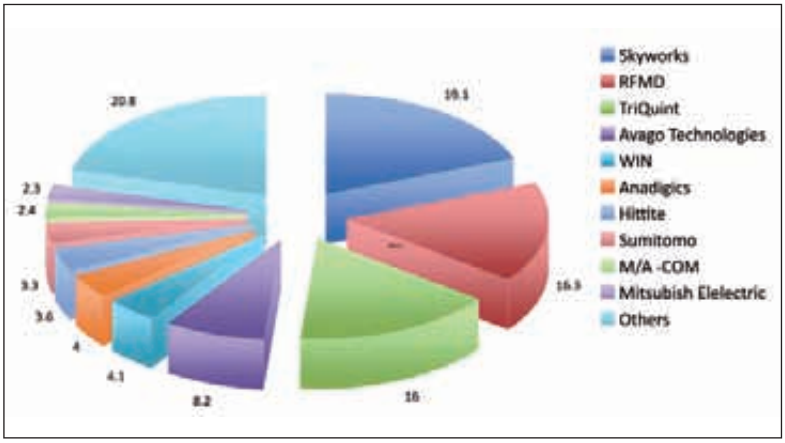


Figure 1. Data produced by Strategy Analytics shows that the three big US GaAs chipmakers – Skyworks, RFMD and TriQuint – had more than half of the total market in 2010, which was valued at $5.45 billion, when revenue from foundries is included

Turbo-charging transistors

Taiwanese foundry WIN Semiconductors detailed two new processes at CS Mantech: One for making rugged InGaP/GaAs HBTs for multi-mode, multi-band PAs, and another for producing Bi-HEMTs that feature a low on-resistance pHEMT and are suitable for LTE applications.

The multi-mode, multi-band PAs that WIN is developing will target next-generation handsets and tablets, which can support various different wireless standards. They will work with the higher data rates promised by 3G WCDMA/HSPA and 4G LTE, while also being compatible with existing 2G GSM and 2.5 G GPRS/EDGE standards. In addition, they will feature rugged HBTs that can withstand the stresses associated with high-voltage, standing-wave-ratio mismatches.

WIN has improved the ruggedness of its HBTs by tweaking the collector design so that it combines a high off-state breakdown voltage with a significant on-state breakdown voltage. To provide better protection from moisture and vibration, SiN films have replaced thinner ones made from polyimide.

An additional change has been a switch from a conventional layout, where the metal finger surrounds the emitter mesa, to a configuration involving the removal of outer base metal fingers. This trims base-collector capacitance by shrinking the base mesa area and increasing power gain (see Figure 2).
Tests reveal the benefits of all these changes. Refinements to the collector did not impact power gain or power-added-efficiency, but enabled a 50 percent improvement in the collector-emitter voltage during a ruggedness evaluation (the voltage standing wave ratio was fixed at 10:1 for 360 degree all-phase rotation, and the collector-emitter voltage was increased from 3.6 V to device failure – 7.5 V for a HBT made with the new process, compared to 5 V for a device made with the standard approach). Meanwhile, the new architecture with a reduced base-finger-area led to a slightly higher

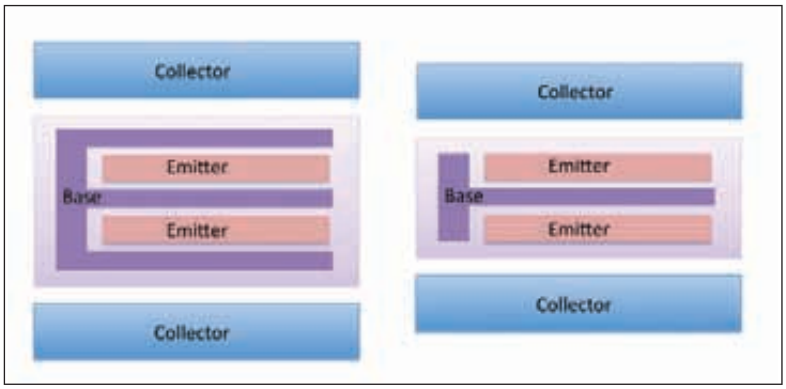


Figure 2. WIN can increase the power gain produced by its HBT by removing the outer base metal fingers, a step that reduces base-collector capacitance and trims base mesa area. The traditional HBT architecture is on the left; the advanced, higher-power version is on the right

gain at frequencies below 3 GHz, the spectral range used for handsets.

Better BiHEMTs

WIN's latest BiHEMT process, which unites pHEMTs and HBTs, is designed for a new generation of PAs that have two states: A high power mode; plus a low power mode, the most common operating condition for the handset. The power-added-efficiency of the PA can be improved by optimizing performance in both modes.

The Taiwanese pure-play foundry's two commercially released BiHEMT processes, which are known as H2W technologies, produce pHEMTs with a significantly higher insertion loss than stand-alone equivalents. This inferiority must be addressed in order to capture the market for two-power-state PAs – a high insertion loss can drag down the amplifier's power-added-efficiency in low-power-mode operation, and in turn, prevent the H2W process from fulfilling the high-linearity demands in emerging standards, such as 4G and LTE. To trim insertion losses, engineers at WIN have developed a H2W process that employs the company's latest BiHEMT structure and its HBT4 process, and uses these in combination with a signal gate recess process and an optimized pHEMT epi-structure design. Like the improved standalone HBT previously described, the new process features a thick SiN layer in the place of a thinner polyimide film, plus the opportunity to define multiple gates, which can be used for high-isolation, high-linearity switch applications.

Characteristics for the HBT part of the BiHEMT include a typical turn-on voltage of 1.27 V, a DC current gain of 130, and breakdown voltages of 28 V and 14 V between base-and-collector, and emitter-and-collector, respectively. Meanwhile, the pHEMT has an on-resistance of 0.95 Ω.mm, 50 percent less than that produced by the previous H2W process. To evaluate RF switch performance, WIN's engineers have constructed a full periphery design featuring a single-gate, 9 μm by 125 μm device. Insertion loss was just 0.1 dB, 0.05 dB lower than that for the original H2W process.

pHEMT's bleak future

A rump session discussing the future of pHEMTs failed to find any silver lining within a looming black cloud. Everyone at that gatering believes that switches in handsets will be increasingly made from some form of advanced silicon, rather than GaAs, and nothing can be done to stop this. Although GaAs switches offer the best levels of performance, they are more expensive, and the current trend towards higher throw switches plays into the hands of silicon-on-insulator devices.

New opportunities for pHEMTs were considered during this discussion, but none seemed tremendously promising. For example, pHEMTs could be used to make WiFi products, but they would have to compete with silicon variants – and in battles between the compounds and silicon, the latter tends to come out on top. It's a similar story in the automotive radar market, where pHEMTs have been used in reasonable volumes to make transceivers operating at 77 GHz, but are likely to loose market share to SiGe-based chips offering higher levels of integration.

Fortunately, handset manufacturers will not stop making models that use pHEMT switches overnight, so sales from these transistors will slowly decline over several years. In many cases, these chipmakers also have HBT processes, so hopefully any revenue losses incurred can be compensated by growth in power amplifier sales. Over the next few years, growing sales of products made with this class of transistor seem a sure bet.

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Lifting limitations in photovoltaics

Traditional triple-junction photovoltaics are marred by brittleness, inflexibility and an efficiency that is limited by the germanium cell. To address all of these issues MicroLink has developed a whole-wafer, high-volume epitaxial lift-off technique for producing ultra-thin cells on GaAs. **Richard Stevenson** reports.

Developers of multi-junction solar cells tend to try and improve device performance by inserting new materials to boost efficiency. But there are many other ways to make the cells more appealing, such as trimming weight, increasing robustness, cutting material costs and enhancing flexibility.

One company that has developed a technology that allows high-efficiency cells to excel in all these regards is MicroLink Devices, which is based in Niles, a northern suburb of Chicago, Illinois. Founded in 2000, MicroLink is best known for its MOCVD growth of epitaxial wafers for handsets and other wireless products, but over the last five years it has also been developing a wafer-scale, epitaxial lift-off process for manufacturing ultra-light, photovltaics with one, two or three cells.

Left: MicroLink's solar cell arrays, which are made with its proprietary epitaxial lift-off technology, are an attractive option for powering electric unmanned aerial vehicles, thanks to their high efficiency, low weight and excellent flexibility. With an aerial mass density of less than 350 g/m^2 and a power density exceeding 250 W/m^2, these arrays have doubled the endurance of the Raven. This small, hand-launched, remote-controlled aerial vehicle that is powered by a lithium ion battery can fly at altitudes of 10,000 feet to 15,000 feet and reach speeds of 60 miles per hour

The performance of these devices, which are mounted on a flexible metal backing, is very promising. Measurements replicating the sun's spectrum yield efficiencies for MicroLink's best 1 cm^2 cells of 31 percent in space (AM0) and 33.9 percent on the ground (AM1.5). Scale the cell size to 20 cm^2, and efficiencies fall by just one percentage point. These high-efficiencies, combined with an incredibly low cell weight, make these photovoltaics attractive candidates for powering satellites. These cells are also flexible, so they can wrap around the topside of the wings of battery-powered, unmanned aerial vehicles (UAVs), increasing their endurance.

One organization starting to look at doing just this is the US Air Force Research Laboratory, and it is funding a project involving MicroLink. If this project has widespread success, it could do far more than just aiding the military – those working in the real-estate sector, for example, view UAVs as an attractive approach to surveying vast areas of land.

MicroLink's cells could also be a competitive product for the terrestrial concentrating market, thanks to relatively low production costs that stem from multiple re-use of GaAs substrates, which just require a polish before they re-enter the MOCVD chamber. Using re-polished substrates makes no impact on device performance. "The substrate is a considerable fraction of the bill of materials for the device," explains Chris Youtsey, Fab Director at MicroLink. "The limitations on how many times you can re-use the substrate come down to how much material you remove from the polishing and [the frequency of] breakages."

Youtsey claims that a reasonable goal is to re-polish the wafer ten times. He points out that polishing removes as little as 10 μm, and says that thinning a GaAs substrate by 100 μm or so should have no impact on the deposition of a high-quality epitaxial structure. Even higher rates of substrate re-use are theoretically possible, but they produce ever diminishing returns. Enter this regime and the rewards do not justify the efforts.

Peeling it off

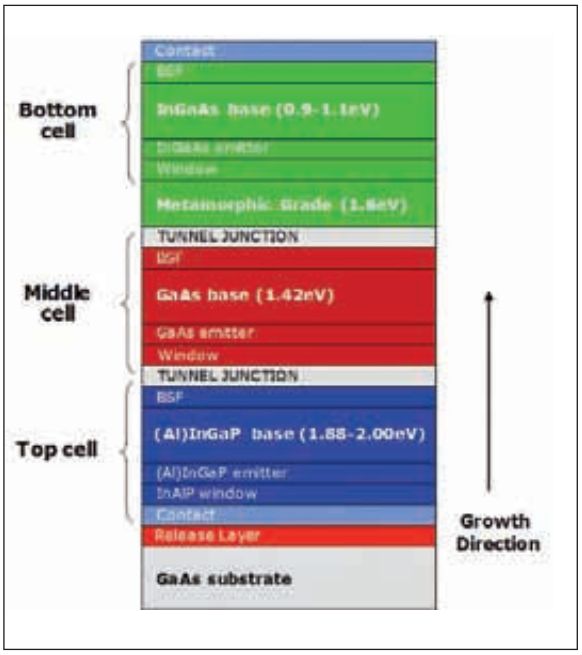
The epitaxial lift-off technology that MicroLink uses is certainly not new. Reports of such efforts date back to 1978, when a Japanese team from Tokyo Institute of Technology published a paper on the fabrication of high-efficiency GaAs solar cells with a 'peeled film' technology. Progress in the 1980s and 1990s included efforts by Eli Yablonovitch from Bell Communications Research, who revealed the extreme etching selectivity of AlAs compared to GaAs. And further strides on epitaxial lift-off technology have been made during the last 15 years, with John Schermer's group from Radboud University reaching a new level of understanding of the process, and devising new ways to increase the etch rate.

However, epitaxial lift-off is still an intrinsically slow process, according to Youtsey: "It's not seconds or minutes – it's hours. So if you want to get high throughput, you have do it in batches."

Switching to batch processing is one of the two big breakthroughs in epitaxial lift-off technology made by MicroLink Devices, whose team has a background in high-volume GaAs fabs, including TriQuint. Running in pilot product, MicroLink processed 1400 4-inch wafers in 2011, and it could increase this throughput substantially – each etching bath that it uses is capable of processing 1500 wafers per month. Youtsey says that another significant breakthrough made by his team is the simplification of the process – no longer are weights used to separate substrates and epilayers: "Our approach uses a proprietary support layer, which allows us to efficiently batch process."

At MicroLink, photovoltaic production begins with MOCVD growth of an inverted metamorphic structure featuring InGaP, GaAs and InGaAs cells. This epitaxial stack contains a 5 nm-thick AlAs layer sandwiched between the substrate and triple-junction cell.

After attaching a thin, flexible metal carrier layer to the uppermost epitaxial layer, the resulting composite is immersed in a bath of concentrated hydrofluoric acid, which selectively dissolves the release layer – the etch



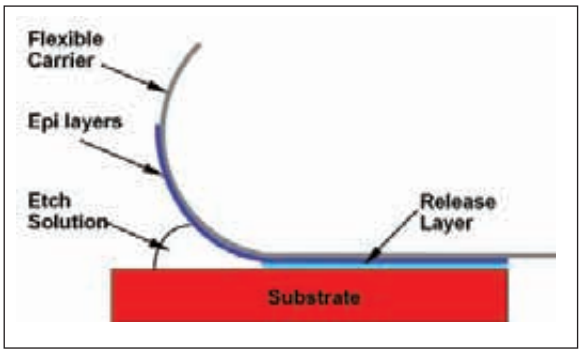
MicroLink forms its metamorphic cells on a GaAs substrate. Etching a sacrificial, AlAs layer about 5 nm-thick with hydrofluoric acid allows separation of substrate and epilayers

selectivity of AlAs relative to the GaAs epitaxial structure exceeds 10^5. After etching for 12 hours or so, the metal carrier and solar cell epilayers are completely separated from the GaAs substrate. Engineers at MicroLink mount these epitaxial lift-off foils to a temporary, rigid carrier, so that they can process the wafer into devices. This involves evaporation and lift-off of a metal ohmic contact, wet etch isolation, evaporation of an anti-reflection coating made from a bilayer dielectric stack, and dicing of the processed wafer into individual devices. Following that, the solar cells are removed from the temporary carrier.

Epitaxial lift-off does not degrade the material quality of the cells. Transmission electron microscopy images from the National Renewable Energy Laboratory fail to uncover any delamination, cracking, threading dislocations or voids in the cells. An absence of cracks and defects holds the key to the fabrication of cells with very large areas.

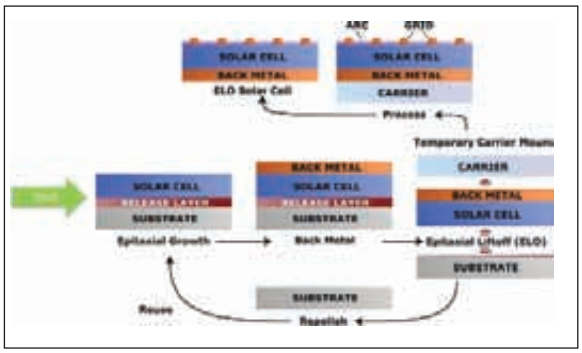
A better base

MicroLink's metamorphic structure features: An InGaAs bottom cell with a bandgap that can be tuned from 0.9 eV to 1.1 eV; a 1.42 eV GaAs middle cell; and an (Al)InGaP top cell with a bandgap that is adjustable from 1.88 eV to 2.00 eV. "I think that's pretty close to optimum," claims Youtsey. To evaluate the impact of re-polishing on device quality, engineers at Micolink have compared the efficiency of 1 cm^2 cells formed on 25 substrates that were initially pristine, and then re-polished once, twice, three and then four times. Their conclusion: The average cell efficiency on the three re-polished device populations is comparable to that of cells grown on original, prime GaAs substrates.



After a flexible metal carrier is attached to the solar cell epi-structure, the GaAs substrate is removed by etching in hydrofluoric acid

If these cells are to be used in space applications, they need to be able to withstand bombardment from various forms of radiation. Youtsey believes that the cells can meet this demand: "The radiation hardness of individual epitaxial lift-off junctions, such as InGaP, GaAs and InGaAs, follows the expected trends for these materials."



Processing begins with the growth of an AlAs release layer and a solar cell structure on a GaAs substrate. After etching in hydrofluoric acid the GaAs substrate is re-polished and used again, while the solar cell and back metal composite is temporarily bonded to a carrier wafer for device processing

Scaling cell size also appears to have no impact of device performance – typical conversion efficiencies of 29 percent were recorded for 1 cm^2 cells and 20 cm^2 equivalents, which were both measured at NASA Glenn using the AM0 spectrum.

Flexible solar sheets have been produced at MicroLink by interconnecting 30 large cells with silver-based foil ribbons and laminating the structure between transparent sheets to yield flexible solar sheets. The resulting composite is highly flexible, and can wrap around curved structures, such as the wings of solar-powered planes. One great attribute of this solar sheet is its incredibly high specific power, which exceeds 400 W/kg.

According to Youtsey, triple-junction germanium cells with a 150 μm thickness are at least four times as heavy: "From an application point of view, that is a big deal." In addition, cells formed on germanium substrate are very brittle. "You have to build a wafer fab to accommodate them," explains Youtsey.

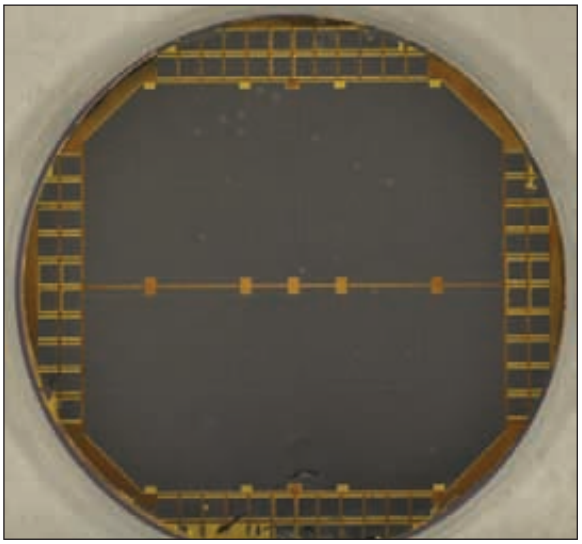
A 4-inch film produced by MicroLink's epitaxial lift-off process features two, 20 cm^2 solar cells on a thin, flexible metal backing

Bigger and better

MicroLink has also fabricated 61 cm^2 cells from 6-inch GaAs wafers. Part of the motivation behind producing such large cells is to demonstrate the quality of MicroLink's process. "But there is interest, in terms of panels assembly, in working with large cells: Fewer part counts, fewer interconnects," explains Youtsey.

Today, however, MicroLink's primary focus is not on making bigger and bigger cells. Instead, it is setting its sights on increasing efficiency and streamlining process flow. Success will simplify ramping to production volumes and it will also increase yield. To boost efficiency, efforts will focus on increasing the open-circuit voltage and fill factor. Improvements in material quality will underpin these programmes. Further efficiency gains could result from increasing the number of junctions to four or five, but Youtsey acknowledges that this step is not easy to execute in high-volume production.

MicroLink is currently in pilot production, and it plans to progress to full commercialisation within the next two years. When it hits that milestone, customers of multi-junction cells will have some head-scratching to do. Up until that point, selecting a device has been based on efficiency, reliability and price, but from then on factors such as weight, flexibility and robustness will come into the play.



Two 61 cm^2 triple-junction cells formed by applying MicroLink's epitaxial lift-off process to a 6-inch GaAs wafer

Thermophotovolatics

MicroLink's epitaxial lift-off process is an attractive approach for making any type of device that has a large proportion of its cost associated with that of the substrate. One such example is thermo-photovoltaics, devices built on InP substrates that convert heat into electricity. Reducing the number of InP substrates needed to make thermo-photovoltaics could lead to massive cost savings, because InP substrates are nearly an order of magnitude more expensive than GaAs equivalents.

Boosting battery life

Today's designers of cutting-edge phones face the same challenge that their predecessors wrestled with: extending the time between battery charging. To succeed now, these designers must build efficient front-end systems offering the high levels of linearity demanded by digital networks operating with complex coding schemes. There are many options for fulfilling these requirements, and they all have their pros and cons, argues **Chris Novak, General Manager of 3G/4G Solutions at RFMD.**

We are in the midst of a connectivity and mobility revolution. This is driving a dramatic change in communication technologies throughout the world, and the engineers that are responsible for networks and the development of mobile devices are facing tremendous technical challenges.

These challenges are spurred by soaring sales of hand-held smart devices, which are ramping up the number of high-speed data connections. According to Cisco, wireless data usage is going to increase at a compound annual growth rate of almost 80 percent through 2016, as more consumer use handheld devices for social networking and entertainment. This explosion of wireless traffic will be driven by the uptake of sleek-form-factor devices that combine seamless connections with an increase in time between charges.

To keep pace with this rocketing demand for data, smart devices and networks are migrating to broader frequency ranges, wider signal bandwidths and higher data rates. This is fuelling innovation in the RF front-end industry, with engineers developing new designs for making best use of the limited energy stored in the battery.

RF system challenges

Efforts to increase data rates and improve the network's spectral efficiency have included the introduction of new standards employing advanced coding techniques, such as orthogonal frequency-division multiplexing (OFDM). One of the downsides of these complex coding techniques is that the modulations can lead to a significantly increased variation in the amplitude of the modulated signal – this is needed to encode more information for each transmitted symbol (see Figure 1). In addition, improvements in spectral efficiency diminish the efficiency of the RF transmission system. This reduces in-use time for the mobile device, and also heats it up.

Increasing spectral efficiency is only going be part of the solution, due to the relentless pace of growth of wireless data. To help to meet this demand, additional frequency spectrum is being allocated to networks. However, these allocations to digital networks are haphazard. They are regulated by independent governments, and the decision makers are not concerned with designing a cost-effective global radio system. What is happening is that the frequency bands being given over to digital networks differ greatly from region to region. This uncoordinated approach means that smart devices have to cope with an increasing number of frequency bands of varying bandwidths – there are now more than 36 cellular transmit bands of

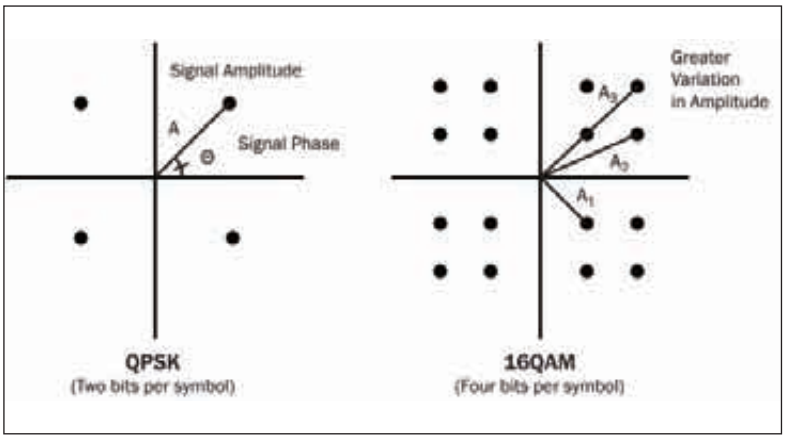


Figure 1. An example showing modulation constellations with increasing amplitude variation

various bandwidth, ranging from 695 MHz to 3800 MHz. Compounding this issue are the incremental, yet challenging, RF specifications for ensuring that digital networks can operate without interference with other wireless systems, such as public safety bands, global positioning systems, and wireless LAN (WiFi).

One of the demands that the latest digital network modulation schemes place on smart devices is the requirement for linear amplification. To ensure a high-quality wireless network, the RF transmit system must accurately and proportionally amplify the input signal – significant distortions in either phase or amplitude cannot be tolerated. Excessive distortion has two unwanted consequences: Data errors in the transmitted signal; and a spilling of the transmission energy into other bands, which results from modulation products. In the latter case, this leads to interference with other data devices.

In general, improvements to the spectral efficiency of the modulation scheme increase the crest factor or peak-to-average ratio (PAR) of the signal (see Figure 2). PA efficiency peaks when this amplifier is at or near its

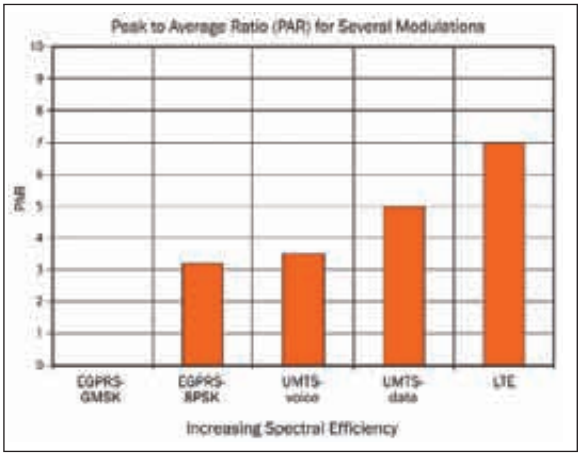


Figure 2. Increase in peak-to-average ratio (PAR) for common digital network modulation schemes

compression point (see Figure 3 for the compression curve and efficiency of a typical power amplifier). However, when PAR increases, the PA spends more time operating further from compression. In other words, efficiency is compromised to maintain sufficient linearity and ultimately preserve peak amplitudes.

Transmission: The big battery drainer

When smart devices are transmitting, especially at higher power levels, the power amplifier draws a great deal of energy from the battery. The time that the smart device can go between charging, which is also known as the battery life, is governed by the efficiency of the amplifier portion of the RF front-end. To extend battery life, engineers are developing amplifier front-end designs that excel in efficiency and linearity, so that the PA can operate closer to compression and thus hit higher efficiency.

There are several approaches for meeting these goals. One is pre-distortion – making the system compensate for PA non-linearities by applying inverse non-linearities to the amplifier's input signal, so that the PA operates closer to compression. Alternatively, one can use 'feed-forward', a technique based on correction of non-linearity by subtracting an estimate of the non-linearity at the PA output. Yet another option is 'feedback (Cartesian or Polar)': Detecting the output signal, comparing it to the desired input signal and correcting the input. And last but by no means least, there is 'envelope elimination and restoration' (EER). This involves amplification of a constant envelope signal featuring phase information, onto which is superimposed amplitude information produced by modulating the amplifier's power supply.

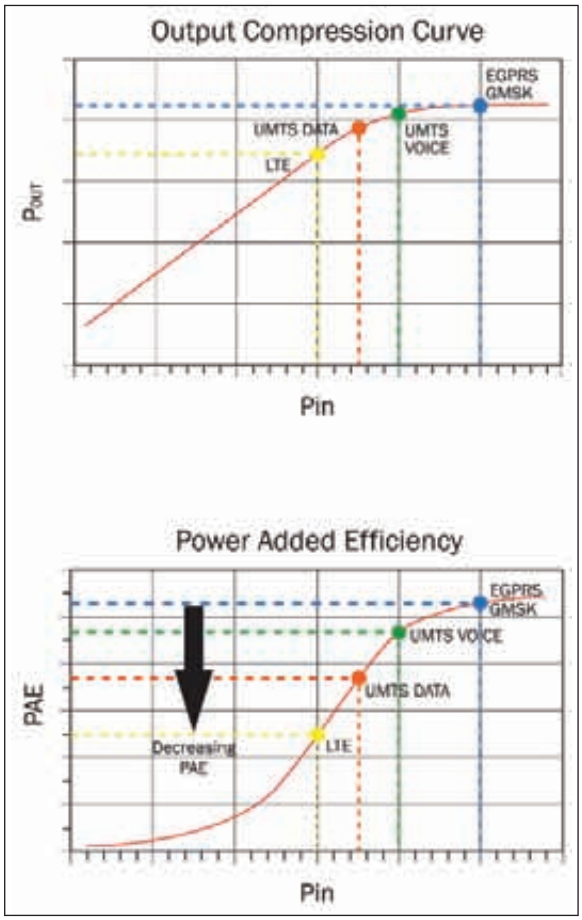


Figure 3. The compression curve and power-added efficiency (PAE) for a typical power amplifier showing the effect of greater PAR

At RF Micro Devices, which is headquartered in Greensboro, NC, we believe that envelope tracking (ET) – a variation of EER with additional back-off to guarantee linearity – is rapidly rising to the top as the most effective power optimization technology for higher power RF transmission. One of its greatest attributes is that it works well across a wide frequency range, a wide bandwidth and across multiple modulations. This makes it well suited to satisfying the needs of the global smart device market. However, it's worth noting that in some applications the best performance might result from a combination of technologies previously discussed (see Figure 4 for a graphic representation of relative efficiency improvements for several methods).

Throttling back

In modern digital networks, power control schemes reduce the total transmit power during the times when full power is not necessary. The benefits are not limited to saving energy, as this approach also minimizes unnecessary interference, leading to a higher system capacity. The key to working well in this type of network is to design the RF front-end for efficient transmission over a large dynamic range of output powers.
There are many ways to enhance RF efficiency over a large dynamic range. Two of the most obvious are to turn off the final PA stages when the power is low enough to be delivered by just the driver stages, and to trim the bias current at lower powers to cut current consumption. Alternatively, engineers can adopt a Doherty configuration, tuning the main amplifier to favourable (high) impedance at low power and turning on an auxiliary amplifier at higher powers to maintain correct impedance. Another option is to employ load manipulation techniques, such as 'chain matching' or 'load switching', with favourable impedances maintained over a wide power range through the switching in and out of matching elements. And there is also average power tracking (APT) or multi-state power management. With this approach, the PA is kept close to saturation by turning down the amplifier's power supply voltage when the average power falls.

In practice there are trade-offs in complexity, cost and benefit for all these techniques that can deliver efficiency enhancement over wide ranges of modulations, frequency bands, bandwidths, and output power requirements. However, we have seen a rise in the popularity of systems taking advantage of PA power management, such as DC-DC converters. Go down this route and a single converter technology can be cost-effectively applied across all the different PA

components and configurations needed to cover the required transmit bands and modulations (see Figure 5). Many alternatives are inferior, because they solve similar problems with techniques that potentially add to the cost and complexity of each component.

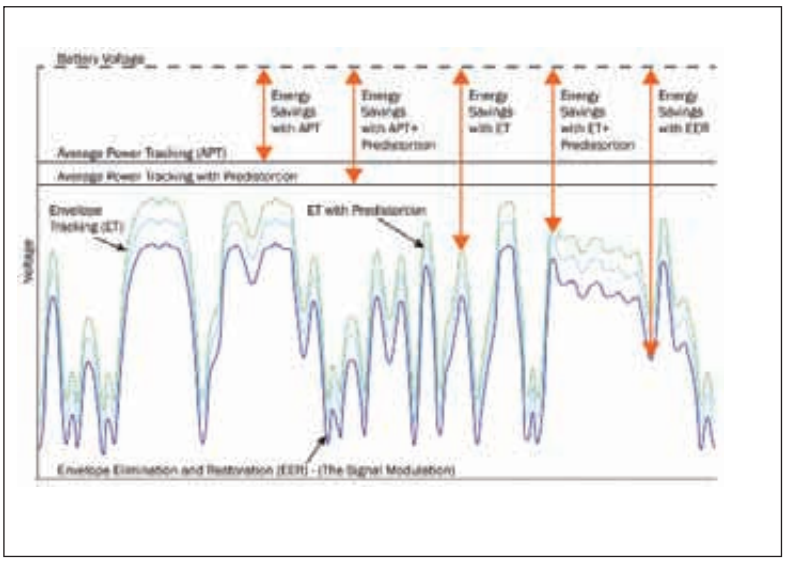
We can illustrate this point with a block diagram of an ET design that we have put together. (see Figure 5). Further improvements in high-power efficiency may result from adding pre-distortion – this could increase high-power efficiency by allowing the PA to operate closer to compression (see Figure 3 for an example of how this can increase system efficiency).

However, effective, high-bandwidth envelope tracking demands a DC-DC converter that is capable of delivering the rapid, accurate changes in voltage required to follow the envelope of high PAR modulations. Unfortunately, gains in PA efficiency resulting from this approach are offset by declines in the conversion efficiency of the ET DC-DC converter and the circuitry needed to rapidly follow the modulation envelope (operating at a wider bandwidth reduces the converter efficiency). The good news, however, is that the system 'up-lift' is favourable. In other words, the PA efficiency improvement, minus the 'cost' of the ET implementation circuitry, is beneficial rather than detrimental.

As transmit power is lowered, a point can be reached where the PA benefit is effectively cancelled by the conversion efficiency of the ET circuitry. When this happens, the efficiency enhancement method must be changed for optimum performance. Several options are available: Switching the system to an APT mode with greater DC-DC conversion efficiencies; adjusting PA bias, or using similar low-power efficiency enhancement techniques; or adopting optimum combinations of these techniques, which come together to ensure high-efficiency transmit operation over the full range of conditions.

Bringing it all together

We believe that these new generations of RF platforms will require closer co-ordination of transceiver, power management and power-amplifier blocks. These latest designs must also be capable of handling complex communication, as well as timing signals to ensure proper operation with the transceiver – there needs to be a seamless, well executed transition between the various efficiency enhancement techniques providing transmit operation over a wide range of modulations, frequencies and power levels. Desirable qualities from the power management include rapid, accurate changes in voltage capable of following a high PAR envelope if ET is used, plus the prevention of excessive switching noise, preservation of spectral purity and maintenance of sufficiently high power conversion efficiencies to reap the rewards of this approach.



Additionally, the PA must be designed with the optimum load line for operation across the dynamic range. This implies proper device scaling, and careful trade-offs, such as judicious selection of the supply capacitance so that the smart device fulfils the complex requirements of the wireless network.

It is clear that for the foreseeable future, consumer demand for mobility and high data rate connectivity in smart devices will continue to drive complexity and challenges in the RF front-end market. In response, engineers will continue to improve and optimise the energy usage, thermal performance and battery life of modern data devices through innovation in the individual components, as well as integration of these components into a cohesive RF platform.

Figure 4. A graphic representation of the PAE improvements for several enhancement methods, neglecting conversion efficiency associated with implementation

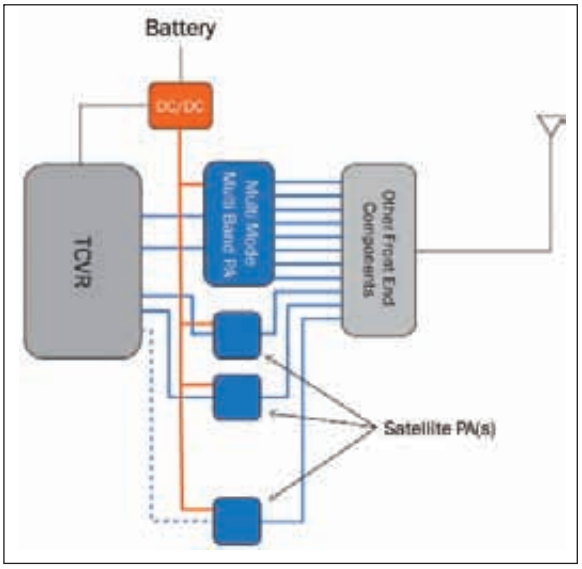
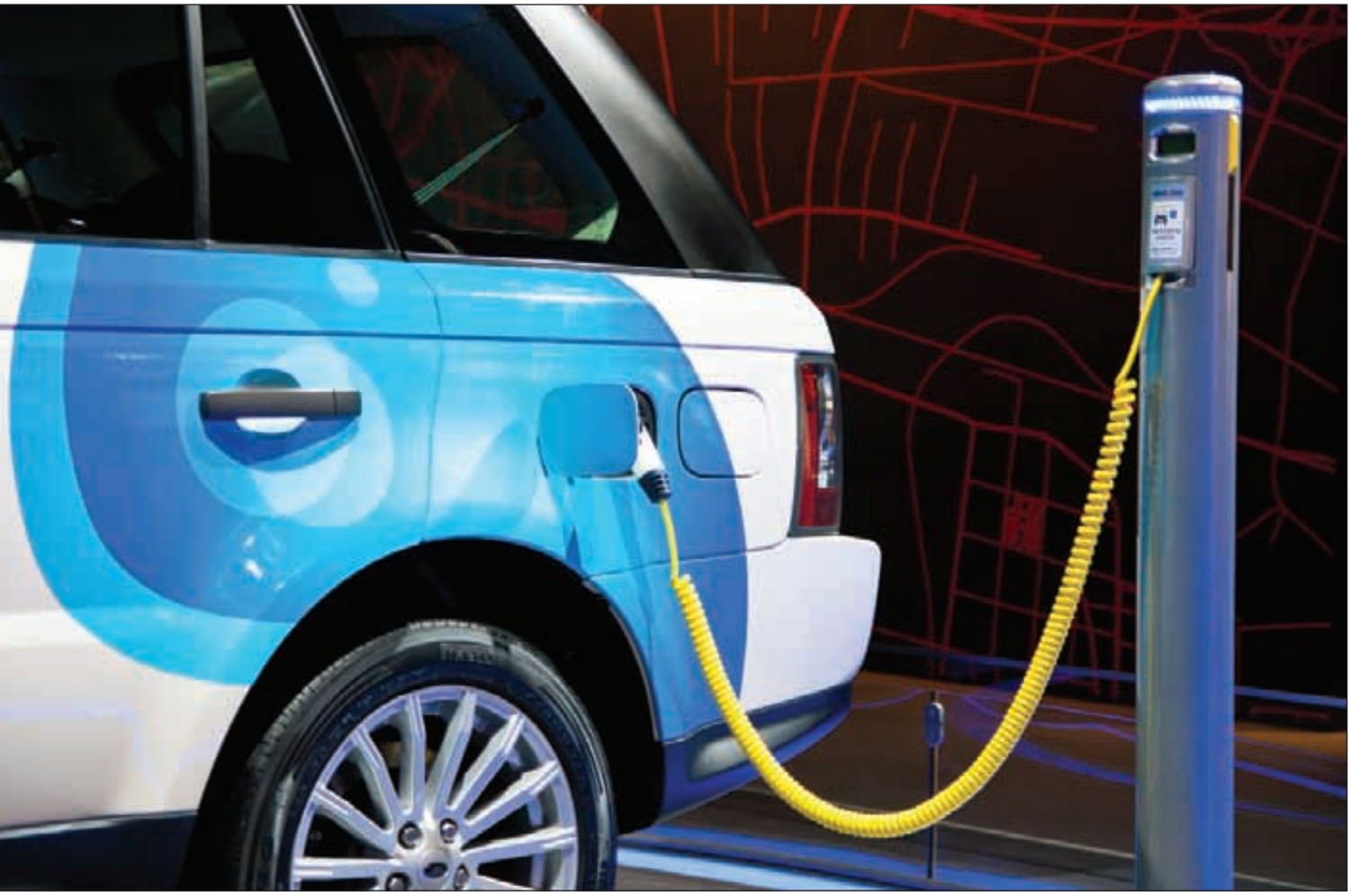


Figure 5. A representation of an RF front end showing PA power management (DC-DC converter) to multiple PA components



SiC and GaN electronics: Where, when and how big?

Switching from silicon electronics to wide bandgap alternatives promises to deliver improvements in the performance of power supplies, wind turbines, solar systems, hybrid electric vehicles, trams, trains and industrial machinery. **Richard Eden from IMS Research, which was recently acquired by IHS**, takes a detailed looked at all of these opportunities for wide bandgap devices and identifies the barrier to their mass adoption.

Silicon's vice-like grip of the power electronics market in coming under increasing pressure from a pair of wide bandgap semiconductors. One of these is SiC, a material that has been touted for use in power electronics for some 30 years. And the other is GaN, a semiconductor that has recently received tremendous investment and is most famous for its widespread use in blue and white LEDs in high-volume consumer applications. The SiC Schottky barrier diode, the first SiC power device brought to market, made its debut in 2001. Back then it was hoped that SiC would quickly become a suitable semiconductor material for high-efficiency power electronics; however, development has been delayed by difficulties

associated with the manufacture of SiC substrates. Its rival, GaN, is now arguably the best semiconductor material, in terms of the combination of performance and cost. It is used today for making RF power amplifiers, thanks to its inherent advantages in voltage and temperature performance over GaAs. Strengths of this wide bandgap semiconductor include the promise of making devices with incredibly low loss, and the opportunity to deposit epilayers on standard silicon substrates. The latter virtue enables production costs to be significantly below those for SiC.

At IMS Research, a market research firm based in the UK, we have been looking at various applications for SiC and GaN power semiconductors, and figuring out how they will evolve over the next ten years. In the remainder of this article we'll look at the impact of this pair of wide bandgap devices on a wide range of applications: Power factor correction (PFC) power supplies, uninterruptable power supplies (UPS), hybrid and electric vehicles, industrial motor drives, PV inverters, wind turbines, and traction.

For SiC and GaN devices, many of the barriers to mass adoption are similar. Neither of these devices will make a big impact until their prices approach those of silicon SuperJunction MOSFETs and high-voltage IGBTs. This affordability target will be pursued through moves to manufacture on larger substrates and improve material quality.

Other factors that will determine how quickly SiC and GaN devices can make an impact are: The time taken for SiC and GaN transistors and power modules to demonstrate long-term reliability in long-life industrial or health-and-safety-critical applications; how quickly the strength of competition increases between the qualified suppliers of SiC wafers and GaN-on-silicon epitaxial wafers; and whether there will be new legislation or government initiatives on the energy efficiency of power electronic systems. Greater competition from increasing numbers of established power semiconductor manufacturers offering SiC and/or GaN products will also help to drive greater adoption of wide bandgap devices, which can sell in higher volumes as their portfolios broaden. The SiC product range should grow to include higher-voltage devices operating at 1700 V, 2.5 kV, 3.3 kV, 4.5 kV and above, plus GaN diodes and transistors at 1200 V and above.

Power supplies

PFC power supplies were the first key application to use both forms of wide bandgap power device. In this sector, the long-term winner is likely to be GaN. 600 V and 650 V will be the typical device voltage ratings for power supplies in consumer and office equipment running off of the mains, and we forecast that GaN transistors and diodes operating in this regime will cost less than SiC-based equivalents – they could ultimately match silicon prices. Industrial three-phase mains power supplies sell in smaller quantities than PFC supplies, and they require 1200 V-rated devices, a requirement that is easier to satisfy with SiC technology.
SiC and GaN switches offer substantial benefits in PFC stages of hard-switching power supply units (PSUs); less so in soft-switching circuits. The increase in power conversion efficiency is actually quite small – perhaps tenths-of-a-percent to 1 percent. The far bigger gain resulting from the introduction of wide bandgap electronics in a substantial cut in the size of the PSU, with increased power density made possible by fewer, smaller secondary components required in the snubber circuit. The reason behind this is the opportunity to increase switching frequency, which is made possible with SiC and GaN diodes.

Few vendors of the other big selling class of power supplies, the UPS, are building products incorporating SiC or GaN power devices. However, the relatively small market for SiC Schottky diodes in UPS is no reflection of the improvement wrought with wide bandgap semiconductors. In our view, in UPS, the revenue potential for SiC or GaN Schottky diodes is relatively small. Sales should be greater for SiC power transistors and SiC hybrid and full-power modules. We predict that discrete SiC and GaN power devices will be used in just smaller single-phase UPS systems rated up to 5.1 kVA, while SiC power modules will be deployed in UPS systems rated between 5.1 kVA to 250 kVA.

Better electronics for better cars

Exciting opportunities for wide bandgap power devices also exist in the hybrid and electric vehicle market. Adoption of the devices could increase inverter efficiency, leading to a longer vehicle range between recharges.

There are three potential areas for the deployment of wide bandgap devices in hybrid and electric vehicles: The mains battery charger, found only on plug-in hybrids and battery electric vehicles; DC-DC voltage conversion systems; and the drivetrain. Increasing the power density in these electronic systems, which is possible with a switch from silicon to wide bandgap semiconductors, allows for reductions in size and weight. This is highly desirable because space in an electric car is tight, and using less of it for electronic systems gives designers more freedom. In addition, reducing weight increases the vehicle's acceleration and range.

Inverters are needed to convert the DC output from the cells into an AC form that can be fed into the grid. Increases in efficiency that lead to better returns are possible by replacing the silicon electronics in the inverter with SiC devices

Today's HEVs are fitted with silicon power electronics, and use two separate cooling systems. That's because the inverter mounted on or near the internal combustion engine block must be maintained at a lower temperature than the engine. When SiC devices start to take the place of silicon IGBTs that have inferior thermal capabilities, it may allow the inverter to run at the same temperature as the engine casing and consequently use the same cooling system.

Unfortunately, none of the current SiC switch technologies are sufficiently mature to match the reliability of silicon devices or even of SiC Schottky diodes. This will delay adoption of SiC transistors in HEVs. SiC JFETs should meet the reliability requirements first, because they have the same basic structure and materials as diodes. But these transistors may not dominate the market, because there could be significant competition from SiC BJTs, which seem to offer good reliability in terms of life test, high-temperature operation and temperature cycling, plus robustness to shocks and vibrations.

In the long term, GaN transistors and diodes are of great interest for HEVs, because they could eventually undercut the price of equivalent products built from SiC. Discrete GaN devices will probably only find deployment in the battery charger, but it is possible that they might also be used in drivetrain power modules. As with SiC devices, adoption of GaN will not take place until devices have proven reliability to automotive specifications.

Industrial motor drives

The greatest revenue opportunity for SiC power devices, particularly for power modules, is in the industrial motor drive market. Here, SiC can be used in equipment for driving and controlling industrial motors within factory automation systems. This equipment can be single-phase or three-phase; drive AC, DC or servo motors; and operate at variable speed or variable frequency. The main benefit of this equipment is improved control and efficiency when driving motors.

The increase in power density resulting from the switch from silicon devices to those built with SiC trims the inverter's size, its weight and its cooling requirements. However, this market is extremely cost-sensitive, with drives sold on price versus performance and size. To win sales, the prices of SiC devices must plummet to a level comparable with silicon equivalents.

Power conversion efficiency values will become increasingly important. The market for low-voltage AC and DC drives should benefit from European Union legislation that has established minimum motor efficiency requirements as a result of the Eco-design of Energy-related Products Directive. Beginning in 2015, a mandate that has led from this directive has dictated the use of either an IE3 efficiency motor (which operates at 'premium efficiency'), or an IE2 efficiency (which operates at 'high efficiency) motor coupled with a drive. Most modern motors are IE2 efficient, and we believe that many customers will take the cheaper option of adding a drive to an existing IE2 motor, rather than replacing it with a new IE3 motor. This should lead to ramping sales in the drives market.

Designers of systems with long operational life, such as industrial motor drives, only want devices with excellent reliability. These are some unanswered questions concerning the reliability of SiC devices, and diodes and transistors will only be qualified after extensive load-cycling, temperature-cycling and life-test data has been produced and evaluated. However, we predict that this scrutiny will not reveal any major weaknesses, and that there will come a time when discrete SiC and GaN power devices are used in single-phase drives, and SiC power modules in three-phase, industrial motor drives.

There are two significant, far from obvious benefits that result from the use of SiC or GaN devices in industrial motor drives: Higher switching frequencies are possible, leading to quieter motors; and there is an opportunity to modify the inverter circuit topology to incorporate a transformer. Go down the latter route and it is possible to generate sine-wave voltage and current outputs, which can drastically diminish RF electromagnetic compatibility noise.

Boosting PV efficiencies

Owners of all forms of photovoltaic system want to generate as much energy as possible. Increasing the efficiency of the inverter helps, which is possible by replacing silicon devices with those made from SiC or GaN. Even an improvement of just 0.5 percent is viewed as highly worthwhile, because it allows the end-user to make more money selling the electricity to power companies.

Consequently, it is of no surprise that the PV inverter market is the second largest one for SiC Schottky diodes and it will be the first one to start using SiC transistors in volume. An inverter built with SiC diodes and transistors can operate at a switching frequency that is two-to-three times that of a silicon-based equivalent, and potentially be half the size.

Despite their relatively high price, 600 V SiC Schottky diodes should win deployment in micro-inverters and single-phase string inverters. However, we believe that those devices will subsequently be displaced by lower-priced GaN Schottky diodes, which will make inroads once their reliability is proven.

Moving on to transistors, our view is that those made from GaN could eventually replace high-voltage MOSFETs in 600 V systems for string inverters and

As with SiC devices, adoption of GaN will not take place until devices have proven reliability to automotive specifications

Industrial motor drives, such as those found on large wood-working machines, offer the greatest revenue opportunity for SiC power devices.

micro-inverters operating below 5 kW. SiC transistors will also enjoy success, and are likely to replace silicon IGBTs in 900 V or 1200 V single-phase string inverters operating above 5 kW. In 1200 V three-phase central inverters, we expect to see the introduction of SiC power modules.

Making best use of the wind

Wind turbines are another form of renewables that can benefit from wide bandgap power electronics. Experiments reveal that replacing silicon IGBT-based power modules with SiC equivalents delivers an improvement in overall system efficiency of approximately 1 percent. This efficiency boost translates to an operation cost benefit of $1.50 per hour per MW for the owners of a turbine generating electricity that can be sold for $150 per MW-hour. The switch to SiC also enables a hike in power density, leading to the design of smaller power converter systems.

There are several significant barriers preventing the adoption of SiC modules: High cost, reliability concerns, and the lack of availability of products with high current ratings. Today, SiC power devices are limited to a maximum current rating of 30 A, far less than the 100-150 A rating for silicon IGBTs deployed in wind turbines.

Note that it is also unlikely that discrete SiC power semiconductors will be used in wind turbines, because one would need dozens of discretes to switch the required power. The preference will be for power modules, which integrate six or more devices in a housing for heat-sinking, possibly with protection and control circuitry included.

In virtually all cases, wind turbines are built with 1700 V power modules, which are designed to work with 690 V, three-phase mains voltages. These turbines are being built with longer and longer blades, driving up output power. This is putting pressure on the makers of power modules to increase the handling current of their products, or reduce prices. We believe that this trend is hampering the uptake of SiC modules and depressing their penetration in this application.

With wind turbines, like many other applications, device reliability is crucial. The location of the wind turbine determines the consequences of the failure of an individual module, which stops a wind turbine power converter from operating. If the turbine is on land, an electrician can make the necessary repairs in a day. But if the turbine is off-shore, specialist engineers must get on a service boat, which can only reach the required destination in good weather and never during the winter months.

Off-shore turbines tend to be larger, causing failures that lead to losses in average annual generated-electricity revenues roughly a thousand times higher than those of on-shore installations.

Aiding transportation

In traction applications three-phase 690 V mains is standard, so most power modules are typically rated at 1700 V. However, some are rated higher – the maximum is 6.5 kV. Two types of inverter tend to be used in electric traction vehicles; a main inverter for the propulsion motor drive and an auxiliary inverter for battery charging. In a two or three car tram, six power modules are needed in an inverter; ten times this are

The batteries that are fitted to trains, power the control systems, the brakes, lighting, heating, ventilation and all the electrical sockets in the carriages. The battery-charger circuit normally uses fewer modules than the propulsion system, because current and power ratings are lower

required in a locomotive. Current ratings for power modules used in motor propulsion are between 1200 A and 2400 A, which significantly exceeds the capabilities of any of today's SiC power modules.

The batteries that are fitted to trains, power the control systems, the brakes, lighting, heating, ventilation and all the electrical sockets in the carriages. The battery charger circuit normally uses fewer modules than the propulsion system, because current and power ratings are lower. For this reason, battery-charging inverters will lead the way with the uptake of SiC power modules.

Switching from silicon to SiC produces a 1 percent increase in power-conversion efficiency. This gain can lead to a trimming of energy consumption or an increase in speed. Thanks to the wide operating temperature capability of SiC, it is also possible to reduce the size of the cooling systems. And on top of this benefit, SiC enables the introduction of higher switching frequencies, a step that can lead to the use of smaller inductive components. The upshot of all these strengths is a lighter train that requires less power to drive, particularly when moving off from stationary. This benefit is more significant than the trimming of inverter size or volume, because space is not a big issue in traction locomotives. Arguably, audible motor noise is more of a concern, and this could fall through an increase is switching frequencies.

If SiC devices are going to make an impact, prices must fall, concerns regarding reliability must be banished, and modules with high current ratings, particular those based fully on SiC, must become available. High prices are the biggest barriers, and it will take several years before they fall to the level necessary for widespread adoption.

Other opportunities

There are many other opportunities for wide bandgap technologies. High-voltage SiC devices could find deployment in the military and aerospace industry; in drilling and mining; in medical equipment; and other industrial applications. Meanwhile, for low-voltage GaN devices, applications include: The secondary side of high-end switch-mode power supplies for telecom and datacom networks and servers; DC-DC conversion, including point-of-load; power over Ethernet; and many emerging technologies that will drive significant growth in the future, such as wireless charging.

Our view is that the greatest potential for SiC power devices is in military and aerospace applications. In aviation, the SiC devices can be used for power distribution within the airframe; the low-voltage side is handled by MOSFETs, but 1200 V SiC MOSFETs are attractive candidates for replacing contactors in the high-voltage stage. Key benefits are increased power density – there is a five-fold-to-ten-fold increase in switching frequency, so size and weight diminish – and the opportunity to operate devices at higher temperatures. The latter benefit reduces cooling/heatsink requirements, and also saves weight.

GaN transistors will make their initial inroads in applications where they can replace low-voltage silicon MOSFETs and yield an increase in power conversion efficiency. Such an opportunity exists in a wide range of power supplies: DC-DC power supply units, such as power-over-Ethernet equipment, network power supplies, point-of-load converters, 48 V telecom power supply units, server-farm 12 V or 48 V power rails, medical equipment, and various forms of lighting, including that based on LEDs.

Other opportunities are also there for GaN. When low-voltage devices made from this wide bandgap semiconductor match those of silicon MOSFETs, GaN transistors will be adopted in the secondary side of switch-mode power supplies in high volume applications like consumer/domestic PCs, notebooks and tablets. In addition, 600 V GaN transistors will be adopted in other applications, such as electric bicycles and domestic appliance drives and inverters. What's more, GaN is being investigated for space and military applications, because the radiation hardness of this material is inherently superior to that of silicon.

And it is anticipated that GaN power devices will be a disruptive technology that will allow commercialisation of inventions struggling to succeed with silicon devices. Examples include wireless charging, digital power conversion and RF envelope tracking.

Grabbing market share

Due to the great potential of GaN and SiC power devices in a vast number of applications, sales of these products are outpacing the growth of the total market for power devices. Although wide bandgap sales made up less than 1 percent of total power semiconductor revenues last year, if we assume that materials maintain their trajectory of falling cost and devices demonstrate long-term reliability, we can expect a market worth over $3 billion by 2021 – that's approaching 9 percent of the total market for power semiconductors.

In other words, in the next ten years, penetration of these devices in the power market will increase ten-fold.

Further reading

"The World Market for Silicon Carbide & Gallium Nitride Power Semiconductors – 2012 edition" by IMS Research

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Rare earth oxides: A great intermediary for GaN on large-area silicon

GaN-on-silicon products will become far more competitive when processing is carried out at fully depreciated 200 mm silicon fabs. This requires the use of very flat wafers, which can be formed through the introduction of rare oxide epi-layers that can also enhance the performance of LEDs, transistors and solar cells, say **Michael Lebby, Andrew Clark and Guoying Ding from Translucent.**

To fulfil the unrelenting drive for cheaper consumer products, scientists need to develop and introduce new materials that can slash the cost of semiconductor devices. This is especially true for GaN-based technologies – these can form a wide range of devices at costs that will get more and more competitive when epitaxial growth is performed on large silicon wafers. Such devices promise to spur the widespread adoption of LED-based lighting, aid the penetration of GaN-based transistors in the power electronics industry, and help the growth of the multi-junction solar cell market that is traditionally making products for satellites, but is now complementing this with devices for terrestrial concentrating photovoltaic systems.

At Translucent of Palo Alto, CA, we are playing a key role in the development of engineered, silicon-based substrates for the manufacture of GaN products. These large-diameter 'on-silicon' wafer platforms, which provide a strong foundation for GaN and germanium epitaxial growth, are by no means the only engineered platforms that exist. However, they have a major advantage over many of them, thanks to their silicon base: They can be processed in the high-volume, highly automated 150 mm and 200 mm silicon fabs dotted around the world. This means that they promise to trim the price of electronic devices based on GaN-on-silicon and germanium-on-silicon, which tend to be made on smaller substrates.

In addition, they can be an attractive alternative to sapphire for the growth of LEDs. The GaN LED industry is migrating from 2-inch, 4-inch and 150 mm platforms used today to 200 mm and beyond.

The appeal of our engineered substrates is not limited to their competitive price – they also simplify epitaxy and wafer fab processing. Given the standard tool kits in these large silicon fabs, thin flat wafers are a pre-requisite for automatic batch loading.

One of the first demands from the silicon community, when faced with the request to process wafers featuring GaN or germanium is essentially: "We need flat wafers folks. We are not interested in the quality of your GaN, but if you want us to process them – they had better be flat."

Silicon is certainly not the only foundation looking to impact these fast growth markets; scaling to 200 mm has been demonstrated in both sapphire and germanium.

However, both these alternatives suffer from cost, fragility, yield and thickness issues, which don't plague epitaxial structures formed with our engineered substrates.

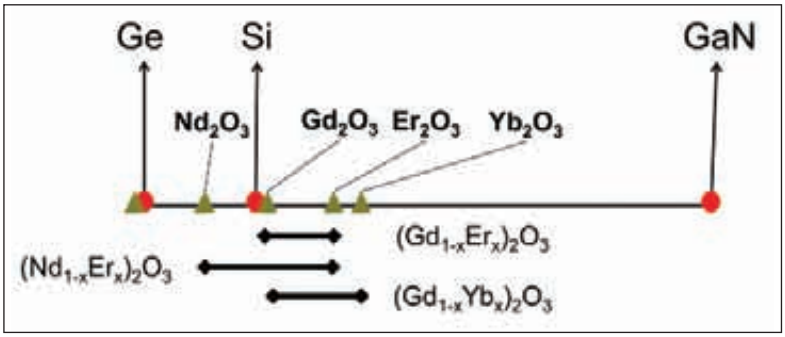


Figure 1. Comparison of surface unit cells (decreasing left to right)

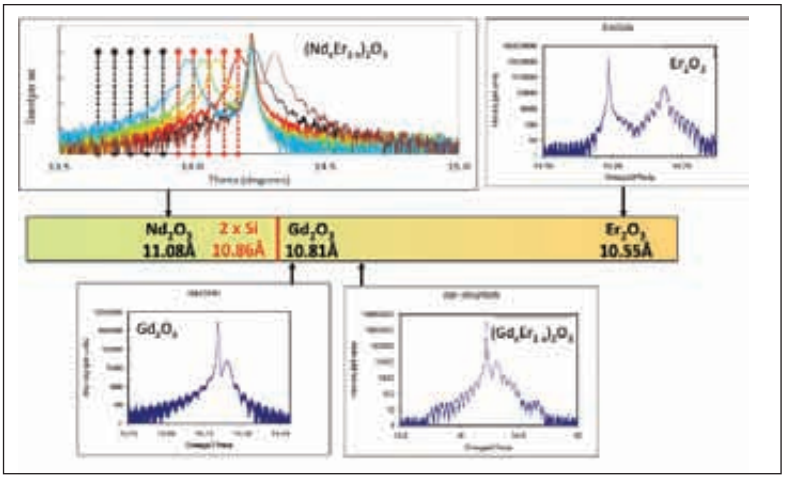


Figure 2. X-ray diffraction scans for various rare earth binary and ternary oxide alloys

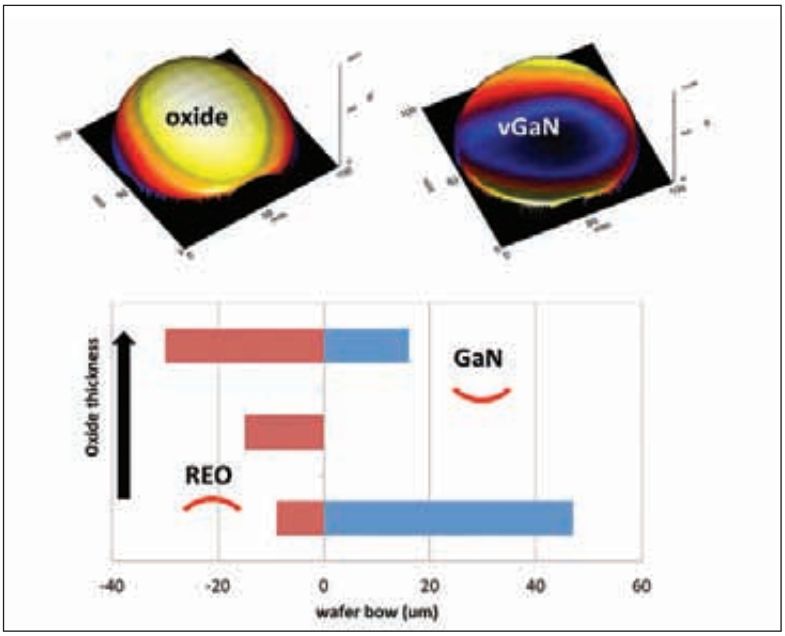


Figure 3. Ex-situ bow data for oxide and oxide + GaN wafers of 100mm

Rare earth oxides

Our engineered 'on-silicon' templates are formed using crystalline rare earth oxides (REOs). Working with this family of materials is beneficial for many reasons: REOs permit strain engineering; they can scale to 200 mm; they enable field screening in FETs, if this wide bandgap oxide is inserted between GaN and silicon; and if they are stacked with silicon, they can form a distributed Bragg reflector that can reflect the emission produced by the LED away from the silicon substrate, which would otherwise absorb this light. In addition, REOs have the potential to form a high-*k* gate dielectric through *in-situ* deposition without breaking vacuum (note that this feature is not discussed in this article).

We have successfully developed epitaxial growth processes for a range of crystalline REOs on silicon (111), including Gd_2O_3 and Er_2O_3. The process has already been scaled from 50 mm to 200 mm, and there is the opportunity to migrate to larger platforms in the future.

The epitaxial deposition process for forming GaN materials employs custom-designed, solid-source epitaxy reactors. These are based in part on the principles of MBE, but modified to handle oxides and silicon fab cluster tools. We have recently completed the design of a 200 mm epitaxial reactor that can handle a single 200 mm wafer. This will complement our growing range of multi-wafer tools: This year we are implementing multi-wafer tools for a capacity of 7 x 150 mm or 3 x 200 mm wafers.

A perfect match

One of the great assets of crystalline oxides is the value of their lattice spacing, which is almost exactly twice that of silicon. Within the rare earth series (lanthanides) of the periodic table there are a number of elements with slightly different-sized cells. The most notable of these are oxides of: ytterbium, erbium, gadolinium, neodymium and lanthanum.

We have grown all of these oxides, before studying their properties to determine whether they can support alternative material templates. When comparing lattice dimensions to other semiconductors, such as GaN and even germanium, it is clear that these oxides can be used to engineer silicon wafers for use as epitaxial templates (see Figures 1 and 2; the former provides a comparison of the relative surface unit cells of (0001) GaN, (111) silicon, germanium and $^1/_2$ unit cell (111) REOs.)

'Tunability' of various rare earth binary and ternary oxide alloys are demonstrated in X-ray scans (see Figure 2). If there is a requirement for a lattice coincident oxide, also known as a matched oxide, Gd_2O_3 is a good candidate because its lattice constant is very close to twice the lattice constant of silicon, 10.86 Å. But if the preference is for a little tensile strain, this oxide can be graded with Er_2O_3 to form a range of ternary alloys with lattice spacing ranging from 10.81 Å to 10.55 Å. And if compression is desired, it is possible to use ternary alloys constructed from Er_2O_3 and Nd_2O_3 (see Figure 2). To date the predominant use of this alloy has been as a template for SiGe growth - the plot in Figure 2 shows an overlay of 10 percent steps in the composition of SiGe with corresponding data from a matched ternary oxide.

It is this ability to set a final oxide lattice spacing that is the key to strain engineering. However, with any template engineering another criteriion must be

satisfied: The material must withstand all upstream thermal budgets. Fortunately, crystalline REOs are very stable, as revealed by X-ray patterns that are repeatable when the material is subjected to temperature cycling up to 1100 °C. In addition, X-ray spectra show that it is possible to form repeatable material compositions over the course of a year.

Growth of GaN-on-silicon is known to be difficult. This is primarily due to the large mismatches in lattice constants and coefficients of thermal expansion (CTE) between GaN and silicon. Left unchecked, this can cause wafers to bow and even crack.

To address this issue, we have adopted a strain management strategy based on two approaches: Lattice engineering via REO composition and grading as previously discussed, and pre-straining of wafers using oxides of varying thicknesses. The results of the second approach, which produces a greater strain effect, are detailed in the remainder of this article. Taking this tack makes it possible to apply differing amounts of strain compensation to 100 mm silicon wafers by varying the thickness of the REO and the GaN layer (see Figure 3). Repeating these experiments revealed that our strain engineering technique can be scaled to larger format silicon wafers.

Reflected glory

The high crystalline quality of REOs makes them an ideal template for subsequent epitaxy. For example, it is possible to deposit, *in situ*, a distributed Bragg reflector (DBR) by pairing the oxide with another material with a different refractive index. At 450 nm, the difference in refractive index between silicon and Gd_2O_3 is 2.2. This difference is far larger than that for AlN-GaN materials used to date in some LEDs, implying that DBRs incorporating Gd_2O_3 are much more efficient.

This promise is borne out in practice. Measurements show that a DBR with a peak reflectivity exceeding 85 percent can be built with a four-period mirror made from Gd_2O_3 and silicon; if III-N materials are used instead, ten periods are required to hit this reflectivity (see Figure 4). What's more, the combination of Gd_2O_3 and silicon increases the width of the stopband. Using an identical number of mirror pairs, the stopband for Gd_2O_3-and-silicon is three times that for the III-Ns (181 nm, compared to just 61 nm).

A fully embedded DBR mirror on a silicon wafer enables a new level of flexibility in the fabrication and processing of LEDs. Armed with this composite platform, a complete GaN/InGaN LED device can be directly grown without the need for substrate removal, wafer bonding, and the associated

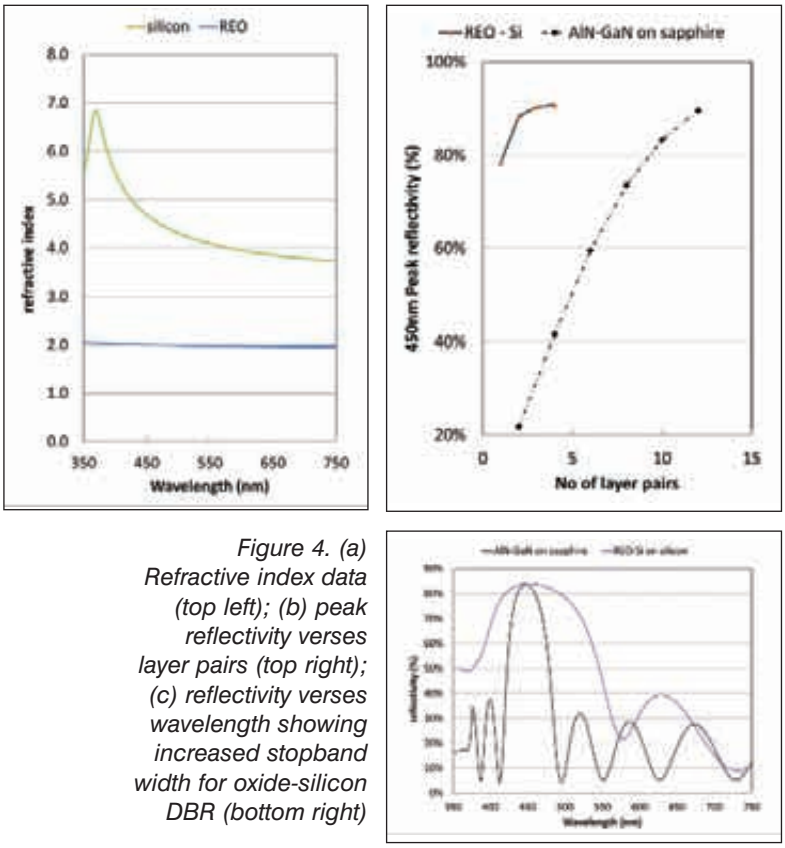


Figure 4. (a) Refractive index data (top left); (b) peak reflectivity verses layer pairs (top right); (c) reflectivity verses wavelength showing increased stopband width for oxide-silicon DBR (bottom right)

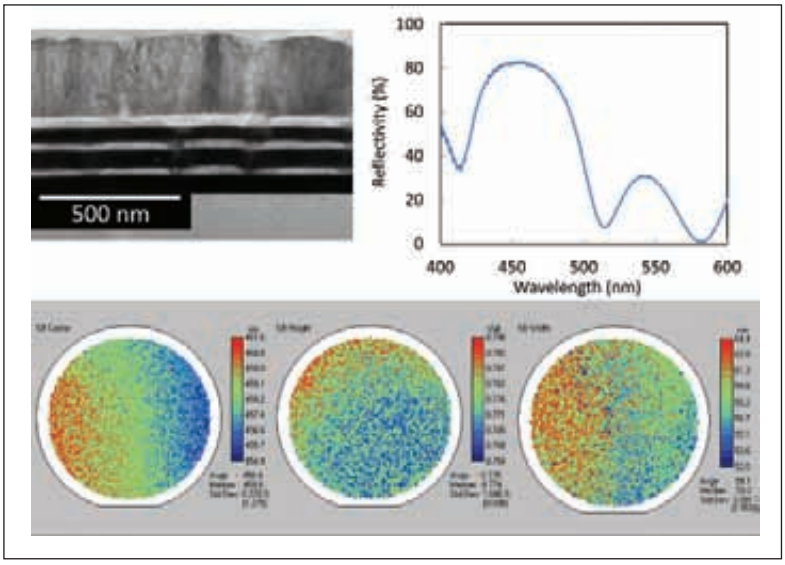


Figure 5. (a) Transmission electron microscopy images of the REO-silicon stack, spectral data for DBR, (top, left to right); (b) Wafer maps for centre wavelength, stop bandwidth and peak reflectivity from a 100 mm diameter wafer (bottom, left to right).

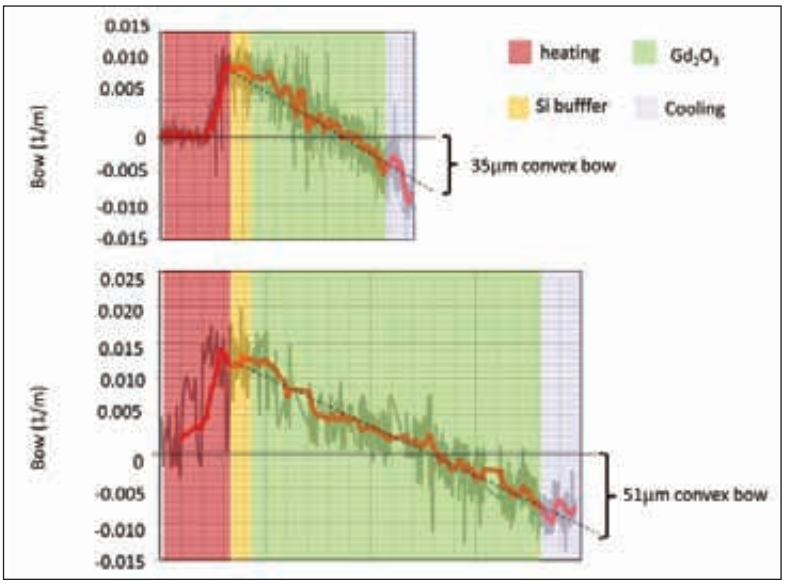


Figure 6. In-situ bow data from 300 nm REO thickness (top); and (b) in-situ bow data for 500 nm REO (bottom). Note that graphs are to scale

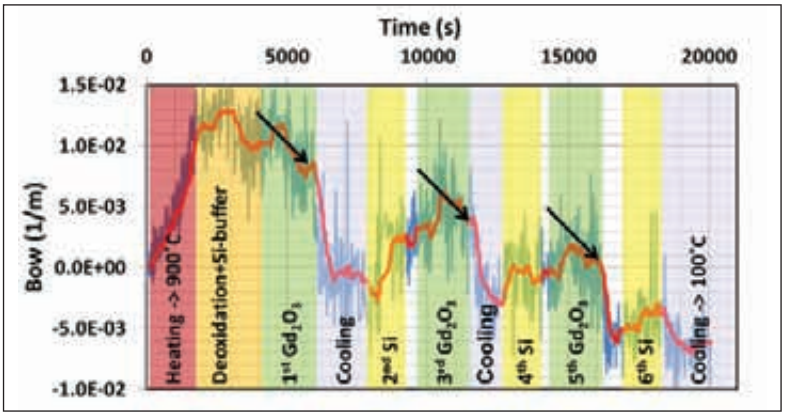


Figure 7. In-situ bow measurements of a three-pair REO- and silicon-based DBR mirror on a 200 mm silicon (111) wafer. Arrows indicate the compressive strain induced by each oxide layer as it is grown

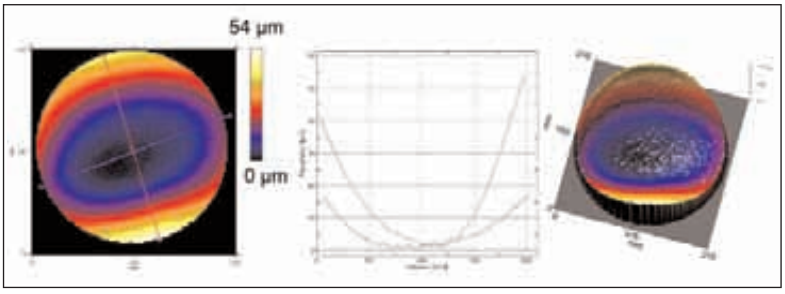


Figure 8. Ex-situ bow measurements of a three-pair DBR mirrors after growth of bulk GaN showing center to edge wafer bow of 54 µm

fabrication steps of removing silicon. The high reflectivity of the DBR prevents light emitted by the LED from being absorbed in the silicon substrate.

Although many manufacturers have demonstrated substrate removal techniques, this process gets more complex and its cost becomes prohibitive as wafers scale to 200 mm and beyond. It seems that the concept of 'chip and ship' is rising in importance as the LED industry gains in maturity and volume through applications such as solid-state lighting. We have been able to construct high-quality, *in situ* embedded DBR mirrors on wafers with diameters of 50, 100, 150 and 200 mm. Alternating layers of epitaxially grown Gd_2O_3 and silicon have combined to form a DBR wafer with a peak reflectivity of 82 percent at 450 nm (see F. Erdem Arkun *et al.* Phys. Status Solidi C **9** 814 (2012) for details of the growth of REO-based mirrors and their integration with GaN). Depending on design, stop bandwidths are typically in the range 60-80 nm and are highly suited to handling LEDs with light emission in the 440-470 nm range.

Scaling to large sizes

The promise of wafer processing at fully depreciated silicon fabs is a key value proposition for GaN-on-silicon technology. To spur this on, processes must be developed for manufacturing 200 mm flat wafers that can quickly win acceptance within the mature silicon industry.

What is meant by flat? Wafer bow must be below 100 μm over a 200 mm wafer. To meet this target, strain management must be accomplished as part of the epitaxy stack. This management must not be limited to single oxide layers, but must include more complex structures, such as DBR mirrors that include silicon layers.

Our efforts in this direction have included the growth of single layers of Gd_2O_3 with thicknesses of 0.1 μm-0.5 μm on 200 mm silicon (111) wafers. Measurements of bow were performed during the growth, before the wafers were taken out of the reactor and evaluated again.

Measurements on wafers with 300 nm and 500 nm oxides show that this layer induces convex bow (see Figure 6). This bow increases as more of the REO is deposited, revealing that it is possible to control the level of compressive strain in an oxide-based template by selecting the thickness of the oxide.

Growth of oxide-based DBRs on 200 mm wafers produced similar results. During the deposition of alternating oxide and silicon layers with thicknesses of $\lambda/4$ and $3\lambda/4$, the addition of every oxide layer imparts compressive strain to the multi-layer stack (see the arrows in figure 7). Note that this DBR is not fully optimized, due to a reduction in total oxide thickness. We have found that the silicon layers within the DBR result in some tensile strain, due to the different growth temperatures used in the multilayer structure. However, overall the direction is towards the desired compressive strain.

Subsequent growth of GaN confirms this – the final centre-to-edge bow for this 200 mm diameter wafer was 54 μm concave (figure 8), a figure that satisfies silicon industry specifications for this size wafer. Complete strain management is possible, but this requires additional oxides.

Nonetheless, given that the silicon substrate was only 750 μm in thickness, this is a very encouraging result and confirms that REO templates offer a successful route to strain engineered GaN-on-silicon.

The deployment of multiple layers of oxides for strain management and improved device performance is not limited to LEDs; this form of architecture also promises to pay dividends in GaN-on-silicon power devices (see Figure 9 for an example of both structures). REOs combine a wide bandgap with a high value of permittivity – it is greater than 12 – and may allow an *in-situ* gate oxide to be deposited on top of a GaN FET stack witout breaking vacuum.

Capacitance-voltage measurements show minimal hysteresis, while breakdown testing reveals a consistent breakdown voltage of 4 MV/cm.

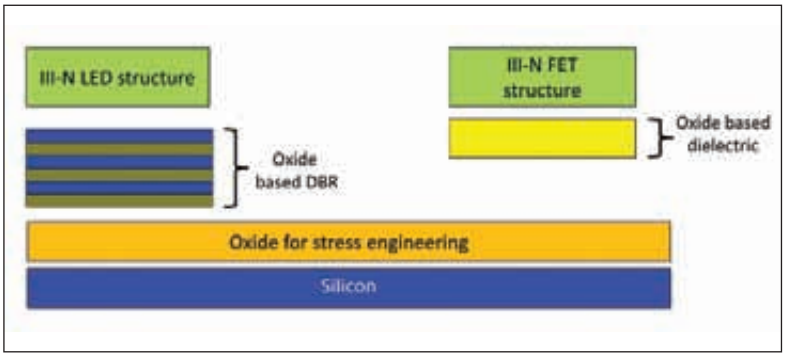


Figure 9. Oxide-based template engineering for strain, optical and electrical enhancement of silicon based III-N wafers.

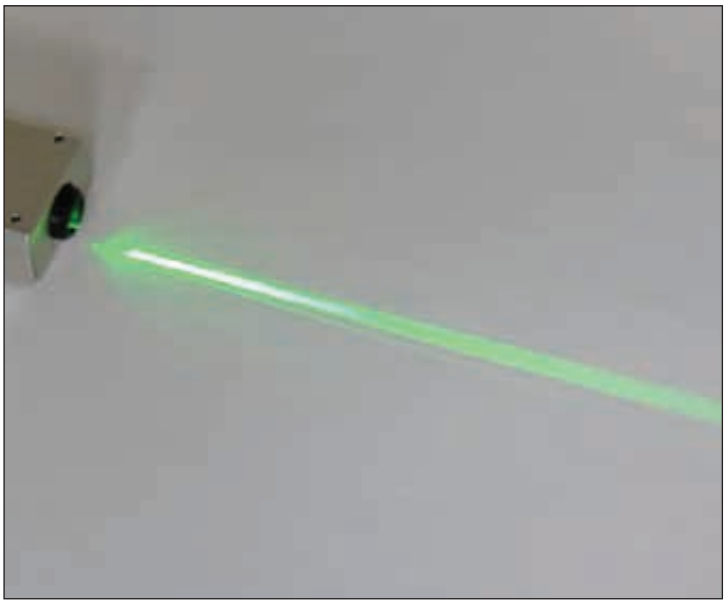
It's clear from these results with simplified LED and transistor structures that REOs offer great promise to improve device performance and trim manufacturing costs. The range of oxides is considerable. This means that there are many avenues – some still to be explored – for taking LEDs, transistors and solar cells to new levels of affordability and performance.

Output power rockets for green II-VI lasers

A novel material system produces powerful, continuous-wave laser emission at 536 nm, an ideal wavelength for the green source in pico-projectors

A JAPANESE TEAM has smashed its own record for the continuous-wave (CW) output power of green lasers built from a beryllium-based family of II-VI alloys.

The latest green laser produced by researchers from Hitachi and the National Institute of Advanced Industrial Science and Technology (AIST) combines a new device structure with improved material quality to deliver a 70 mW output. This is a tremendous hike in power compared to team's 1.5 mW, 545 nm laser fabricated in conjunction with Sony and reported in summer 2010.



Green lasers made by Hitachi and AIST can produce up to 70 mW at 536 nm.

Beryllium-based lasers are an attractive alternative to those based on InGaN, which are targeting the market for the green source for pico-projectors, but emit at shorter wavelengths that would compromise the colour range produced by a red-green-blue laser display, according to AIST's Ryouichi Akimoto.

He explains that when engineers try to push their nitride lasers to 530 nm and beyond, threshold current density rockets, driving down efficiency.

This, plus difficulties in growing high-quality InGaN with the high indium content needed to push emission to longer wavelengths, have pegged back the wavelength of the first commercial green nitride lasers, which are made by Nichia and have an emission between 510-520 nm.

Nichia's lasers are made on *c*-plane, polar GaN substrates. Switching to a semi-polar platform, an approach pioneered by Sumitomo, can extend the reach of GaN lasers to just beyond 530 nm. However, this adds to manufacturing costs.

"I have no exact number for the price of semi-polar GaN substrates, but I presume that they are one order of magnitude higher than those of GaAs substrates, [which we used for making our beryllium-based lasers]," says Akimoto. "This will make a significant difference in the fabrication costs of II-VI and InGaN lasers."

Back in the early 1990s, prior to the first big successes of GaN, II-VI materials were the most promising devices for delivering blue and green laser emission. However, lifetime was restricted to 500 hours or so, due to the ease of propagation of defects in these alloys, which have a high degree of ionic bonding.

Lasers produced by Akimoto and his co-workers are markedly different from the ZnSe-based devices of the 1990s – they also contain beryllium, which increases 'covalency' and promises to lead to longer laser lifetimes.

This lifetime boost is yet to be quantified. "According to Sony's review paper on blue-green lasers reported in 2000, the crystal defect density in the epitaxial layers of a laser is the critical factor that determines the lifetime of II-VI lasers," says Akimoto. "Based on that report, we presume that the crystal defect density in our lasers is still high, hence the lifetime is short."

The team's 536 nm, gain-guided laser was fabricated by wet etching the p-type contact to form a mesa structure. After Ti/Pt/Au and AuGe/Ni/Au electrodes were added by evaporation, cleaving formed 800 μm-long cavities featuring 7 nm-thick BeZnCdSe quantum wells.

Laser chips with a 2 μm-wide mesa and front and rear facet reflectivities of 90 percent produced a threshold current and voltage of 55 mA and 9.8 V under CW operation at 25 °C. Driven at 118 mA, light output power hit 50 mW, rising to 70 mW when front-fact reflectivity was reduced to 70 percent.

Akimoto believes that it will be possible to reduce the operating voltage of these lasers. "We presume that p-contact and p-cladding layers are not optimized yet, hence electrical resistivity is high. We expect that the threshold voltage will go down to about 5 V after optimization."

To make their lasers suitable for the pico-projector market, the team are trying to build 50 mW devices with 2000-hour lifetimes, a 5 V threshold voltage and a threshold current density of 1 kA cm^{-2}.

"The improvement of the lifetime is the most important challenge," admits Akimoto. "We expect that the keys to achieving this goal are a decrease in crystal defect density in *p*-layers and a full use of the 'berylium effect', which will strengthen chemical bonds in a BeZnCdSe active layer."

S. Fujisaki et al. Appl. Phys. Express **5** 062101 (2012)

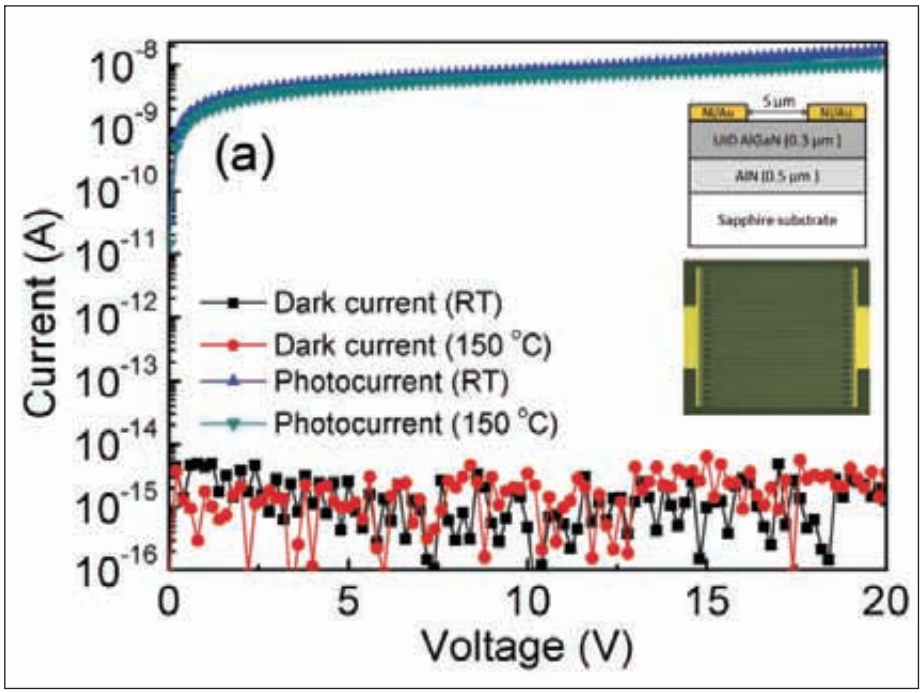
Solar-Blind AlGaN Photodetectors With Record-Low Dark Current

AlGaN photodectors have been fabricated by Chinese researchers using a proprietary high temperature MOCVD process and a special surface treatment

A collaboration between researchers from Nanjing University and Nanjing Electron Devices Institute, China has developed a high quantum efficiency AlGaN-based solar-blind photodetector with a very low dark current.

Despite their significant applications including missile plume sensing, environmental monitoring, chemical/biological agent detection and solar physics, AlGaN-based solar-blind photodetectors commonly suffer from low quantum efficiency and a high dark current. This significantly limits their weak signal detection capability.

But for use in harsh environments, such as flame detection for gas turbines or in complex battle field applications, photodetectors capable of operating at high temperature are very much needed.



To address this problem, the research team, led by Hai Lu, a professor at Nanjing University, has fabricated a novel AlGaN-based solar-blind MSM photodetector. Using a proprietary high temperature epitaxial growth process and a special surface treatment technique, they have created a device that they say has a record low dark current – not only at room temperature, but also at elevated temperatures.

The photodiode structure, grown on sapphire by MOCVD, consists of a high-temperature AlN buffer layer and an undoped $Al_{0.4}Ga_{0.6}N$ active layer. Standard optical lithography and lift-off techniques have been used to define the Ni/Au semi-transparent interdigitated contact electrodes. Before the deposition of the Schottky metal by e-beam evaporation, a special surface chemical treatment was conducted.

The researchers point out that dark current measurement of the photodetector at room temperature is limited by the experimental setup. Theminimum current level the scientists' current-voltage measurement setup can resolve is 1 fA, which is the noise floor of the high-end setup. If the actual dark current is below 1 fA, what can be seen is only an irregular current noise signal around 1 fA.

One femtoamp corresponds to an ultra-low dark current density of less than 1.25×10^{12}A cm^{-2}. Even at 150 °C, the dark current of the photodetector is still in the fA range. The photodetector also exhibits a sharp spectral cut-off in the solar-blind wavelength region and a high quantum efficiency. It had a maximum room-temperature quantum efficiency of 64 percent at about 275 nm, with a solar-blind/UV rejection ratio up to 4 orders of magnitude under a 10 V bias.

Record low dark current is achieved in the AlGaN-based solar-blind photodetector at room temperature as well as in a high temperature environment

At a temperature of 150 °C, the maximum quantum efficiency of the photodetector was still more than 50 percent with a reasonable rejection ratio of more than 8000, suggesting it has potential applications in high temperature deep-UV detection.

"This is very nice result from the technology point of view and is the first high temperature characterisation of AlGaN-based solar-blind photodetectors" says team leader Hai Lu. Using the material growth and processing techniques developed in this work, the research team has now fabricated a high performance large area MSM solar-blind photodetector.

The maximum device area is 5 x 5 mm^2, and the scientists say this is the largest AlGaN-based solar-blind photodetector reported so far. They also say the epi-layer has excellent uniformity.

"If we can make high performance large area PDs, theoretically we can make large-scale solar-blind focal plane arrays for deep UV imaging applications, which would be the next step of the research team," adds Lu.

F. Xie et al. IEEE Sensors J. **12** 2086 (2012)

Powerful QCLs stretch to shorter wavelengths

Strain-balanced QCLs deliver continuous-wave output powers in excess of 500 mW at wavelengths as short as 3.4 μm

ENGINEERS AT Northwestern University, Illinois, have extended the spectral coverage of powerful quantum cascade lasers (QCLs) to shorter wavelengths.

Prior to their efforts, the shortest wavelength continuous-wave QCL, which was reported by Corning in late 2011, delivered a room-temperature output of 40 mW at 3.55 μm. This bar has now been raised with a pair of highly strain-balanced, InP-based AlInAs/GaInAs QCLs that emit 504 mW at 3.39 μm and 576 mW at 3.56 μm when driven in continuous-wave (CW) mode at room-temperature.

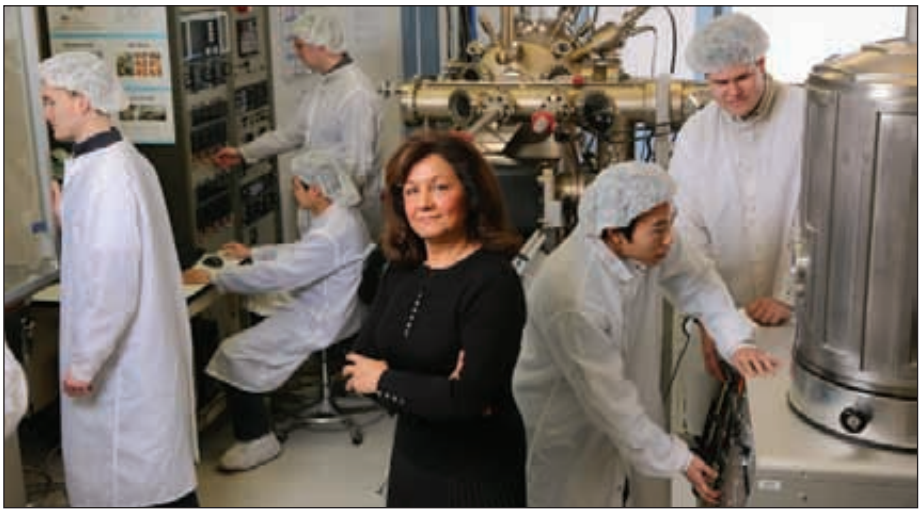
These powerful emitters can be used for remote sensing and jamming. In the former application, QCLs can unveil the presence of many hydrocarbons, which have strong absorption in the 3.3 μm to 3.6 μm range due to stretching modes of the carbon-hydrogen bonds. These organic materials include nerve agents such as cyclosarin, soman and tabun gas, and some explosives.

"For jamming applications, the 3.0 – 3.5 μm range is used by missile seekers to look for hot metal objects," explains Manijeh Razeghi, head of the group at Northwestern University. "A laser in this wavelength range can be used to 'dazzle' the missile seeker so that it cannot acquire a target."

Another class of laser that emits around 3 μm is the interband cascade laser. However, the performance of this class of device tends to vary far more with changes in temperature than a QCL. Historically, shorter wavelength QCLs have lagged behind their longer wavelength cousins in temperature insensitivity, but lasers from Northwestern have significantly closed this gap.

"We believe our success is partly due to the use of better electron confinement and a three-well active region," reveals Razeghi.

The QCL community has made pulsed-mode QCLs operating at room-temperature from three different types of material system: InAs/AlSb/InAs, GaInAs/AlAs(Sb)/InP and GaInAs/AlInAs/InP. Razeghi and her co-workers use latter of these because its yields the best material quality, and it is best suited to commercial device manufacture. "A large infrastructure exists that is dedicated to the growth of antimony-free InP-based compounds," says Razeghi, who adds that antimony-containing systems would require significant 'retooling' and process development. The QCLs that she and her co-workers fabricate span an emission range from 3 μm to the terahertz range.



Manijeh Razeghi's group produces powerful QCLs on InP

When GaInAs/AlInAs structures are lattice-matched to InP, the quantum-well depth is just 505-520 meV, which in insufficient for electron confinement for making QCLs operate below 6 μm. It is possible to increase the depth of the well a great deal by switching from GaInAs to InAs and replacing AlInAs with AlAs. However, this alternative material system is not lattice-matched to InP, preventing the growth of high-quality films that are a pre-requisite for making devices.

"To grow a device with a deep quantum well, good interfaces and without dislocations, the compressive strain of the InAs-rich material must be balanced – on the scale of one cascade stage – with the tensile strain of the AlAs-rich layer," explains Razeghi. Those strain-balanced layers have a depth of about 1 eV. "This allows us to reach much shorter emission wavelengths with good electron confinement."

Using this approach led to the construction of a 3.39 μm, double-channel ridge-waveguide QCL with an 8.6 μm width and 5 mm laser cavity. Driven with 500 ns pulses at a 100 kHz repetition rate, this laser produces 1.1 W at room temperature. Switch to CW operation and output falls to 504 mW, 403 mW and 88 mW at 15 °C, 25 °C and 55 °C, respectively. The QCL's 3.56 μm cousin has a 10.5 μm-wide ridge, and produces 1.66 W when driven in pulsed mode. In CW operation, output falls to 576 mW, 437 mW and 45 mW at 15 °C, 25 °C and 55 °C, respectively.

QCL performance can be improved with a buried heterostructure geometry that trims ridge widths and optical losses, while increasing thermal conductance. Performance then improves on several fronts: Threshold current falls; slope efficiency rises, resulting in higher output power; and internal temperature increases are smaller at all drive currents. The two major benefits that result from all these gains are an increase in the power saturation current density and a threshold current that is low, even at high temperatures. "This leads naturally to a higher operation temperature for CW operation," remarks Razeghi.

Along with her co-workers, she is trying to improve material homogeneity, which will lead to better QCL performance. "We are systematically trying to identify the source of inhomogeneity. This includes investigations of reactor hardware limitations, growth conditions and interface effects."

N. Bandyopadhyay et al. Appl. Phys. Lett. **100** 212104 (2012)

A watertight explanation for LED droop?

Experimental measurements of LED droop are replicated with a model that includes carrier leakage

A PARTNERSHIP between Fred Schubert's team at Rensselaer Polytechnic Institute, New York, and Samsung LED, Korea, claims that it has a new, comprehensive explanation for LED droop. The team's model for droop, the decline in an LED's efficiency as its current is cranked up, is based on the leakage of electrons out of the active region of the device.

"[Our] model is able to conclusively describe all aspects of efficiency droop," says Schubert. This includes temperature dependence, the dependence on third-order and fourth-order terms of carrier density and the scale of this efficiency-limiting phenomena in different material systems, such as those based on GaN and AlGaInP.

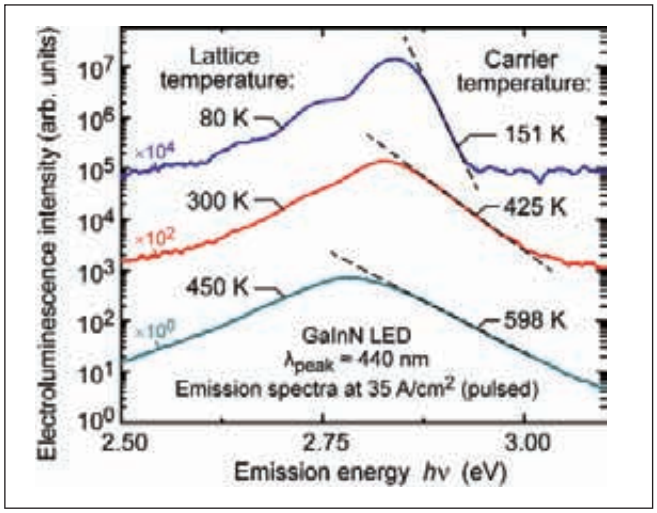


Figure 1. Pulsed emission spectra of an InGaN LED reveals the significant difference between lattice and carrier temperatures. Carrier temperatures were extracted from the high energy slope using the an equation: Intensity is proportional to $exp(-h\upsilon/kT_{carrier})$

Strong asymmetry in electron and hole transport characteristics form the basis for the model, which also includes polarization effects. "The polarization fields lower the effective barrier height of the electron blocking layer, thereby facilitating electron leakage," explains Schubert.

The origin of LED droop is highly controversial, and several groups have argued that it is predominantly caused by Auger recombination, a process involving three carriers. An Auger-effect contribution that is proportional to the third order of the carrier density is included in the model built by Schubert's team. Fitting this model to experimental data reveals an Auger coefficient of the order of 10^{-31} cm^6 s^{-1}, two orders of magnitude smaller than a drift leakage term, which also depends on the cube of the carrier density.

"Although the Auger effect is real, it is, in the present context, certainly a secondary effect. It's probably negligible, maybe even irrelevant," claims Schubert.

His team's model, which was built from scratch, accounts for high-injection conditions, where electron drift in the p-type layer leads to a reduction in the injection efficiency. According to the team, droop kicks in when LEDs are operating in the high-level injection regime, which is 'more easily reached' when the *p-n* junction is made from materials that have a strong asymmetry in electron and hole mobility and concentration, such as GaN.

When diodes enter the high-level injection regime, some of the applied voltage starts to drop across the low-conductivity *p*-type layer, and drift current rises with the total current. At high drive currents, it is significant and leads to a reduction in the injection efficiency into the active region. This causes droop in the LED.

Schubert and his co-workers claim that there are three reasons why this leakage current is higher than one might expect: The electron temperature is significantly higher than the lattice temperature (see Figure 1); experimental measurements of tunnelling currents through barriers generally exceed theoretical estimates; and polarization fields can reduce carrier capture and enhance carrier leakage, due to the positive sheet charge at the interface between the electron-blocking-layer and spacer in InGaN LEDs.

An equation that includes third-order and fourth-order terms for drift-induced loss through leakage, plus a third order term for Auger recombination, has been used to fit efficiency-versus-current plots for three high-quality blue LEDs (see Figure 2). The team claims that the theoretical fits to the emission of all three LEDs, which have peak emission between 448 nm and 451 nm, are excellent. They are clearly superior to the widely used 'ABC' model, which does not include a fourth-order term.

"Having the understanding and knowledge available for the cause of droop, we will be able to develop the tools that allow us to reduce the droop for blue as well as green emitters," says Schubert.

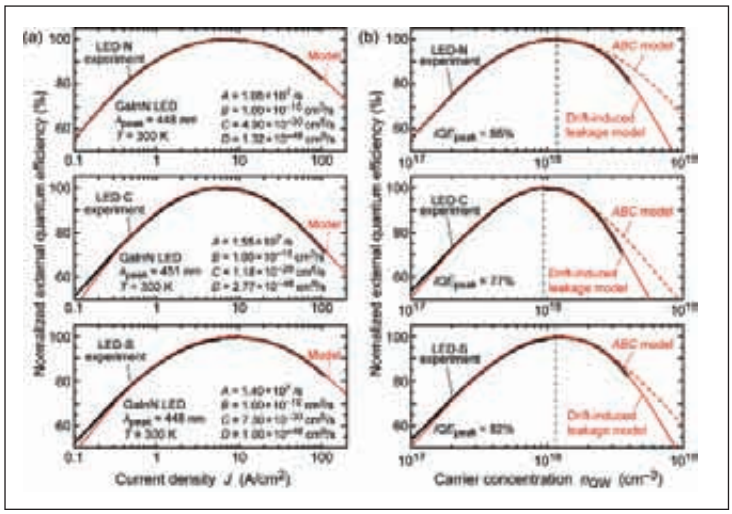


Figure 2. At high current densities, the well known ABC model fails to fit experimental results. In comparison, the model of Schubert and co-workers, which include a carrier leakage loss term that depends on the third and fourth order of the carrier density, fits the experimental data very well.

G.-B Lin et. al. Appl. Phys. Lett. **100** 161106 (2012)

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News Digest Contents

LEDs

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

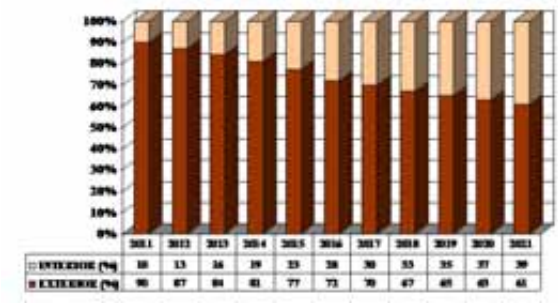
The global consumption value of component-level LEDs in SSL general lighting applications will increase at 37% per year from 2011-2016. Between 2016-2021, the annual average growth rate will be even higher, at 51%

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

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

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

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



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

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

Extending LED lifetime by eliminating the driver

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

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

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

The LED operates at 85 lumens/Watt and has a CRI

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

With a new production line currently under construction, the product is available in bulk quantities and sample orders are also accepted.

GaN developer mLED to expand with £348,000 funding

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

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

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

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

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

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

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

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

The firm is developing a roadmap of products aimed at a range of high volume embedded applications and is already commercially engaged with some of the world's leading system integrators.

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

UCSB awarded $500,000 for GaN research

The university has been awarded to develop the use of gallium nitride in electronics and solid state lighting

UC Santa Barbara's Solid State Lighting & Energy Centre (SSLEC), has received the half million dollar endowment from Seoul Optodevice Company to further its research on GaN for use in electronics and solid state lighting.

James Speck, a professor of materials at UCSB, member of SSLEC's Executive Committee, and director of the Interdisciplinary Centre for Wide Band-Gap Semiconductors, has been named the campus's first Seoul Optodevice Chair in Solid State Lighting.

James Speck

“Mr. Chung Hoon Lee and the Seoul Optodevice Company are leaders in the field, and have been longstanding supporters of UC Santa Barbara’s Solid State Lighting and Energy Centre, which is advancing the frontiers of research in energy-efficient solid state lighting, and helping to create a more sustainable future for us all,” says Chancellor Henry T. Yang.

“We are deeply grateful for their vision and generosity in establishing the Seoul Optodevice Chair in Solid State Lighting, and we are very proud that Professor Jim Speck will be the inaugural chair holder. Professor Speck is world-renowned for his pioneering research in electronic materials and physical properties, and is the ideal choice to hold this prestigious endowed chair.”

The endowment represents an important partnership between UCSB and the Seoul Optodevice Company. Established in Korea in 2002, the company is a global leader in engineering products with a variety of applications, including outdoor and architectural lighting, LCD technology, and both V- and UV-LED products.

“Under the visionary leadership of Mr. Chung Hoon Lee, Seoul Semiconductor and Seoul Optoelectronic Device Companies are leading the transformation to solid state lighting,” Speck comments. “UCSB and the Solid State Lighting and Energy Centre have greatly benefited from the strong support from these two companies. I am honoured to serve as the first Seoul Optodevice Chair at UCSB and extend my personal thanks to Mr. Lee.”

Most silicon-based semiconductors in today’s electronics, such as those found in computer microprocessor chips and transistors, are highly inefficient in their use of energy. New processors that use GaN as a wide band-gap semiconductor offer increased data processing capabilities while using minimal power. GaN is one of the most important next-generation semiconductor materials because it can be used for high-frequency, high-power transistors capable of operating at high temperatures.

“This endowment by Seoul Optodevice Company is critically important because our research in gallium nitride semiconductors places the college at the forefront of energy efficiency technology,” adds Rod Alferness, dean of the College of Engineering. “Professor Speck is leading this charge and understands how our relationship with industry is a driving force behind discoveries in solid state lighting.”

Speck’s research focuses on the relationship between thin-film electronic materials growth, and microstructure, as well as the link between microstructure and physical properties. He has worked extensively on the materials science of GaN and related alloys, and has consistently been lauded for his research.

Among his honours, Speck received the Quantum Device Award from the International Symposium on Compound Semiconductors in 2007. In 2010, he received the IEEE Photonics Society Aron Kressel Award for his work on nonpolar and semipolar GaN-based materials and devices.

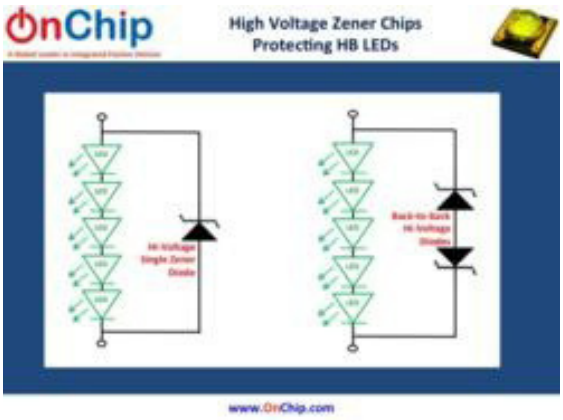
“Jim Speck is the world’s leading expert in gallium nitride materials and crystal growth,” concludes Steven DenBaars, co-director of SSLEC, a professor of materials, and of electrical and computer engineering, as well as the Mitsubishi Chemical Professor in Solid State Lighting & Display. “SSLEC is very fortunate to have him.”

OnChip reveals Zener ESD protection diodes for HB & power LEDs

The compact silicon diodes offer a very high breakdown voltage for indium gallium nitride high brightness and power LEDs

OnChip Devices, an innovator in Integrated Passive Devices (IPD), has introduced miniature, wire bondable, silicon ESD (Electrostatic Discharge) protection diodes targeted at the High Brightness and Power LED markets.

The ESD7979 and ESD9595 diodes are designed with a junction, which enables conduction of high transient currents. OnChip says these Zeners exhibit no device degradation when compared to Multilayer Varistors (MLV). All devices meet the requirements of IEC61000 and safely dissipate ESD strikes of over 8kV when tested to the stringent MIL-STD-883 conditions.



High Brightness LEDs (HB-LED) and High Power White LEDs using InGaN technology are manufactured to enable a market transition to energy efficient Solid-State Lighting (SSL). These LEDs continue to make major inroads into lighting applications that were traditionally dominated by incandescent light and other light sources.

LEDs can be found in a wide array of applications ranging from traffic signals and automotive brake lights to full-colour displays and LCD backlights. However, one of the main drawbacks of HB-LED products is the fact that they are extremely sensitive to ESD. OnChip's ESD7979 and ESD9595 diodes help to eliminate this weakness.

OnChip's ESD7979 diode measures 7.9 x 7.9 mils (0.2mm x 0.2mm) in size with a thickness of 6 mils (0.15mm or 150um). The ESD9595 is slightly larger at 9.5 x 9.5 mils (0.24mm x 0.24mm) but with a thickness of 4 mils (0.1mm or 100µm). The tiny form-factor and single wire-bond feature make this device suited for applications that have very confined spaces and miniature packaging.

Though small in size these devices are manufactured to protect over 8kV of electrostatic discharge. A single high voltage ESD9595 has a Zener diode voltage of 55V, whereas the ESD7979 diode exhibits a 100V breakdown voltage.

They can be used for protecting a number of LEDs in a string ranging from 1 to 30 such as in RGB modules and other multi-chip modules. Protection from both positive and negative pulses (bidirectional signal) can also be possible by connecting two individual diodes with back-to-back topology.

OnChip also offers silicon and ceramic carriers or submounts that it says greatly improve the performance of HB-LEDs.

The OnChip ESD7979 and ESD9595 are globally available now at a price range of USD $0.02 to $0.03 in quantities of 100k to 150k units. They are available for shipment in wafer-form either diced or undiced. These components are designed and developed at OnChip Devices' S

Seoul Semi increases LED brightness 5 to10 fold

Bulbs using the firm's new technology named "nPola," require just a single LED Korean firm, Seoul Semiconductor unveiled a new LED product based on a new technology, to an audience of the Korean LED industry and press.

This new product, called "nPola", that Seoul Semiconductor holds the unique patented technology rights to, has been under development by Seoul Semiconductor for over 10 years. The brightness has been dramatically improved by 5 times over the conventional LED based on equivalent die surface area. The company expects further improvements will increase this to more than

10 times existing LEDs.

Currently, the brightness of a power chip LED in mass production is around 100 lumens in warm white but this new product produces 500 lumens which is 5 times better. As an example, when making a LED bulb for a 60W household bulb replacement, generally, 10-20 LED packages are used, but when this new product is applied, the same brightness can be achieved with only 1-2 packages.

LED Bulb Using New nPola Technology

Seoul Semiconductor CEO, Chung Hoon Lee, expressed strong confidence in the new product by saying "I've worked very hard for the past 20 years in this industry and it is safe to say that this new product is the culmination of 20 years of core technologies development. It is a major milestone for the LED light source." Shuji Nakamura, who many believe as the father of the LED, was also present at this event to comment on the new technology. He is currently a professor at the University of California, Santa Barbara and an advisor to Seoul Semiconductor.

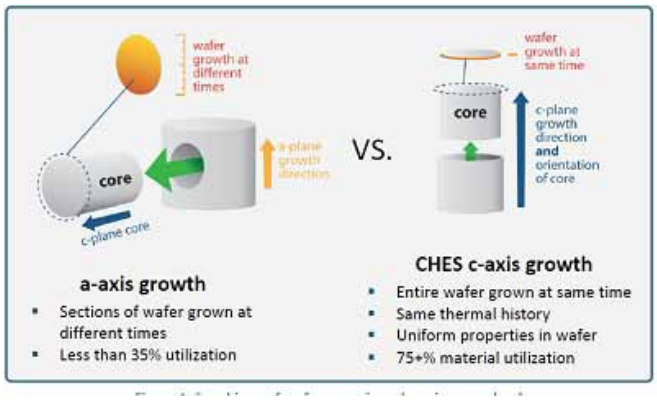
In addition to the release of the new product, the event provided booths where attendees could experience Seoul Semiconductor's core products such as its Acrich AC LED technology, UV LEDs, white LEDs, and others.

The company said it will immediately begin production of this new product with sales domestically and in strategic markets abroad.

ARC Energy's CHES sapphire produces 5% brighter LEDs

The company has conducted an LED manufacturing study and a new white paper explains how CHES technology and CHES furnaces are enabling sapphire growth companies to meet increasing demands

In a white paper entitled "LED Manufacturing Study on CHES Sapphire," ARC Energy has published results of a study showing that sapphire grown from its proprietary CHES technology yield 5% greater LED brightness than the industry standard.



Sapphire wafers from a-axis and c-axis grown boules

The study purposefully included sapphire material exhibiting a wide range of etch pit distortion (EPD) levels to determine whether or not EPD affects LED manufacturing. The study took sapphire through the complete LED chip manufacturing process and concluded that all material passed LED standards and that no correlation was found between LED performance and EPD level of CHES wafers.

"We are pleased to see CHES achieving significantly higher LED brightness which translates to higher profits for our customers," says Rick Schwerdtfeger, co-founder and chief technology officer for ARC Energy. "CHES is rapidly establishing itself as the technology of choice for the future of HB-LED production."

ARC's study is the first subject in a new series called "CHES Foundations", which explains how CHES technology and CHES furnaces are enabling sapphire growth companies to meet increasing demand.

Several ARC customers have already announced that their CHES sapphire has been qualified by multiple LED manufacturers.

ARC Energy's CHES furnaces are unique in several ways. One key advantage is dramatically higher material utilization due to sapphire growth on the c-plane. This approach produces large diameter substrates at a significantly lower cost.

Greater than 75% material utilisation can be achieved using c-plane ARC Energy CHES furnaces while other methods are limited to less than 35%. CHES furnaces are also highly automated—a key feature which brings operator costs down and provides consistent output.

CHES furnaces are designed to produce higher performance sapphire at larger wafer sizes compared to older technologies. A CHES furnace produces high-yield sapphire up to 10" diameter, providing higher efficiency downstream in the LED manufacturing process and upstream as c-plane growth significantly reduces waste.

The study results show CHES-grown sapphire is capable of production-level performance. As the HB-LED market expands, CHES gives sapphire growers significant advantages, including higher yield, a scalable technology, and better LED chip performance. ARC Energy offers CHES furnaces and a variety of support services for crystal growth companies seeking to lead in the HB-LED industry

LED MOCVD tools to experience turbulent investment cycles

In the coming years, lithography, plasma etching, PECVD & PVD tools will also experience an upheaval

According to the report, "LED Front-End Manufacturing", by Yole Développement,to be published on 16th July, the packaged LED market still presents significant opportunities for growth in the next 5 years, but is expected to saturate in value by the end of the decade.

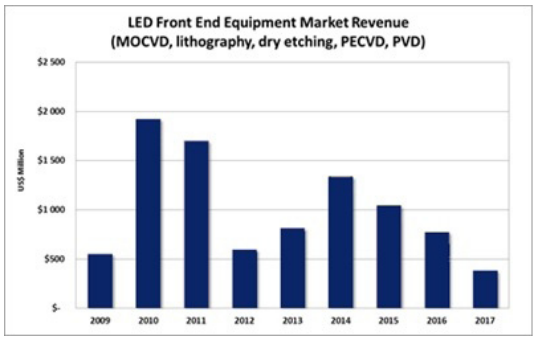
Driven by MOCVD reactors, the equipment market experienced an unprecedented investment cycle in the 2010-2011 period. The cycle was driven by demand in LCD backlight displays, anticipation of the general lighting market and generous subsidies offered by the Chinese central and local governments in a bid to stimulate the domestic chip production and create world leading chip companies.

This has resulted in a significant overcapacity situation that will take 12 to 18 months to absorb. The next investment cycle driven by lighting applications will start in 2013 and will be more limited in value than the previous cycle due to improvements in equipment throughput and yields. The MOCVD equipment market is anticipated to represent a $4.3 billion opportunity in the 2012-2017 period.

Together, lithography, plasma etching, PECVD and PVD tools represent a $650 million opportunity and will essentially follow a similar trend with some exceptions.

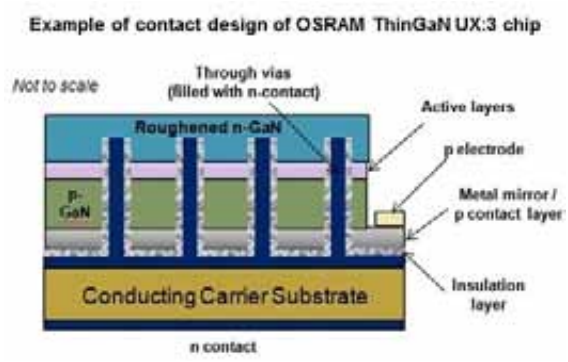
The market for dry etching tools is still growing in 2012 due to increasing adoption for PSS (Patterned Sapphire Substrate). The market for most lithography tools will however decrease as the industry transitions to larger diameter substrates and the number of wafer starts initially increases moderately but starts decreasing in 2015.

PVD equipment will also experience moderate growth during the next investment cycle. E-beam evaporators have turned into commodities, with systems available from dozens of vendors at very low cost. But opportunities exist in promoting sputtering for ITO deposition and sputtering could also gain some traction in metal deposition if the industry adopts large diameter wafers and moves from batch to single wafer processing. Sputtering equipment could then offer improved cost of ownership.



To enable massive adoption in general lighting applications, significant technology and manufacturing efficiency improvements are still needed to reduce the cost per lumen of packaged LEDs. Front-End LED manufacturing typically represents about 50% of the total cost of a packaged LED and offers significant opportunities. Continuous progress is being made in terms of LED structures and materials to improve performance, manufacturability or reduce cost.

MOCVD represents the single largest opportunity for front end cost reduction. Downstream, the emergence of LED dedicated tools has already contributed significantly to cost reduction in lithography, plasma and PVD processing.



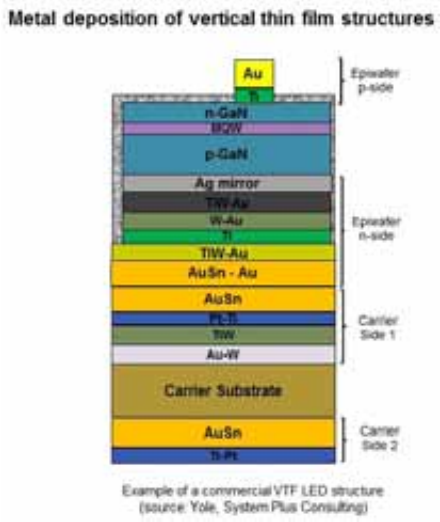
Traditional large semiconductor equipment suppliers are mostly absent from the LED manufacturing equipment markets. For MOCVD, the tools are very different than the epitaxy tools used in mainstream semiconductor manufacturing. Designing and building such equipment requires significant and unique expertise that Aixtron, Veeco and Tiyo Nippon Sanso, the leading companies in the sector, have acquired through almost 2 decades.

Other front end LED manufacturing tools are similar in essence to those used in mainstream semiconductor production.

For example, Applied Materials, a dominant force in the silicon sector, has been working with imec on the design of an 8” reactor for the growth of GaN-on-Silicon LEDs.

However, as experienced by AMAT, the reactors often require a full redesign in order to deliver optimum performance and cost of ownership for LEDs.

This has opened the door to smaller companies eager to capture the opportunity offered by this niche market. These companies are now offering LED dedicated tools delivering significant COO improvements.



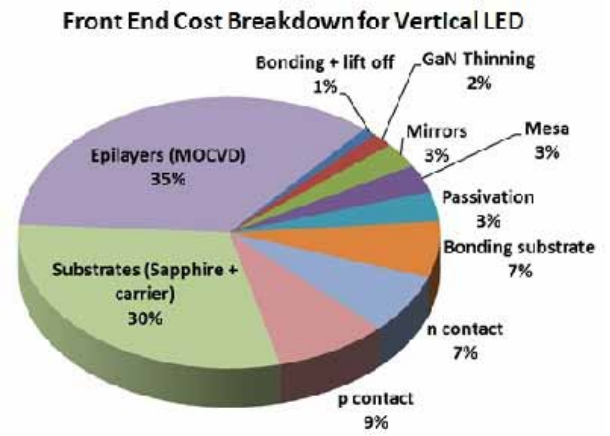
MOCVD is still a key factor in reducing manufacturing costs.

With close to 100 companies involved in front end LED manufacturing, the industry is too fragmented to generate significant economies of scale. Yole expects massive consolidation within the next 3 years (2012-2015) which should eventually speed up process and tool standardisation and allow economy of scale.

LED manufacturing still uses methods that would be considered outdated in most semiconductor industries. Consolidation and emergence of LED “giants” will also facilitate and speed up adoption of manufacturing paradigms coming from the IC industry.

Adoption of silicon substrates for LED manufacturing could speed up those trends by rapidly moving LED epiwafer processing into

existing, highly automated and fully depreciated CMOS fabs. This would also give LED makers access to extended “process toolboxes” which could pave the way for entirely new LED structures.



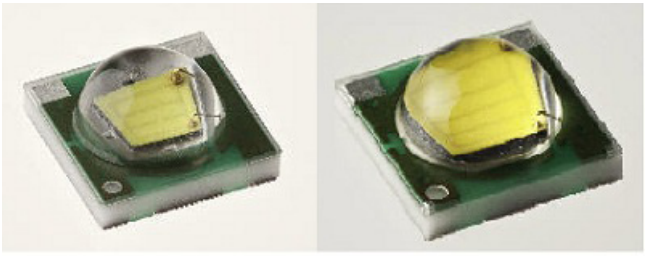
SemiLEDs launches EV LED family

The EV LED has been designed to have higher thermal endurance, ensuring better reliability at higher temperatures

SemiLEDs has launched its new ‘Enhanced Vertical’ (EV) LED product series. The EV LEDs feature SemiLEDs’ vertical chip structure on a patented metal alloy substrate, which the company says, offer advantages in optical output and high thermal conductivity over competitive products. SemiLEDs’ EV LEDs are available for global sales and immediate sampling in blue, green and UV. Chip sizes of 0.4mm x 0.4mm up to 1.5mm x 1.5mm are being offered.

Cree LEDs brighten largest municipal street in China

The firm’s XLamp LEDs in the Beibei district are estimated to deliver annual maintenance and electricity savings of US $3 million. Officials in the Beibei district of Chongqing, China recently completed the installation of more than 20,000 street lights featuring 1.9 million Cree XLamp XP-E and XP-G LEDs.



XP-E LED XP-G LED

The country’s largest municipal intelligent lighting control project began in July 2011 and includes nearly 16 miles of highway, with Cree LED-based luminaires installed along 119 streets and one tunnel. Officials estimate the installation will result in annual maintenance and electricity savings of more than RMB 19.5 million (approximately US $3 million) and 17.6 million kWh.

The Municipal Bureau of the Beibei District initiated the project to improve the living environment for local citizens and to meet China’s stringent roadway lighting requirements for light efficacy, brightness, luminance, heat dissipation and service lifespan. The street lights engineered by Chongqing Silian Optoelectronics Science and Technology Corporation (Silian), a major LED lighting company in China, have replaced antiquated sodium-vapour street lighting along the Yuwu Highway, which extend from Chongqing to Wusheng. Silian developed and manufactured the intelligent lighting control system, which features an advanced wireless network management system that detects lighting issues with sensors and can adjust the brightness of the LED street lights in accordance with vehicle and pedestrian traffic flow.

In conjunction with LED street lighting, this control system enables optimal lighting and energy efficiency for the Beibei District. “We are very pleased with the performance of Cree’s XLamp LEDs in our luminaire systems,” says David Reid, chief operating officer, Silian. “Cree LEDs emit high-quality light with low heat dissipation that meets China’s lighting standards while saving the municipality millions of Renmenbi.” “Cree LEDs are perfect for large-scale lighting projects such as the Beibei District installation,” adds Tang Guoqing, senior advisor, Cree Hong Kong Limited. “Designed to last more than 50,000 hours, Cree XLamp LEDs offer the high efficiency and easy integration with intelligent lighting systems needed to reduce overall costs while providing beautiful light.”

Taiwan's NCH University selects Aixtron reactor for GaN-on-Si research

The MOCVD system will be used to investigate the heteroepitaxial growth of gallium nitride based alloys on silicon wafers, mainly for LED research

Aixtron SE has announced that National Chung Hsing University (NCHU), a new customer and technical university in Taiwan, has placed an order for one Close Coupled Showerhead (CCS) MOCVD system in a 3x2-inch wafer configuration.

NCHU will use the CCS system to research GaN-on-Silicon. One of Aixtron´s local service support teams has already installed and commissioned the new reactor in a dedicated cleanroom facility at NCHU's site in Taichung, Taiwan.

Wuu, a professor at the Department of Materials Science and Engineering at NCHU, comments, "Aixtron's Close Coupled Showerhead system is the ideal choice for the study of GaN-on-Silicon. This is not only my opinion from my years of familiarity with the technical challenges of these materials, but also the consensus of many leading researchers around the world who are using the Aixtron MOCVD system."

Horng, another professor at NHCU, based at the Graduate Institute of Precision, adds, "The reactor has demonstrated its versatility, ease of operation and reproducibility over the range of parameters of interest to us, we therefore will be able to produce high-quality GaN-on-Si epilayers and other novel structures."

Since 2001, the research team led by Wuu and Horng at NCHU has developed many unique LED technologies for both GaN and AlGaInP materials. Today, their integrated laboratory from epitaxial growth to device processing and packaging has established itself as one of the leading research centre in Taiwan. Many of its successful academic-industry cooperation projects have also been awarded by the National Science Council of Taiwan.

NCHU claims to be the only state-run university in central Taiwan that offers a comprehensive choice of both research and taught curriculum programmes. The institute has been investing in three centres of research excellence including biotechnologies, nano-biomimetics and advanced industrial precision instrumentation technologies, as it strives to become a world-class university over the next five years.

Cree and SemiLEDs make peace on patent litigation

SemiLEDs has agreed to make a one-time payment to Cree for past damages and to stop the importation and sale of its accused products in the United States SemiLEDs and Cree have agreed to end their respective patent infringement litigation against each other.

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

"The conclusion of the disputes between SemiLEDs and Cree will allow us to now focus our full resources on developing our business and serving our customers. We continue to innovate and are introducing to the market an exciting, new line of LED products," says Adam Lin, VP of Business Development and General Counsel of SemiLEDs Corporation.

A new vacuum pump specially for LED & CS epitaxy

Edwards' new iXH645H dry vacuum pump has been designed with nitride LEDs and III-V compound semiconductor MOCVD growth in mind. The company says it requires minimal maintenance and maximises uptime in harsh manufacturing environments Edwards is introducing a new iXH645H dry pump which has been optimised for MOCVD processes used in LED manufacturing.

The pump is also suited for use in the growth of III-V materials in gate stacks.

Edwards' iXH645 pump

The iXH645H delivers very high gas flow capability and is able to operate continuously at the high loads required for the latest-generation LED manufacturing tools. Edwards says the advanced technology of the iXH pump minimises maintenance requirements and maximises pump uptimes, helping to lower cost-of-ownership.

"This new addition to our iXH family of dry pumps is designed to address the needs of two rapidly growing segments of high technology manufacturing," saysWei Shao, Edwards' LED market sector manager. "Due to their superior lighting efficiency, LEDs are increasingly being seen as an environmentally-friendly alternative to incandescent lighting, as shown by recent legislation passed in China, Korea, Japan and the U.K to phase out traditional high power lighting."

Shao adds, "At the same time, the use of III-V materials in compound semiconductor manufacturing is enabling the continuation of Moore's Law to next-generation design nodes."

Both LED and compound semiconductor manufacturing processes typically use high flows of light hydrogen and highly-corrosive ammonia gasses. The iXH645H has been designed to support these requirements with superior hydrogen pumping performance and a corrosion-resistant design, including a patented nitrogen purge barrier to protect the pump seals.

The high-temperature capabilities of the pump help prevent condensation of the phosphorous compounds which may be present.

What's more, its advanced oil lubrication and seal technology eliminate periodic maintenance requirements, while its thermal and motor design prevent overheating, motor overloads or zones of limited operation. The pump's optimised temperature control system ensures the pump is ready for process within approximately 30 minutes of start-up.

Oslon Signal blue LED gets the green light

Osram 's new blue LED chip for emergency vehicle lighting comprises indium gallium nitride and can be operated at a high current while providing a sustained, powerful, bright blue light with the Oslon Signal, Osram Opto Semiconductors says it has developed a new LED that currently boasts the world's brightest blue light.

Oslon Signal LED

The Oslon Signal LED is made using a special thin-film chip technology.

This powerful blue light that lasts during long journeys is crucial for the signal lights needed by police and emergency vehicles.

Osram's Oslon Signal produces a blue colour with a luminous flux of 52 lumens at 350 mA. Its wavelength of 472 nm and all colour bins (groups) comply with the EU and US standards for signalling, in particular for Emergency Vehicle Lighting. The package platform of the Oslon family, consisting of a ceramic substrate with built-in connecting contacts and a silicone lens, remains stable and resistant to

aging caused by the short-wave blue light.

The Oslon Signal includes chips incorporating UX:3 technology, which are capable of operating at very high performance levels even at extremely high currents. This is an important aspect, as blue signal light is often pulsed and therefore requires from high currents even greater luminous power. The LED measures only 3 x 3 mm. It is equipped with an insulated heat sink, and so can be mounted easily and conveniently, especially in combination with a conventional FR4 board.

The lens has a radiation angle of 80° and provides a highly symmetrical light output. This means the Oslon Signal can be easily mounted in existing emergency vehicle lighting applications and help provide significantly brighter signal lighting.

“Our developers have succeeded in doubling the brightness increase with blue LEDs within a very short time and therefore supplying the world’s brightest product in this sector. That’s why we support not only our customers in this regard but also contribute to greater road safety, as emergency vehicles can be seen sooner and better”, says Jennifer Rieder, marketing manager at Osram Opto Semiconductors.

In addition to blue LEDs, the entire Oslon family of the Regensburg-based company includes a variety of other colours such as red, yellow, green and white, which are all created using the latest thin-film chip technologies, which make them particularly effective.

Rubicon ranked number 13 on Chicago 2012 “Fast 50 List”

The provider of sapphire substrates and products to the LED, RFIC, semiconductor, and optical industries has seen a 546 percent five-year revenue growth, with $134 million in revenue in 2011 Rubicon Technology, was ranked #13 on Crain’s Chicago Business’ 2012 Fast 50.

This is an annual list of the fastest growing public and private companies in the Chicago area.

Crain’s ranks the fastest-growing public and private companies in the Chicago area based on five-year revenue growth. Rubicon has seen a 546 percent five-year revenue growth, reporting $134 million in revenue in 2011 up from $21 million in revenue in 2006.

“Rubicon’s growth over the past five years reflects our leadership in the market for sapphire substrates, the essential building block for LED chips and Silicon on Sapphire (SoS) RFIC chips,” says Raja M. Parvez, President and Chief Executive Officer of Rubicon.

“Throughout our 11 year history, Rubicon’s focus on continuous innovation has helped us develop proprietary crystal growth technology that enabled us to be first-to-market with high quality, large-diameter polished sapphire wafers. Customers rely on Rubicon because of the purity and low defect density of our product and because, as a vertically integrated supplier, we are a highly reliable partner. We look forward to continued growth as LED technology is adopted in the general lighting market and as product developers find additional applications for commercial sapphire.”

Rubicon is one of the world’s largest provider of large-diameter sapphire wafers. As a vertically integrated supplier, Rubicon perfected the process to grow large sapphire crystals from raw materials in custom-built, proprietary furnaces replicating the organic sapphire creation process found in nature.

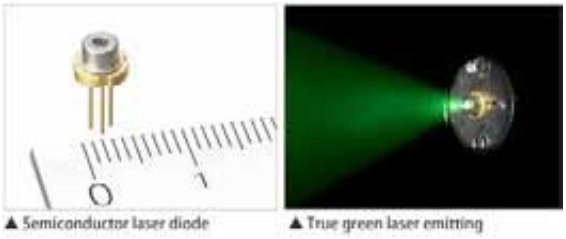
As a result, Rubicon says it has been able to scale the growth of bulk crystal from 30 kg to 85 kg to 200 kg without compromising high quality or high yield. The company completes the final stage of vertical integration with high precision core drilling, wafer slicing, surface lapping, large diameter polishing and wafer cleaning in its Penang, Malaysia facility. To date, Rubicon has shipped more than 230,000 large diameter wafers to the LED and SoS markets.

World`s first 520nm green semiconductor LD over 100mW

By using a {20-21} semi-polar gallium nitride substrate, adjusting crystal growth, wafer

processing, and laser production processes, a joint venture has developed a true green laser diode

Sumitomo Electric and Sony have jointly developed what the firms say is the world's first semiconductor laser diode with an optical output power of over 100mW in the true green region.

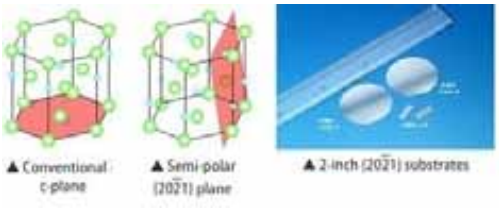


▲ Semiconductor laser diode ▲ True green laser emitting

At a wavelength of 530 nm, this laser diode (LD) can be mounted on laser projectors and many other display devices. The new device features twice the luminosity of conventional GaN green laser diodes (which are considered to operate at 60mW or less and at 520nm or less), and a colour gamut broadened by 182% based on the NTSC standard (CIE 1976 colour gamut). T

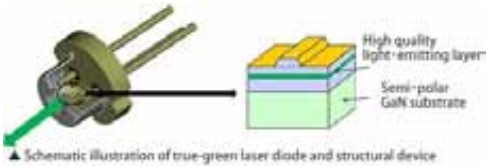
his standard compares the new true green LD with current red and blue laser diodes. This development could lead to a significant improvement in the performance of laser projectors and other display devices, to reproduce vibrant video and images. Red and blue laser diodes have been commercially available among the primary red-green-blue (RGB) colours, and the technology of these LDs is well known. But there has been a far greater need for high output green laser diodes to enhance the overall performance of high laser projectors and display devices which are needed today. Currently, green lasers are generated by converting the wavelength of infrared laser light from a light source using optical materials, but the light source is large and expensive. What's more, conventional GaN-based green lasers have problems achieving sufficient luminosity as their performance is limited to an output power of several tens of milliwatts at a wavelength of 520nm or less.

To overcome these challenges, Sony and Sumitomo Electric collaborated on the development of a true green semiconductor laser for practical use. The research drew on Sumitomo Electric's semi-polar GaN substrate, crystal growth, and wafer processing technologies and Sony's GaN-based laser technology, acquired through Blu-ray development. By introducing new techniques and improving the entire semiconductor laser production process, the firms were able to develop a true green semiconductor laser with an optical output power of more than 100mW at a wavelength of 530nm. Changes in the process included structural design, crystal growth, wafer processing, and electrode configuration. This true green semiconductor laser diode is claimed to be highly reliable as it has a wall-plug efficiency of over 8%. The development of the true green semiconductor laser diode completes the three basic colours of the RGB laser light sources. Sumitomo Electric and Sony anticipate a wide variety of applications for this technology such as incorporation into advanced laser projectors with high luminosity and broad colour gamut, as well as compact, light, energy-efficient laser projectors.



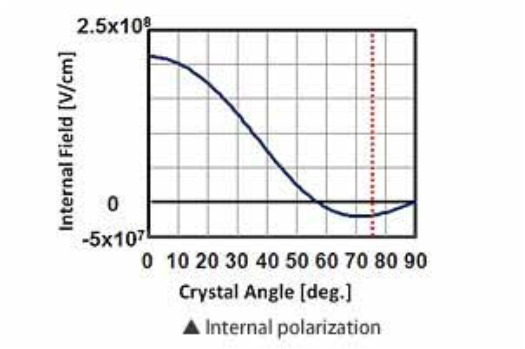
▲ Conventional c-plane ▲ Semi-polar (20$\bar{2}$1) plane ▲ 2-inch (20$\bar{2}$1) substrates

The device was grown using a semi-polar (20-21} GaN substrate. In this instance, the plane is tilted 75 degrees compared to the conventional GaN crystal *c*-plane. The semi-polar GaN substrate enables the sustainable production of homogenous indium-based active layers, leading to the successful growth of a high quality light-emitting layer.



▲ Schematic illustration of true-green laser diode and structural device

In GaN-based green light-emitting devices, luminous efficiency declines in the green region due to the internal field effects resulting from distortion in the crystal structure and the resultant internal polarisation. It is possible to suppress the internal field effects by adopting semi-polar GaN substrates. However, this isn't enough; it is also necessary to optimise the entire laser production process, and this is exactly what the joint venture did, building on Sony's knowledge. Sumitomo Electric and Sony managed to reduce the operating current and voltage in the laser through the optimisation of the laser structure, impurity control in crystal, and minimisation of electrode resistance.



▲ Internal polarization

In the future, the two companies will continue to jointly develop true green semiconductor laser diode to achieve even higher output power, efficiency, and laser quality.

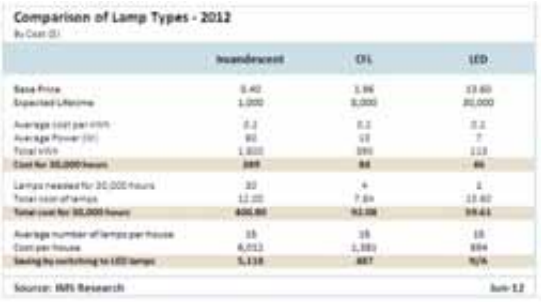
LED lamps to save $100 billion over 5 years

In the long term, LEDs for lighting should overtake the CFL lamp market despite the fact that CFLs are currently the most economical choice,the widespread adoption of retrofit LED lamps will create global energy savings worth $100 billion over the next five years, according to a recent report from IMS Research, recently acquired by IHS. Although the use of LED lamps for general lighting is not currently widespread, IMS Research's report "Opportunities for Power Components in LED Lighting," revealed that a rapid uptake of retrofit LED lamps will result in a potential market of more than 4 billion units by 2016.

The report was compiled following more than 40 hours of interviews with leading suppliers to the industry. Whilst adoption is currently driven largely by legislation, it is forecast to accelerate as consumers become more aware of the long term savings that are attainable when compared with competing lighting technologies. Report Co-Author and Senior Market Analyst Ryan Sanderson comments, "The environmental impact that global adoption of LED lighting will have is colossal.

Lighting accounts for approximately 19 percent of the world's energy use at present. IMS Research predicts that in 2016 around 15 percent of all lighting will be accounted for by LED, which would reduce global energy consumption of lighting by around 20 percent." Retrofit LED lamps use a fraction of the power of incandescent lamps to provide a similar luminance IMS Research forecasts that in 2012 alone, the use of retrofit LED lamps in place of incandescent lamps will result in energy savings of more than 30 GW hours. By 2016, with widespread adoption of retrofit LED lamps, these savings are forecast to reach more than 300 GWe.

It is calculated that the five-year cumulative total will be more than 800 GWe, worth more than $100 billion. Another of the co-author of the study, Jonathon Eykyn adds, "To generate the 800 GWe of energy in 2016 years you would need to run more than 50 nuclear power stations at full capacity. At a time when the world is struggling to balance the use of more sustainable power sources with the need to provide access to low cost power sources to support economic growth, LED lighting could be a large part of the solution." The benefits of using LED lamps to the general consumer are reductions in average household energy bills. Currently, it costs the average household $20 to buy and power an incandescent lamp for four hours a day for a year. To buy and power an LED lamp for the same time period would cost $16, a saving of 20 percent. However, compact fluorescent lamps (CFLs) compete much better on efficiency with LED lamps and are becoming a popular lower-cost alternative to incandescent lighting.


Comparison of Lamp Types - 2012

	Incandescent	CFL	LED
Base Price	0.40	1.96	13.60
Expected Lifetime	1,000	5,000	30,000
Average cost per kWh	0.2	0.2	0.2
Average Power (W)	60	13	7
Total kWh	1,800	390	210
Cost for 30,000 hours	360	84	46
Lamps needed for 30,000 hours	30	6	1
Total cost of lamps	12.00	7.84	13.60
Total cost for 30,000 hours	400.80	92.08	59.61
Average number of lamps per house	15	15	15
Cost per house	6,012	1,381	894
Saving by switching to LED lamps	5,118	487	N/A

Source: IMS Research — Jun-12

Despite a CFL lamp currently costing on average just $6 to buy and power for a year, making it the most economical choice today, LED lamps use, on average, half of the power of a CFL lamp. Therefore, the advantages of LED lamps become apparent in the longer term, helped by dislike of CFLs due to their poor light quality. An LED lamp has an average life expectancy of 30,000 hours which is 30 times longer than an incandescent lamp and 3.75 times longer than a CFL lamp. If the savings were calculated over the lifetime of the lamp, LED lamps become the cheapest solution. For example, a typical house with 15 lamps would

save more than $5,100 over 20 years by switching from incandescent to retrofit LED lamps. A house with CFLs installed would save nearly $500 over 20 years by moving to retrofit LED lamps. These savings will increase as the cost of LED lamps continues to fall significantly, especially over the next five years.

How to 'heal' plasma-damaged GaN with hydrogen radical treatment

Exposing plasma-damaged GaN to high doses of H radicals, restores the photoluminescence to almost the level of unetched GaN

Gallium nitride (GaN) is a highly promising material for a wide range of optical and high-power electronic devices, which can be fabricated by dry etching with plasmas.

However, the plasma-induced defects and surface residues that remain after such processes tend to degrade the optical and electrical properties of the devices.

Now, a team of Japanese researchers has developed and tested a new way to "heal" such defects.

The team exposed plasma-damaged GaN to hydrogen (H) radicals at room temperature. After testing various doses of H radicals, the researchers evaluated the optical properties of the GaN. The intensity of light emitted when electrons near the edge of the valence shell in GaN absorbed and then re-emitted photons drastically decreased after chlorine plasma-beam etching. After treatment with the higher-level doses of H radicals, however, the photoluminescence was restored to almost the level of unetched GaN.

The researchers say it is likely that the H radicals terminated the dangling bonds of gallium on the GaN surface, as well as desorbed the surface residues and that these two factors led to the recovered optical performance. A key characteristic of the new healing process is that it is performed *in situ*, immediately after the etching process. This is important because unwanted surface oxidation can easily occur on plasma-damaged GaN that is exposed to air.

Further details of this work have been published in the paper, "Photoluminescence recovery by in-situ exposure of plasma-damaged *n*-GaN to atomic hydrogen at room temperature," by Shang Chen *et al, AIP Advances*, 2, 022149 (2012).

Enhancing efficiency of GaN LEDs with copper substrates

The internal stresses generated when the gallium nitride crystals originally formed on the silicon substrate are reduced when the epilayers are transferred to a copper substrate

Researchers from Sun Yat-sen University, Guangzhou, China,have succeeded in transferring GaN LEDs grown on a layer of silicon to a layer of copper.

The new copper substrate enabled the GaN crystals to release some of the internal stresses generated when they originally formed. This relaxation helped minimise the so-called "quantum confined Stark effect," a vexing problem for LEDs that reduces their efficiency.

In comparison with LEDs on silicon substrates, the light output of LEDs on copper was enhanced by 122 percent. The relocation of the LEDs produced no obvious deterioration in the crystals' light-emitting region, known as multiple quantum wells.

The researchers attributed the improvements in efficiency to a number of factors. These included the removal of the absorptive substrate, the insertion of a metal reflector between the LEDs' structure and the copper submount. The elimination of electrode shading, which reduces efficiency and the rough surface of the exposed buffer layer, which improves crystal orientation on the substrate, also layed a part .

Further details of this will be described in the paper, "Crack-free InGaN multiple quantum wells light-emitting diodes structures transferred from Si (111) substrate onto electroplating copper submount with embedded electrodes," by Tufu Chen *et al,* which has been accepted for publication by the American

Institute of Physics' journal *Applied Physics Letters*.

1080p LED hybrid laser projector unveiled by ViewSonic

The new projector is targeted towards the pro AV market. In the system, the combination of LED and laser light result in a vibrant and rich display colour

ViewSonic, aglobal provider of computing, consumer electronics and communications solutions, is expanding its professional projector series with the new Pro8300, while previewing its LED hybrid laser technology in the Pro9000.

Pro8300 LED laser projector

In ViewSonic's new hybrid laser andLED Full HD Pro9000 projector, the LED light and lasers combine to create a single light source, resulting in vibrant and rich display colour that the firm says far exceeds that of a normal mercury light projector.

In addition to being environmentally friendly, this mercury-free technology also delivers a longer operation life of over 20,000 hours. Coupled with dual HDMI ports and its lamp-free design, the Pro9000 is ideal for home cinema environments and Pro-AV installations. The Pro9000 is expected to be available in Q3 2012.

"Laser hybrid illumination technology has changed the way that projectors are able to manipulate light and images. This new model is lamp-free for an even lower total cost of ownership. As a result, users get a higher quality picture and ultra high contrast ratio, making projectors with this technology ideal for home entertainment, professional audio-video, corporate or education use," saysRoger Chien, product manager for ViewSonic.

The Pro8300 professional 1080p commercial grade projector is suited tobusiness data projection. It incorporates ViewSonic's "BrilliantColorTechnology" with a powerful Pixelworks10-bit image processor for vivid colours, while its 1920x1080 native resolution, 3,000 ANSI lumens and a 4,000:1 dynamic contrast ratio produce razor sharp images that shine in virtually any ambient light environment. Paired with a wide 1.5X optical zoom adjustment for more than 36% additional zooming capability and integrated speakers, the Pro8300 delivers stunning audio and visual experience.

"Full HD resolution has become somewhat of a standard feature across consumer home and cinema entertainment projectors; however, finding hi-def capabilities in a quality yet affordable projector offering for businesses is far less common," continuesChien. "Our Pro8300 breaks tradition by bringing precise standalone 1080p projection to business owners and corporations at a price that's within reach for any company."

RGB chipsets improve projector performance by up to 40%

Luminus says its latest nitride Big Chip LED is the world's brightest

Luminus Devices has announced it has tripled the brightness of its semiconductor green LEDs over the last five years, and expects to at least double it again.

Green light is the major primary colour that contributes to white light generation in systems with Red-Green-Blue illumination, and the performance of Green LEDs is considered by the industry as the major limiting factor in replacing high pressure mercury lamps in projection displays.

Combined with its thermally-enhanced packaging technology, Luminus' latest achievements in Pure Green LED output allow its projection-optimised RGB chipsets to achieve new performance levels in projection system categories covering portable,

home video, video walls and mainstream business and education.

For instance, the company's latest 5.4 mm2 green LED can output up to 3000 lumens at a current density of 3.0 A/mm2. This chipset allows system manufacturers to design portable LED projectors with performance in excess of 700 lumens, a 40% improvement over products introduced only 1 year ago.

"The rapid pace of improvement of our Pure Green LEDs is a testimony to the large untapped potential of this technology," says Arvind Baliga, VP of Engineering. "Alternative approaches such as phosphor conversion technologies rely on mature platforms with limited upside potential and also come with a broad spectrum that results in increased optical losses of up to 20%."

"Our customers recognise that Luminus Projection Chipsets enable the brightest projectors today and more importantly, place them on a faster trajectory to transition their portfolio to a lamp-free model. Increased investment in R&D and rapid prototyping will dramatically accelerate our progress in reaching brightness targets needed to move into the business and education segments," notes Baliga.

"Luminus' world's brightest green LED just got better, and the best testimony to this achievement is over 1 million consumer and professional of lamp-free projection displays that have been deployed using our technology - a market that did not even exist only 4 years ago," adds Stephane Bellosguardo, Director of Global Product Marketing at Luminus Devices.

"After virtually eliminating lamps in markets such as video walls, our technology is now gaining similar momentum in consumer video, education and business projection markets. With RoHS exemptions for most high pressure mercury lamps set to expire in 2015, these latest advancements in Pure Green LED technology provide our customers with a path towards an environmentally friendly light source that combines cost-effectiveness and performance."

Luminus will be showcasing its latest advances in LED technology at InfoComm 2012 in Las Vegas at booth #C7942 at the Las Vegas Convention Centre.

Plessey aims to provide GaN-on-Si LEDs with Aixtron reactor by year end

The first Aixtron CRIUS II-XL Reactor will be used to set up a process for growing gallium nitride-on-silicon LEDs. Aixtron SE has a new MOCVD system order from Plessey Semiconductors Ltd., UK.

The contract is for the first of a set of production ready CRIUS II-XL reactors in a 7x6-inch wafer configuration. The reactors are dedicated to the growth of high brightness LED wafers based on GaN-on-Silicon materials.

Barry Dennington, COO of Plessey Semiconductors, comments, "We are on schedule for the production of a world class LED that will become the high performance lighting LED at the price breakthrough the market has been waiting for. We completed the acquisition of the University of Cambridge spin-off company CamGaN in February 2012 and are now installing the capability for the full commercial exploitation of GaN-on-Silicon technology. Furthermore, we will be in early prototype production before the end of Q3 2012 and in full production by Q2 2013."

CamGaN has already developed a six inch GaN-on-Silicon process on a single wafer Thomas Swan reactor and this process will be transferred to Plessey's Plymouth plant onto the new Aixtron reactor. According to sources at Plessey, the firm aims to purchase further reactors once the manufacturing process has been established on the CRIUS II-XL tool.

Neil Harper, HB LED Programme and Product Line Director, adds "The CRIUS II-XL reactor will form the basis of our commencement of full production of materials for LEDs. Plessey's branded MAGIC (Manufactured on GaNICs) LEDs will be fabricated on large area silicon substrates through our 6-inch integrated circuit fabrication line in Plymouth. Aixtron's latest CRIUS technology has many advantages that meet our needs, such as the best cost-of-ownership for GaN epi-layer growth on 6-inch silicon substrates and eventually on 8-inch silicon substrates. In addition, we can draw upon the excellent support services in the UK from Aixtron Ltd. and Aixtron Europe.

"Bernd Schulte, COO of Aixtron, adds, "We are very pleased to be able to make this announcement.

Plessey is a well-established name in the electronics industry and they are now accelerating the commercial exploitation of one of the most promising areas of epitaxial technology, GaN-on-Silicon. Plessey technology has the potential to transform the LED industry by lowering the cost of LEDs as demanded by the solid state lighting industry. Aixtron is well positioned to meet the challenges provided by Plessey's technology and looks forward to this exciting next wave of the LED market."

Earlier this year, Plessey announced its plan to bring to market low cost 'MAGIC' HB-LED products, initially for the replacement incandescent bulb market, within the next six months. The firm also plans to develop a range of smart-lighting products that incorporate Plessey's existing unique sensing and control technologies.

Revolutionising displays with indium, gallium and zinc oxide technology

A new material should enable even higher resolutions, lower power consumption, and higher performance touch screens, as well as narrower bezel widths for LCD display panels used in mobile devices such as smartphones

Sharp Corporation and Semiconductor Energy Laboratory (SEL) have jointly developed a new oxide semiconductor (IGZO) technology with high crystallinity.

This jointly developed new IGZO technology imparts crystallinity in an oxide semiconductor composed of indium, gallium and zinc. Compared to current amorphous IGZO semiconductors, Sharp says this new material enables even smaller thin-film transistors to be achieved and provides higher performance.

Sharp believes that IGZO will be adopted for use in LCD displays for mobile devices such as smartphones where the trend toward higher screen resolutions is growing increasingly strong. What's more, it can also be adapted for use in organic EL displays which hold out high expectations for the future.

Although challenges to commercialisation remain in terms of both service life and production, the two companies will continue to push ahead with R&D in anticipation of future market needs.

Aiming towards early commercialisation in LCD displays using this new IGZO technology, the two companies will also be pursuing R&D to expand the use of this material in non-display devices and to develop applications other than displays in the future.

The LCD display will have a screen size of 4.9 inch by 6.1 inch and a pixel resolution of 720 x 1280 and 2560 x 1600. The pixel density will be 302 ppi and 498 ppi. Envisioned applications include mobile devices, in particular smartphones.

During the development of the oxide semiconductor, Sharp and SEL found a new crystalline structure and have named it CAAC (*C*-Axis Aligned Crystal) structure.

Single crystal IGZO is characterised by having a hexagonal structure when seen from the *c*-axis direction and a layered form when seen from the direction perpendicular to the*c*-axis (see Figs. 1 (a) and (b)).

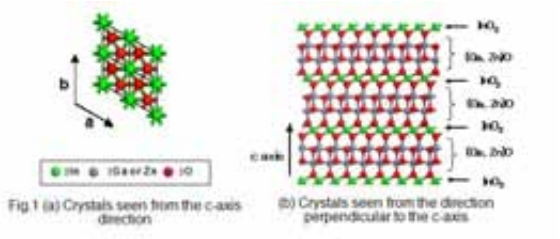


Fig.1 (a) Crystals seen from the c-axis direction (b) Crystals seen from the direction perpendicular to the c-axis

The researchers found the IGZO layer is a crystalline hexagonal structure, as shown in a plane TEM image and cross-sectional TEM image, depicted in Figs. 2 (a) and (b)

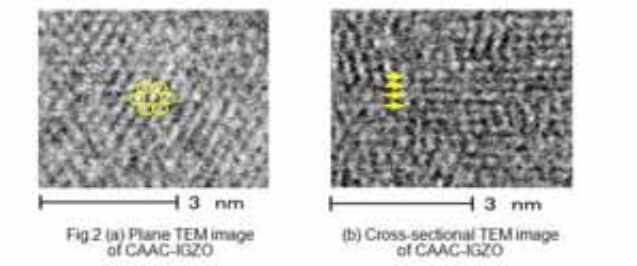


Fig.2 (a) Plane TEM image of CAAC-IGZO (b) Cross-sectional TEM image of CAAC-IGZO

Another cross-sectional TEM image shows the relationship between a surface of the layer and the

c-axis: the *c*-axis of the IGZO crystal is aligned in a perpendicular direction to the surface of the layer see Fig. 3(a), (b) The name of the structure, the*C*-Axis Aligned Crystal CAAC structure, comes from this relation.

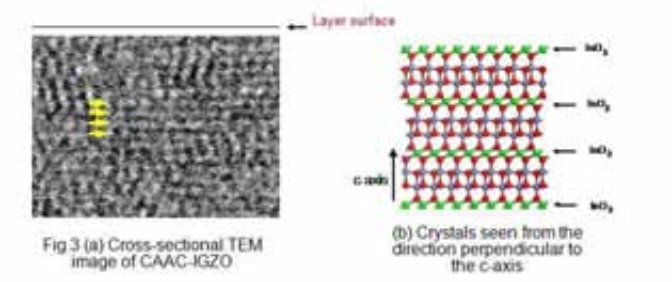


Fig 3 (a) Cross-sectional TEM image of CAAC-IGZO

(b) Crystals seen from the direction perpendicular to the c-axis

A conventional amorphous IGZO TFT has had a problem of shift in electrical characteristics in the gate bias temperature (BT) stress tests, especially in the gate BT stress tests with light irradiation. Meanwhile, a CAAC-IGZO TFT is less influenced by (is resistant to) the gate BT stress tests with light irradiation and has high reliability (see Fig. 4(a), (b)), which means that the TFT can be stable with CAAC-IGZO.

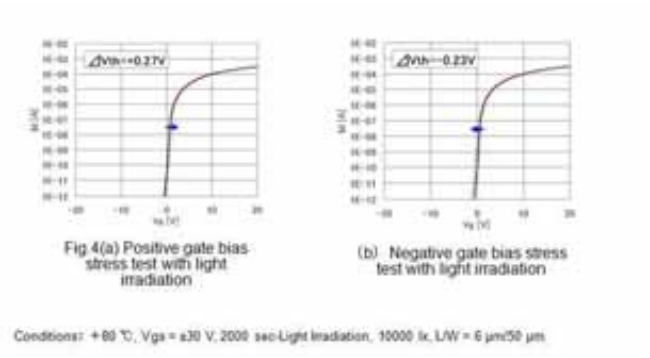


Fig 4(a) Positive gate bias stress test with light irradiation

(b) Negative gate bias stress test with light irradiation

China to benefit from Cree LED technology centres

The firm has unveiled new centres in Shenzhen and Shanghai to aid customers in luminaire design and evaluation services to help accelerate LED product development

Cree is opening two new technology centres in China, further expanding its TEMPO (Thermal, Electrical, Mechanical, Photometric, Optical) Services in these key markets.

The technology centres support demand for Cree products and services throughout China and demonstrate Cree's commitment to accelerate broader market adoption of LED lighting.

The firm's TEMPO services provide LED lighting manufacturers a comprehensive suite of evaluation services for LED luminaires – ensuring customers have information needed to design and market quality LED products.

The new technology centres will offer a range of TEMPO Services to meet the unique needs of lighting manufacturers in China, including the Cree TEMPO 21 and TEMPO Thermal Simulation Services.

Cree's experience indicates that many of the common quality issues and failure modes seen in Solid State Lighting products are not detected by currently available standardised tests. TEMPO 21 examines critical aspects of quality that commonly go unchecked such as chemical compatibility, driver spikes, dimmer compatibility and electrolytic capacitor analysis.

"Cree delivers our customers end-to-end development support and the opening of our new technology centres in Shenzhen and Shanghai is further evidence of our commitment to their success," says Tang Guoqing, senior advisor, Cree Hong Kong Limited.

"TEMPO Services can give manufacturers competitive advantages by helping them avoid costly design mistakes and by providing access to a broad range of test environments that are, in many cases, cost-prohibitive for them to build and operate."

Effective LED luminaire thermal design is essential to ensure reliability and optimum performance. TEMPO Thermal Simulation predicts the thermal behavior of LED-based fixtures, including junction temperature, heat sink temperature, temperature profile and airflow profile.

TEMPO SPOT gives customers access to complex, costly equipment to measure the photometric performance of luminaires and replacement lamps. Every TEMPO Service delivers an accurate, easy-to-understand TEMPO report that includes all testing results and relevant performance data.

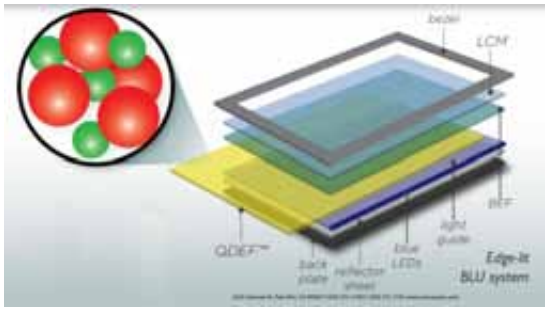
Apart from the new centres in China, Cree currently provides TEMPO Services at its U.S. technology centres located in Durham, N.C. and Santa Barbara, California.

Nanosys and 3M to brighten up LCDs with QDEF technology

The companies will further develop quantum dot technology for consumer displays. Nanosys and the Optical Systems Division of 3M Company are unting to provide wide colour gamut technology for consumer electronic displays, allowing Liquid Crystal Displays (LCDs) to display 50 percent more colour.

3M and Nanosys will work together to commercialize Nanosys' Quantum Dot Enhancement Film (QDEF) technology.

The QDEF drop-in film's active material is composed of Nanosys' proprietary, high efficiency quantum dot phosphors. These tiny phosphors convert blue light from a standard GaN LED into different wavelengths based upon their size.



Larger dots emit longer wavelengths (red), while smaller dots emit shorter wavelengths (green). Blending together a mix of dot colours allows the engineering of a new spectrum of light.

LCD manufacturers can integrate QDEF with existing production processes. It utilises the light emitting properties of quantum dots to create an ideal backlight for LCDs, one of the most critical factors in the colour and efficiency performance of LCDs.

"Combining the world class-technology and materials expertise of Nanosys with the engineering, design and supply chain capabilities of 3M will unlock a powerful new colour viewing experience for consumers," says Jim Bauman, Vice President of the Optical Systems Division at 3M.

Over the years, 3M technologies have improved LCD performance. However, colour performance of LCD's has gone largely unchanged. Current LCDs are limited to displaying 35 percent or less of the visible colour spectrum. This means the viewing experience on an LCD is vastly different than to what a person sees in the real world. Wide colour gamut displays will allow consumers to enjoy more visceral, more immersive and truer to life colour.

"We are working together to improve an area of display performance that has been largely neglected for the last decade," adds Jason Hartlove, President and CEO of Nanosys. "Improving colour performance for LCDs with drop-in solutions will bring a stunning new visual experience to the consumer and a competitive advantage to the LCD manufacturer against new display technologies such as OLED. Working together with 3M and utilising their outstanding design and supply chain capabilities will allow our QDEF technology to be widely deployed across all product segments and will ensure availability to all customers."

A quantum dot, which is 10,000 times smaller than the width of a human hair, can emit light at a very precise wavelength. The ability to control the spectral output of a quantum dot allows QDEF to create an ideal white backlight specifically designed for LCDs.

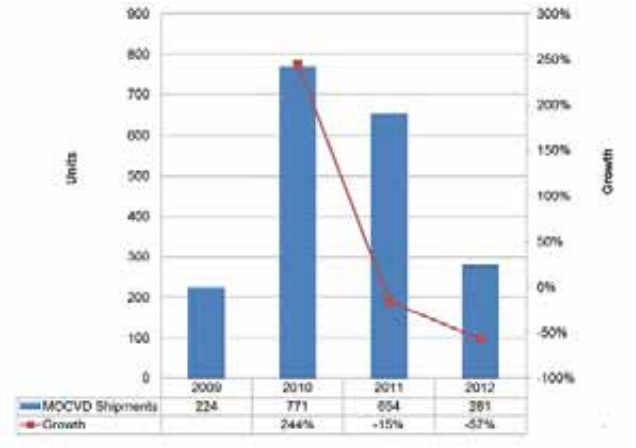
Trillions of these quantum dots are packaged into a thin film that fits inside an LCD backlight unit. QDEF replaces a similar film already found inside LCD backlights, which means that adding QDEF to manufacturing processes requires no new equipment or process changes for the LCD manufacturer.

Veeco to overshadow Aixtron in GaN MOCVD LED equipment market

Due to overcapacity, projected shipments of reactors used in the growth of gallium nitride based LEDs have been downgraded for 2012. Veeco will also have a clear lead over Aixtron for GaN LED tools for the full year 2012

IMS Research has cut its forecast for 2012 GaN MOCVD shipments to 281, according to the second quarter 2012 MOCVD update of its "GaN LED Quarterly Supply and Demand" report.

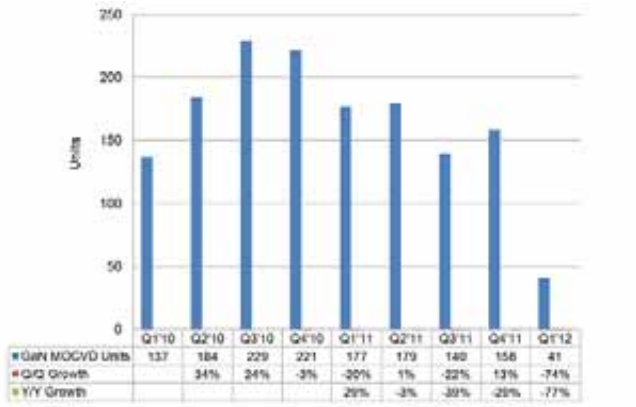
IMS Research Analyst Jamie Fox comments, "The decline in 2012 is due to sufficient tools being in place for backlighting, lighting not yet fully taking off and expiring subsidies in China. The revision to our forecast is due to an analysis of the latest supplier earnings calls and our latest surveys of manufacturers which showed that some companies' purchase plans have been cut back more than expected in recent months, particularly in China. We have heard about capacity utilisation moving up in Taiwan this quarter, but we don't see this as a worldwide trend at the moment."



The graph above shows that 2012 shipments will be much lower than 2010 and 2011, but will still be higher than in 2009.

2012 will be a quiet year as, in terms of equipment installation, it will be the low point between the backlighting and lighting cycles. After a huge rush to buy in China in 2011 (it peaked at 92 percent of shipments in the fourth quarter), sales here are dropping significantly in 2012.

The entire worldwide market in the first quarter of 2012 was about the same size as the one largest order in China in the fourth quarter of 2011. However IMS Research believes the market has bottomed out in the first half of 2012 and that modest growth should return in the second half of 2012.



While the industry is currently in an overcapacity situation which will continue in the short term, longer term projections show that many more reactors will be needed over the coming years to meet the demand in lighting.. At present, big changes to the long term outlook are not anticipated.

Last quarter IMS reported on a strong quarter for Aixtron, which regained the lead in the fourth quarter of 2011. However, as anticipated, this has not lasted, and Veeco was well ahead again in the first quarter with an estimated 59 percent market. Veeco will also have a clear lead over Aixtron for GaN LED tools for the full year 2012, according to surveys with end customers.

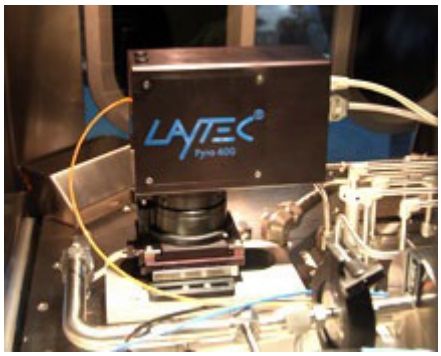
What's more, with Veeco having very recently released three new MOCVD systems for LED growth , this may further improve the firm's market share.

According to IHS, China came top in terms of shipments in the first quarter, followed by Taiwan. With typical tool prices remaining at about $2 million, Veeco's K465i, used for the growth of gallium nitride based LEDs, was the most popular tool in the first quarter. Also, according to IHS, Epistar is the leader in cumulative tools installed, while Elec-Tech is ranked top in projected 2012 customers.

LayTec's Pyro 400 endorsed by GaN LED manufacturer Lextar

The pyrometer, which operates in the 400nm range, has been specifically designed to measure real surface temperature in gallium nitride based LEDs. The temperature can be correlated to wafer bow and optimised to improve wafer yields

Lextar Electronics, a major Taiwanese LED producer, headquartered in Hsinchu, has qualified LayTec´s GaN surface temperature measurement tool Pyro 400 for its GaN LED production.



Pyro 400 on Aixtron planetary reactor

A niggling problem in today's GaN based LED production is the inability to measure and control the real wafer temperature during epitaxial growth. The real surface temperature of GaN-based materials is sensitive to changes in carrier gas, rotation speed, and reactor pressure.

To measure the real temperature in III-nitrides, it is not possible to use conventional infrared pyrometry (which is around 950nm). To overcome this problem, Laytec has developed the Pyro 400 ; it measures the exact surface temperature of GaN layers using pyrometry at 400 nm. At this wavelength GaN absorbs and thermally emits light.

Another important factor in LED manufacturing is wafer bow and temperature uniformity; this is critical for III-nitride process yield enhancement. LayTec says its Pyro 400 provides excellent insight into the correlation between the wafer bow and real wafer surface temperature uniformity.

Johnson Wang, the department manager of EPI Engineering/Manufacturing, who was responsible for the Pyro 400 product qualification process, states, "With Pyro 400 we can now better control the later emission wavelength of the LED already during growth. The qualifications tests have proven that the surface temperature of the GaN measured by Pyro 400 at MQW growth can be directly correlated with the later ex-situ PL emission wavelength. This tool is a quantum leap in wafer-to-wafer temperature control in LED Production."

Elisabeth Steimetz, Director, Marketing & Sales at LayTec, adds, "The qualification of Pyro 400 by Lextar is a significant milestone for LayTec. Through collaboration with this important and innovative customer we were able to further improve our product and qualify it for daily LED production application. We could successfully demonstrate that precise surface temperature control gives room for even further LED yield improvement and cost reduction. We are very thankful to Johnson Wang and his team at Lextar Corporation for giving us the opportunity to qualify the product."

New suite of GaN LED MOCVD tools revealed by Veeco

The three new reactors, suited to the growth of gallium nitride based LEDs, come in 2, 4, 6 and 8" wafer configurations

Veeco Instruments has introduced three new models of its TurboDisc MOCVD systems for the production of high brightness LEDs.

These are the TurboDisc MaxBright M, TurboDisc MaxBright MHP and TurboDisc K465i HP.

MaxBright MHP reactor

The MaxBright M is a modular and more compact version of Veeco's multi-reactor system. It is claimed to provide easier serviceability and up to 15% improved footprint efficiency compared to Veeco's MaxBright tool. It also features improved layout configuration flexibility to accommodate various fab spacing requirements.

The MaxBright MHP, is a high performance version of the new modular "." described above. Veeco says this model provides as much as 20% within-wafer wavelength uniformity improvement over the MaxBright. Higher yields are achieved from technology advancements that result in improved thermal and flow capability. The MaxBright MHP also provides lower cost of ownership as compared to MaxBright.

The final reactor is the K465i HP, which a high performance option for Veeco's single-reactor MOCVD system . It apparently delivers up to 20% within-wafer wavelength uniformity improvement compared to the K465i and a lower cost of ownership.

These new systems are available in 2, 4, 6 and 8" configurations.

Veeco says existing MaxBright and K465i systems are easily field-upgradeable to the high performance HP option. All of Veeco's MOCVD systems feature its TurboDisc technology, which enable very good throughput.

William J. Miller, Ph.D., Executive Vice President, Veeco Process Equipment, comments, "This new suite of products provides our customers with tremendous flexibility to make the most of their capital investments and choose the system that works best in their unique production environment. The innovation in the MaxBright M, MaxBright MHP and K465i HP was accomplished by listening to our customers and focusing on system improvements that could drive their productivity and yield – two critical factors in our customers' success."

John R. Peeler, Chairman and Chief Executive Officer of Veeco adds, "This new product line-up, all based on our industry leading technology and automation expertise, can help to accelerate worldwide adoption of LED lighting by reducing manufacturing costs. Veeco remains committed to providing the industry's highest capacity, highest throughput and lowest cost of ownership MOCVD systems available."

According to IMS Research, the K465i, introduced in 2010, was the top selling MOCVD tool that year, and the MaxBright, launched in 2011, was the top seller last year.

Earlier this year, Compound Semiconductor Magazine awarded Veeco the "Compound Semiconductor Manufacturing Award, stating "MaxBright was the biggest breakthrough in compound semiconductor manufacturing over the last 12 months."

China's Sinoepi to enhance nitride LED production with Aixtron system

The company, which specialises in indium gallium nitride wafer and chip manufacturing, has ordered a 69 x 2-inch CCS reactor from the MOCVD equipment specialist

Aixtron SE has a new customer in Sinoepi, a manufacturer of epitaxial wafers and chips used for LEDS.

The Chinese firm has placed an order for one MOCVD system, a CRIUS II-L reactor in a 69 x 2-inch wafer configuration. The system will be used for the production of epitaxial wafers for ultra-high brightness (UHB) GaN based LEDs.

The reactor was ordered in the fourth quarter of 2011 and was delivered during the second quarter of 2012. Aixtron´s local service support team will install and commission the CRIUS II-L at the Sinoepi production complex located in Beijing.

"Although this is our first new piece of equipment from Aixtron, my team is already very familiar with CRIUS technology," says Ye, General Manager of Sinoepi.

"We are particularly impressed with its high performance-to-cost ratio compared to other systems, as well as the seamless and short process transfer. CCS technology is well established around the world due to its outstanding reputation

for producing superior performance LEDs. The CRIUS II-L matches our requirements for very high throughput epitaxial growth of nitride-based wafer materials excellently. It will enable us to develop our processes quickly and efficiently," he continues.

"On behalf of the Aixtron team involved in the lead-up to this very important new order, I am delighted to announce that another customer is about to benefit from the excellent characteristics of this generation of Aixtron CRIUS systems," adds Bernd Schulte, Aixtron's Chief Operating Officer. "Sinoepi has opted for the CRIUS II-L after thoroughly evaluating all systems currently available on the market. The CRIUS II-L has already set new industry standards which we back up with a service that provides everything our customers need to ramp up their production. We look forward to expanding our relationship with Sinoepi."

Founded in August 2010, Sinoepi Co., Ltd. is located within the Beijing Economic and Technological Development Area. The company's main products include UHB InGaN LED epitaxial wafers and chips for use in LCD TV backlighting and LED solid-state lighting, as well as other applications.

Kyma's new K-Slice diamond wire technology cuts sapphire

The wire technology, which was initially used to cut silicon carbide and gallium nitride, has been modified so that it can now be used to cut sapphire

Kyma Technologies has announced the improvement and successful application of its proprietary and exclusively-licensed, patent-pending K-Slice diamond wire technology.

The process is used for the slicing of high quality sapphire boules for LED substrate manufacturing.

The first slices from a 2" LED quality sapphire boule using Kyma's K-Slice super-abrasive diamond wire technology in a commercial multi-wire saw configuration

Kyma says its K-Slice diamond wire utilises a steel core and metal matrix approach which has several advantages over competing diamond wire technologies. The K-Slice diamond wire is claimed to be more durable than that produced using steel plus epoxy approaches, is less costly than that produced using electroplating techniques. The firm also says it features high thermal conductivity and a long wire lifetime.

While Kyma has routinely used K-Slice diamond wire to slice such hard materials as GaN and SiC, initial attempts to slice sapphire (Al2O3) boules indicated there was opportunity to further improve the K-Slice manufacturing process.

Eugene Shishkin, Kyma's Senior Wafering Engineer, investigated how the K-Slice manufacturing process could be modified to create a more sapphire-friendly wire. His efforts were successful and have helped Kyma to greatly improve the quality and speed of slicing 2" diameter sapphire boules while maintaining low kerf loss and long wire lifetime.

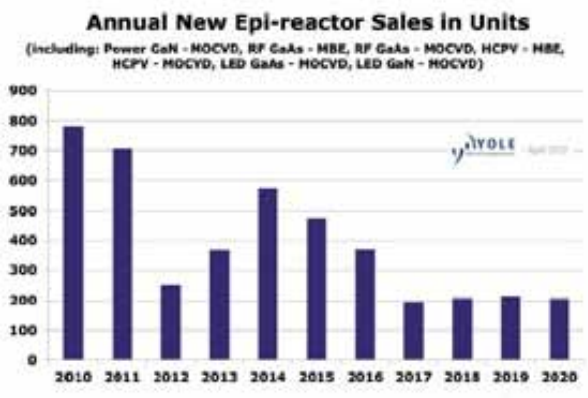
Kyma's K-Slice diamond wire is available on spools with a wire length between 1km and 3km. It is available with an outer diameter of 220-225µm and diamond size 20-30µm. Other wire diameters and diamond sizes are available upon request.

The market for nitride semiconductor devices was about $9 billion in 2011 and is expected to surpass $60 billion over the long term, including $30 billion in visible lighting applications and $30 billion in power electronics applications.

Veeco, Aixtron and Riber still rule the roost in epitaxy

Although there are another fifteen players in the MOCVD and MBE markets, they have had trouble establishing themselves due to the dominance of the other three firms

A new report , "III-V Epitaxy Equipment & Applications Market", from Reportlinker.com says that MOCVD and MBE are the techniques used to grow practically all III-V wafers. OK, but tell us something we didn't know. So what else has been revealed in the study? Well, apparently, the MBE and MOCVD market combined is predicted to hit around $6.1 billion between 2012 and 2020.



LED is by far and away the single largest application for MOCVD. In 2010 and 2011, the MOCVD market experienced the largest investment cycle in its history driven by a combination of drivers. These included demand for LED backlit LCD TVs, subsidies by the Chinese central and local governments and expectation in the general lighting market. On the down side, this has put the market into a significant overcapacity situation that could take 12 to 18 months to absorb. The next investment cycle driven by lighting applications and expected to start in 2013, will be more limited than the previous cycle due to improvements in equipment throughput and yields.

Following this cycle, further Cost of Ownership (COO) improvements offered by the next generation of MOCVD reactors should justify the replacement of 2nd generation-old reactors installed during the 2010-2011 boom and drive a last small equipment cycle in the second half of the decade. By that time, power GaN will also represent a substantial upside for reactor makers. All in all, MBE use is heavily driven by R&D systems (over 50% of the total market) and laser applications (telecom, industrial, medical, research) that are not covered in the report. Regarding applications covered in the report, the MBE market is predicted to be essentially driven by the continuous growth in the cell phone and wireless applications that are making heavy use of GaAs based RF components. Emerging applications like smart grid and the trend towards increasing connectivity and "intelligence" incorporated in many consumer products will provide further opportunities. But, alternative technologies such as silicon CMOS, LDMOS, SoS, HR SOI represent a potential threat; they could capture shares of the GaAs RF market and reduce the opportunity for MBE.

What's more, MOCVD is making progress in HEMT manufacturing. HCPV, however, could provide a small potential upside for MBE makers. MOCVD and MBE equipment market are duopolies but many emerging players could change the landscape: Aixtron and Veeco are the leaders in MOCVD, and together represented 96% of the market in 2011. Production MOCVD reactors are complex systems. Design and optimisation require expertise in multiple fields including flow dynamics, thermodynamics, chemistry, mechanical and electrical engineering. This makes technological barriers into the market pretty high. More than fifteen emerging players have been identified but so far, have been struggling to capture any sizeable share of the market. But the pressure is mounting and established MOCVD makers will need to maintain that technology gap to keep emerging competitors at bay. The main battlefield is that of total cost of ownership. Established MOCVD makers all have technology roadmaps to enable COO reduction of three to four times more within the next 5 years through a combination of improved yields, throughputs and precursor utilisation efficiency.

For MBE, Riber and Veeco are the only two players offering large capacity / large throughput MBE production tools for volume manufacturing. Reportlinker.com expects they will maintain this dominancy. However, there are about ten other MBE manufacturers offering R&D or pilot production systems that also have a strong presence on the general MBE market (DCA, SVT, Eiko among others).

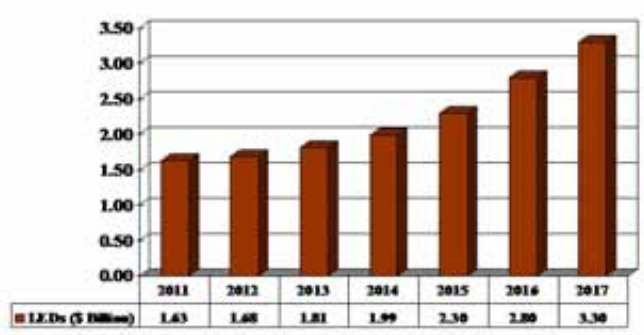
Potential overcapacity in MO precursor supply: The Metal Organic precursor market will also be essentially driven by LED applications. But MOCVD reactor technology improvements ; yield, consumption and wafer size to name but a few, will lower the amount of TMGa and TMIn needed per cm^2 of epiwafer. The 2010 metal organic shortage ended mid 2011 thanks to aggressive capacity expansion by leading suppliers. Further capacity expansion plans from established and emerging suppliers could come online within the next 3 years. If executed as announced, Reportlinker.com expects significant oversupply starting from 2012 that could continue through 2016 and beyond. This situation could put pressure on prices. Further MO synthesis technology improvements could provide opportunity for cost reductions. However, the usually volatile prices of raw indium and gallium also have a significant impact on cost.

LED market to boom in Asia Pacific region

The American region and the Asia Pacific region (APAC) have an even market share this year. However, the APAC region is forecast to expand at a faster pace

ElectroniCast Consultants has released a new market forecast of the global market consumption of packaged LEDs used in signage and professional displays.

According to the firm's " Global Market Review & Forecast (2011-2017) ", the consumption value will increase with rising quantity growth largely offset by declining average prices. Global consumption value LEDs used in signage & professional displays in 2011 was over $1.63 billion, up from $1.5 billion in 2010. In the year 2017, consumption is forecast to reach $3.3 billion. In terms of consumption value, high brightness (HB) LEDs hold a relative market share of nearly 67 percent for the year 2012.



Light Emitting Diode (LED) Used in Signage & Professional Display Global Market Forecast ($, Billion)

The American region (South, Central and North America) and the Asia Pacific region (APAC) are even in market share (2012). However, the APAC region is forecast to expand at a faster pace.

The Europe, Middle East and African region (EMEA) holds over a 20 percent share of global consumption value in 2012 but is forecast for relatively flat growth for the next few years. This 2011-2017 market review and forecast considers standard-type versus HB-LEDs used in signage and professional displays. HB-LEDs defined by ElectroniCast, are component-level bulbs with a Lumens/Watt rating of 30 lm/W and above. Standard-type LEDs are considered to have a rating of less than 30 lm/W.

This application category covers LEDs that are used in signs and displays. This includes LEDs used in building facades, large outdoor video screens, digital billboards, sport/stadium displays, small indoor retail displays, food displays (restaurants/supermarkets), signs on taxis and destination signs on mass-transit vehicles, channel-lettering/light-boxes, LED/LCD TV screens (used exclusively for professional purposes), amongst other applications. The market share leader, in terms of volume (the quantity/number of LEDs), are the standard-type LEDs, with over 95 percent in 2012; however, since there is a huge difference in average selling prices between HB-LEDs and standard LEDs, HB-LEDs hold the consumption value leadership position.

The High-Brightness (HB) category also includes Ultra-High Brightness (UHB) LEDs with a Lumen/

Watt rating of over 70lm/W. The ASP for both standard and HB-LEDs will decrease annually. However, UHB-LED prices have a substantial premium over HB-LED prices, and although currently there is a relatively small use of UHB-LEDs, as their usage increases, the overall effect shows the HB-LED category with only a slight annual decrease, in terms of average selling prices between 2011 and 2017.

A novel projection cube LED for smartphones and cameras

Osram's new nitride based chip offers double the system brightness for embedded projection over previous versions, thanks to a new green LED component

One of the greatest challenges, so far for lighting technology, has been the limited efficiency of green LEDs. High brightness is essential if a projected image is to be seen with ambient light. Now, Osram Opto Semiconductors has released the Ostar Projection LED Cube. The integrated miniature projector, which uses LEDs as the light source, can display images on a much larger surface than existing displays for smartphones and cameras.

The new Osram Ostar Projection Cube LED for "embedded projection" for brilliant projected colours from a smartphone

Efficient LEDs for red and blue light have been available for some time now but LEDs that produce green with acceptable output have been rare. Osram new says its Ostar Projection Cube has now plugged this important gap. At 110 lumen per watt (lm/W) it is claimed to be much more efficient than all other previously available green LEDs in the embedded projection sector. The Ostar Projection Cube enables high output to be achieved in embedded projectors. "The new LED almost doubles the brightness in smartphone applications so embedded projectors with a system brightness of up to 25 lumen are possible", says Wolfgang Schnabel, Marketing Manager Projection at Osram Opto Semiconductors. This means that the image is clearly visible even with ambient light and, thanks to the efficiency of LED technology, the projector can also be used in mobile applications with limited battery capacity.

The new green LED chip comes in two sizes; 1 x 1 mm and 0.75 x 0.75 mm. The Osram Ostar Projection Cube is therefore suitable for most standard imager formats in mobile terminals. The two LED versions are also very bright. Depending on the size of the chip, they produce 260 lm at 700 mA and 2.3 W or 130 lm at 350 mA and 1.2 W. This high luminance from a small surface area is made possible with the aid of special encapsulation. This sharply defines the light surface so the light is emitted from this defined surface without package reflections. With an area of 3.8 x 4.1 mm²and a height of 0.6 mm the new LED enables extremely low-profile projection units to be designed, which is ideal for modern smartphone and camera designs.

The Osram Ostar Projection Cube does not have a glass cover, which means that external optics can be placed very close to it and the light can be used efficiently. With a thermal resistance of typically 6 K/W, the power draw is 2.3 W for the 1 mm2 chip and 1.2 W for the 0.75 x 0.75 mm chip. Osram says the LED has a lifetime of over 20,000 hours.

Nitride Solutions awarded $150,000 grant

Nitride Solutions has been awarded a National Science Foundation (NSF) grant to commercialize its innovative manufacturing technology

Nitride Solutions, a developer of next-generation nitride substrates for LEDs, lasers and power electronics — has been awarded a National Science Foundation (NSF) grant to commercialize

its innovative manufacturing technology. The nearly $150,000 Phase I Small Business Innovation Research (SBIR) award supports the company's work to produce aluminum nitride substrates at a high volume and low cost.

According to Jeremy Jones, president and CEO of Nitride Solutions, their end product will be used to create more effective and more affordable water purification systems, consumer and industrial lighting, Blu-ray players, flat-screen TVs, and power systems for hybrid vehicles.

"Our process will bring nitride substrates — which will be critical in so many emerging applications — to commercial reality," Jones said. "The NSF has recognized that this is potentially a breakthrough technology, and that our company has the capital, the team and the equipment to create it."

Troy Baker, Ph.D., Nitride's research and development director, is the project's principal investigator. Baker has extensive experience in the growth of bulk aluminum and gallium nitride substrates. He performed his doctoral work at UC Santa Barbara under Professor Shuji Nakamura, who is credited with the invention of nitride-based LEDs and laser diodes.

The NSF selected just 10 percent of applicants for the 2012 Phase I award.

Beginning July 1, the six-month grant will support Nitride's movement toward commercial production. Jones expects the company to be selling their product by the end of the year. If Nitride's Phase I results are deemed successful, the company will be eligible for a Phase II SBIR grant of up to $500,000 to further support its growth.

The SBIR program encourages technological innovation and commercialization in small businesses while producing advancements that can improve people's lives. According to the NSF, SBIR programs are the single largest source of patents in the country.

Founded in 2009, Nitride Solutions' leadership has 30-plus years of experience in advanced materials businesses — both start-ups and Fortune 500 companies — and a total of 25 years in nitride crystal development. The company maintains strong ties to Kansas State University in Manhattan, with key employees and advisors hailing from the university, as well as UC Santa Barbara. To date, Nitride has raised $2.5 million in investor funding from groups including Midwest Venture Alliance, NetWork Kansas, Mid-America Angels, Nebraska Angels and Aurora UV.

ARC Energy Names Dr. Philip C.S. Yin Vice President and General Manager of China

Advanced Renewable Energy, a provider of c-axis sapphire growth technologies and turnkey solutions for the LED solid-state lighting and other clean energy markets, today announced that it has named Dr. Philip C.S. Yin as vice president and general manager, China region.

In his new role, Dr. Yin will be responsible for building deep relationships and satisfying customer expectations, directing the rapidly growing China organization, and helping grow ARC Energy's business in the China region.

Dr. Yin is a recognized leader in the LED and semiconductor industry. He previously served as the chairman and chief executive officer for AXT Inc., where he catapulted AXT to a leadership position as a manufacturer of compound semiconductor materials, and ensured the success of its customers. Prior to AXT, Dr. Yin was the U.S. general manager for Aixtron, a leader in MOCVD technology, and led the deployment of LED MOCVD technology at a leading LED chip manufacturer. He brings to ARC Energy a wealth of experience from other previous management, technology, and product positions with companies such as ATMI and IBM, among others.

"Rapid adoption of LEDs in lighting is increasing demand for large diameter sapphire, which in turn is driving up demand for ARC Energy's cost effective, highly automated CHES sapphire growth furnaces," said Hap Hewes, ARC Energy's senior vice president. "Phil is a true technology leader with significant operations, business, and LED expertise. We look forward to working with him to expand our China operations so that we can continue to meet and exceed the needs of our rapidly growing customer base in China."

Dr. Yin holds a Ph.D. in Material Science from Brooklyn Polytechnical Institute, and attended the executive education program at Stanford Law School. He is affiliated with the American Association for Crystal Growth (AACG) and Electro-Chemical Society (ECS).

Dr. Yin is based in ARC Energy's Shanghai office.

Telecoms

Finisar to acquire amplifier vendor RED-C Optical Networks

RED-C will operate as a subsidiary of Finisar, with principal operations continuing at its current facility in Israel

Finisar is again to expand through acquisition.

The optical component and subsystems vendor has revealed it has agreed to acquire all of the outstanding equity interests in RED-C Optical Networks, Inc., a developer of optical amplifiers.

Finisar will pay approximately $23.7 million cash initially, as well as an additional $20 million in cash or shares of Finisar common stock to stockholders and certain RED-C employees if financial performance targets are met during calendar 2013.

Founded in 2000 and incorporated in Delaware, all of RED-C Networks' 140 employees are located in its subsidiary operations based in Tel Aviv. As of March 31, 2012, RED-C had $3.2 million of cash and no debt.

Upon completion of the acquisition, which Finisar expects to close this month, RED-C will operate as a subsidiary of Finisar, with principal operations continuing at its current facility in Israel. Finisar expects the acquisition of RED-C to be slightly positive to non-GAAP earnings per share in its fiscal year ending April 30, 2013.

RED-C provides a variety of EDFA, Raman, and hybrid optical amplifiers (see, for example, "RED-C introduces PON and WDM-PON amplifier suite" and "RED-C amplifiers target next-generation ROADM networks").

"RED-C has been an innovator in optical amplification, which we view as an increasingly critical technology as networks get faster and more complex," says Eitan Gertel, Finisar's CEO. "As we have further penetrated the line card market with our differentiated WSS [wavelength-selective switch] technology, we see this acquisition as a tremendous opportunity to further innovate for our customers and advance our vertical integration strategy."

"We expect RED-C's high performance EDFAs and Raman amplifiers, currently deployed in optical networks around the globe, to continue to deliver strong growth for the RED-C business," said John Clark, Finisar's executive vice president, technology and global R&D. "Going forward, we anticipate additional growth opportunities for the novel Hybrid Raman EDFA platform."

Clark based his optimistic outlook about the hybrid amplifier on its applicability to coherent-based high-speed networks. "We expect RED-C's Hybrid optical amplification platform to replace standard EDFAs for next-generation LH and ULH optical networks," he said.

"We have been impressed with the RED-C amplifiers in terms of their performance and quality. For next-generation networks, there will be an increased need for advanced EDFA, Raman and Hybrid amplifier solutions that RED-C provides," comments Transmode's VP R&D Mohamad Ferej. "With the addition of optical amplifiers from RED-C, Finisar is now offering a complete portfolio of optical components and sub-systems to support our mission to develop innovative network solutions."

RFMD unveils 4.9GHz to 5.85GHz 802.11a/n GaAs FEM

The device employs the firm's gallium arsenide pHEMT technology RFMD's new RF5836 provides a complete integrated solution in a single front end module (FEM) for WiFi 802.11a/n systems.

RF5836

The ultra-small form factor and integrated matching minimises the layout area in the customer's application and greatly reduces the number of external components. The RF5836 integrates a power amplifier (PA), single-pole double-throw switch (SP2T), and a power detector coupler for improved accuracy. The device is provided in a 3mm x 3mm x 0.5mm, 16-pin package. This module meets or exceeds the RF front end needs of IEEE 802.11a/n WiFi RF systems.

The device features a single supply voltage of 3.0V to 4.8V and a low control voltage above1.6V. It has an integrated 5GHz amplifier, SPT2T Tx/Rx Switch, and power detector coupler. POUT is 15.5dBm (11a, 54Mbps at 4% EVM) and 14.5dBm (11n, 65Mbps at 2.8% EVM). The low-height package is suited for SiP and CoB designs.

Applications for the module are in cellular handsets, mobile devices, tablets and in consumer electronics.

IPG acquires 22.5% minority interest in Russian subsidiary

The developer and manufacturer of high-power fibre lasers and amplifiers is taking full ownership of NTO IRE-Polus. IPG Photonics Corporation has purchased the outstanding 22.5% minority interest in its Russia-based subsidiary, NTO IRE-Polus (NTO), that it previously sold to Open Joint Stock Company "Rusnano."

IPG regained complete control of NTO for $55.4 million in cash. The Company expects the transaction to be accretive starting in the third quarter of 2012. The net income attributed to Rusnano's non-controlling interest in NTO had resulted in a reduction to IPG Photonics' earnings of $0.07 per diluted share in 2011 and $0.01 per diluted share in the first quarter of 2012.

"The proceeds from the original investment in NTO by Rusnano allowed IPG to accelerate its investment in R&D, further develop our sales and manufacturing infrastructure in Russia, and enhance our presence in that region by leveraging Rusnano's brand and network," says Valentin Gapontsev, IPG's Chief Executive Officer. "Given the financial flexibility provided by the recent secondary offering, it is now an ideal time to regain complete ownership of our Russian subsidiary and fully benefit from the opportunities there."

In December 2010, IPG sold a 12.5% minority ownership stake in NTO to Rusnano, which later purchased an additional 10% in June 2011, as permitted under the original agreement. In addition, IPG had a call option commencing in December 2013 to buy back the minority stake at a predetermined value and Rusnano had a put option commencing in December 2015 to sell its minority stake to IPG at a predetermined value. Under the terms of the agreement, the put and call options terminated.

Rewriting quantum chips with a ray of light

Illuminating a sample of gallium arsenide with a pattern of light aligns the spins of all the electrons simultaneously, creating a spintronic circuit

The promise of ultrafast quantum computing has moved a step closer to reality with a technique to create rewritable computer chips using a beam of light.

Researchers from The City College of New York (CCNY) and the University of California Berkeley (UCB) used light to control the spin of an atom's

nucleus in order to encode information.

The technique could pave the way for quantum computing, a long-sought leap forward toward computers with processing speeds many times faster than today's.

Current electronic devices are approaching the upper limits in processing speed, and they rely on etching a pattern into a semiconductor to create a chip or integrated circuit. These patterns of interconnections serve as highways to shuttle information around the circuit, but there is a drawback.

"Once the chip is printed, it can only be used one way," explains Jeffrey Reimer, UCB professor of chemical and biomolecular engineering and the study co-author of a paper recently published on the work.

The team, including CCNY Professor of Physics Carlos Meriles and Ph.D. graduate students Jonathan King of UCB and Yunpu Li of CCNY, saw a remedy for these problems in the emerging sciences of spintronics and quantum computing.

They have developed a technique to use laser light to pattern the alignment of "spin" within atoms so that the pattern can be rewritten on the fly. Such a technique may one day lead to rewritable spintronic circuits.

Digital electronics and conventional computing rely on translating electrical charges into the zeros and ones of binary code. A "spintronics" computer, on the other hand, would use the quantum property of electron spin, which enables the electron to store any number between zero and one.

Imagine this as if the electron were a "yin-yang" symbol in which the proportions of the dark and light areas, representing values from zero to one, could vary at will. This would mean that multiple computations could be done simultaneously, which would speed up processing power.

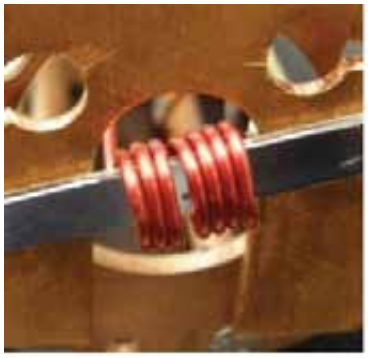
Attempts at using electrons for quantum computing have been plagued, however, by the fact that electron spins switch back and forth rapidly. This makes them very unstable vehicles to hold information. To suppress the random switching back and forth of electrons, the UCB and CCNY researchers used laser light to produce long-lasting nuclear spin "magnets" that can pull, push, or stabilise the spins of the electrons.

They did this by illuminating a sample of GaAs with a pattern of light, much as lithography etches a physical pattern onto a traditional integrated circuit. The illuminated pattern aligned the spins of all the atomic nuclei, and, thus, their electrons, at once, creating a spintronic circuit.

The probe head used to send radio-frequency pulses onto the coil used for pulsed spin manipulation of a GaAs sample. (Credit: Yunpu Li)

"What you could have is a chip you can erase and rewrite on the fly with just the use of a light beam," said Meriles. Changing the pattern of light altered the layout of the circuit instantly.

"If you can actually rewrite with a beam of light and alter this pattern, you can make the circuit morph to adapt to different requirements," he added. "Imagine what you can make a system like that do for you!"



Close up of the mount used to hold a GaAs sample, showing the radio-frequency coil used for pulsed spin manipulation. (Credit: Yunpu Li)

This work was supported by the National Science Foundation.

Further details of this research has been published in the paper, "Optically Re-Writable Patterns of Nuclear Magnetization in Gallium Arsenide", by J. P. King *et al*, *Nature Communications*, published online on 26th June 2012. DOI: http://dx.doi.org/10.1038/ncomms1918

IBM to help advance GigOptix E-band SiGe wireless solutions

GigOptix will use IBM's silicon germanium technology to reduce power, size and increase the integration level of chips

Fabless telecom semiconductor supplier GigOptix has signed a license agreement with IBM to leverage IBM's SiGe millimetre wave transceiver technology.

The contract is related to GigOptix's E-band wireless solutions portfolio including its newly released advanced E-band power amplifier.

Internet traffic from mobile devices is forecasted to exceed traffic from wired devices by 2016. The ubiquitous use of mobile devices such as smartphones and tablets, coupled with the increased use of cloud enabled services, is forcing network operators to upgrade not only their optical networks to 40Gbps and 100Gbps links but also their wireless networks to higher capacity gigabit and multi-gigabit links to satisfy mobile users' growing demands for data.

"We are very excited about the opportunities that IBM's SiGe millimetre wave technology enables," comments Andrea Betti-Berutto, Senior Vice President and Chief Technology Officer of GigOptix. "SiGe enables much lower power, smaller size and much higher levels of integration to the current gallium arsenide solutions in the market."

IBM's SiGe technology, which was developed and enabled by contributions from researchers at IBM's Haifa Research Lab in Israel, provides GigOptix with a proven, scalable and highly integrated SiGe RF platform which the company intends to leverage in a number of innovative directions.

Levering IBM's expertise and many years of development experience provides GigOptix with the opportunity to bring to the market a unique innovative, full suite of technology to enable transforming cost efficient and revolutionary integrated E-band transceiver products.

"Coupling IBM's SiGe with GigOptix's millimetre wave packaging and high power GaAs amplifiers will enable the high spectral efficiencies and data rates being demanded by network operators on their wireless mobile backhaul networks," Betti-Berutto adds. "We feel that GigOptix is uniquely positioned in the data communication market offering a complete bundled solution for both high speed optical networks and now high speed wireless E-band links."

EJL Wireless Research, in its most recent report, forecast E-band point-to-point radio links as being one of the fastest growing segments in the wireless mobile backhaul market with greater than 100% Compounded Annual Growth Rate to 2016.

Gaas Labs acquires GaN RF innovator Nitronex

With this move, Nitronex hopes to expand its market presence in the rapidly growing, high performance, GaN RF power device market using its gallium nitride on silicon technology

Gaas Labs, LLC, a private investment fund targeting the communications semiconductor market, has acquired privately-held Nitronex Corporation.

Nitronex designs and manufactures GaN based RF solutions for high performance applications in the defence, communications, cable TV, and industrial & scientific markets.

Founded in 1999 and headquartered in Durham, North Carolina, Nitronex provides high-performance

GaN-on-Silicon semiconductor solutions using its proprietary SIGANTIC manufacturing process.

The Nitronex process combines the superior power, efficiency and bandwidth performance of GaN with the reliability, ease of use and low-cost advantages of industry standard silicon substrates. Financial terms of the transaction were not disclosed.

"We are excited to add Nitronex, a leading innovator in GaN-based RF solutions, to our portfolio of RF semiconductor companies," says John Ocampo, Co-Founder and President of Gaas Labs. We look forward to helping Nitronex further leverage its products and technologies and extend its RF market leadership."

Charles Shalvoy, CEO of Nitronex comments on the acquisition, "John Ocampo and Gaas Labs have demonstrated their ability to build and develop companies that realise their full growth potential. Partnering with Gaas Labs is an important milestone for Nitronex, which will enable us to deliver greater value to our customers in the rapidly growing, high performance, GaN RF power device market. We are thrilled to continue advancing our GaN-on-Silicon technology and expanding our market presence with Gaas Labs' backing and the aid of their strategic and operational expertise."

Chairman and CEO of Fabrinet joins GigOptix Board of Directors

Tom Mitchell, co-founder and president of Seagate Technology company, and formerly Thailand's largest foreign employer, has been appointed as an independent Class I Director

GigOptix, a fabless supplier of semiconductor and optical components that enable high speed information streaming has appointed David T. (Tom) Mitchell to fill a vacancy on GigOptix's Board of Directors.

Mitchell has over 33 years of experience in the electronics and semiconductor industries, while founding and co-founding two of the biggest manufacturing names in the industry. Currently, Mitchell is the Chairman, Chief Executive Officer and founder of Fabrinet for which he established the company vision of striving through manufacturing excellence and customer focus to be the very best manufacturing outsourcing solution for complex optical, industrial and automotive products. Mitchell was also a co-founder and president of Seagate Technology, a leading disk drive company, and formerly Thailand's largest foreign employer.

Tom Mitchell is widely considered a pioneering force in the establishment of Asia as the pre-eminent manufacturing base for the hard disk drive industry. With his extensive experience in manufacturing of complex high precision electronics, Mitchell leveraged his expertise into other vertical markets such as optical, automotive and industrial products.

Today many of the world's leading technology companies look to Fabrinet for the manufacture of their complex technology products. Mitchell has successfully established high quality, high volume, and low cost manufacturing bases in Singapore, Thailand, Malaysia, India and China.

Mitchell received his Bachelor of Science degree in Economics from Montana State University. He has also served as Captain in the U.S. Marine Corp.

"As we move from an early stage company to a globally mature, world-class quality manufacturing organisation, I am delighted that Tom accepted our invitation to join our Board of Directors and welcome him on board," comments Avi Katz, Chairman, Chief Executive and President of GigOptix.

"His wealth and depth of experience, pioneering the Asia Contract Manufacturing Industry, and building the leading CM of high-speed optical components in the world, will certainly add a new level of professional and technical expertise to our team, as we continue to rapidly grow as a production trusted partner with our large number of industry leading customers. With Tom's appointment, we now have a board comprised of five independent directors whose diverse experiences will lead us to new and exciting horizons in GigOptix journey's next chapter."

"This is the first time I have accepted such an offer to join a board of directors of a public company and I am looking forward to this new role as a Director on the GigOptix Board. The future looks very promising for GigOptix based on their innovative

products, aggressive execution and approach to business, primarily through partnering," states Mitchell. "I look forward to offering my experiences and collaborating with my fellow directors and the leadership team to support the ambitious goals of the company."

Infinera ships first 500 Gb/s super-channel DTN-X

The indium phosphide PIC developer is building on its 100Gb/s platform with the new third generation system

Infinera has made its first shipments of the 500 Gb/s DTN-X platform to customers for deployment.

The firm is continuing to undertake multiple trials and has received purchase orders from new and existing customers.

To date, Infinera has announced plans to deploy the DTN-X platform with two new customers, Cable&Wireless Worldwide for its Europe Persia Express Gateway (EPEG) and DANTE for its GÉANT European Research and Education Network.

The Infinera DTN-X platform delivers what it believes is the world's first 500 gigabit per second (Gb/s) long-haul FlexCoherent super-channels, enabling service providers to deploy massive optical transport while lowering operational costs.

The DTN-X platform features 5 Terabits per second (Tb/s) of optical transport network (OTN) switching capacity. Integrated switching enables service providers to build highly efficient networks with switching activated wherever it is needed to improve wavelength fill and decrease the number of wavelengths that must be deployed.

This results in networks with a high network Efficiency Quotient and potentially lowers the total cost of ownership (TCO). The DTN-X also features an industry leading GMPLS control plane that makes the platform easy to use and further simplifies operations.

Infinera first began shipping the DTN platform in 2004, revolutionising the marketplace by offering the only optical networking solution based on 100 Gb/s photonic integrated circuits (PICs). The DTN-X platform builds on this foundation of innovation and features the third generation 500 Gb/s PICs today, delivering to service providers a solution that focuses on simplicity, scalability, efficiency and reliability.

"While our competitors talk about their roadmaps for metro 400 Gb/s super-channels, Infinera is delivering the industry's first 500 Gb/s long haul FlexCoherent super-channels," notes Dave Welch, co-founder, EVP and Chief Strategy Officer at Infinera.

"With DTN-X, we are also bringing the largest capacity OTN switch to market and delivering the industry's first deployable FlexCoherent capability. Infinera delivers on the capabilities that help service providers scale, simplify and make their networks more efficient to lower overall lifecycle TCO."

Infinera 100 Gb/s InP PIC honoured at Next Generation Optical Networking 2012

The platform, which employs the firm's indium phosphide technology, was awarded for its disruptive impact on the optical network industry

Infinera's 100 gigabit per second (Gb/s) photonic integrated circuit (PIC) was awarded Best Optical Component Product - 100G at the Next Generation Optical Networking Awards 2012 in Monaco.

The firm's first generation PIC was honoured for the disruptive impact it has made in the optical network industry. Integrating more than 60 components onto a pair of chips, the 100 Gb/s PICs are embedded into Infinera's highly successful DTN platform and boasts more than 725 million hours of field operation without a known failure in live networks worldwide.

Infinera is now shipping the DTN-X platform based on 500 Gb/s PICs. Infinera believes the DTN-X is the only platform on the market that delivers 500 Gb/s long-haul super-channels, and also the only platform to integrate 5 Terabits per second of optical transport network switching in the same chassis.

This award was established to celebrate and recognise the achievements made by service providers and solutions providers in the optical networking industry. Infinera's award was accepted by Michael Capuano, Infinera's vice president of corporate marketing.

"We are delighted to see our PIC receive this award," gushes Capuano. "We believe that our PICs change the dynamics of the optical networking industry by dramatically increasing optical transport network efficiency while reducing total cost of ownership."

Toshiba unveils Ka-band high power GaN MMIC for SATCOM

The gallium nitride device is suited to applications such as high definition video broadcast and broadband data communication

Toshiba America Electronic Components, Inc. (TAEC), a company that collaborates with technology companies to create breakthrough designs, has unveiled a Ka-Band High Power GaN microwave monolithic integrated circuit (MMIC) featuring one of the highest power and efficiency performances in its class. Toshiba is planning to release a complete family of Ka-Band products to support SATCOM applications. Ka-Band SATCOM has been on the rise, and is continuing to show steady growth to support broadband communication and increasing demand for higher bandwidth in SATCOM frequencies. Due to the limited availability of high power microwave Solid-State devices, replacing tube-base amplifiers with Solid-State Power Amplifiers for Ka-Band has not been a cost-effective design option. Toshiba's new Ka-Band MMIC will provide a solution to support the anticipated surge of solid-state amplifiers to the millimetre wave frequency range for SATCOM applications. "As a longtime supplier of high-performance GaN and gallium arsenide microwave devices for wireless applications in various frequency bands, Toshiba plans to continue efforts to expand the product line with new solutions," says Homayoun Ghani, business development manager, microwave devices, for TAEC's Discrete Business Unit. A datasheet for Toshiba's new MMIC will be available in Q4 2012, with sampling beginning Q1 2013.

Hybrid GaN IC for X-band revealed by Toshiba

The gallium nitride HIC is optimised for high gain and high powerand is suited to AESA, and PESA radar applications

Toshiba America Electronic Components, Inc. (TAEC) is introducing a new GaN hybrid IC (HIC), which is optimised for high gain and power.

Available in small hermetically-sealed packages, the gain-enhanced HIC is targeted to transmitter and receiver modules (TRMs) used in radar applications - such as active electronically scanned array (AESA) and passive electronically scanned array (PESA).

The new X-Band hybrid IC, the TGM9398-25, operates in the 9.3 to 9.8 GHz range, and has output power at 1dB of 25W, or 44.0dBm (typ.), linear gain of 25dB (typ.) and power added efficiency of 35 percent.

Toshiba commercially launched the 50W discrete GaN internally-matched HEMT for the band, the TGI8596-50, in 2008 and the TGI0910-50, in 2010. The new device is in a package that is footprint-compatible with the existing discrete internally-matched GaN HEMT, to support easy upgrades for legacy designs.

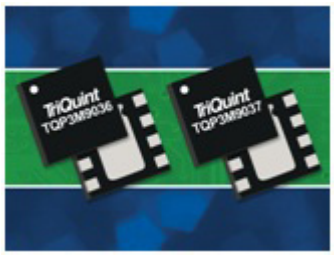
"The high power density of GaN technology makes this possible," says Homayoun Ghani, business development manager, microwave devices, for TAEC's Discrete Business Unit. "With the energy-saving features associated with higher gain, this hybrid IC will help our customers design more advanced telecommunication systems."

Samples of Toshiba's GaN hybrid IC will be available in Q4 2012.

TriQuint touts packaged GaAs LNAs for 400 to 2700 MHz

The firm claims the two devices deliver the lowest noise figure of any integrated, packaged solutions for base station and similar applications

TriQuint Semiconductor has announced initial sample availability of two packaged, surface-mount low-noise amplifiers (LNAs).



The new devices are based on the company's GaAs E-*p*HEMT process and include the TQP3M9036 that operates from 400 to 1500 MHz with a noise figure of 0.45dB and the TQP3M9037 that operates from 1500 to 2700MHz with a noise figure of 0.40dB.

Both are well suited for infrastructure applications such as cellular base stations, tower-mounted amplifiers (TMAs), small cell wireless networks, repeaters, 700MHz LTE networks, and emerging wireless systems using "white spaces" in the UHF spectrum.

TriQuint's new solutions simplify RF design by integrating key functions on-chip and within the package that are typically performed by external components. They also address the growing TDD-LTE market with integrated digital shut-down biasing capability and can deliver high performance from bias voltages of +3 V to +5 V without a negative supply voltage.

The biasing network maintains stability over temperature through a current mirror and resistive feedback; it also provides the switching circuit for the digital power-down function. TriQuint's new LNAs have been optimally configured on-chip to provide the best combination noise figure, linearity and reliability.

Both of TriQuint's new devices are pin-compatible with similar products in the TriQuint portfolio and are housed in industry-standard, RoHS-compliant 2 x 2mm, 8-lead DFN packages. They are very rugged and can block high-power interfering input signals or transmit power leakages greater than +22dBm. The devices are also unconditionally stable to eliminate potential oscillations. The TQP3M9036 and TQP3M9037 are internally matched to 50Ω and do not require any external matching circuitry for operation.

Initial samples of TQP3M9036 and TQP3M9037 are currently available and production is expected in September 2012.

GaN HEMT incorporated in the first ever single-chip transceiver

The 10 GHz gallium nitride device reduces chip footprint by over 90%, enabling more compact radars and wireless communications equipment

Fujitsu Laboratories has announced that it has successfully developed the world's first single-chip transceiver using GaN high electron mobility transistor (HEMT) technology that features an output of 6.3 W and that operates at a frequency of 10 GHz. In order to simultaneously handle strong transmission signals and weak incoming signals in the same chip, you need to efficiently switch between outgoing and incoming signals, while reducing the impact that outgoing signals have on incoming signals.

However, until now, it has been difficult to accomplish both of these objectives in tandem. Fujitsu Labs has resolved this issue by developing a duplexer with low signal loss using a GaN-HEMT, and through high-output circuit integration design technology that controls signal interference between the outgoing and incoming signals. The result is a transceiver chip with a footprint that is less than 10% of the size of the multiple chips that have been needed until now. With this technology, it is now possible to configure a high-output transceiver using just one chip, enabling systems such as radar equipment and wireless communications equipment to be made more compact.

GaN is used as a material in blue LEDs. Compared to the conventional semiconductor materials of silicon and GaAs, GaN features a high electron transfer rate and a relatively high breakdown voltage. Given these characteristics, GaN HEMTs, or field-effect transistors that use GaN, show promise for high-output, exceptionally efficient operations. They are ideally suited to a wide range of core technologies for IT applications, including satellite transceivers, mobile phones, GPS-based navigations systems, and broadband wireless networking systems.

Background

In line with the advancement of a network-based society, radio wave demand in a variety of wireless systems is expected to increase even further. For example, aircraft radar uses the 10 GHz frequency band, which is able to measure the distance and direction of physical objects with high precision. Existing radars are configured with separate equipment for transmitters and receivers. A transceiver chip that integrates both function, would allow more compact systems.

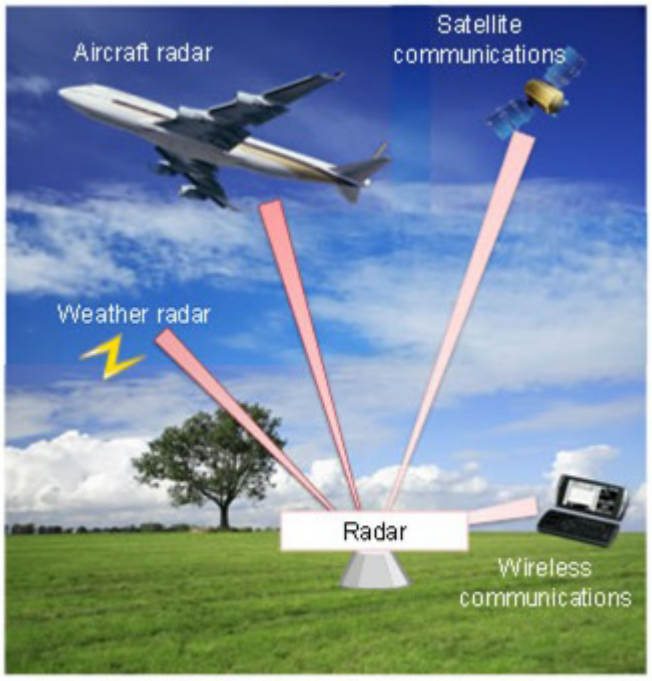


Figure 1: Typical uses of the 10-GHz band

Technical Issues

The transceiver chips necessary to make radar and other equipment more compact must deliver high-capacity communications and high output in order to cover a large area. Transmitting high-power signals using the same chip that receives low-power signals requires high-efficiency switching in the outbound signal and reduced impact of outbound signals on inbound signals. Achieving both of these goals has been a problem.

Newly Developed Technology

Now, Fujitsu Labs has what it says is the world's first single, compact transceiver chip that uses GaN-HEMT and operates in the 10-GHz band. Its key features are as follows:

1. Ultra-compact transmit/receive switch

A new duplexer was developed that uses GaN-HEMT (Figure 2, right). Measuring a compact 1.8 mm × 2.4 mm, with 1.1 dB transmission loss in the 0–12 GHz range. This is far smaller and lighter than earlier switches using magnetic materials (Figure 2, left), less than 10% the size.

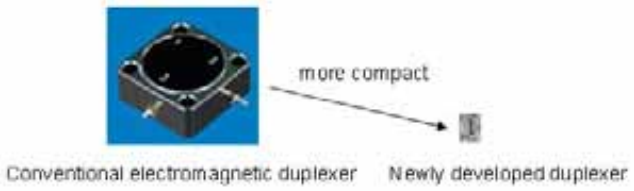


Figure 2: Comparison of conventional transmit/ receive switches and the newly developed one

2. High-output circuit integration design technology

Via holes for grounding are arrayed around the transistors, shielding against the release of unwanted signals. What's more, the locations and layouts of signal wiring and circuitry were optimised using three-dimensional analysis of electromagnetic radiation to suppress unwanted signal interference (Figure 3). This technology ensures stable operation, preventing the oscillations of high-power circuitry from causing malfunctions.

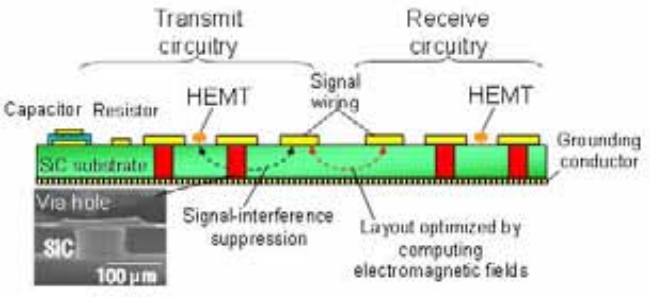


Figure 3: Technologies to suppress unwanted signal interference

These technologies were integrated into a single prototype chip that combines a duplexer, a transmitting amplifier, and a receiving amplifier (Figure 4). The chip operates at 6.3 W in the 10-GHz band and measures 3.6 × 3.3 mm, less than one-tenth the size of earlier multi-chip systems.

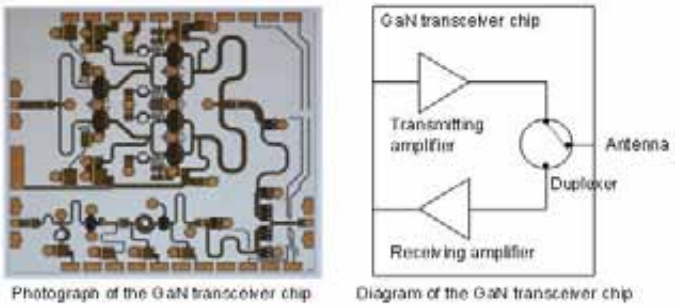


Figure 4: Photo and diagram of the newly developed GaN transceiver chip

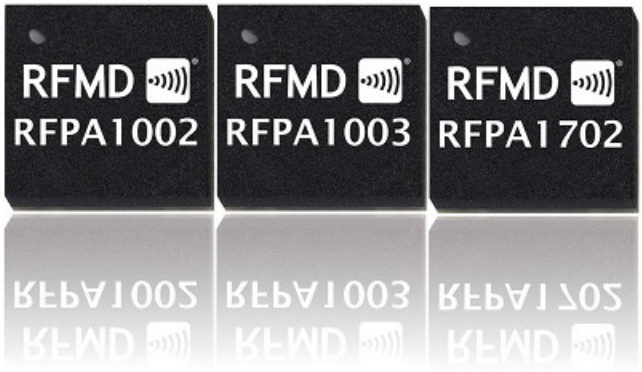
The result shows that these technologies make it possible to design a high-output transceiver around a single chip, with applications in radar and broadband communications, promising smaller, lighter systems. In the future, Fujitsu Labs intends for this technology to be put to use in a wide range of applications that require compact modules with high output, including wireless communications and radar systems.

New high-performance GaAs PAs from RFMD

The devices expand the company's portfolio of radio chipsets targeting cellular backhaul and other markets and rely on the firm's gallium arsenide pHEMT technology

RF Micro Devices is introducing three new power amplifiers for high-frequency point-to-point radio applications.

The RFPA1002, RFPA1003, and RFPA1702 deliver over1W RF output power in the 10GHz to 20GHz frequency bands.



By delivering exceptional power output, linearity and gain, RFMD's RFPA1002, RFPA1003, and RFPA1702 help to satisfy the increasing capacity and performance requirements of next-generation point-to-point radio systems.

All the high-frequency GaAs PAs are packaged in a 6x6 mm QFN, combining low-cost packaging with excellent electrical performance.

In addition to the point-to-point radio market, the RFPA1002, RFPA1003, and RFPA1702 are ideally suited for satellite communications, military radar, and electronic warfare applications. RFMD's expanding portfolio of microwave radio chipsets also includes upconverters, downconverters, VCOs, and gain blocks.

Samples and production quantities are available now through RFMD's online store or through local RFMD sales channels.

Toshiba's new C-band GaAs FET PAs target microwave applications

The improved gain of the new gallium arsenide devices will help microwave designers reduce the number of parts in their overall system

Toshiba America Electronic Components (TAEC) has expanded its GaAs field effect transistor (FET) line-up with two new devices optimised for power efficiency.

The new power added efficiency enhanced GaAs FETs are targeted to microwave radios and block up

convertors (BUCs).

Toshiba's new C-Band GaAs FETs for microwave digital radios support point-to-point and point-to-multipoint terrestrial communications, and BUCs support satellite communications. The TIM5359-16EL and the TIM5964-16EL operate in the 5.3 to 5.9 GHz range and the 5.9 to 6.4 GHz range respectively.

The TIM5359-16EL and TIM5964-16EL have an output power at one-dB gain compression point of 16W, or 42.5dBm (typ.), linear gain at one-dB gain compression point of 11.5dB (typ.) and power added efficiency of 38 percent.

"High gain and high power added efficiency features will help designers build energy-efficient microwave radios," notes Homayoun Ghani, business development manager, microwave devices, for TAEC's Discrete Business Unit.

"By combining our new 16W product along with the linearity enhanced broadband C-Band 4W microwave monolithic integrated circuit (MMIC), Toshiba's TMD0608-4, a simple two-chip design solution is provided for microwave radio applications. The improved gain will help microwave designers reduce the number of parts in their overall system."

Samples of the Toshiba high gain GaAs FET family are available now.

Sumitomo Electric premiers series of GaAs MMICs for communication

The firm has developed a family of singlechip multiple-input receiver MMICs and transmitter MMICs (or transceivers), which incorporate gallium arsenide 3-D MMIC chip technology

Sumitomo Electric Device Innovations USA, Inc. (Sumitomo), will showcase its E-band MMICs for radio link applications at the IMS 2012 Show in Montreal.

Sumitomo offers one-stop SMT solutions from 6 GHz to 80 GHz for radio link applications. Featured at IMS will be offerings for E-Band. The E-Band chip set utilises Wafer Level Chip Scale Package technology.

The firm says this technology achieves excellent frequency performance and easy, reproducible mounting by incorporating flip-chip, 3-D MMIC GaAs technology in products spanning from C-band up through E-band. Sumitomo's low cost SMT chip set offering enables the design of compact, economical E-band transceivers.

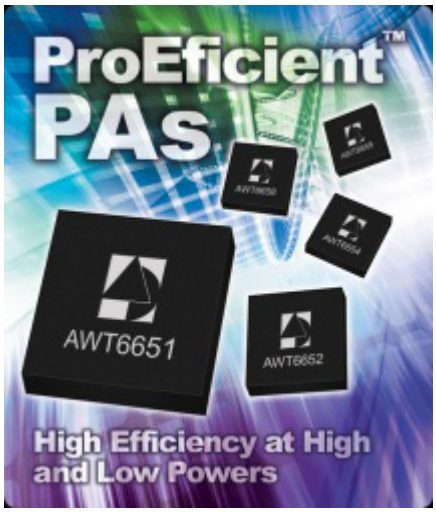
The products will be on display at IMS 2012 at booth #2003.

Anadigics unveils ProEficient InGaP PAs for 4G

Employing the firm's advanced indium gallium phosphide HBT MMIC technology, these modules are suited to for use in the world's most widely used 3G/4G frequency bands

Anadigics has introduced the new ProEficient WCDMA / LTE power amplifier (PA) product family.

The company's ProEficient PAs have been optimised for the next generation of 4G devices across all power levels. These products combine greater talk time in low-power mode with longer data application use in high-power mode. The result is an enhanced overall user experience and extended battery life across all operating conditions of modern smartphone and tablet devices, as well as lower overall system cost.



"4G devices enable users to tap into ultra-fast broadband speeds, resulting in greater data use," notes Jerry Miller, vice president of business development and marketing at Anadigics. "This change in use patterns drives the power amplifier to operate more frequently in high power mode. By delivering outstanding efficiency in both high and low power modes, Anadigics' new ProEficient power amplifiers are helping manufacturers set the standard for 4G battery-life."

These PAs use the company's exclusive InGaP-Plus technology to achieve outstanding efficiency at high and low power modes in order to maximize 4G battery-life without the use of a DC-DC converter. The devices are also optimised for use with average power tracking to further increase efficiency and reduce current consumption at medium and low operating powers.

In addition to outstanding efficiency, ProEficient power amplifiers deliver exceptional linearity to ensure a stable connection for clear voice and high-speed data. The first ProEficient PAs are available for use in the world's most widely used 3G/4G frequency bands, such as bands 1, 2, 3/4/9/10, 5, and 8.

With a low quiescent current, Anadigics says this product family offer best-in-class linearity (ACLR1). They are LTE compliant, WCDMA, HSPA, and HSPA+ compliant and CDMA/EVDO compliant. The highly integrated 3 mm x 3 mm modules have Internal voltage regulation and integrated DC blocks on RF ports. They offer RF matching optimised for output power, efficiency, and linearity in a 50 Ω system.

Anadigics ProEficient PA Family Key Facts and Highlights:

Product	Frequency Band	Efficiency (R99)	Linearity (ACLR1)
AWT6651	1920 to 1980 MHz (Band 1)	48% @ +28.5 dBm 23% @ +17 dBm	-40 dBc @ +28.5 dBm
AWT6652	1850 to 1915 MHz (Band 2, 25)	48% @ +28.3 dBm 23% @ +17 dBm	-40 dBc @ +28.3 dBm
AWT6654	1710 to 1785 MHz (Bands 3, 4, 9, & 10)	48% @ +28.6 dBm 23% @ +17 dBm	-40 dBc @ +28.6 dBm
AWT6655	814 to 849 MHz (Band 5, 18, 26)	47% @ +28.3 dBm 22% @ +17 dBm	-40 dBc @ +28.3dBm
AWT6658	880 to 915 MHz (Band 8)	47% @ +28.5 dBm 22% @ +17 dBm	-40 dBc @ +28.5 dBm

Samples of the ProEficient PAs are available now for qualified programs.

New Freescale GaAs RF power device raises the performance bar

The MMDS25254H 2300-2700 MHz device employs a gallium arsenide MMIC and indium gallium phosphide HBT technology

Freescale Semiconductor has introduced new Airfast transistors engineered to boost the efficiency, peak power and signal bandwidth of next-generation base stations.

With the new offerings, Freescale's flagship Airfast RF power product line now includes at least one solution for each cellular band and supports both small and large cell base station deployments.

The cost-effective, small-configuration Airfast RF power solutions are designed to help network equipment manufacturers and operators support multiple wireless standards, manage escalating data transmission rates and keep capital and operating costs low.

To complement the new Airfast devices, Freescale is also announcing a new class of control products called advanced Doherty alignment modules (ADAM) that enables real-time adjustment of phase and amplitude for the optimisation of traditional Doherty power amplifiers. The modules are designed to work with Airfast devices to boost overall system performance, including increased power efficiency, output power and linearity across the frequency band.

The firm has released a number of LDMOS solutions.

Another module, the MMDS25254H ADAM, is a new class of highly integrated GaAs MMIC control circuits designed specifically to optimise the performance of today's Doherty amplifiers. ADAM provides the ability to align and optimise the RF performance in the carrier and peaking paths of a Doherty amplifier thus providing improved overall BTS performance. The 2300-2700 MHz device also employs E-*p*HEMT and InGaP HBT technology.

When combined with Airfast power transistors, this sophisticated technology provides increased

manufacturing yields and power added efficiency. Available for frequency bands spanning 700 MHz to 2800 MHz. Product families for 700-1000 MHz and 1800-2200 MHz are also in development.

The RoHS compliant device is manufactured in a cost-effective industry standard QFN 6x6 mm package. It also has digital control of amplitude and a phase and constant 90 degree phase offset between port 2 and port 3 versus frequency (500 MHz bandwidth). Freescale also says it displays excellent over temperature amplitude and phase performance and digital adjustment precision and excellent repeatability.

New GaAs RF PAs offer high linearity & efficiency

At 1W power output, these TriQuint products are ideal for use in Very Small Aperture Terminals (VSATs) and point-to-point as well as point-to-multipoint microwave applications

TriQuint Semiconductor has released two new cost-effective packaged RF power amplifiers.

The TriQuint TGA2527-SM is very linear and operates from 12.5 to 15.5 GHz, while the TGA4539-SM operates from 28 to 30 GHz.

The TGA2527-SM offers very high efficiency, typically 20% greater than competing devices, at its saturated power level (Psat) of 31.5dBm.

Both devices have P1dB RF power output of 30dBm (1W) and are housed in cost-efficient 5 x 5mm QFN packages; both solutions are RoHS compliant and have onboard power detectors for monitoring purposes. They are designed to be extremely easy to integrate into RF circuits and are highly rugged.

The TGA2527-SM can handle an RF input power of 24dBm CW and the TGA4539-SM can handle 22dBm.

The new TGA2527-SM and TGA4539-SM are both in production. Samples and fully-assembled evaluation fixtures are available.

RFMD flexes its muscles with new GaN transistors for pulsed-radar

The gallium nitride matched power device extends range, reduce size and weight, and improves overall ruggedness in new and existing radar designs

RF Micro Devices has just released a highly-efficient 280 W pulsed GaN RF matched power transistor, the RFHA1025.

The RFHA1025 delivers superior performance versus competing silicon power technologies.

RFMD's RFHA1025 complements the recently released 380 W RF3928B, the highest output power S-Band device in RFMD's matched power transistor family.

RFMD says its GaN matched power transistors extend range, reduce size and weight, and improve overall ruggedness in new and existing radar

architectures. The RFHA1025 operates over a broad frequency range (0.96-1.2GHz) and delivers 280 W pulsed power, a gain of over 14dB, and peak efficiency of over 55%.

What's more, the RFHA1025 incorporates internal matching to simplify and shrink designers' circuits. Packaged in a hermetic, flanged ceramic package, the RFHA1025 leverages RFMD's advanced heat sink and power dissipation technologies, delivering excellent thermal stability and conductivity. RFMD's RF393x unmatched power transistors (UPT) can be used as drivers to the RFHA1025.

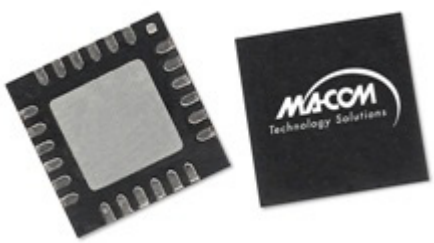
Jeff Shealy, general manager of RFMD's Power Broadband Business Unit, says, "RFMD is pleased to expand our GaN-based product portfolio, offering industry-leading power performance in support of diverse end markets. RFMD's GaN product portfolio demonstrates our commitment to technology and product leadership, and we look forward to introducing additional GaN devices in the near term that feature superior power density, high power efficiency, and rugged dependability."

Samples and production quantities are available now through RFMD's online store or through local RFMD sales channels.

New 6-Bit GaAs serial/parallel module driver from M/A-COM Tech

The package, based on gallium arsenide technology, provides a smaller footprint than is typically available for a digital phase shifter with an internal driver

M/A-COM Technology Solutions has unveiled a new 6-Bit addition to its family of digital phase shifters for communication antenna and radar applications.



MAPS-011007

The MAPS-011007 is a GaAs pHEMT 6-Bit 1.2GHz to 1.4GHz digital phase shifter with an integrated CMOS driver. Housed in a 4mm 24-Lead PQFN Package, the phase shifter provides 360° phase shift range with a step size of 5.6°. The package provides a smaller footprint than is typically available for a digital phase shifter with an internal driver. The device is ideally suited for applications where high phase accuracy with minimum loss variation is required. The design has been optimised to minimise variation in attenuation over the phase shift range, and facilitates easy implementation.

The GaAs pHEMT 6-Bit phase shifter meets the high performance requirements of communications and radar system manufacturers, optimising for fast switching speed, low phase error, and serial or parallel control capability. Its insertion loss is 3.8dB, with a low 0.4dB RMS attenuation error over the 1.2 to 1.4 GHz frequency range. "The MAPS-011007 was specifically designed for L-Band Radar and Communication applications," says Kevin Harrington, Product Marketing Manager. "It's ideal for customers looking for the lowest RMS phase and attenuation error from 1.2GHz to 1.4GHz." Production quantities and samples of the MAPS-011007 are available from stock.

RFMD reveals "industry-best" GaAs/InGaP WiFi FEMs

Designed for both "chip on board" and "system-in-package" (SiP) implementations, both product families employ the firm's gallium arsenide pHEMT and gallium indium phosphide HBT technology and operate over a wide range of operating voltages. The highly integrated FEMs significantly reduce external component count outside the core WiFi chipset

RF Micro Devices has revealed four high-performance front end modules (FEMs) for next generation WiFi applications.

The RFFM8200, RFFM8500, RFFM8202, and RFFM8502 are highly integrated FEM solutions covering multiple WiFi standards and frequency bands, particularly IEEE802.11n and the emerging 802.11ac specification. RFMD's FEMs achieve excellent linear power and dynamic error vector magnitude (EVM) performance in support of the newest reference designs from the leading WiFi chipset providers.

The WiFi market is growing rapidly, driven by increasing consumer demand for access to mobile broadband data and the expanding operator requirements for data offload to accommodate increased cellular and cable network services. By 2015, it is projected the WiFi FEM mobile/ embedded and consumer premises equipment markets will exceed $1.8 billion.

Rohan Houlden, general manager of RFMD's wireless connectivity business unit, says, "RFMD's newest WiFi front end modules demonstrate industry-leading performance and are aligned with the industry's leading WiFi chipset providers on their most anticipated reference designs. By achieving superior linearity and dynamic EVM, RFMD's WiFi front end modules enable the proliferation of mobile broadband connectivity across an ever-expanding range of growth markets, including smartphones, tablets, notebooks, ultra-books, PCs, TV/video, e-readers, gaming, and automotive."

Dynamic EVM is a critical design specification for high data rate WiFi systems. While competitor solutions have traditionally measured static EVM performance, RFMD says its FEMs achieve superior dynamic EVM to deliver best-in-class real-world WiFi system performance. This enables optimum data throughput at increased operator range, current savings through optimal transmit and receive speeds, and an enhanced user experience during video streaming, gaming, and other high data rate applications.

The RFFM8200/8202 (2.5GHz) and RFFM8500/8502 (5GHz) FEMs integrate the power amplifier, LNA, and switch functionality into a single plastic QFN package. Designed for both "chip on board" and "system-in-package" (SiP) implementations, both product families deliver best-in-class linear output power while operating over a wide range of operating voltages. The highly integrated FEMs significantly reduce external component count outside the core WiFi chipset.

Samples and production quantities are available now through RFMD's online store or through local RFMD sales channels.

TriQuint unleashes new GaN products on the defence & commercial markets

The new gallium nitride solutions are claimed to increase RF performance and enable smaller circuits, as well as better-performing low voltage and high power systems

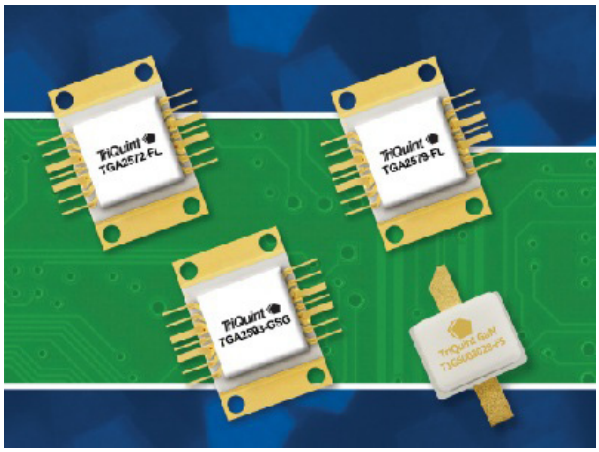
TriQuint Semiconductor released four new GaN devices at the IMS / MTT-S Symposium in Montreal, Canada. TriQuint says its GaN solutions improve RF efficiency, reduce overall costs and enhance system ruggedness.

RF designers attending IMS / MTT-S can access public forums where TriQuint will explore high performance GaN capabilities and ways this technology can enable smaller circuits, as well as better-performing low voltage and high power systems. GaN-based integrated circuits outperform silicon, gallium arsenide and other semiconductor technologies. GaN devices are also seen by the industry as key to future 'green' RF and DC-DC power solutions that can reduce network electrical consumption, enable greater range in electric vehicles or extend smartphone battery life.

"TriQuint is advancing state-of-the-art high frequency / high power GaN research. Our internal product development programs are creating new commercial and defense lower-voltage devices. Today we are announcing four new GaN products enabled by TriQuint's high performance technology leadership," says TriQuint Defence Products and

Foundry Services Vice President and General Manager, James L. Klein.

TriQuint has also revealed three new GaN power amplifiers that deliver greater efficiency, wideband coverage and excellent performance for communications, defence and civilian radar. These are the TGA2572-FL (14-16 GHz), now available; as well as the TGA2579-FL (14-15.5 GHz) and the TGA2593-GSG (13-15 GHz), which will be available in July.



TriQuint is also announcing the availability of the T1G6003028-FS, a 30W wideband GaN packaged transistor that can cut the number of driver circuits in a typical power amplifier design by 50%.

First ever 802.11ac Wi-Fi RF module released by TriQuint

The device, suited for next-generation smartphones and tablets, enables greater range and performance for video streaming. It employs the firm's E/D pHEMT technology which incorporates an indium gallium arsenide active layer

TriQuint Semiconductor has introduced what it says is the industry's first 802.11ac Wi-Fi RF module for next-generation mobile devices.

The TriConnect TQP6M9017 utilises TriQuint's E/D *p*HEMT and HBT technologies to integrate active and passive components into a compact, high-performance module. The E/D *p*HEMT has an InGaAs active layer.

In addition to supporting faster download speeds, TriQuint's TriConnect TQP6M9017 high-performance WLAN module improves the wireless experience by enabling connectivity from greater distances; it allows nearly 60% further range than its predecessor, the TQP6M9002, thanks to advances in output power technology.

As demand for Wi-Fi proliferates worldwide, consumers have developed an ever-growing appetite for faster mobile data rates to support video streaming and other multimedia applications. With data rates up to 1.3 gigabits per second, the new IEEE 802.11ac standard will deliver transfer rates three to four times faster than current-generation 802.11n Wi-Fi. In-Stat predicts one billion devices with 802.11ac technology will ship by 2015.

"TriQuint is at the forefront of technology with the first 802.11ac-ready module for mobile devices. A major manufacturer has selected our new high-performance TriConnect component for its next-generation smartphone, and it's also included on a reference design by a leading chipset supplier," says Shane Smith, Vice President of Global Marketing for Mobile Devices at TriQuint. "Our 802.11ac technology expertise also expands our future market opportunity for infotainment applications such as in-home video distribution."

The TriConnect TQP6M9017 is a highly integrated, dual-band WLAN module that provides a complete solution for 802.11 a/b/g/n/ac Wi-Fi and Bluetooth applications, thus simplifying RF design for device manufacturers. It integrates two power amplifiers for the 2.4 and 5 GHz frequency bands with a switch,

filtering, baluns and other components - all in an compact 4 x 4mm package.

TriQuint says its integrated WLAN solutions take up less PCB space for mobile device manufacturers, while providing several performance advantages over competitive technologies. With an increased operating range, it offers better amplification of weak signals and extends wireless connectivity over greater distances; it offers as much as 2dB higher power output than the previous generation device. The TQP6M9017 also offers extended battery life and faster connectivity ; rapid data transfers enable faster downloads, providing a more enjoyable consumer experience for video streaming and other data-intensive applications.

TriQuint has shipped nearly 300 million Wi-Fi modules since 2009, and nearly doubled its WLAN revenues from 2010 to 2011.

Volume production of the dual-band component is planned next month.

RFMD updates design kits for Agilent's ADS 2011 software

The enhanced PDKs are immediately available to current and prospective RFMD Foundry Services customers for the firm's gallium nitride and gallium arsenide process technologies

RF Micro Devices has announced that its Foundry Services business unit has updated its process design kits (PDKs) for use with Agilent Technologies' recently released Advanced Design System (ADS) 2011 EDA software.

The RFMD PDKs support a complete ADS front-to back-end MMIC design flow with scalable devices, a native design rule checker, and the layout capabilities in ADS 2011. The PDKs work seamlessly with ADS 2011, ADS 2009 Update 1 and ADS 2008 Update 2, enabling RFMD Foundry Services customers to take full advantage of the significant performance advantages of ADS 2011.

RFMD's GaN and GaAs process technologies are available to Foundry Services customers, supported by RFMD's industry-leading cycle times. RFMD's foundry offerings include GaN1 (GaN for high power), a 0.5µmGaN-on-SiC process technology enabling 65V CW operation and optimised for maximum performance at 4 GHz and below.

RFMD's GaN1 power technology provides a high breakdown voltage above 400V, while RFMD's GaN2 is a 0.5 µmGaN-on-SiC process technology offering high linearity for high performance communications systems. Both GaN technologies are manufactured in RFMD's Greensboro, NC, fab, one of the world's largest III-V fabs.

The Grensboro fab also manufactures HBT8D, RFMD's high-volume rugged InGap technology for handset and mixed signal applications, and IPC3, an integrated passive component technology that complements RFMD's GaN technology portfolio with high power compatibility.

Additional RFMD foundry offerings include FD25, a low noise, 0.25 µmGaAs pHEMT technology, and FD30, a high power 0.3 µm GaAs pHEMT technology, both of which support applications up through 25 GHz. RFMD's technology portfolio also includes FET1H, a 0.6-micron GaAs pHEMT technology, and FET2D, a 0.6 µm GaAs E/D pHEMT technology. Each of RFMD's pHEMT technologies is manufactured in the Company's Newton Aycliffe, UK, fab.

Tom Joseph, manager of technology in RFMD's Foundry Services business unit, says, "The ADS 2011 release provides RFMD Foundry customers access to Agilent's latest multi-technology platform for our GaN and GaAs process technologies. By leveraging Agilent's new Library architecture and simulation enhancements, RFMD's foundry customers can improve their design efficiencies and reduce time-to-market for their end market products."

"We are very happy that our mutual customers can now leverage the ADS 2011 product enhancements in RFMD's GaN and GaAs technologies," adds Juergen Hartung, foundry program manager of Agilent's EEs of EDA organisation.

"With these PDKs, our customers can now enjoy the industry's most comprehensive multi-technology design platform using Momentum, the industry-leading 3-D planar EM simulator, our integrated full 3-D FEM engine, the industry-proven design-for-manufacturing capabilities inside ADS, and an

upgraded design rule checker. These capabilities are just some of the reasons the majority of MMIC designers choose ADS to increase performance, consistency and yield."

Infinera introduces system to assess optical transport networks

The indium phosphide PIC innovator's "Network EQ" promises to lower total cost of ownership

Infinera, a provider of digital optical InP based communications solutions, has revealed the Network Efficiency Quotient (EQ).

Network EQ is a framework for comparing next-generation optical transport network architectures, enabling network operators to evaluate the ripple effect of architectural decisions on the total cost of ownership (TCO).

As part of the announcement, Infinera unveiled two new applications that enable rapid estimation and analysis of transport network EQ, the EQ Estimator and EQ Power Analyser. What's more, Infinera is introducing EQ Engagement which provides select customer engagements with Infinera consultants for network specific TCO analysis.

As a relative measure of optical transport network efficiency, EQ compares the impact of capital expenses (CapEx) and operating expenses (OpEx) of architectural alternatives over time. Infinera says the results show that some operators may be able to reduce TCO by up to 70% with an optimal architectural approach.

As optical transport bandwidth requirements grow -- driven by mobile, cloud and video services -- operators have to invest in scaling their networks to meet these demands. Simultaneously, operators must maintain or improve CapEx and OpEx over revenue financial ratios to satisfy their investors.

Network operators can no longer meet both of these objectives by simply increasing optical capacity, such as moving from 10 gigabits per second (Gb/s) to 40 Gb/s or 100 Gb/s optical transmission speeds; they also need to deploy modern architectures that deliver scalability while converging network layers to simplify operations and boost efficiencies. An architecture that integrates OTN switching with WDM transmission without compromise can dramatically improve network EQ, helping network operators improve their bottom line over legacy architectures that rely only on WDM transmission, without the benefits of OTN switching.

The TCO benefits of an integrated OTN switching and WDM architecture can be further enhanced through the use of systems that utilise photonic integrated circuit (PIC) technology. PICs enable converged OTN/WDM architectures without compromise. They provide important additional benefits; rapid system commissioning to lower installation costs; service-ready bandwidth to enable operators to respond faster to customer service requests; lower power use, higher density to reduce rack space and co-location costs; reduced numbers of line-cards and fiber connections to simplify network operations; and greater reliability for improved service availability.

"Through several years of deploying and maintaining Infinera technology across our optical transport network we have enjoyed the improved network efficiencies enabled by a system that combines OTN switching with Photonic Integrated Circuit-based WDM optics," says Randy Nicklas, senior vice president and chief technology officer at XO Communications. "By working with Infinera, we've been able to realise the benefit of increasing wavelength efficiency while reducing space and power consumption compared to alternative solutions."

"Our recent OTN Deployment Strategies survey showed that 75% of operators plan to deploy OTN switching in their networks. More than half of these operators want OTN switching integrated with WDM, as they see it as a means to improving network efficiency and lowering network lifecycle costs. It is good to see that Infinera has developed a framework that will help operators evaluate their architectural choices," adds Andrew Schmitt, Principal Analyst, Optical at Infonetics Research.

"In conversations with service providers around the world, we are seeing increased focus on driving efficiencies from the transport network to the bottom line of their income statement," concludes Tom Fallon, Infinera CEO. "The EQ framework simplifies

the analysis of transport network architectures as they impact total cost of ownership, providing operators a quick way to recognize opportunities to improve network efficiency for their bottom line."

Anadigics introduces small-cell wireless InGaP PAs for Band 5

The devices, manufactured using an advanced indium gallium phosphide HBT MMIC technology, offer reliability, temperature stability, and ruggedness

Anadigics, has unveiled the AWB7125 and AWB7225 small-cell power amplifiers (PAs).

Both devices are optimised for Band 5 WCDMA and LTE applications, including picocells, enterprise-class femtocells, and high performance customer premises equipment (CPE).

Anadigics' complete family of small-cell power amplifiers provides a combination of high output power, efficiency, and linearity.

"The rapid growth in mobile data usage is driving carriers to seek cost effective methods to increase network capacity, especially in dense geographic locations," says Glenn Eswein, director of product marketing for broadband RF products at Anadigics. Small-cell devices, such as picocells and femtocells, provide carriers with an economical, high performance solution that can be deployed quickly."

Anadigics' small-cell power amplifiers have been developed specifically for these applications, and enable wireless infrastructure solutions that are more thermally-efficient, consume less power, enable higher throughput, and provide greater coverage and range.

The AWB7125 wireless infrastructure PA provides +24.5 dBm linear output power, while the AWB7225 provides +27 dBm linear output power. Both power amplifiers are optimized for WCDMA, HSPA, and LTE small-cell base stations operating in the 860 MHz to 894 MHz frequency bands. Anadigics' complete family of small-cell wireless infrastructure power amplifiers is manufactured using the Company's exclusive InGaP-*Plus* technology to achieve best-in-class efficiency, linearity and thermal performance.

Pre-production samples of the AWB7125 are available now. Engineering samples of the AWB7225 are available now for qualified programs.

Sofradir boosts performance of HOT MCT infrared detector

The firm's newest L-HOT MWIR tool, based on mercury cadmium telluride technology, offers thermal equipment makers power efficiency with no trade-off in detection range

Sofradir, a developer and manufacturer of infrared detectors for military, space and industrial applications, is touting a prototype High Operating Temperature L-HOT MWIR integrated detector cooler assembly (IDCA) that offers a significantly improved detection range over earlier models.

Sofradir says the L-HOT MWIR demonstrator meets system integrators' requirements to reduce SWaP (Size, Weight and Power) in military equipment.

"Producing infrared detectors that are compact, lighter and save energy is driving much of our developments at Sofradir," says David Billon-Lanfrey, VP R&D at Sofradir. "L-HOT MWIR ensures that customers get a high operating temperature IR detector with all the gains and no trade-off in image quality and NETD in order to keep the highest detection range."

NETD (Noise-Equivalent Temperature Difference), the signal over noise ratio of the IR detector is an

important attribute for evaluating image quality and detection range (the ability to see smaller objects at greater distances in all weather conditions).

An IR chip with high standard NETD performance is more apt at detecting slight differences in temperature between objects. This provides more detail and more accurate images, which is desirable for users looking for SWaP reductions in hand-held thermal imagers, small gimbals for small Unmanned Aerial Vehicles as well as long endurance systems, such as border surveillance or 24 hour surveillance.

Yet, with high operating temperature IR detectors and increased power efficiency comes dark current (useless information like noise) that can interfere with NETD. By using a *p*-on-*n* MCT photodiode technology, Sofradir believes it has overcome the dark current problem, while keeping the nominal five-micron cut-off wavelength.

"To achieve a cut-off wavelength at five microns that enables L-HOT MWIR to offer low power consumption in a full performance IR detector with no trade-off in NETD, Sofradir switched to a *p*-on-*n* photodiode technology," points out David Billon-Lanfrey, VP R&D at Sofradir.

"With a cut-off wavelength at four microns obtained with other technologies, there are fewer input photons on the IR detector and the NETD is degraded. Our L-HOT MWIR prototype has a cut-off wavelength of five microns at 150K and that is a significant achievement."

The TV format 15 micron pitch L-HOT MWIR integrated detector cooler assembly prototype operates at 150K (-123°C). The firm says this is 60K higher than standard MCT IR detectors (90K, -183°C) in the three to five-micron waveband and consumes less than 2 W.

Today, it achieves the same NETD (better than 20mK) as Sofradir's standard full performance mid-waveband IR detectors.

A new analogue variable gain amplifier operating at 400 to 2700MHz

The new RFVA0016 amplifier for broadband applications incorporates RFMD's gallium arsenide HBT, indium gallium arsenide HBT and LDMOS technology
RFMD's new amplifier is an integrated, analogue-controlled, Variable Gain Amplifier (VGA) with external matching, allowing operation in all bands from 400MHz to 2700MHz within a single module.

RFVA0016

It features a linearity, with OIP3 greater than 40dBm, and provides over a 30dB gain control range. A mode logic pin enables the VGA to be selected for either a 0V to +3V or a +3V to 0V analogue-controlled attenuation slope. The RFVA0016 is a compact 5.2mm x 5.2mm multichip leadless laminate module with thermal vias for ultra-low thermal resistance, and is external matched to 50Ω at each individual band.

The mode pin enables a switch of the attenuation slope and a gain of 25dB. The ACPR is over -60dBc at +10dBm POUT (for the dual carrier WCDMA) and the device operates with a +5V supply .

The product is currently available in production quantities with pricing beginning at $8.72 each for 100 pieces.

OPEL restructures board and receives $3 million to develop III-V POET technology

The company intends to continue developing the POET platform which enables monolithic fabrication of integrated circuit gallium arsenide devices on a single wafer
OPEL Technologies Inc. is welcoming Mark Benadiba, Peter Copetti and Sam Peralta to its board of directors.

Benadiba currently serves on the board of directors of Cott Corp. and will serve as Executive Chairman of the Board of OPEL. He was involved in helping Cott Corp. shift its strategy to refocus on its core business activities in late 2008, and has experience negotiating licensing agreements.

Copetti will serve as an executive board member. He has extensive capital markets and managerial experience and will be focused on rationalizing costs while defining the strategic direction of the Company with regard to the Planar Optoelectronic Technology (POET) semiconductor platform.

Peralta is pleased to rejoin the board of directors; he had served on OPEL boards since January 2007; all issues leading to his February 2012 resignation have been resolved. Until May he served on the board of Axiom NDT Corporation; stepping down from there allows time to help renew OPEL's POET strategy. Peralta has broad experience in the high-technology sector; he brings a continuity of technological vision to the reformulated board.

Lawrence Kunkel and Tristram Collins have both decided not to stand for re-election to the board of directors in order to pursue other opportunities. To allow for the new directors to join, they have both agreed to step down at this time. The Company would like to thank both Kunkel and Collins for their efforts, and wishes them both well in their future endeavours.

Benadiba notes, "I would like to join Mr. Pierhal in thanking the outgoing board members for all their efforts on behalf of the Company. Mr. Copetti, Dr. Peralta and I are ready to join Pierhal and O'Donnell at the board level in an aggressive effort to drive down costs and maximise returns for all stakeholders."

A core component of the Company's strategy going forward is to continue to develop the POET platform. POET enables monolithic fabrication of integrated circuit gallium arsenide devices containing both electronic and optical elements on a single wafer.

Geoff Taylor, the Company's Chief Scientist, and his team have developed the technology over the past 18 years. The Company has 36 patents issued and 14 patents pending in both its PV systems and for its semiconductor POET process. "I am excited to be working with the new board members to further develop the POET platform." comments Taylor.

The Company continues to progress work with a third party in the validation of the technology. "OPEL Heralds Independent Validation of a Critical Component of the POET Semiconductor Platform by BAE Systems".

The Company also has announced a financing with IBK Capital Corp. (IBK) whereby IBK will act as agent, on a best efforts basis, to conduct a private placement offering of up 13,043,478 Units at a price of $0.23 per unit for proceeds of up to $3,000,000. Each unit consists of one common share and one common share purchase warrant.

One full warrant allows the holder to acquire one common share of OPEL for a period of three years at an exercise price of $0.35 per share. The private placement has been conditionally accepted by the TSX Venture Exchange. The securities issued pursuant to the private placement will be subject to a hold period which expires four months and one day following closing.

A first tranche of $507,690 has been completed with the remaining approximately $2,500,000 to be closed on or before July 30, 2012. The Company will pay a cash commission of 7% of the funds raised and 10% of the units sold in the form of broker warrants. Each broker warrant allows the holder to acquire one common share of OPEL at a price of $0.23 for 48 months after the closing date.

Benadiba and Copetti have each entered into a consulting agreement wherein they will each be

paid the sum of $8,400 per month for a term of one year with respect to their services as Executive Chairman and an executive director respectively, They will each be granted 2,500,000 stock options and Peralta will be granted 500,000 stock options pursuant to the Company's incentive stock option plan.

The options will be exercisable for a period of five years at a price of $0.235 per share. The options vest 25% immediately and 25% every six months thereafter.

A*STAR and Rolls Royce to develop GaN power technology

Together, they will advance gallium nitride power devices for the development of high-power-density converters operating at temperatures of up to 300°C

A*STAR Institute of Microelectronics (IME) is to collaborate with Rolls-Royce, the global power systems company, for the research and development of advanced power electronics devices.

This research collaboration aims to use GaN power devices for the development of high-power-density converters that can reliably measure various physical parameters at soaring temperatures of up to 300°C and at environmental pressure of up to 30kpsi.

This collaboration will be delivered through IME's Rugged Electronics programme, which was set up to support Singapore's drive to become a technology hub for the aerospace, oil and gas sectors. The focus of IME's Rugged Electronics programme is to develop a wide range of solutions from sensing, packaging, telemetry, non-volatile memory to integrated circuits

"This collaboration leverages IME's established competence and enables us to extend our research to innovate in new industries," comments Dim-Lee Kwong, Executive Director of IME. "More importantly, this strategic partnership offers an excellent opportunity for Singapore to build knowledge in this industry and move further up the value chain."

"We are excited to work with IME in the research and development of advanced power electronics systems and high temperature electronics. IME's expertise, flexibility and positive approach makes them an excellent research partner," concludes Kurichi Kumar, Director of Research & Technology - Asia, Rolls-Royce Singapore.

Phasor Solutions & TowerJazz move forward with SiGe for communications

The silicon germanium BiCMOS process was chosen over traditional gallium arsenide solutions due to its ability to operate in the 12GHz to 15GHz band. What's more, the process allows multiple analogue and digital functions to be integrated into a single chip

Foundry firm TowerJazz and Phasor Solutions, have together developed a new phased array technology for communications on the move using SiGe process platforms from TowerJazz.

Phasor is targeting the multi-billion dollar satellite communications and radar market with a unique design that is claimed to provide an order of magnitude improvement over competing solutions.

Phasor recently demonstrated a proprietary technology which allows moving vehicles (aircraft, ships or trucks) to communicate with stationary satellites, or antennas that track moving satellites, with no moving parts. Technically, the system is able to self-align to a desired signal source and track it in real time, which the firm says has never been done before.

Utilising TowerJazz's high performance 155GHz SiGe BiCMOS process (SBC18HX) ,Phasor is manufacturing its innovative transceiver chipset for mobile broadband service on moving platforms such as trains, manned and unmanned airplanes, and military vehicles.

TowerJazz's SiGe BiCMOS process was chosen over traditional GaAs solutions used in phased array radar due to its ability to operate

in the required 12GHz to 15GHz band and for its integration capabilities allowing for multiple analogue and digital functions to be integrated into a single chip.

As a result, TowerJazz's process provides for a reduction in component count, cost and complexities associated with multiple discrete devices.

Over the past 50 years, conventional phased arrays followed a similar system design. Phasor offers the opportunity to rethink the system design, providing massive efficiencies in cost. Phasor chips include all the radio frequency functions (amplifiers, oscillators) and phase shifting circuits, as well as the logic and data modulation/demodulation required.

This novel approach to phased array technology aims to reduce costs by over ten times and provide added value such as a flat design (less than 1 inch high), conformal to any surface, modular approach, and high reliability as there are no moving parts. One of Phasor's initial targets is wireless internet access on trains, an estimated available market of over 500 million users worldwide, however airborne satcoms and other Comms-On-The-Move (COTM) applications are likely to be larger markets.

The SBC18HX process offered by TowerJazz includes high performance 0.18µm SiGe bipolar and high quality passive elements combined with high density 0.18-micron CMOS, well-suited for high-speed networking and millimetre wave applications. This edge process achieves an Ft of 155GHz and an Fmax of 200GHz, an optimal choice for a variety of high frequency applications. Six layers of metal are standard with deep trench and metal resistor options.

"Phasor is carving the way for the next decades of phased arrays by providing a paradigm shift in satellite communications. It took the industry over 40 years to develop phased arrays which are typically expensive to buy and to operate. But now, with the invaluable support of our partners, and in particular TowerJazz, we have been able to deliver semiconductors which provide an order of magnitude reduction in costs compared to current solutions," says David Garrood, Managing Director, Phasor Solutions. "Phasor has been able to achieve this milestone with the support of the TowerJazz team and relying on the stability and performance of its SBC18HX process."

"We are pleased to continue working with Phasor to enable this novel product. Our advanced SiGe BiCMOS technology provides higher integration at lower cost than GaAs solutions, allowing cost-effective satellite communications on the move to be realized," adds Marco Racanelli, Senior Vice President and General Manager for the RF & High Performance Analogue and Aerospace & Defence Business Groups at TowerJazz.

"Together, we have begun volume manufacturing to enable a high gain antenna, which consists of 20,000 chips. In addition, we continue to invest in advanced SiGe and recently announced our latest process, SBC18H3, which supports devices with speeds of 270GHz and offers a path for further performance, power, and noise improvement in next-generation products."

RFMD reveals 400MHz to 2700MHz GaAs PA

The new RFPA1012 gallium arsenide HBT linear power amplifier is specifically designed for wireless infrastructure applications

Using a GaAs HBT fabrication process, RFMD's latest high performance single-stage amplifier achieves a high IP3/DC power ratio that operates over a broad frequency range.

RFPA1012

RFMD says the RFPA1012 is an excellent

solution for 2nd and 3rd stage LNAs for wireless infrastructure. It is also suitable for use as a GaAs pre-driver for base station amplifiers and class AB operation for DCS, PCS, UMTS, and WiFi transceiver applications.

The module has a high linearity of OIP3 = 44dBm at 900MHz and low noise (NF = 3.5dB at 900MHz). With a low DC power of 5V at 90mA, the device operates in the range of 400MHz to 2700MHz.

This product is currently available in production quantities. Pricing begins at $2.76 each for 100 pieces.

InGaAs technology sorts the good berries from the bad

By using indium gallium arsenide technology, more efficient shape and colour sorting in berries is possible. This increases productivity, improves quality and reduces labour costs

Buhler has revealed the SORTEX E, a new optical sorter for berries.

SORTEX E optical sorter Employing advanced InGaAs technology, smaller volume processors can improve performance and reduce costs even more than was possible previously. The need for manual sorting by hand pickers is reduced dramatically. The SORTEX E has been trialled successfully in Europe and the USA. Two units are currently installed at a customer's plant in the North West region of United States to sort blueberries, loganberries, raspberries and other berry varieties. David Adams, Buhler Sortex Business Manager reports that the customer is delighted with the results. "The volume handled maximises productivity. After one pass some hand picking is still required but by putting our two SORTEX Es in line, this requirement will be minimised so that the number of pickers needed will be reduced by 80pc," he says. The physical characteristics of berries vary. Blueberries, for example, are cultivated commercially in the United States and so are larger than the wild berries that are harvested in Eastern Europe and Scandinavia. With cultivated varieties, most extraneous vegetable matter, or EVM, is extracted by mechanical pre-cleaning equipment prior to sorting. As a result the sorting process is primarily concerned with identifying discoloured berries and, of course, eliminating any residual EVM.

Wild berries undergo a similar process but EVM contamination is at a higher level than with cultivated varieties. The challenge at the sorting stage therefore is to extract a higher level of EVM such as pine needles, stems, leaves and stick fragments. So the sorting process focuses on both colour and shape. The SORTEX E sorts EVM primarily by shape but is also successful in identifying colour defects. Blueberries, whether discoloured or unripened, can show green or yellow and raspberries, similarly, can be white, pink or brown. InGaAs technology performs a vital function in identifying plastic or wood fragments, cardboard and both light and dark coloured stones.

RFMD reveals 9W GaN wideband power amplifier

The PA designed for use in CW and pulsed applications, employs the firm's proprietary gallium nitride HEMT technology

RFMD's new RFHA1006 is a wideband Power Amplifier (PA) designed for use in wireless infrastructure, RADAR, two-way radios and general purpose amplification.

RFHA1006

Using an advanced high power density GaN semiconductor process, RFMD says these high-performance amplifiers achieve high efficiency, flat gain, and a large instantaneous bandwidth in a single amplifier module.

The device is suited to class AB operation for public mobile radio and can provide a PA stage for commercial wireless infrastructure. It can also be employed in general purpose Tx amplification, test instrumentation and in civilian and military radar applications.

This GaN transistor is packaged in an air cavity ceramic package for excellent thermal stability through the use of advanced heat sink and power dissipation technologies.

Ease of integration is accomplished through the incorporation of optimised input matching network within the package that provides wideband gain and power performance in a single amplifier. An external output match offers the flexibility of further optimizing power and efficiency for any sub-band within the overall bandwidth.

With an output power of 9W,the device employs advanced heat-sink technology and has a 225MHz to 1215MHz instantaneous bandwidth. It is input Internally matched to 50Ω, typically operates at 28V and has an output power of 39.5dBm. The module also has a gain of16dB and power added efficiency of 60% and works in the temperature range -40°C to 85°C Large signal models are also available.

Apple iPhone charged up by Ascent Solar CIGS power

The solar firm has broken into a new market. It intends to provide its CIGS modules in other chargers for other smart phones, including the latest Samsung Galaxy, very soon

Ascent Solar, a developer of flexible thin-film photovoltaic modules, has launched a charger for the Apple iPhone 4/4S smart phone.

Branded under Ascent's new "EnerPlex" line of consumer products, the charger incorporates the company's ultra light CIGS solar cells in a sleek, protective iPhone 4/4S case, along with a thin battery. Ascent says the charger adds minimal weight and size to an iPhone smart phone, yet provides significantly improved battery life by harnessing sunlight for electric power.

Enerplex charger powered by CIGS technology

This is the first product in a forthcoming line of smart phone chargers from Ascent. The company also plans to introduce similar chargers for other smart phones, including the newly launched Samsung Galaxy S III, in the near future.

Ascent Solar's President and CEO, Victor Lee, comments, "The EnerPlex charger is the first protective iPhone case to leverage the lightweight qualities and superior aesthetics of our CIGS solar technology. It will extend the usage time of iPhone smart phones while preserving the high level of design quality that consumers demand. Apple customers can now incorporate green technology into their everyday life, improving the performance of their smart phone without compromising style."

Lee continues, “The growth of the smart phone market has been tremendous and is expected to continue for several years to come. Apple has sold over 175 million iPhone smart phones. Samsung is introducing new products in a competitive market where the number of smart phones in use globally is expected to reach 1 billion in the next 4 years. 144 million smart phones were sold globally in the first quarter of this year alone. Ascent’s EnerPlex line is focused on providing millions of smart phone customers with a product that prolongs battery life, increases mobility and allows them to be ‘green’, all without adding significant size or weight to the phone.”

Working with strategic partners, including China-based TFG Radiant Investment Group Ltd, the company plans to ship EnerPlex chargers to customers and partners in Asia within weeks. Ascent’s partners have already begun receiving purchase orders for this product for shipments beginning in the third quarter. Global shipments will follow in the fourth calendar quarter of this year.

Opnext and Oclaro a match made in heaven

After much deliberation, optical module and component maker Opnext has decided that the merger with manufacturer of optical communications and laser products, Oclaro, should go ahead in Q3 2012

On May 31st, 2012, the board of directors of Opnext Inc. determined that an unsolicited non-binding offer to acquire all of the issued and outstanding capital stock of Opnext for $1.40 per share was not superior to Opnext’s proposed merger with Oclaro, Inc.

The offer had been received on May 23rd, 2012 from a technology-focused private equity firm with significant available capital and was subject to the performance of due diligence by the private equity firm.

After careful consideration and consultation with its financial and legal advisors and with Opnext management, Opnext’s board of directors determined that the offer was not financially more favourable to Opnext’s stockholders than the transactions contemplated by the Agreement and Plan of Merger and Reorganisation, dated as of March 26th, 2012, entered into among Opnext, Oclaro, Inc., and Tahoe Acquisition Sub, Inc.

Opnext notes that significant progress has been made on the pending merger with Oclaro. Opnext believes, subject to receipt of the required stockholder approvals of Opnext and Oclaro and other remaining third party regulatory consents, the merger is on target for a closing early in the third calendar quarter of 2012.

Two new projects target GaAs imaging and GaN power

The two ventures will look at developing gallium arsenide imaging and sensing and gallium nitride-on-silicon power devices

A couple of new projects which centre on the use compound semiconductors are to be funded through the Technology Inspired Innovation competition for collaborative research & development funding. They are described below.

Project title: System development of novel CW OPO for hyperspectral imaging and sensing

Project outline: SYNOPOSIS will develop an active, long-wave mid-infrared (LWIR) imaging system capable of catering for a wide range of applications including the detection of explosives, oil and gas prospecting and medical diagnostics.

To date, active imaging systems operate mostly in the short-wave mid-infrared spectral region. Moving the technology to longer wavelength will enable access to the so-called molecular fingerprint region where the interaction with light and molecules is significantly stronger, therefore enabling higher sensitivity and specificity.

The limiting factor in the context of LWIR active imaging technology has so far been the availability of practical LWIR light sources. SYNOPOSIS will address this issue by advancing the continuous-wave, intracavity-pumped, optical parametric oscillator into the LWIR by employing novel

nonlinear materials such as orientation-patterned gallium arsenide and zinc germanium diphosphide.

Partners in the project are M Squared Lasers Ltd , based in Glasgow, who will lead the project. Other collaborators include Solus Technologies Ltd and the Institute of Photonics based in the University of Strathclyde.

Project title: PEARGaN - Power Electronics Applications for Reliability in GaN

Project outline: GaN-on-Silicon is a hot topic at the moment. One of its applications is in discrete devices for high-voltage power electronics applications, with the potential to deliver superior performance in breakdown voltage, on-state resistance and higher switching speeds. This material system also promises to reduce system losses and enable greater levels of efficiency at lower cost than current solutions.

The PEARGaN project has assembled a consortium of world class partners from UK industry and academia, to develop new system level concepts and circuit architectures, evaluate advanced manufacturing process technologies and create device demonstrators to fully understand the device behaviour and failure mechanisms, proving that these devices are robust and can deliver the required levels of life-time reliability that is demanded by the early adopters in a broad range of power management and control applications.

The lead partner is NXP Semiconductors UK Ltd based in Stockport. Also involved in the project are IQE (Europe) Ltd, Bristol University – Device Reliability Centre, Manchester University – Power Conversion Group and Liverpool University – Materials & Structures Centre.

The offer of funding to these projects is conditional and remains subject to the successful completion of Technology Strategy Board, Scottish Enterprise and BBSRC compliance and financial review processes.

Cree's GaN HEMT is a game changer in radar and satellite communications

The firm's four new gallium nitride devices are suited to the X-Band and come in fully matched 50W or 100W packages

Cree has released a range of high- efficiency X-Band, fully matched GaN HEMT transistors for commercial radar and satellite communications applications.

Rated at 50W and 100W, these new GaN devices are claimed to deliver "game- changing" efficiency and performance improvements when compared to existing GaAs MESFET transistors or Travelling Wave Tube (TWT) based amplifiers.

"The new Cree X-Band GaN HEMT product family represents disruptive technology that we believe will set new standards of efficiency and performance for high-frequency, high-power applications such as satellite communications and X-Band commercial radar," explains Jim Milligan, director, RF and microwave.

"The performance advantages of higher power ratings, higher linear efficiency and higher gain, combined with a reduced footprint, offer dramatic advantages when compared to GaAs MESFET transistors or TWT amplifiers. We believe this new product family will deliver comprehensive system benefits, including superior thermal management and significantly-reduced power supply loads. The new product family also offers a lower cost alternative to TWT amplifiers and associated high-voltage power supplies and linearisation systems while improving overall system reliability."

The X-Band product family consists of four new GaN HEMT transistors; two for satellite communications (CGHV96050F1 and CGH96100F1) and two for commercial radar applications (CGHV96050F2 and CGHV96100F2). All four transistors are offered in a compact footprint of 0.9 x 0.7" package.

Product
Output Power @ VDD=40V
Frequency

Power Added Efficiency
CGHV96050F1
50W (25W linear under OQPSK)
7.9-8.4GHz
30% (Linear)
CGHV96100F1
100W (50W linear under OQPSK)
7.9-8.4GHz
28% (Linear)
CGHV96050F2
50W Pulsed (100µSec, 10% duty)
8.4-9.6GHz
50% (PSAT)
CGHV96100F2
100W Pulsed (100µSec, 10% duty)
8.4-9.6GHz
45% (PSAT)

The efficiency advantages in using these new GaN devices can be up to three times greater when compared to current GaAs MESFET transistors.

Ehat's more, the wide video bandwidth of GaN HEMT transistors allows for their use in multi-carrier applications with two-tone spacing up to 70MHz.

The fully matched GaN HEMT transistors complement two previously released packaged MMICs, designated the CMPA5585025F and CMPA801B025F, which can also be used as drivers for the CGHV96050 or CGHV96100.

Skyworks in Globe 100 for fourth time in a row

The company was ranked 8th in the Boston Globe's 2011 Listing of the best performing public companies in Massachusetts

Skyworks Solutions, an innovator of analogue semiconductors enabling a broad range of end markets, has been named in the Boston Globe's list of top performing public companies in Massachusetts for the fourth consecutive year. The Globe 100 ranking, which is now in its 24th year, is based on several financial factors including year-over-year revenue growth and profit margin, as well as return on average equity.

For the first time in three years, the Globe 100 list features 100 companies. In 2010 and 2011, less than 100 companies qualified given the impact of the recession. "The positive momentum we are seeing in the economic recovery is illustrated by the Globe 100 returning to full strength," says Shirley Leung, business editor at the Boston Globe. "It's a powerful testament to the resiliency of Massachusetts' businesses." "Skyworks is delighted to once again be recognised as one of Massachusetts's most highly regarded and well performing companies," adds David J. Aldrich, president and chief executive officer at Skyworks.

"In 2011, Skyworks made significant progress towards solidifying our leadership position in analogue semiconductor solutions across a diverse set of applications. We are capitalising on consumers' demand for mobile connectivity and are well positioned to benefit from the explosive growth in wirelessly-enabled platforms and services." The Globe 100 ranks Massachusetts-based public companies based on financial data from the four quarters ending December 31, 2011. To be eligible, the company must be traded publicly for the entire 2011 calendar year on the New York Stock Exchange, the Nasdaq or the American Stock Exchange and report revenue and profit for both 2010 and 2011.

RF Electronics

RFMD unveils 4.9GHz to 5.85GHz 802.11a/n GaAs FEM

The device employs the firm's gallium arsenide pHEMT technology

RFMD's new RF5836 provides a complete integrated solution in a single front end module (FEM) for WiFi 802.11a/n systems.

RF5836

The ultra-small form factor and integrated matching minimises the layout area in the customer's application and greatly reduces the number of external components. The RF5836 integrates a power amplifier (PA), single-pole double-throw switch (SP2T), and a power detector coupler for improved accuracy. The device is provided in a 3mm x 3mm x 0.5mm, 16-pin package. This module meets or exceeds the RF front end needs of IEEE 802.11a/n WiFi RF systems.

The device features a single supply voltage of 3.0V to 4.8V and a low control voltage above1.6V. It has an integrated 5GHz amplifier, SPT2T Tx/Rx Switch, and power detector coupler. POUT is 15.5dBm (11a, 54Mbps at 4% EVM) and 14.5dBm (11n, 65Mbps at 2.8% EVM). The low-height package is suited for SiP and CoB designs.

Applications for the module are in cellular handsets, mobile devices, tablets and in consumer electronics.

Gaas Labs acquires GaN RF innovator Nitronex

With this move, Nitronex hopes to expand its market presence in the rapidly growing, high performance, GaN RF power device market using its gallium nitride on silicon technology

Gaas Labs, LLC, a private investment fund targeting the communications semiconductor market, has acquired privately-held Nitronex Corporation.

Nitronex designs and manufactures GaN based RF solutions for high performance applications in the defence, communications, cable TV, and industrial & scientific markets.

Founded in 1999 and headquartered in Durham, North Carolina, Nitronex provides high-performance GaN-on-Silicon semiconductor solutions using its proprietary SIGANTIC manufacturing process.

The Nitronex process combines the superior power, efficiency and bandwidth performance of GaN with the reliability, ease of use and low-cost advantages of industry standard silicon substrates. Financial terms of the transaction were not disclosed.

"We are excited to add Nitronex, a leading innovator in GaN-based RF solutions, to our portfolio of RF semiconductor companies," says John Ocampo, Co-Founder and President of Gaas Labs. We look forward to helping Nitronex further leverage its products and technologies and extend its RF market leadership."

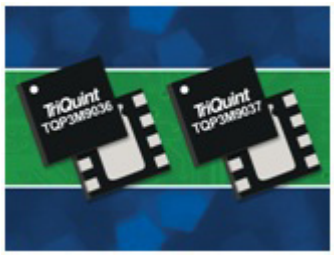
Charles Shalvoy, CEO of Nitronex comments on the acquisition, "John Ocampo and Gaas Labs have demonstrated their ability to build and develop companies that realise their full growth potential. Partnering with Gaas Labs is an important milestone for Nitronex, which will enable us to deliver greater value to our customers in the rapidly growing, high performance, GaN RF power device market. We are thrilled to continue advancing our GaN-on-Silicon technology and expanding our market presence with Gaas Labs' backing and the aid of their strategic and operational expertise."

TriQuint touts packaged GaAs LNAs for 400 to 2700 MHz

The firm claims the two devices deliver the lowest noise figure of any integrated, packaged solutions for base station and similar applications

TriQuint Semiconductor has announced initial sample availability of two packaged, surface-mount

low-noise amplifiers (LNAs).



The new devices are based on the company's GaAs E-*p*HEMT process and include the TQP3M9036 that operates from 400 to 1500 MHz with a noise figure of 0.45dB and the TQP3M9037 that operates from 1500 to 2700MHz with a noise figure of 0.40dB.

Both are well suited for infrastructure applications such as cellular base stations, tower-mounted amplifiers (TMAs), small cell wireless networks, repeaters, 700MHz LTE networks, and emerging wireless systems using "white spaces" in the UHF spectrum.

TriQuint's new solutions simplify RF design by integrating key functions on-chip and within the package that are typically performed by external components. They also address the growing TDD-LTE market with integrated digital shut-down biasing capability and can deliver high performance from bias voltages of +3 V to +5 V without a negative supply voltage.

The biasing network maintains stability over temperature through a current mirror and resistive feedback; it also provides the switching circuit for the digital power-down function. TriQuint's new LNAs have been optimally configured on-chip to provide the best combination noise figure, linearity and reliability.

Both of TriQuint's new devices are pin-compatible with similar products in the TriQuint portfolio and are housed in industry-standard, RoHS-compliant 2 x 2mm, 8-lead DFN packages. They are very rugged and can block high-power interfering input signals or transmit power leakages greater than +22dBm. The devices are also unconditionally stable to eliminate potential oscillations. The TQP3M9036 and TQP3M9037 are internally matched to 50Ω and do not require any external matching circuitry for operation.

Initial samples of TQP3M9036 and TQP3M9037 are currently available and production is expected in September 2012.

New high-performance GaAs PAs from RFMD

The devices expand the company's portfolio of radio chipsets targeting cellular backhaul and other markets and rely on the firm's gallium arsenide pHEMT technology

RF Micro Devices is introducing three new power amplifiers for high-frequency point-to-point radio applications.

The RFPA1002, RFPA1003, and RFPA1702 deliver over1W RF output power in the 10GHz to 20GHz frequency bands.

By delivering exceptional power output, linearity and gain, RFMD's RFPA1002, RFPA1003, and RFPA1702 help to satisfy the increasing capacity and performance requirements of next-generation point-to-point radio systems.

All the high-frequency GaAs PAs are packaged in a 6x6 mm QFN, combining low-cost packaging with excellent electrical performance.

In addition to the point-to-point radio market, the RFPA1002, RFPA1003, and RFPA1702 are ideally suited for satellite communications, military radar, and electronic warfare applications. RFMD's expanding portfolio of microwave radio chipsets also includes upconverters, downconverters, VCOs, and gain blocks.

Samples and production quantities are available now through RFMD's online store or through local

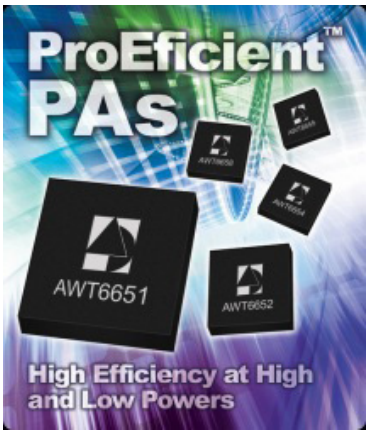
RFMD sales channels.

Anadigics unveils ProEficient InGaP PAs for 4G

Employing the firm's advanced indium gallium phosphide HBT MMIC technology, these modules are suited to for use in the world's most widely used 3G/4G frequency bands

Anadigics has introduced the new ProEficient WCDMA / LTE power amplifier (PA) product family.

The company's ProEficient PAs have been optimised for the next generation of 4G devices across all power levels. These products combine greater talk time in low-power mode with longer data application use in high-power mode. The result is an enhanced overall user experience and extended battery life across all operating conditions of modern smartphone and tablet devices, as well as lower overall system cost.



"4G devices enable users to tap into ultra-fast broadband speeds, resulting in greater data use," notes Jerry Miller, vice president of business development and marketing at Anadigics. "This change in use patterns drives the power amplifier to operate more frequently in high power mode. By delivering outstanding efficiency in both high and low power modes, Anadigics' new ProEficient power amplifiers are helping manufacturers set the standard for 4G battery-life."

These PAs use the company's exclusive InGaP-Plus technology to achieve outstanding efficiency at high and low power modes in order to maximize 4G battery-life without the use of a DC-DC converter. The devices are also optimised for use with average power tracking to further increase efficiency and reduce current consumption at medium and low operating powers.

In addition to outstanding efficiency, ProEficient power amplifiers deliver exceptional linearity to ensure a stable connection for clear voice and high-speed data. The first ProEficient PAs are available for use in the world's most widely used 3G/4G frequency bands, such as bands 1, 2, 3/4/9/10, 5, and 8.

With a low quiescent current, Anadigics says this product family offer best-in-class linearity (ACLR1). They are LTE compliant, WCDMA, HSPA, and HSPA+ compliant and CDMA/EVDO compliant. The highly integrated 3 mm x 3 mm modules have Internal voltage regulation and integrated DC blocks on RF ports. They offer RF matching optimised for output power, efficiency, and linearity in a 50 Ω system.

Anadigics ProEficient PA Family Key Facts and Highlights:

Product	Frequency Band	Efficiency (R99)	Linearity (ACLR1)
AWT6651	1920 to 1980 MHz (Band 1)	48% @ +28.5 dBm 23% @ +17 dBm	-40 dBc @ +28.5 dBm
AWT6652	1850 to 1915 MHz (Band 2, 25)	48% @ +28.3 dBm 23% @ +17 dBm	-40 dBc @ +28.3 dBm
AWT6654	1710 to 1785 MHz (Bands 3, 4, 9, & 10)	48% @ +28.6 dBm 23% @ +17 dBm	-40 dBc @ +28.6 dBm
AWT6655	814 to 849 MHz (Band 5, 18, 26)	47% @ +28.3 dBm 22% @ +17 dBm	-40 dBc @ +28.3dBm
AWT6658	880 to 915 MHz (Band 8)	47% @ +28.5 dBm 22% @ +17 dBm	-40 dBc @ +28.5 dBm

Samples of the ProEficient PAs are available now for qualified programs.

New GaAs RF PAs offer high linearity & efficiency

At 1W power output, these TriQuint products are ideal for use in Very Small Aperture Terminals (VSATs) and point-to-point as well as point-to-multipoint microwave applications

TriQuint Semiconductor has released two new cost-effective packaged RF power amplifiers.

The TriQuint TGA2527-SM is very linear and operates from 12.5 to 15.5 GHz, while the TGA4539-SM operates from 28 to 30 GHz.

The TGA2527-SM offers very high efficiency, typically 20% greater than competing devices, at its saturated power level (Psat) of 31.5dBm.

Both devices have P1dB RF power output of 30dBm (1W) and are housed in cost-efficient 5 x 5mm QFN packages; both solutions are RoHS compliant and have onboard power detectors for monitoring purposes. They are designed to be extremely easy to integrate into RF circuits and are highly rugged.

The TGA2527-SM can handle an RF input power of 24dBm CW and the TGA4539-SM can handle 22dBm.

The new TGA2527-SM and TGA4539-SM are both in production. Samples and fully-assembled evaluation fixtures are available.

RFMD reveals “industry-best” GaAs/InGaP WiFi FEMs

Designed for both “chip on board” and “system-in-package” (SiP) implementations, both product families employ the firm’s gallium arsenide pHEMT and gallium indium phosphide HBT technology and operate over a wide range of operating voltages. The highly integrated FEMs significantly reduce external component count outside the core WiFi chipset

RF Micro Devices has revealed four high-performance front end modules (FEMs) for next generation WiFi applications.

The RFFM8200, RFFM8500, RFFM8202, and RFFM8502 are highly integrated FEM solutions covering multiple WiFi standards and frequency bands, particularly IEEE802.11n and the emerging 802.11ac specification. RFMD’s FEMs achieve excellent linear power and dynamic error vector magnitude (EVM) performance in support of the newest reference designs from the leading WiFi chipset providers.

The WiFi market is growing rapidly, driven by increasing consumer demand for access to mobile broadband data and the expanding operator requirements for data offload to accommodate increased cellular and cable network services. By 2015, it is projected the WiFi FEM mobile/embedded and consumer premises equipment markets will exceed $1.8 billion.

Rohan Houlden, general manager of RFMD’s wireless connectivity business unit, says, “RFMD’s newest WiFi front end modules demonstrate industry-leading performance and are aligned with the industry’s leading WiFi chipset providers on their most anticipated reference designs. By achieving superior linearity and dynamic EVM, RFMD’s WiFi front end modules enable the proliferation of mobile broadband connectivity across an ever-expanding range of growth markets, including smartphones, tablets, notebooks, ultra-books, PCs, TV/video, e-readers, gaming, and automotive.”

Dynamic EVM is a critical design specification for high data rate WiFi systems. While competitor solutions have traditionally measured static EVM performance, RFMD says its FEMs achieve superior dynamic EVM to deliver best-in-class real-world WiFi system performance. This enables optimum data throughput at increased operator range, current savings through optimal transmit and receive speeds, and an enhanced user experience during video streaming, gaming, and other high

data rate applications.

The RFFM8200/8202 (2.5GHz) and RFFM8500/8502 (5GHz) FEMs integrate the power amplifier, LNA, and switch functionality into a single plastic QFN package. Designed for both "chip on board" and "system-in-package" (SiP) implementations, both product families deliver best-in-class linear output power while operating over a wide range of operating voltages. The highly integrated FEMs significantly reduce external component count outside the core WiFi chipset.

Samples and production quantities are available now through RFMD's online store or through local RFMD sales channels.

TriQuint unleashes new GaN products on the defence & commercial markets

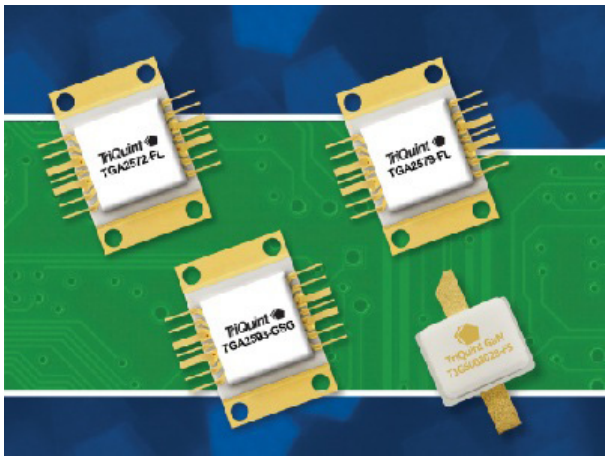
The new gallium nitride solutions are claimed to increase RF performance and enable smaller circuits, as well as better-performing low voltage and high power systems

TriQuint Semiconductor released four new GaN devices at the IMS / MTT-S Symposium in Montreal, Canada. TriQuint says its GaN solutions improve RF efficiency, reduce overall costs and enhance system ruggedness.

RF designers attending IMS / MTT-S can access public forums where TriQuint will explore high performance GaN capabilities and ways this technology can enable smaller circuits, as well as better-performing low voltage and high power systems. GaN-based integrated circuits outperform silicon, gallium arsenide and other semiconductor technologies. GaN devices are also seen by the industry as key to future 'green' RF and DC-DC power solutions that can reduce network electrical consumption, enable greater range in electric vehicles or extend smartphone battery life.

"TriQuint is advancing state-of-the-art high frequency / high power GaN research. Our internal product development programs are creating new commercial and defense lower-voltage devices. Today we are announcing four new GaN products enabled by TriQuint's high performance technology leadership," says TriQuint Defence Products and Foundry Services Vice President and General Manager, James L. Klein.

TriQuint has also revealed three new GaN power amplifiers that deliver greater efficiency, wideband coverage and excellent performance for communications, defence and civilian radar. These are the TGA2572-FL (14-16 GHz), now available; as well as the TGA2579-FL (14-15.5 GHz) and the TGA2593-GSG (13-15 GHz), which will be available in July.



TriQuint is also announcing the availability of the T1G6003028-FS, a 30W wideband GaN packaged transistor that can cut the number of driver circuits in a typical power amplifier design by 50%.

TriQuint will also be describing its gallium nitride, gallium arsenide, SAW and BAW solutions for networks, defence and aerospace products at IMS / MTT-S 2012 at booth #1815.

First ever 802.11ac Wi-Fi RF module released by TriQuint

The device, suited for next-generation smartphones and tablets, enables greater range and performance for video streaming. It employs the firm's E/D pHEMT technology which incorporates an indium gallium arsenide active layer

TriQuint Semiconductor has introduced what it says is the industry's first 802.11ac Wi-Fi RF module for next-generation mobile devices.

The TriConnect TQP6M9017 utilises TriQuint's E/D *p*HEMT and HBT technologies to integrate active and passive components into a compact, high-performance module. The E/D *p*HEMT has an InGaAs active layer.

In addition to supporting faster download speeds, TriQuint's TriConnect TQP6M9017 high-performance WLAN module improves the wireless experience by enabling connectivity from greater distances; it allows nearly 60% further range than its predecessor, the TQP6M9002, thanks to advances in output power technology.

As demand for Wi-Fi proliferates worldwide, consumers have developed an ever-growing appetite for faster mobile data rates to support video streaming and other multimedia applications. With data rates up to 1.3 gigabits per second, the new IEEE 802.11ac standard will deliver transfer rates three to four times faster than current-generation 802.11n Wi-Fi. In-Stat predicts one billion devices with 802.11ac technology will ship by 2015.

"TriQuint is at the forefront of technology with the first 802.11ac-ready module for mobile devices. A major manufacturer has selected our new high-performance TriConnect component for its next-generation smartphone, and it's also included on a reference design by a leading chipset supplier," says Shane Smith, Vice President of Global Marketing for Mobile Devices at TriQuint. "Our 802.11ac technology expertise also expands our future market opportunity for infotainment applications such as in-home video distribution."

The TriConnect TQP6M9017 is a highly integrated, dual-band WLAN module that provides a complete solution for 802.11 a/b/g/n/ac Wi-Fi and Bluetooth applications, thus simplifying RF design for device manufacturers. It integrates two power amplifiers for the 2.4 and 5 GHz frequency bands with a switch, filtering, baluns and other components - all in an compact 4 x 4mm package.

TriQuint says its integrated WLAN solutions take up less PCB space for mobile device manufacturers, while providing several performance advantages over competitive technologies. With an increased operating range, it offers better amplification of weak signals and extends wireless connectivity over greater distances; it offers as much as 2dB higher power output than the previous generation device. The TQP6M9017 also offers extended battery life and faster connectivity ; rapid data transfers enable faster downloads, providing a more enjoyable consumer experience for video streaming and other data-intensive applications.

TriQuint has shipped nearly 300 million Wi-Fi modules since 2009, and nearly doubled its WLAN revenues from 2010 to 2011.

Volume production of the dual-band component is planned next month.

RFMD updates design kits for Agilent's ADS 2011 software

The enhanced PDKs are immediately available to current and prospective RFMD Foundry Services customers for the firm's gallium nitride and gallium arsenide process technologies

RF Micro Devices has announced that its Foundry Services business unit has updated its process design kits (PDKs) for use with Agilent Technologies' recently released Advanced Design System (ADS) 2011 EDA software.

The RFMD PDKs support a complete ADS front-to back-end MMIC design flow with scalable devices, a native design rule checker, and the layout capabilities in ADS 2011. The PDKs work seamlessly with ADS 2011, ADS 2009 Update 1 and ADS 2008 Update 2, enabling RFMD Foundry Services customers to take full advantage of the significant performance advantages of ADS 2011.

RFMD's GaN and GaAs process technologies are available to Foundry Services customers, supported by RFMD's industry-leading cycle times. RFMD's

foundry offerings include GaN1 (GaN for high power), a 0.5µmGaN-on-SiC process technology enabling 65V CW operation and optimised for maximum performance at 4 GHz and below.

RFMD's GaN1 power technology provides a high breakdown voltage above 400V, while RFMD's GaN2 is a 0.5 µmGaN-on-SiC process technology offering high linearity for high performance communications systems. Both GaN technologies are manufactured in RFMD's Greensboro, NC, fab, one of the world's largest III-V fabs.

The Grensboro fab also manufactures HBT8D, RFMD's high-volume rugged InGap technology for handset and mixed signal applications, and IPC3, an integrated passive component technology that complements RFMD's GaN technology portfolio with high power compatibility.

Additional RFMD foundry offerings include FD25, a low noise, 0.25 µmGaAs pHEMT technology, and FD30, a high power 0.3 µm GaAs pHEMT technology, both of which support applications up through 25 GHz. RFMD's technology portfolio also includes FET1H, a 0.6-micron GaAs pHEMT technology, and FET2D, a 0.6 µm GaAs E/D pHEMT technology. Each of RFMD's pHEMT technologies is manufactured in the Company's Newton Aycliffe, UK, fab.

Tom Joseph, manager of technology in RFMD's Foundry Services business unit, says, "The ADS 2011 release provides RFMD Foundry customers access to Agilent's latest multi-technology platform for our GaN and GaAs process technologies. By leveraging Agilent's new Library architecture and simulation enhancements, RFMD's foundry customers can improve their design efficiencies and reduce time-to-market for their end market products."

"We are very happy that our mutual customers can now leverage the ADS 2011 product enhancements in RFMD's GaN and GaAs technologies," adds Juergen Hartung, foundry program manager of Agilent's EEs of EDA organisation.

"With these PDKs, our customers can now enjoy the industry's most comprehensive multi-technology design platform using Momentum, the industry-leading 3-D planar EM simulator, our integrated full 3-D FEM engine, the industry-proven design-for-manufacturing capabilities inside ADS, and an upgraded design rule checker. These capabilities are just some of the reasons the majority of MMIC designers choose ADS to increase performance, consistency and yield."

Anadigics introduces small-cell wireless InGaP PAs for Band 5

The devices, manufactured using an advanced indium gallium phosphide HBT MMIC technology, offer reliability, temperature stability, and ruggedness

Anadigics, has unveiled the AWB7125 and AWB7225 small-cell power amplifiers (PAs).

Both devices are optimised for Band 5 WCDMA and LTE applications, including picocells, enterprise-class femtocells, and high performance customer premises equipment (CPE).

Anadigics' complete family of small-cell power amplifiers provides a combination of high output power, efficiency, and linearity.

"The rapid growth in mobile data usage is driving carriers to seek cost effective methods to increase network capacity, especially in dense geographic locations," says Glenn Eswein, director of product marketing for broadband RF products at Anadigics. Small-cell devices, such as picocells and femtocells, provide carriers with an economical, high performance solution that can be deployed quickly."

Anadigics' small-cell power amplifiers have been developed specifically for these applications, and enable wireless infrastructure solutions that are more thermally-efficient, consume less power,

enable higher throughput, and provide greater coverage and range.

The AWB7125 wireless infrastructure PA provides +24.5 dBm linear output power, while the AWB7225 provides +27 dBm linear output power. Both power amplifiers are optimized for WCDMA, HSPA, and LTE small-cell base stations operating in the 860 MHz to 894 MHz frequency bands. Anadigics' complete family of small-cell wireless infrastructure power amplifiers is manufactured using the Company's exclusive InGaP-*Plus* technology to achieve best-in-class efficiency, linearity and thermal performance.

Pre-production samples of the AWB7125 are available now. Engineering samples of the AWB7225 are available now for qualified programs.

A new analogue variable gain amplifier operating at 400 to 2700MHz

The new RFVA0016 amplifier for broadband applications incorporates RFMD's gallium arsenide HBT, indium gallium arsenide HBT and LDMOS technology

RFMD's new amplifier is an integrated, analogue-controlled, Variable Gain Amplifier (VGA) with external matching, allowing operation in all bands from 400MHz to 2700MHz within a single module.

RFVA0016

It features a linearity, with OIP3 greater than 40dBm, and provides over a 30dB gain control range. A mode logic pin enables the VGA to be selected for either a 0V to +3V or a +3V to 0V analogue-controlled attenuation slope. The RFVA0016 is a compact 5.2mm x 5.2mm multichip leadless laminate module with thermal vias for ultra-low thermal resistance, and is external matched to 50Ω at each individual band.

The mode pin enables a switch of the attenuation slope and a gain of 25dB. The ACPR is over -60dBc at +10dBm POUT (for the dual carrier WCDMA) and the device operates with a +5V supply .

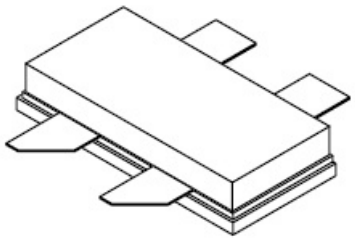
The product is currently available in production quantities with pricing beginning at $8.72 each for 100 pieces.

Freescale breaks into GaN power RF market

Suitable for cellular infrastructure applications, the RF power innovator adds the efficiency, performance and bandwidth advantages of gallium nitride technology to its portfolio

Freescale Semiconductor has revealed its first RF power amplifier product built using GaN technology.

The company's RF power GaN products will initially target the cellular infrastructure market, with potential future applications including avionics, radar, ISM and software-defined radio.



AFG25HW355S schematic

Freescale's first GaN product, the AFG25HW355S device, is the latest addition to its power amplifier portfolio. Current Freescale RF power offerings include 12V, 28V and 50V silicon LDMOS products, 5V GaAs HBT, 5V and 12V GaAs pHEMT solutions, and high-frequency SiGe technology featuring

operation up to 100 GHz and beyond.

"Freescale's GaN RF power solutions underscore our technology-agnostic approach to the RF power market," says Ritu Favre, vice president and general manager of Freescale's RF Division. "Working with GaN in development since the mid-2000s, we have established an ideal blend of cost-efficiency, performance and reliability, and the time is now right to add GaN-based products to our broad array of RF power amplifier solutions."

The AFG25HW355S is a 350W, high-performance-in-package, 2:1 asymmetric device operating between 2.3 GHz and 2.7 GHz. With 56 dBm peak power and 50 percent efficiency, the device has a gain of 16 dB and comes in NI-780 packaging.

Advantages of using GaN technology in power amplifiers include smaller product form factors, low parasitic loss, elevated power density and higher-frequency operation. Potential GaN cellular applications include quasi-linear, high efficiency (Doherty), high-powered pulsed (non-linear) applications, broadband PAs and switch-mode amplifier configurations.

The AFG25HW355S will be available soon to select customers in sample quantities, with full qualification and volume shipping planned by Q2 2013.

RFMD reveals 400MHz to 2700MHz GaAs PA

The new RFPA1012 gallium arsenide HBT linear power amplifier is specifically designed for wireless infrastructure applications

Using a GaAs HBT fabrication process, RFMD's latest high performance single-stage amplifier achieves a high IP3/DC power ratio that operates over a broad frequency range.

RFPA1012

RFMD says the RFPA1012 is an excellent solution for 2nd and 3rd stage LNAs for wireless infrastructure. It is also suitable for use as a GaAs pre-driver for base station amplifiers and class AB operation for DCS, PCS, UMTS, and WiFi transceiver applications.

The module has a high linearity of OIP3 = 44dBm at 900MHz and low noise (NF = 3.5dB at 900MHz). With a low DC power of 5V at 90mA, the device operates in the range of 400MHz to 2700MHz.

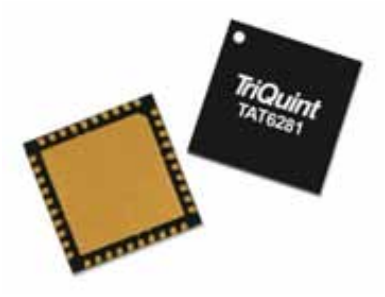
This product is currently available in production quantities. Pricing begins at $2.76 each for 100 pieces.

TriQuint touting new GaAs amplifiers for CATV

The new cost-effective gallium arsenide CATV products simplify RF connectivity and are claimed to reduce BOMs & improve performance

TriQuint Semiconductor is unleashing two new TriAccess amplifiers designed to replace multiple products in CATV systems. TriQuint says its new devices are economical and built with its market-tested GaAs technology, offering greater functional integration and higher efficiency. The TAT6281 variable gain receiver for single family units (SFUs) employs PIN diode variable attenuation to provide a consistent, low-distortion method of adjusting gain. TriQuint's integrated module delivers low-noise RF performance while simplifying FTTH amplifier designs and reducing bills of materials (BOMs). The TAT6281 builds on the success of TriQuint's TAT6254 product line, millions of which have been

deployed in CATV / FTTH networks worldwide



TAT6281

TriQuint's new TAT2814A satisfies the DOCSIS 3.0 specification with more than 4dB (typical) margin. By integrating two stages of amplification and a variable gain attenuator, TriQuint says its TAT2814A can greatly simplify CATV RF design by reducing the number of discrete RF components. According to the company, other solutions require up to five-times the PCB space to deliver DOCSIS 3.0 performance while consuming up to twice the electrical power. TriQuint's new product solution is ideal for DOCSIS 3.0 output stage amplifier designs including Edge QAM and CMTS (cable modem termination system) applications. The TAT2814A is also ideally suited for Ethernet over Coax (EOC) supporting DOCSIS 3.0 PA levels.

TAT2814A

TAT2814A 45-1003 MHz; fully integrated two stage amplifier with variable gain attenuator; meets DOCSIS 3.0 with +4dB typical performance margin; < 5W nominal power consumption; low-reflection differential input/output stages; 30dB typical max gain; 4.5 typical noise figure; 6x6mm leadless SMT package.

Samples are now available.

TAT6281 45 to 1003 MHz variable gain receiver; 8dB pA/rtHz typical EIN; 5V @ 220 mA bias supply; 20dB PIN diode variable gain attenuator; 18dB typical and 37dB maximum gain; 18dB return loss; 8 to + 1dBm optical input range; 20dBmV RF output; 6 x 6mm leadless SMT package.

Samples will be available from July 27th, 2012.

RFMD to outsource MBE and MOCVD wafer manufacturing

The transfer of RFMD's MBE growth facility to IQE should cut manufacturing costs

As previously announced, RF Micro Devices has entered into a definitive agreement to transfer its MBE wafer growth facility in Greensboro, North Carolina, to IQE.

RFMD's MBE growth facility supplies MBE wafer starting material to its wafer manufacturing facilities. The firm will continue to own and operate in Greensboro, and Newton Aycliffe, UK.

RFMD's GaAs semiconductor products incorporate transistor layers grown using either an MBE or MOCVD process. RFMD outsources all MOCVD-based starting material, and will now also begin to outsource MBE-based starting material with the completion of the transfer.

Now, RFMD has announced that IQE will supply RFMD with both MBE- and MOCVD-based starting materials.

The transfer and supply agreement will lower RFMD's manufacturing costs, beginning in the September 2012 quarter. In the June 2012 quarter, RFMD currently estimates the transaction will result in a non-cash GAAP charge of approximately $0.02 to $0.03 related to equipment and inventory write-offs and will be approximately neutral to non-GAAP operating results.

Bob Bruggeworth, president and CEO of RFMD, states, "We believe this is a mutually beneficial transaction for both RFMD and IQE. Of note, we expect this transaction will provide RFMD with lower MBE and MOCVD pricing, higher return on invested capital (ROIC), and more predictable operating results."

RFMD reveals 9W GaN wideband power amplifier

The PA designed for use in CW and pulsed applications, employs the firm's proprietary gallium nitride HEMT technology

RFMD's new RFHA1006 is a wideband Power Amplifier (PA) designed for use in wireless infrastructure, RADAR, two-way radios and general purpose amplification.

RFHA1006

Using an advanced high power density GaN semiconductor process, RFMD says these high-performance amplifiers achieve high efficiency, flat gain, and a large instantaneous bandwidth in a single amplifier module.

The device is suited to class AB operation for public mobile radio and can provide a PA stage for commercial wireless infrastructure. It can also be employed in general purpose Tx amplification, test instrumentation and in civilian and military radar applications.

This GaN transistor is packaged in an air cavity ceramic package for excellent thermal stability through the use of advanced heat sink and power dissipation technologies.

Ease of integration is accomplished through the incorporation of optimised input matching network within the package that provides wideband gain and power performance in a single amplifier. An external output match offers the flexibility of further optimizing power and efficiency for any sub-band within the overall bandwidth.

With an output power of 9W,the device employs advanced heat-sink technology and has a 225MHz to 1215MHz instantaneous bandwidth. It is input Internally matched to 50Ω, typically operates at 28V and has an output power of 39.5dBm. The module also has a gain of16dB and power added efficiency of 60% and works in the temperature range -40°C to 85°C Large signal models are also available.

Skyworks in Globe 100 for fourth time in a row

The company was ranked 8th in the Boston Globe's 2011 Listing of the best performing public companies in Massachusetts

Skyworks Solutions, an innovator of analogue semiconductors enabling a broad range of end markets, has been named in the Boston Globe's list of top performing public companies in Massachusetts for the fourth consecutive year. The Globe 100 ranking, which is now in its 24th year, is based on several financial factors including year-over-year revenue growth and profit margin, as well as return on average equity. For the first time in three years, the Globe 100 list features 100 companies. In 2010 and 2011, less than 100 companies qualified given the impact of the recession. "The positive momentum we are seeing in the economic recovery is illustrated by the Globe 100 returning to full strength," says Shirley Leung, business editor at the Boston Globe.

"It's a powerful testament to the resiliency of Massachusetts' businesses." "Skyworks is delighted to once again be recognised as one of Massachusetts's most highly regarded and well performing companies," adds David J. Aldrich, president and chief executive officer at Skyworks. "In 2011, Skyworks made significant progress towards solidifying our leadership position in analogue semiconductor solutions across a diverse set of applications. We are capitalising on consumers' demand for mobile connectivity and are well positioned to benefit from the explosive growth in wirelessly-enabled platforms and services." The Globe 100 ranks Massachusetts-based public companies based on financial data from the four quarters ending December 31, 2011. To be eligible, the company must be traded publicly for the entire 2011 calendar year on the New York

Stock Exchange, the Nasdaq or the American Stock Exchange and report revenue and profit for both 2010 and 2011.

Lasers

Rewriting quantum chips with a ray of light

Illuminating a sample of gallium arsenide with a pattern of light aligns the spins of all the electrons simultaneously, creating a spintronic circuit

The promise of ultrafast quantum computing has moved a step closer to reality with a technique to create rewritable computer chips using a beam of light.

Researchers from The City College of New York (CCNY) and the University of California Berkeley (UCB) used light to control the spin of an atom's nucleus in order to encode information.

The technique could pave the way for quantum computing, a long-sought leap forward toward computers with processing speeds many times faster than today's.

Current electronic devices are approaching the upper limits in processing speed, and they rely on etching a pattern into a semiconductor to create a chip or integrated circuit. These patterns of interconnections serve as highways to shuttle information around the circuit, but there is a drawback.

"Once the chip is printed, it can only be used one way," explains Jeffrey Reimer, UCB professor of chemical and biomolecular engineering and the study co-author of a paper recently published on the work.

The team, including CCNY Professor of Physics Carlos Meriles and Ph.D. graduate students Jonathan King of UCB and Yunpu Li of CCNY, saw a remedy for these problems in the emerging sciences of spintronics and quantum computing.

They have developed a technique to use laser light to pattern the alignment of "spin" within atoms so that the pattern can be rewritten on the fly. Such a technique may one day lead to rewritable spintronic circuits.

Digital electronics and conventional computing rely on translating electrical charges into the zeros and ones of binary code. A "spintronics" computer, on the other hand, would use the quantum property of electron spin, which enables the electron to store any number between zero and one.

Imagine this as if the electron were a "yin-yang" symbol in which the proportions of the dark and light areas, representing values from zero to one, could vary at will. This would mean that multiple computations could be done simultaneously, which would speed up processing power.

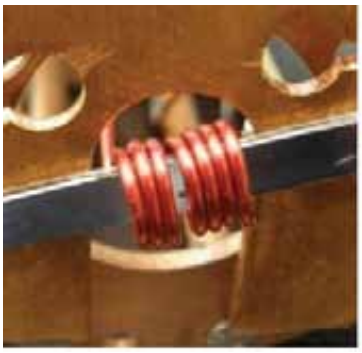
Attempts at using electrons for quantum computing have been plagued, however, by the fact that electron spins switch back and forth rapidly. This makes them very unstable vehicles to hold information. To suppress the random switching back and forth of electrons, the UCB and CCNY researchers used laser light to produce long-lasting nuclear spin "magnets" that can pull, push, or stabilise the spins of the electrons.

They did this by illuminating a sample of GaAs with a pattern of light, much as lithography etches a physical pattern onto a traditional integrated circuit. The illuminated pattern aligned the spins of all the atomic nuclei, and, thus, their electrons, at once, creating a spintronic circuit.

The probe head used to send radio-frequency pulses onto the coil used for pulsed spin manipulation of a GaAs sample. (Credit: Yunpu Li)

"What you could have is a chip you can erase and rewrite on the fly with just the use of a light beam," said Meriles. Changing the pattern of light altered the layout of the circuit instantly.

"If you can actually rewrite with a beam of light and alter this pattern, you can make the circuit morph to adapt to different requirements," he added. "Imagine what you can make a system like that do for you!"



Close up of the mount used to hold a GaAs sample, showing the radio-frequency coil used for pulsed spin manipulation. (Credit: Yunpu Li)

This work was supported by the National Science Foundation.

Further details of this research has been published in the paper, "Optically Re-Writable Patterns of Nuclear Magnetization in Gallium Arsenide", by J. P. King *et al*, *Nature Communications*, published online on 26th June 2012. DOI: http://dx.doi.org/10.1038/ncomms1918

1080p LED hybrid laser projector unveiled by ViewSonic

The new projector is targeted towards the pro AV market. In the system, the combination of LED and laser light result in a vibrant and rich display colour

ViewSonic, aglobal provider of computing, consumer electronics and communications solutions, is expanding its professional projector series with the new Pro8300, while previewing its LED hybrid laser technology in the Pro9000.

Pro8300 LED laser projector

In ViewSonic's new hybrid laser andLED Full HD Pro9000 projector, the LED light and lasers combine to create a single light source, resulting in vibrant and rich display colour that the firm says far exceeds that of a normal mercury light projector.

In addition to being environmentally friendly, this mercury-free technology also delivers a longer operation life of over 20,000 hours. Coupled with dual HDMI ports and its lamp-free design, the Pro9000 is ideal for home cinema environments and Pro-AV installations. The Pro9000 is expected to be available in Q3 2012.

"Laser hybrid illumination technology has changed the way that projectors are able to manipulate light and images. This new model is lamp-free for an even lower total cost of ownership. As a result, users get a higher quality picture and ultra high contrast ratio, making projectors with this technology ideal for home entertainment, professional audio-video, corporate or education use," saysRoger Chien, product manager for ViewSonic.

The Pro8300 professional 1080p commercial grade projector is suited tobusiness data projection. It incorporates ViewSonic's "BrilliantColorTechnology" with a powerful Pixelworks10-bit image processor for vivid colours, while its 1920x1080 native resolution, 3,000 ANSI lumens and a 4,000:1 dynamic contrast ratio produce razor sharp images that shine in virtually any ambient light environment. Paired with a wide 1.5X optical zoom adjustment for more than 36% additional zooming capability and integrated speakers, the Pro8300 delivers stunning audio and visual experience.

"Full HD resolution has become somewhat of a standard feature across consumer home and cinema entertainment projectors; however, finding

hi-def capabilities in a quality yet affordable projector offering for businesses is far less common," continuesChien. "Our Pro8300 breaks tradition by bringing precise standalone 1080p projection to business owners and corporations at a price that's within reach for any company."

InnoLas shows off three new laser products

The new lasers are suited to industrial, commercial, micromachining and scientific & research applications

German based InnoLas Laser, which develops and manufactures laser sources for scientific and industrial applications, has added three new products to its portfolio.

The first is the InnoLas picolo AOT series. These laser sources are finding use in a wide range of industrial, commercial and R&D applications.

These compact modules comprise efficient high repetition-rate short-pulse solid state lasers (sub-nanosecond). They operate at high energy in the UV, visible and near infra-red ranges.

InnoLas says its proprietary high speed switching technology allows the E-O Q-switched laser products to deliver kHz pulses below 1ns duration that are synchronisable to external events with sub-nanosecond accuracy.

InnoLas picolo MOPA unit

The InnoLas picolo AOT product range comprises oscillator and oscillator/amplifier (MOPA) units. The modules operate from 0 - 100kHz pulse rate, to over 100 µJ pulse energy and over 100kW peak power.

InnoLas says its picolo AOT lasers provide pulses of one order of magnitude (or more) shorter than competitive products. Shorter, more intense pulses can provide the user many advantages.

For instance, in precision processing and marking, the short interaction time reduces workpiece heating effects and improves quality. In applications like ranging, and in 'excite and probe' studies, short pulses increase temporal resolution. In non-linear harmonic and parametric processes, the high intensity of the short pulses leads to high conversion efficiency.

The second new product is from the NANIO family and is the NANIO 532-10-V-20 InnoLas Laser. This laser has been designed for demanding micromachining applications.

Pulse energies of more than 500µJ and pulse widths as small as 12ns open new opportunities in demanding applications like HQ glass cutting for smart phone or tablet displays.

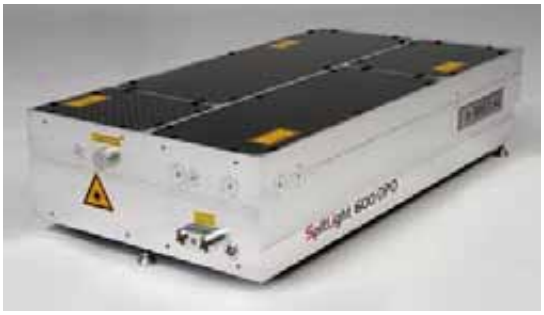
Module from InnoLas NANIO series

What's more ceramics and carbon fibre compounds can now be processed with the NANIO 532-10-V-20 in quality levels which have been achieved only by using cost and service intensive picosecond lasers so far.

The NANIO 532-10-V-20 InnoLas Laser can use a power supply which fits all lasers. This means there is no need for adaption or recalibration when changing laser heads. Like the other NANIO lasers in the series, the new laser has a fully detachable laser head and power supply, field replaceable pump diode modules, variable external attenuator, constant pulse energy mode, or multi circuit chiller which allows using up to 4 lasers on just one chiller.

The final family is called the InnoLas OPO series, which is suited to science and research applications.

Itoffers nanosecond OPOs (optical parametric oscillators) as complete systems. The pump laser, the modules for frequency multiplication as well as the OPO resonator are integrated into a compact case.



InnoLas SpitlLght600 OPO unit

All modules are centrally fed by a supply unit and operated using a µ-controller. Available are standard systems for the visible range (410nm – 700nm) and the infrared range (670nm – 950nm) with an energy output of 5mJ – 100mJ and a repetition rate of 10Hz.

An ultrafast phase adjustment module enables the unrestricted choice of output wavelengths for each single laser pulse within the entire tuning range. The systems are composed of modules and can be adjusted flexibly to the customers' needs. This includes options such as midband/broadband outlets, fiberglass inlets, outlets for signal/idler/ pump radiation and many more. Just like all InnoLas lasers, the new OPO series guarantees for uncomplicated operation through its robust setup, user-friendly software and fast, reliable customer service.

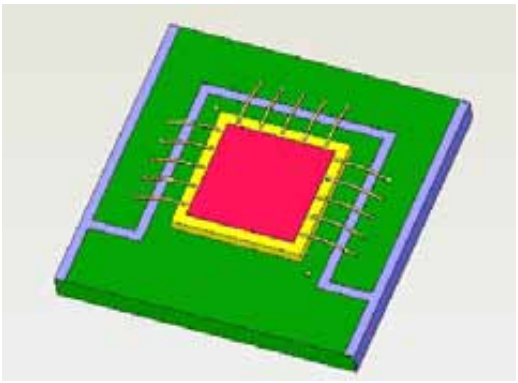
Princeton Opto sets the world alight with its 800nm IR VCSELs

The gallium arsenide based illuminator chips are suited for consumer electronic 3D sensor applications

Princeton Optronics is marketing 800 and near 800nm VCSEL arrays with output powers ranging from 100mW to over 10W peak power.

These devices are designed for use in consumer electronic applications such as gesture recognition, natural user interface and 3D content creation where near infrared illumination is needed.

In 3D image sensing, the VCSEL arrays provide very low speckle, sub-nanosecond rise and fall times, and high electrical-to-optical conversion with over 45% efficiency.

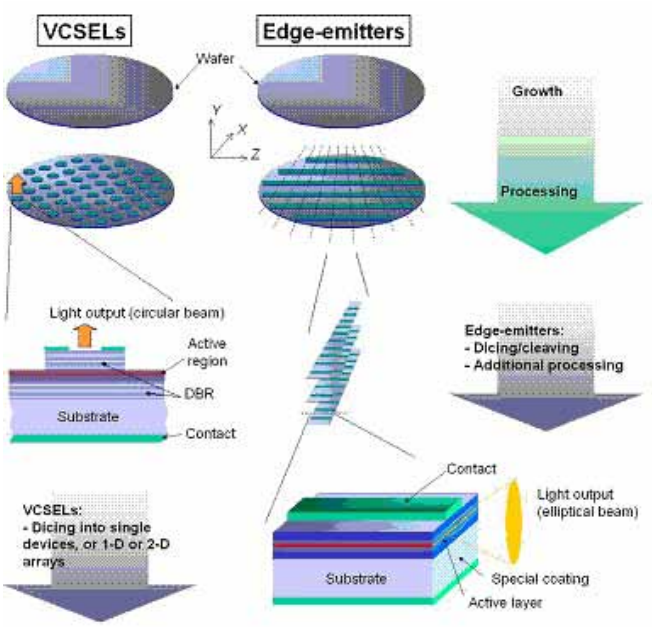


Schematic of packaged VCSEL chip

These devices are highly suited to time-of-flight (TOF) or structured light applications and Princeton Opto believes they are preferred to LEDs and edge emitting lasers. This is because of their high efficiency, narrow and circular emission angle, short rise and fall times and flattop intensity profile.

They also work at temperatures as high as 800C.

The VCSELs are currently being made in large quantities and are claimed to ensure both high reliability and competitive costs compared to LEDs and conventional edge emitting lasers.



Comparison of the growth/processing flow of VCSEL and edge-emitter semiconductor lasers

The chips can be packaged in a variety of configurations for high volume applications, very similar to LEDs. They do not require a hermetically sealed housing, reducing packaging costs.

Chip sizes range from 0.5 x 0.5mm2 to 3 x 3mm2 depending on output power. The optics can be added to the package creating greater options for beam handling in the customer's illumination system.

Sample chips are immediately available at wavelengths in the 800nm region and additional wavelengths can be fabricated depending on custom requirements.

Opnext and Oclaro a match made in heaven

After much deliberation, optical module and component maker Opnext has decided that the merger with manufacturer of optical communications and laser products, Oclaro, should go ahead in Q3 2012

On May 31st, 2012, the board of directors of Opnext Inc. determined that an unsolicited non-binding offer to acquire all of the issued and outstanding capital stock of Opnext for $1.40 per share was not superior to Opnext's proposed merger with Oclaro, Inc.

The offer had been received on May 23rd, 2012 from a technology-focused private equity firm with significant available capital and was subject to the performance of due diligence by the private equity firm.

After careful consideration and consultation with its financial and legal advisors and with Opnext management, Opnext's board of directors determined that the offer was not financially more favourable to Opnext's stockholders than the transactions contemplated by the Agreement and Plan of Merger and Reorganisation, dated as of March 26th, 2012, entered into among Opnext, Oclaro, Inc., and Tahoe Acquisition Sub, Inc.

Opnext notes that significant progress has been made on the pending merger with Oclaro. Opnext believes, subject to receipt of the required stockholder approvals of Opnext and Oclaro and other remaining third party regulatory consents, the merger is on target for a closing early in the third calendar quarter of 2012.

Solar

First Solar has a new COO

Georges Antoun will initially have responsibility for manufacturing, R&D, quality and product management at the manufacturer of cadmium telluride photovoltaic solar panels

CdTe innovator, First Solar has appointed Georges Antoun as Chief Operating Officer.

Reporting to Antoun will be Tymen DeJong, Senior Vice President of Global Operations; Raffi Garabedian, Chief Technology Officer; and Tom Kuster, Vice President of Product Management and Customer Support.

"Georges brings a depth of operational leadership experience that will help First Solar execute its strategy," says Jim Hughes, First Solar CEO.

Most recently Antoun was a venture partner at Technology Crossover Ventures, a private equity and venture firm. Prior to joining TCV, he was the head of Product Area IP & Broadband Networks for Ericsson. He joined Ericsson in 2007 when Ericsson acquired Redback Networks, where he had served as Senior Vice President of Worldwide Sales and Operations.

After the acquisition, Antoun was promoted to CEO of Redback. Prior to Redback, he spent five years at Cisco Systems, where he served as Vice President of Worldwide Systems Engineering and Field Marketing, Vice President of Worldwide Optical Operations, and Vice President of Carrier Sales. He has also held senior management positions at Newbridge Networks and Nynex (now Verizon Communications), where he was part of its Science and Technology Division.

Antoun earned a Bachelor of Science degree in engineering from the University of Louisiana at Lafayette and a master's degree in information systems engineering from NYU-Poly.

XsunX CIGSolar moves closer to first customer demonstrations

The company is expanding with a new facility and secures institutional investment while focusing on the final assembly of its patent pending CIGSolar technology

XsunX, the developer of "CIGSolar", a patent-pending solar cell manufacturing process offering a capital-efficient, low-cost alternative to the use of silicon solar cells, is expanding its technology development and marketing operations into a new facility in Irvine, California.

The company received equity financing through Ironridge Global IV, Ltd., an institutional investor financing small cap public companies in the energy sector.

XsunX has been working to complete the assembly of its CIGSolar TFPV cell manufacturing system and establish a marketing facility to provide a hands on demonstration environment to customers.

With the aid of the Ironridge investment, XsunX settled approximately $500,000 in accounts payable primarily associated with the assembly of the Company's CIGSolar thermal evaporation technology in exchange for unregistered shares of common stock.

The transaction substantially reduced XsunX's liabilities and enables XsunX to expedite the completion of its baseline CIGSolar co-evaporation system and establish its technology marketing and demonstration facility.

"We are excited that through the aid and confidence of the Ironridge investment we can work to expedite progress toward hosting our first customer demonstrations," saysTom Djokovich, CEO, XsunX. Djokovich further adds, "Over the last couple of years the solar industry has experienced significant change driven primarily through extraordinary pricing reductions to silicon which have driven some companies out of business and left others operating on razor thin margins. In offering a solution to this problem we have focused our efforts on the belief that high performance CIGS solar cells could provide further price reductions and restore operating margins. Our target customers agree with this thinking and we have a number of them anxious to participate in our first demonstrations."

The Company's technology, of which samples were certified delivering 15.91% average efficiency in testing conducted by the National Renewable Energy Laboratory (NREL), utilises multi-small area thermal co-evaporation for rapid deposition of final-sized cells to better control the complex management of the CIGS layer deposition process.

The Company's method, unlike other CIGS manufacturing technology, begins and ends using individual thin stainless steel substrates sized to match silicon cells so that they can be used as an alternative to silicon cells in existing module assembly lines. In addition to providing for a smaller and more precise deposition environment, the CIGSolar process also helps to avoid performance losses experienced when cells are either cut from rolls of manufactured CIGS material or mismatched electrically in monolithic assemblies.

Abound Solar to suspend operations

Over one hundred employees of the cadmium telluride solar panel manufacturer will be affected by the new agreement

Abound Solar, a manufacturer of thin-film CdTe photovoltaic modules intends to file a petition for protection under U.S. Bankruptcy Code in Delaware very soon.

About 125 employees will be affected by the suspension of operations.

Earlier this year, Abound ceased production of its first generation PV module and has been working to scale up manufacturing for its high-efficiency, second generation PV module, which was tested and verified by the National Renewable Energy Laboratory (NREL) to deliver 85 watts per panel and 12.5 percent efficiency.

Abound has been in discussions with potential buyers over the last several months, but ended negotiations when the involved parties were unable to come to an agreement.

The firm's funding has come from $300 million in private investment and $70 million from a DOE loan guarantee program. Abound had used $70 million of the awarded $400 million DOE loan guarantee for construction of solar panel manufacturing lines in Colorado.

Abound has not drawn down any further DOE funds since August of 2011 when the DOE determined that challenging market conditions in the solar industry did not merit additional funding risk.

Abound believes that, at scale, its USA-made CdTe panel technology has the ability to achieve lower cost per watt than competing crystalline silicon technology made in China. However, aggressive pricing actions from Chinese solar panel companies have made it very difficult for an early stage startup company like Abound to scale in current market conditions.

According to the U.S. Commerce Department, the U.S. solar market has seen the prices for panels drop by more than 50 percent in the past year at a time when the value of imports of Chinese-made solar cells nearly quadrupled from $639 million in 2009 to $3.1 billion in 2011. Abound supports recent initiatives to enforce fair trade with import tariffs, but this action is unfortunately too late for the company.

Abound is appreciative of the significant investment from private investors and the U.S. Department of Energy.

Employees should be proud of their continuous innovation and daily efforts to support customers. Abound believes that competitive solar energy remains important to U.S. energy security and job creation, and that longer term, consistent renewable energy policy is critical to encourage further private investment in this sector.

First Solar to supply CdTe solar modules in Catalina project

The cadmium telluride facility will generate enough to power the equivalent of about 35,000 homes annually enXco, an EDF Energies Nouvelles Company, has signed a solar module supply agreement with First Solar.

First Solar will deliver 61 megawatts peak (MWp) of thin film modules starting in September 2012 for enXco's Catalina Solar Project located in Kern County, California.

Catalina Solar will be built in two phases. The first phase of approximately 60 MWp is targeted to go online by the end of 2012 and the remainder of the project by June 2013. The plant will generate enough clean energy to power the equivalent of about 35,000 homes annually and will offset about 74,000 metric tons of greenhouse gas emissions every year.

"We are pleased to enter into this agreement with First Solar to supply a portion of the Catalina Solar Project," says Kristina Peterson, Vice President, Solar Business Unit for enXco. "First Solar has been and continues to be a good partner. Their technology remains one of the lowest LCOE solar PV solutions."

"First Solar has a long-standing relationship with EDF Energies Nouvelles and we're excited to extend this to the United States with enXco," adds Dana Diller, First Solar Vice President for U.S. Business Development. "We're pleased to be a part of the Catalina Solar Project and playing a role in its success as well as helping California reach its renewable energy goals."

CdTe module installation kicks off at Antelope Valley Solar Ranch One

Los Angeles County leaders have installed the first of 3.8 million First Solar cadmium telluride photovoltaic solar panels

The installation of 3.8 million First Solar CdTe solar modules at the 230 MW AC Antelope Valley Solar Ranch One power plant in Los Angeles County has begun.

Jacob Williams, LA County Assistant Director of Public Works (right), installs first PV module at AV Solar Ranch One, with Jim Woodruff, First Solar Vice President for Government Affairs

Representatives from Los Angeles County's departments of Public Works and Regional Planning joined First Solar senior management and project workers in installing the 2-foot by 4-foot thin film photovoltaic (PV) module, marking the start of module installation, which the county approved on June 21st, 2012.

First Solar and Public Works worked to achieve agreement on code certifications to ensure that all applicable building codes were met by the project.

"This process has paved the way for future projects in a region with enormous potential for solar energy development," says Tony Perrino, First Solar Director of Engineering, Procurement and Construction.

Located on 2,100 acres of former farmland, Antelope Valley Solar Ranch One is one of the largest construction projects under way in Los Angeles County. More than 385 workers are now being employed on the 2,100-acre site. When complete in 2013, the PV power plant will generate enough electricity for about 75,000 average California homes, while displacing 140,000 metric tons of carbon dioxide annually, the equivalent of taking 30,000 cars off the road each year.

Rotary sputtering targets for CIGS materialise

New targets incorporating copper, gallium and if wanted, indium, for solar cell manufacturing have just come on the market

Indium Corporation will feature its enhanced copper-indium-gallium (CuInGa) and copper-gallium (CuGa) rotary sputtering targets at Intersolar North America.

The conference is taking place between July 10th and 12th, 2012 in San Francisco, California, USA.

The targets are now available in lengths up to 3.2 metres, and with the thicknesses of the monolithic source layer up to 22 millimetres.

The targets are made by Indium Corporation's vertically integrated proprietary process utilising aerospace powder metallurgy technology. The production process output produces a consistently homogeneous alloy with low ppm (parts per million) contamination levels and uniform density throughout the target, resulting in very consistent sputtering film properties.

The CuInGa ternary alloy targets and CuGa targets can be produced in chemistry ranges standard

to the CIGS industry, and unique chemistries for the R&D and engineering community. Both are produced as a monolithic material, bonded onto the backing tube during Indium Corporation's unique hybrid consolidation process.

HCPV solar market to balloon to $1.6 billion in 2017

With III-V compound semiconductor technology at the forefront in terms of efficiency, a steady roadmap to 45% efficiency in five years and 50% efficiency in 10 years could be on the cards

High-concentrating photovoltaics (HCPV) is a decades-old technology which taps more of the sun's energy than other solar methods.

This technology is poised to finally hit its stride, with a 31% compound annual growth rate until 2017, according to a Lux Research report.

The study, "Putting High-Concentrating Photovoltaics into Focus," says that driven by emerging markets with high solar resources, the market for HCPV will grow to 697 MW in 2017. In doing so, it will create a system market worth $1.6 billion and a module market worth $700 million, reaching a system price of $2.33/W.

"HCPV has had very little success installing commercial systems to date. However, as markets shift due to subsidy cuts from distributed installations in low-DNI (direct normal irradiance) environments such as Germany, to large installations in high-DNI environments such as India, expect HCPV to grow at a faster rate than competing technologies," says Ed Cahill, Lux Research Associate and the lead author of the report.

Lux Research analysts evaluated the emerging solar landscape and the prospects for HCPV, which uses optics such as lenses to concentrate a large amount of sunlight onto a small area of ultra high efficiency photovoltaic cells.

Funding is one of the keys to success. Well-funded companies that expand intelligently will drive the HCPV market. For example, III-V multijunction pioneer Amonix expanded too soon and too fast and has had to make cut backs. As the company is struggling, it has left the door open for emerging players like Soitec, SunCore, and SolFocus.

Developers are also in a race to build the most efficient solar cell. With Solar Junction's record-breaking 43.5% efficient cell and Spectrolab and Emcore scrambling to develop inverted metamorphic cells, the competition to manufacture the most efficient solar cell is heating up. A steady roadmap to 45% efficiency in five years and 50% efficiency in 10 years is feasible says Lux.

Also, HCPV costs are coming down. HCPV systems will turn cost competitive with single-axis-tracked mc-Si (multi-crystalline silicon) in 2017, closing a 33% and 20% gap with fixed and tracked mc-Si systems, respectively. It also will gain cost parity with mc-Si for high-DNI, utility-scale projects in 2018. The cuts will come through lower shipping and labour costs, besides economies of scale.

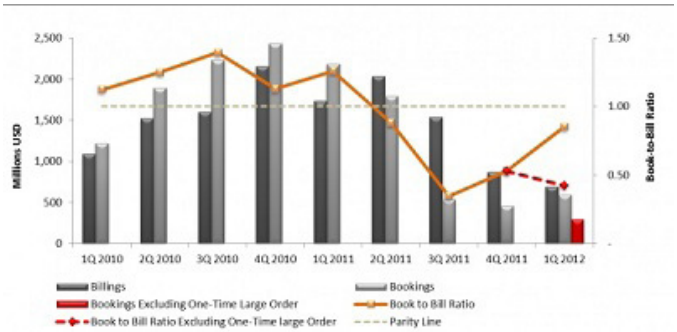
Quarterly photovoltaic equipment market plummets 60%

According to SEMI, there is prolonged challenging environment for PV equipment suppliers

Worldwide photovoltaic manufacturing equipment billings declined for the third quarter in a row, falling another 20 percent for the quarter and 60 percent from the same quarter last year, according to the SEMI Worldwide Photovoltaic Equipment Market Statistics Report for Q1 2012.

The reported total quarterly billings of $695 million slumped to the lowest level since the start of the data collection program in Q1 2010.

The reported total bookings reversed a four-quarter declining trend, up 29 percent for the quarter to $591 million. However, the increase was due to a large one-time order in a Rest-of-World region. Excluding this one-time large order, total bookings continued the negative growth in the last four quarters, down 36 percent for this quarter.



SEMI Worldwide PV Equipment Market Statistics Report, June 2012

Not surprisingly, PV manufacturers are still concerned with overcapacity and balance sheets. This has resulted in capital expenditures being curtailed, creating an extremely challenging environment for PV equipment suppliers worldwide. A significant contraction in 2012 full-year revenue is expected in the PV equipment market.

The worldwide PV equipment billings and bookings data is gathered jointly with the German Engineering Federation (VDMA) from about 50 global equipment companies that provide primary data on a quarterly basis.

First Solar installs 10 millionth solar plant PV module

First Solar installs 10 millionth solar plant PV modules

CdTe solar manufacturer First Solar has announced its Engineering, Procurement and Construction (EPC) team has installed its 10 millionth solar photovoltaic (PV) module in a utility-scale solar power project.

The installation took place at the 550 MW AC Desert Sunlight Solar Farm solar project that the company is constructing for NextEra Energy Resources and GE Energy Financial Services.

First Solar says it is the largest PV solar power plant construction firm, and was recently recognised by Engineering News-Record as the fifth largest construction firm in the power sector.

The Desert Sunlight project is part of First Solar's 2.7 GW AC utility-scale solar project pipeline in North America, which will support 7,000 supply chain and construction jobs over the next several years. Desert Sunlight, located near the community of Desert Centre in Riverside County, California, is creating an average of 400 construction jobs.

"Today's milestone underscores First Solar's leadership in delivering integrated PV solar power plants, and it's only just the beginning," says Jim Lamon, First Solar Senior Vice President of Engineering, Procurement and Construction and Operations and Maintenance.

"It's also fitting to install our 10 millionth EPC module at the Desert Sunlight project, which will set a solar record as well. When completed in 2015, it will be one of the two largest PV solar projects in the world, along with the 550 MW Topaz project we're building in San Luis Obispo County."

First Solar has cumulatively produced almost 80 million of its advanced thin-film solar modules, enough to circle the earth almost 2.5 times. The total represents a peak generating capacity of more than 6 GW, enough to power 3 million homes and displace over 4 million tons of CO2 per year.

Stion sets new record of 14.8% efficiency for production module

The producer of high efficiency thin-film CIGS solar modules has raised the bar for a high volume manufacturing process

Stion says the U.S. Department of Energy's National Renewable Energy Laboratory has verified 14.8% aperture efficiency (13.4% module efficiency) for fully certified commercial modules (65 cm x 165 cm) produced at its Hattiesburg, Mississippi factory.

Stion believes this 145 W module has the highest efficiency verified by NREL for a monolithically integrated CIGS module manufactured on a commercial production line, and exceeds the 140 W module produced by the firm on its San Jose pilot line last August.

"Reaching 14.8% efficiency on a commercial module out of our factory in MS is a significant operational and technical advancement," says Chet Farris, Stion's President and CEO. "We plan to continue driving our technical roadmap while maintaining our focus on capital costs and product costs."

Stion made the first commercial shipment from its 100 MW production line in Hattiesburg this March.

"This is a truly outstanding result and we congratulate Stion on its rapid progress in Hattiesburg," adds Rommel Noufi, the lead researcher for thin-film solar cells at NREL. "Achieving 14.8% efficiency using a large-area production process indicates that Stion is continuing to make significant innovations in CIGS technology that are reproducible and scalable. It speaks to the continued importance of US-made thin film modules in helping meet the Department of Energy's SunShot goals."

Stion's unique approach to CIGS leverages proprietary materials and device expertise along with a

robust, high-volume manufacturing process based on readily available, standardised equipment. Utilising a monolithically integrated circuit design instead of assembling individual cells into a module enables a lower bill of materials and a more streamlined manufacturing process.

First Solar to commence CdTe module installation at AV Solar Ranch One

When completed in 2013, the cadmium telluride solar facility will generate enough electricity to power 75,000 homes

The Los Angeles County Department of Public Works and First Solar have reached an agreement on the installation of solar modules at the Solar Ranch One photovoltaic (PV) power plant currently under construction in the Antelope Valley.

The agreement enables First Solar to continue construction activities of the 230 MW power plant. Installation of the modules had been delayed while First Solar and Public Works worked to achieve agreement related to the module code certifications.

Dennis Hunter, Deputy Director of County Public Works, said the Department was responsible for ensuring that all applicable building codes were met by the project in order to protect the health and safety of county residents.

"We're pleased to see the project back on track," Hunter said. "Following our discussions, we are now confident in First Solar's ability to meet our health and safety requirements."

Work on the project began in August 2011 and is creating about 400 jobs during construction on the 2100 acre site.

Los Angeles County Supervisor Michael D. Antonovich said the AV Solar Ranch was one of the largest construction projects currently underway in the county and provided significant employment opportunities to the Antelope Valley community.

"I am very pleased my office was able to facilitate resolution that helped towards finally resolving the permit issue involving the safety requirements of the AVSR1 project in the Antelope Valley," Supervisor Antonovich said. "More importantly, this resolution will help those employees that have been furloughed to return to work as quickly as possible."

Jim Lamon, First Solar Senior Vice President of Engineering, Procurement and Construction

and Operations and Maintenance, said the company greatly appreciates the collaboration and commitment from Public Works and 5th District staff to approve the module installation plan.

"As the first utility-scale solar PV project in Los Angeles County, this was the county's first opportunity to apply its codes to a facility of this magnitude, which required significant time and effort for everyone involved," Lamon said. "After a very collaborative process, we are confident we have the county's support to keep the project moving to completion, and that this process has paved the way for future projects in the region, which has great potential for solar energy production."

First Solar expects to ramp up staffing for the project over the next several weeks.

Global Solar Energy German subsidiary applying for insolvency

The fully owned subsidiary of the firm will no longer operate the CIGS 35 MWp Berlin, Germany production facility

Global Solar Energy has announced that the German executive team applied for insolvency proceedings at Global Solar's wholly owned German subsidiary, Global Solar Energy Deutschland GmbH (GSED).

The GSED operations focused exclusively on the Global Solar PowerFLEX product line. Under current market conditions, the company believes its Tucson facility has sufficient capacity to meet demand.

U.S.-based Global Solar is consolidating operations and focusing on growth segments through its 40 Megawatt (MWp) Tucson, Arizona factory.

Discussing the German proceedings, CEO DJeffrey Britt states, "The EU renewables market is financially challenging due to high inventories, collapsing prices and significant reductions to European feed-in-tariffs. As a result of this difficult operating environment, a strategic decision has been made to plan and execute an EU capacity reduction and focus investment on the products and technology necessary to meet our customer's needs and fulfil our business plan. Global Solar will continue to honour all of its warranty obligations and service European customers, but from its Tucson facilities.

"While unfortunate, the Berlin facility shutdown provides an opportunity to address financial structure issues, appropriately scale production capabilities and align with growing markets in Asia, the Middle East and North America. We continue to provide our customers with industry leading products, superior service and competitive pricing, while also ensuring the long-term success of Global Solar," continued Britt.

With these strategic changes put into effect, Global Solar will also continue to pursue new investor participation, being led by FTI Capital Advisors, LLC (FTICA), member FINRA/SIPC, the wholly owned investment banking subsidiary of FTI Consulting, Inc.

Ascent Solar charged up with 50,000 unit order for Apple iPhone

The firm's CIGS technology is being used to harness sunlight into charging the latest smartphones. Ascent will debut its chargers in Asia in early August

Ascent Solar Technologies has received a purchase order for 50,000 units of its EnerPlex solar charger for the Apple iPhone.

The EnerPlex charger was launched in early June. It was first publicly displayed at Intersolar conference in Europe last week. The product takes advantage of Ascent's ultra-light, thin and flexible CIGS solar panels and enables iPhone users to provide supplementary charging of their iPhones with sunlight. The order is from Ascent's exclusive distributor in Asia, TFG Radiant, which has advance orders from its channel partners for retail distribution throughout the Asia region. Ascent plans to fulfil the channel orders, supporting the early August retail launch of EnerPlex chargers in Asia. Ascent Solar's President and CEO, Victor Lee, says "Initial response to the EnerPlex solar charger has been excellent.

We are very encouraged by the initial orders we have received from our distribution partners in Asia and we are receiving strong interest from potential distributors worldwide. We plan to work closely with our channel partners in Asia to support the retail launch of EnerPlex while continuing to pursue expansion opportunities for this revolutionary line of products around the world." Lee continues, "Ascent unveiled the EnerPlex charger at Intersolar Europe last week to a tremendous response. The market is clearly excited about our sleek design which provides consumers with a new and fashionable way to power their smartphone. With this launch of our first EnerPlex product, with many more to come, we are taking the first step toward driving a new revenue stream with significant growth opportunity for the company." This charger is the first product under Ascent's new EnerPlex line of consumer products. Ascent is developing future products for other leading smart phones and consumer devices, such as the Samsung Galaxy S III.

Solar InGaN nanowire arrays assist energy conversion

Sandia's latest development shows that indium gallium nitride may increase the conversion percentage of the sun's frequencies and permits flexible energy absorption

Researchers creating electricity through photovoltaics want to convert as many of the sun's wavelengths as possible to achieve maximum efficiency. Otherwise, they're eating only a small part of a shot duck: wasting time and money by using only a tiny bit of the sun's incoming energies.

For this reason, they see InGaN as a valuable future material for photovoltaic systems.

Changing the concentration of indium allows researchers to tune the material's response so it collects solar energy from a variety of wavelengths. The more variations designed into the system, the more of the solar spectrum can be absorbed, leading to increased solar cell efficiencies. Silicon, today's photovoltaic industry standard, is limited in the wavelength range it can 'see' and absorb.

But there is a problem. InGaN is typically grown on thin films of GaN. But because GaN atomic layers have different crystal lattice spacings from InGaN atomic layers, the mismatch leads to structural strain that limits both the layer thickness and percentage of indium that can be added. Thus, increasing the percentage of indium added broadens the solar spectrum that can be collected, but reduces the material's ability to tolerate the strain.

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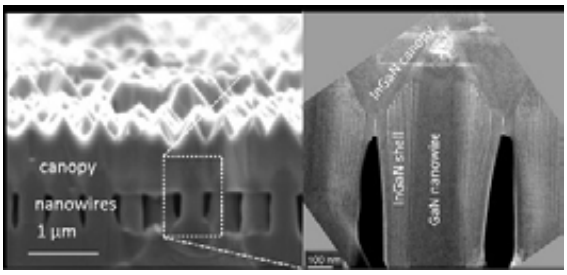

Cross-sectional images of the InGaN nanowire solar cell.(Image courtesy of Sandia National Laboratories)

Sandia National Laboratories scientists Jonathan Wierer Jr. and George Wang reported in the journal *Nanotechnology* that if the indium mixture is grown on a phalanx of nanowires rather than on a flat surface, the small surface areas of the nanowires allow the indium shell layer to partially "relax" along each wire, easing strain. This relaxation allowed the team to create a nanowire solar cell with indium percentages of roughly 33 percent, higher than any other reported attempt at creating III-nitride solar cells.

This initial attempt also lowered the absorption base energy from 2.4eV to 2.1 eV, the lowest of any III-nitride solar cell to date, and made a wider range of wavelengths available for power conversion. Power conversion efficiencies were low - only 0.3 percent compared to a standard commercial cell that hums along at about 15 percent - but the demonstration took place on imperfect nanowire-array templates. Refinements should lead to higher efficiencies and even lower energies.

Several unique techniques were used to create the III-nitride nanowire array solar cell. A top-down fabrication process was used to create the nanowire array by masking a GaN layer with a colloidal silica mask, followed by dry and wet etching. The resulting array consisted of nanowires with vertical sidewalls and of uniform height.

Next, shell layers containing the higher indium percentage of InGaN were formed on the GaN nanowire template via MOCVD. Lastly, In0.02 Ga 0.98N was grown, in such a way that caused the nanowires to coalesce. This process produced a canopy layer at the top, facilitating simple planar processing and making the technology manufacturable.

The results, says Wierer, although modest, represent a promising path forward for III-nitride solar cell research. The nano-architecture not only enables higher indium proportion in the InGaN layers but also increased absorption via light scattering in the faceted InGaN canopy layer, as well as air voids that guide light within the nanowire array.

The research was funded by the DOE's Office of Science through the Solid State Lighting Science Energy Frontier Research Centre, and Sandia's Laboratory Directed Research and Development program.

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Soitec awarded $25 million for San Diego solar plant

The cash from the U.S. Department of Energy, will be used to accelerate the manufacturing of the firm's gallium indium phosphide / gallium arsenide / germanium solar cells

One of Soitec's US Solar Energy subsidiaries has been selected by the U.S. DOE to receive a SUNPATH award of $25 million.

The money will be used to support its new North American solar manufacturing facility in San Diego, California.

SUNPATH, which stands for Scaling Up Nascent PV At Home, seeks to increase America's manufacturing competitiveness in the global solar market.

Last December, Soitec acquired a 176,000-square-foot manufacturing centre on 14.8 acres of land located in San Diego to support over 300 MW of well advanced projects throughout San Diego and Imperial Counties.

The new factory will enable a manufacturing capacity of 200 MW (275 MWp) of Soitec's fifth generation of Concentrix CPV modules, and the firm says this will be the world's largest CPV manufacturing facility.

This major project represents an investment of more than $150 million and is expected to create 450 on-site jobs and more than 1,000 indirect jobs at full capacity. Construction is currently underway, and the first phase is scheduled to be operational by the fourth quarter of 2012.

"This SUNPATH award will accelerate the production and output of Soitec's first large-scale CPV module manufacturing facility in San Diego," says Clark Crawford vice president of Sales and Business Development USA. "We are honoured by this new partnership with the DOE and their support for CPV deployments in the US represented by this award."

"The decision of the DOE to award Soitec with the largest share of the SUNPATH award provides a strong endorsement of our CPV technology," adds Gaetan Borgers, Executive VP of Soitec Solar Energy Division. "The SUNPATH award adds support to our view that CPV is best-suited for regions with extremely hot ambient temperatures and dry weather conditions like the American Southwest."

CPV technology converts sunlight directly into "clean" electricity via concentrator optics and high-efficiency solar cells offering the best design for use in sunny regions, delivering low-cost, reliable, and environmentally-friendly solar generated electricity.

Soitec's fifth generation CPV modules, to be manufactured at the San Diego facility, were developed to reduce installation costs while implementing improved system optics to further increase the efficiency levels of the CPV modules. Soitec's fifth generation Concentrix CPV modules provide a market-leading 30% module efficiency (or 2 to 3 times the efficiency of conventional PV technology).

High volume CPV module production at the San Diego facility will enable Soitec to deliver renewable energy and economic development by expanding its solar power plant customers throughout Southern California and the American Southwest and ultimately support export opportunities around the Pacific Rim.

The SUNPATH award will be finalised pending completion of the contract negotiations with the DOE.

Singulus launches Clustertool system for CIS/ CIGS development

With the aid of this modular plant, innovative large-scale manufacturing processes for CIGSSe solar cells will be developed

Singulus is introducing some new photovoltaic tools including a Clustertool system for the development of CIS/CIGS solar modules for 300 x 300 mm2 substrates.

The goal is to considerably reduce the manufacturing costs for thin-film photovoltaic (PV) modules and to achieve highest module efficiencies. The Clustertool enables the integration of different process steps in a compact, modular machine system. Through a central interface, the substrates are transported to the most important manufacturing steps such as coating, selenisation, wet-chemical or thermal processes.

Singulus will commission the first system in the summer of 2012.

There is demand in many R & D facilities for cost-efficient development tools to further advance CIS/ CIGS technology, to test new process variations and to transfer the results to production scale as quickly as possible.

Within the scope of a sponsorship program of the “Photovoltaics Innovation Alliance”, the “CIS Clustertool” project commenced its research efforts for the development of new manufacturing processes for copper-indium-selenide-based thin-film semiconductors (CIS) in July 2011. The project was sponsored by the German Federal Ministry for Education and Research (BMBF) and the German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU).

PVcomB expands CIGS solar manufacturing capability

The fully owned subsidiary of the Helmholtz Centre Berlin for Materials and Energy (HZB) for photovoltaics has commenced full operation of small solar modules based on copper indium gallium diselenide

The Berlin Competence Centre for Thin Film and Nanotechnology for Photovoltaics (PVcomB) has purchased two thin-film solar-module production tools from German firm Leybold Optics, which are now in operation.

With these inline sputter systems, PVcomB has closed the final gaps in its two research lines for thin-film silicon and CIGS solar modules, and has now commenced full operation with modules measuring 30 x 30 centimetres.

PVcomB sets sputter systems from Leybold Optics in operation. From right to left: Bernd Stannowski and Sven Ring, PVcomB, Berlin. (Picture: HZB)

“Continuous thin-film technology developments in the laboratory which must be implemented on an industrial level as quickly as possible,” says Rutger Schlatmann, head of PVcomB, summing up the mission of the competence centre.

Scientists and technicians work at two research lines, focussing on the needs of industry, with the aim of solving problems related to industrial production. At the same time, alternatives arising out of basic research are developed and tested at each process and analysis stage.

The sputter systems manufactured by Leybold

Optics were finally commissioned in May 2012 thus completing PVcomB's research lines for thin-film silicon and CIGS. The competence centre is now able to perform the entire module production process, from cleaning the glass panels all the way to module encapsulation, for a glass panel size of 30 x 30 centimetres.

The first A600V7 sputter system is part of the reference line for thin-film silicon (a-Si/µc-Si), enabling PVcomB now to produce its own layers for front and back contact systems. "This has finally allowed us to close the final gap in our research line," adds Schlatmann.

The second A600V7 plays a decisive role in the reference line for CIGS. Back contacts made of molybdenum and, above all, the layers comprising copper, gallium and indium are deposited for the so-called "sequential process". In the subsequent steps of the process, these are transformed into CIGS solar modules.

The Leybold Optics systems offer great flexibility, allowing for the subsequent integration of additional components and system extensions. The use of carrier stackers for changing substrates and the ability to coat two substrates simultaneously means that automated processes can be run with a high throughput and high level of reproducibility.

"Our inline sputter systems enable us to fulfil PVcomB's stringent requirements of producing, CIGS and thin-film silicon solar modules in a state-of-the-art environment. At the same time, this cooperation has afforded us a wonderful opportunity to learn from the experience of the PVcomB research team. The resulting findings flow into our ongoing development process for the next system generation," says Patrick Binkowska, manager of the Glass & Solar Division at Leybold Optics, commenting on the commencement of the sputter system's operation by PVcomB.

Leybold Optics develops processes and manufactures complex high-end coatings. It specialises in the fields of sputtering, PEVCD, plasma assisted evaporation, automation and software in the optics and glass and solar markets. The company was acquired by Swiss group Bühler earlie

U.S. PV manufacturing consortium kicks off CIGS roadmap

The collaboration, which includes partners from industry, universities, and government will help to set the direction for this promising renewable energy technology

The U.S. Photovoltaic Manufacturing Consortium (PVMC) has selected a trio of leading solar industry executives to guide development of the first-ever U.S. CIGS PV Roadmap.

The PVMC is an industry-led collaboration headquartered at the College of Nanoscale Science and Engineering (CNSE) of the University at Albany in New York that is designed to accelerate next-generation solar photovoltaic (PV) technologies.

Alain Kaloyeros, Chair of PVMC and Senior Vice President and CEO of the College of Nanoscale Science and Engineering, says, "Through the leadership and vision of Governor Andrew Cuomo, and the critical investment by the U.S. Department of Energy, New York is leading the national effort to accelerate the deployment of efficient and cost-effective solar energy through the development of innovative CIGS technology. The engagement of three leading solar executives is an important step forward in enabling PVMC to deliver the nation's first-ever CIGS PV Roadmap, and we look forward to their guidance and participation in this important endeavour."

Dan Armbrust, CEO of PVMC and President and CEO of Sematech, adds, "One important objective of PVMC is to build leadership around road mapping to establish the disciplines of financial and cost modelling, strategic planning and other long-term activities for CIGS PV manufacturing and applications. PVMC will take a lead role in bringing in the entire industry supply chain to collaborate in defining critical challenges and potential solutions for over the next decade."

Spearheaded by CNSE and *Sematech* as part of the U.S. Department of Energy's (DOE) SunShot Initiative, PVMC is targeting a reduction in the total installed cost of solar energy systems by 75 percent over the next decade. The CIGS PV Roadmap

aims to provide a congruent plan for the national CIGS industry, including module and systems manufacturers, suppliers, and end-users, that will identify common challenges and define the areas of technical developments needed to sustain and advance a competitive U.S. photovoltaic industry.

Larry Kazmerski, Joseph Laia, and Richard Swanson will serve as co-chairs for the groundbreaking effort, which will include participation from all sectors of the photovoltaic industry and support the development and growth of advanced solar PV-related manufacturing processes throughout the United States.

"The National CIGS PV Roadmap effort is a vital initiative, bringing together all sectors of the photovoltaic industry to identify critical challenges and coalesce industry direction and market leadership," concludes Joseph Laia. "I am delighted to be selected co-chair of the CIGS PV Roadmap. I look forward to providing guidance on solutions-driven initiatives that tackle top industry concerns on the technical barriers, manufacturing processes, and business challenges associated with CIGS thin-film solar PV."

"I am honoured and excited to be working with my co-chairs and the roadmap team to help DOE further define and clarify the role CIGS can play in our energy future," gushes Swanson. "We'll be building on earlier PV roadmap initiatives, and collaborating with partners from industry, universities, and government to help set the direction for this promising renewable energy technology."

Serving as the champions for the U.S. CIGS PV Roadmap, the co-chairs will direct the activities and decisions of the Roadmap Executive Steering Committee (RESC) and guide roadmap working groups addressing six focus areas relevant to the entire industry, including roll-to-roll; rigid glass; metrology; modules and packaging; substrates and materials; and reliability, certification, and test.

Kazmerski is Director of the National Centre for Photovoltaics at the National Renewable Energy Laboratory (NREL), where he has led NREL efforts in measurements and characterization for more than 20 years. Kazmerski has published more than 310 journal papers in the areas of solar cells, thin films, semiconductor materials and devices, surface and interface analysis, scanning probe microscopy, nanoscale technology, high-temperature superconductivity, and semiconductor defects, and is a three-time recipient of the R&D 100 awards for novel measurement and characterisation devices.

Laia most recently served as President and Chief Executive Officer of Miasolé. Prior to Miasolé, he was Group Vice President of Metrology at KLA-Tencor, responsible for all of KLA's eight wafer metrology businesses, and served as Chief Executive Officer of Blue29 LLC, a subsidiary of KLA Tencor Corp. He has over a decade of national laboratory experience and spent a number of years in semiconductor capital equipment companies. He holds 10 patents, has published 25 papers, and has edited one book in the area of materials processing.

Swanson founded SunPower Corporation to develop and commercialise cost-effective photovoltaic power systems in 1991, and currently serves as its president emeritus. Along with his students and co-workers, Swanson has published more than 200 articles in journals and conference proceedings, as well as several book chapters. In 2002, Swanson received the William R. Cherry award by the IEEE for outstanding contributions to the photovoltaic field, and was elected to the National Academy of Engineering in 2009. Most recently, he received the Economist's Innovation Award for Energy and Environment, the 2010 IEEE Junichi Nishizawa Medal, and the Karl Boer Solar Energy Medal of Merit.

As the primary sponsor of the effort, PVMC is providing resources for managing and coordinating the roadmap activities. Members of the CIGS PV Roadmap represent all areas of the PV industry including module producers and integrators, equipment suppliers, materials and metrology tools, end-users, and the research community.

Soltecture record CIGS modules hit 12.8% efficiency

What's more, since the company filed for insolvency last year, an International investment process has begun. Soltecture says there is a high interest among potential buyers

Soltecture, a thin-film CIGSe module innovator, says it has reached new heights in efficiencies.

With a peak value of 103.9 W, analogous to a module efficiency of 13.9 percent aperture, the corporation was able to increase the efficiency of its CIGSe based modules.

"Our research and development department was able to increase the module efficiency by another 10 W in less than one year. That is more than a 10 percent increase," notes Nikolaus Meyer, founder and CEO of Soltecture.

The possibilities of CIGSe materials have yet to be exhausted. As such, Soltecture is pursuing its own Technology Roadmap that hopes to bring the company to hit more than 16 percent efficiency by 2015.

This high-tech enterprise, which emerged in 2001 from one of Europe's leading photovoltaic research institutes, conducts its production and development from its headquarters in Berlin-Adlershof. More than fifty highly qualified engineers, with a combined 200 years of technology experience, are employed on the project.

The new Linion 100 W leads Soltecture's product portfolio. It has an aperture efficiency of 13.4 percent and a module efficiency of 12.3 percent. "With the Linion 100 W we are introducing one of the strongest thin film modules on the market," explains. Nikolaus Meyer.

Until now, the Linion line was available in performance classes of 80 W, 85 W and 90 W. The Linion 100 W and Linion 95 W are both IEC 61646 TÜV-certified and are being produced in accordance to the ISO 9001-standard. Soltecture's system solutions for solar construction – from the prefabricated flat-roof element to the solar roof tiles – are now all equipped with the new high-efficiency modules.

On May 9th, 2012, Soltecture filed for insolvency. The responsible local court, Berlin-Charlottenburg, hired attorney Hartwig Albers as a preliminary insolvency administrator. A substantial number of creditors have supported his appointment.

In the meantime, the search for an investor continues as planned. Hartwig Albers, together with the M&A experts of investment bank, Macquarie, have initiated the international investor process. "Numerous investors have already expressed interest in taking Soltecture over," says the restructuring expert of the nationwide partnership Brinkmann & Partner. "Although it is too early to make precise predictions, the interest with potential investors is high." Therefore, he is "confident that we will find a buyer in the coming months."

Stable business operations and a trusted customer base also contribute to the boost in confidence. "Through the commitment of our employees, our customers have felt little impact of the insolvency, and we were able to sustain our transaction volume," says Meyer. The preliminary insolvency administrator confirms that "all parties involved have a vested interest in company's survival." the administrator works together with Meyer on the restructuring and on the permanent preservation of the company.

Soitec installs largest III-V CPV solar power plant in Italy

The firm's gallium indium phosphide / gallium arsenide / germanium solar cells will supply electricity to Enel, Italy's largest power company

Soitec has completed construction and grid connection for the largest concentrator photovoltaic (CPV) solar power plant in Italy.

Located in the Belpasso municipality in the Catania province in Sicily, the highly efficient, 1.17-megawatt-peak (MWp) facility is now ready to generate clean, reliable electricity for the local power grid for decades to come and paves the way for many other CPV plants to be developed in Italy.

The new utility-scale power plant will generate enough electricity to supply approximately 300 homes per year and is expected to offset more than

125 tons of carbon-dioxide emissions per year. It is equipped with 74 of Soitec's high-efficiency CPV trackers, each using 168 Concentrix CPV modules, along with two central inverters of 500 kW each to ensure reliable power distribution to the grid.

Concentrix tracking system

Concentrix technology uses optimised III-V-based triple-junction solar cells (GaInP/GaInAs/Ge) in which three different types of solar cells are stacked on top of one another. Each cell type is designed to convert a certain range of the solar spectrum: short wave radiation, medium wave radiation and infrared.

Operating at higher efficiency than conventional solar PV panels in converting sunlight into electricity, Soitec's systems maximise energy production throughout the day by incorporating multjunction solar cells and dual-axis tracking systems that maintain an optimal angle to the sun. CPV is the most attractive solar technology in high solar resource regions around the globe.

"Completing this solar power plant marks a major milestone for Soitec in Italy while also demonstrating all of CPV's advantages in this part of the world," says Gaetan Borgers, executive vice president of Soitec' Solar Energy division.

"This project has allowed us to show that CPV's leading efficiency and ability to provide a steady, long-term energy supply without consuming excessive amounts of land and water make it exactly the right technology for Italy. We are uniquely positioned with a cost-effective power generation technology at high levels of efficiency and committed to developing this market in Italy."

Fully owned and operated by Soitec, the new solar plant will supply electricity to Enel, Italy's largest power company. Local Italian construction companies provided engineering, procurement and construction (EPC) services for the solar power plant while efficient central-inverter technology was provided by Schneider Electric.

Emcore unveils commercial rooftop CPV system

The system incorporates the firm's III-V compound semiconductor multijunction solar technology

Emcore Corporation has announced that the Emcore Soliant 1000 Commercial Rooftop Concentrator Photovoltaic (CPV) System is now available for pre-production orders.

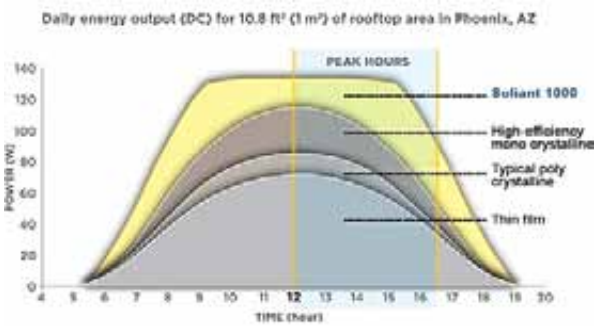
The Soliant 1000 is powered by Emcore's III-V multijunction solar cell technology.

Emcore Soliant 1000

The Emcore Soliant 1000 is designed to generate solar power for commercial buildings with high energy demands. The system offers one of the highest energy production densities of any available solar system, making it a very cost-effective solar solution for commercial rooftops in regions with high Direct Normal Irradiance.

Emcore's Soliant 1000 generates more than 500 watts peak per panel (18 watts peak per square foot), requiring approximately 28% less rooftop area

than polycrystalline and approximately 38% less rooftop area than thin-film solar panels to generate 1000 MWh per year of energy output. The system combines Emcore's solar cell technology with a patent-pending TipTilt Tracking system that tracks the sun's movement all day to maximise critical peak-hour energy output when utility energy is most expensive.



Soliant 1000 38" (97 cm) East to West Spacing. Others 10° tilt, South facing

The Emcore Soliant 1000 panels are low profile, lightweight, non-penetrating and come fully-assembled and ready to drop-in place. This presents a strong value proposition for developers, integrators, and installers as more projects can be completed in less time with lower labour and system costs. Commercial building owners receive the benefits of the lowest Levelised Cost of Energy, which is the final cost to produce a kilowatt-hour of solar power, along with a system that is designed for over 25 years of life.

Christopher Larocca, Chief Operating Officer for Emcore says, "This announcement opens the door for Emcore to enter the estimated $2 billion annual rooftop solar market. Production and deliveries are scheduled to commence later this year and we look forward to addressing this new segment."

SoloPower shows off next generation of solar solutions

The flexible thin-film solar cell and module CIGS manufacturer, is seeking to make solar the main source of power for world's commercial and industrial buildings, which consume 40% of electricity

San Jose, California-based SoloPower, has revealed its next generation of integrated CIGS solar solutions.

SoloPower's solutions include six models of photovoltaic panels and three first-of-their-kind, easy, non-penetrating installation kits: the SoloSaddle, SoloWedge, and the SoloBridge, which increase application versatility at the same time as optimising module performance for commercial and industrial rooftops.

"At SoloPower, we approach the market based on the needs of our customers, with solutions that are rapidly deployable on old and new roofs as well as adaptable to site-specific conditions," says Bruce Khouri, President and Chief Commercial Officer, SoloPower. "The combination of our next generation SoloPanels with our installation kits enables us to expand the solar rooftop market, making solar energy easy and economical for just about any roof type, anywhere."

SoloPower's new suite of solar solutions and installation systems enable the modules to perform optimally and to be integrated into a variety of roof systems globally. The new products are described below.

The SoloPanel SF1 and SP1 modules are optimised for twelve-inch and sixteen-inch standing-seam metal roof integration.

The SoloPanel SP3L and SP3S are large format modules suited to commercial and industrial low-slope building applications.

SoloSaddle is a non-penetrating kit designed to easily integrate the SP3S into membrane based roofing systems. A low-slope curve provides self-cleaning and high performance in hot climates.

The SoloWedge is a non-penetrating kit designed to easily integrate the SP3L into membrane based roofing systems. A five-degree slope provides self-cleaning and maximum performance in cold climates.

The final product, the SoloBridge is a non-penetrating kit designed to easily integrate the SP3L into metal roofing systems.

The introduction of SoloPower's next generation of solar solutions comes at a time when the company is hiring for its high-volume manufacturing facility

in Portland, Oregon, which will begin commercial production later this year. SoloPower's operations in Portland are ultimately expected to have a capacity of 400MW and employ 450 people.

"SoloPower is building our new manufacturing facility in Oregon because of the visionary leadership and support of the State of Oregon, the Oregon Department of Energy, and the City of Portland," adds Tim Harris, Chief Executive Officer, SoloPower. "Portland's highly skilled work force has enabled us to draw on very strong local talent as we create jobs and promote smart job-growth in the energy sector."

SoloPower's proprietary approach embodies critical technology, manufacturing, and cost advantages that enable large-scale "fab-style" production of high-efficiency CIGS-based photovoltaic cells. The CIGS cells are then packaged into unique, flexible, lightweight solar modules that require less balance-of-system hardware and are easier to install than traditional silicon solar panels.

SoloPower's cells and modules are continually subjected to rigorous environmental and accelerated life cycle testing beyond the industry standards and are designed for superior performance under all light conditions.

The firm's modules also have low profile bypass diodes that allow for maximum performance in the shade. The company says its latest solutions advance the possibilities of solar power integration, with proven technology that overcomes the product weaknesses of other thin-film solar modules and offers true flexibility for an large range of applications.

NREL's Sarah Kurtz honoured by IEEE for work on III-V solar cells

The physicist was awarded for her work on gallium indium phosphide / gallium arsenide solar research

A physicist from the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) who helped launch super-efficient multijunction solar cells and who is a pioneer in photovoltaic systems reliability has been awarded the Cherry Award by the Institute of Electrical and Electronics Engineers (IEEE).

Sarah Kurtz

Sarah Kurtz, a principal scientist and group manager at NREL, received the award at the IEEE's annual Photovoltaic Specialists Conference in Austin, Texas, last week.

Kurtz and NREL colleague Jerry Olson championed the early use of multijunction solar cells by showing that a top cell of GaInP and a bottom cell of GaAs can capture and convert photons more efficiently into electricity than previous attempts at using other materials.

They showed that the multijunction concentrator cells not only use a fraction of the precious electronic materials used by the thicker flat plate cells, but that they can capture more light through the course of a day. Olson won the Cherry Award in 2011.

Their breakthrough was embraced by NASA, which uses multijunction solar cells based on this invention to power most space satellites, as well as the Mars rovers, Spirit and Opportunity.

Kurtz's work helped illuminate how to grow high-quality cells, how to measure multijunction cells, and how their performance is affected under various spectra. More recently, she has looked at reliability issues of integrating multijunction cells and solar PV in general into larger systems.

"The question on the street — how to predict the lifetime of modules — comes in different flavours," Kurtz said during a break in the Austin conference. "They come from people who are determining the warranties, customers who want to choose

the most durable product, the investor trying to justify the investment of a billion dollars, and the insurance companies wanting to know how to set rates. Service predictions, by site around the world, looking 20 or 30 years out, are quite challenging experiments to design.

"To win the Cherry Award is a deep honour," Kurtz said. "A lot of people who are very deserving have been nominated, so I feel very honoured."

Kurtz also conducted groundbreaking work on dilute nitrides and on measuring the individual junctions of a series of connected solar cells. At the award ceremony, presenters said, "She has proven to the world high efficiency PV can be done."

Last year, she helped form the International PV Quality Assurance Task Force to develop comparative test standards for PV modules. She is recognized worldwide as an expert on Concentrating PV technology and has received numerous awards both as an individual and as part of a team.

"Sarah's contributions to solar science and technology research can't be overstated," NREL's Director, Dan Arvizu said. "NREL is proud to have two consecutive winners of the Cherry Award, and four altogether, fo rone of the most important awards in the photovoltaic field. Sarah's impact on solar energy has been profound, and it's wonderful to see her recognised."

The Cherry Award is named in honour of William R. Cherry, a founder of the photovoltaic community. In the 1950s, he was instrumental in establishing solar cells as the ideal power source for space satellites and for recognizing, advocating, and nurturing the use of photovoltaic systems for terrestrial applications. The William R. Cherry award was instituted in 1980, shortly after his death. The purpose of the award is to recognise individual engineers or scientists who devoted a part of their professional life to the advancement of the science and technology of photovoltaic energy conversion.

NREL is the U.S. Department of Energy's primary national laboratory for renewable energy and energy efficiency research and development. NREL is operated for DOE by The Alliance for Sustainable Energy, LLC.

Alta Devices discloses its secrets on GaAs solar cell technology

The firm's flexible sheets of high efficiency gallium arsenide based solar cells enable adaptable form factors

At last week's IEEE Photovoltaics Specialists Conference (PVSC), Alta Devices disclosed details of key technologies that enabled its latest record module result.

Alta described how its thin film solar cells are interconnected into flexible sheets creating a new class of solar material that leverages the company's record–setting high efficiency GaAs solar cell technology. These breakthroughs enable flexible solar material that can be formed into different shapes and sizes, making possible new and unique solar applications.

"Up until now, the applications of relatively high efficiency solar have been constrained to those that utilise large and heavy glass plates," said Chris Norris, Alta president and CEO. "But the technology being disclosed this week has the potential to change both the applications and economics of solar."

Alta's solar material can be used differently from those that have been available; it allows meaningful power production anywhere the sun is shining. This results directly from the high efficiency of Alta's material combined with its thin and flexible nature.

It can be deployed in many new kinds of solar applications including: electric vehicles, aircraft and unmanned drones, portable power, roof tiles and other building-integrated uses, and more. Because of the characteristics of Alta's solar technology, the high cost of an entire solar energy system is reduced.

"When you are able to use solar in nearly any form, the applications broaden and the system complexity and cost are dramatically reduced," explained Norris, "And, ultimately, both the economic returns and human benefits increase."

At the PVSC, Laila Mattos presented how Alta was

able to reach a new world record of 23.5% solar module efficiency. This result was confirmed by the National Renewable Energy Lab. In addition to underscoring various previously disclosed techniques for overcoming the cost and complexity of using GaAs, the presentation explained how Alta was able to maintain its efficiency advantage while creating flexible sheets that can be of nearly any size. Specifically, Mattos revealed that Alta's solar cells are self–interconnected in a way that maximises the light captured by the thin, flexible sheets.

Mattos explained, "Traditionally, when solar cells are interconnected to form a module, conversion efficiency is compromised because active solar material is covered with metal busbars and wires, preventing some of the light from entering the cells. In addition, gaps between cells create areas of the module that are not able to convert incident light to electrical energy."

"The key to improving solar performance at the module level is to avoid these problems. Enabled by our cell flexibility, we use a self–interconnected technology that eliminates the wires, thus maximizing the cells' exposure to incident light. The self–interconnected cells form a flexible sheet with no gaps and that can be of any size or aspect ratio," concluded Mattos.

According to Norris, construction of Alta's pilot manufacturing facility is underway, with expectations of material available by the beginning of 2013. "We take every step of our business systematically and don't underestimate the challenges. We are committed to thinking differently about solar energy and how it is used, and are dedicated to realising its potential to improve lives around the world."

Intermolecular and First Solar to accelerate CdTe solar PV roadmap

The joint venture will leverage Intermolecular's high productivity combinatorial platform towards achieving higher cadmium telluride solar panel efficiencies

CdTe solar power innovator First Solar and Intermolecular have signed a licensing agreement aimed at accelerating the efficiency roadmap for First Solar's CdTe photovoltaic (PV) technology. First Solar is one of the world's largest thin film PV solar module manufacturers .

Under a newly signed collaborative development program, First Solar will leverage Intermolecular's High Productivity Combinatorial (HPC) platform in the development of its advanced, CdTe-based, thin film PV manufacturing technology.

The program addresses new opportunities in certain critical materials and processes that may significantly influence the conversion efficiency of CdTe technology. Technical work is to be performed jointly at Intermolecular's San Jose, California, facility and in First Solar's research and development labs.

"We are excited to engage in this ongoing collaboration with Intermolecular," says Raffi Garabedian, First Solar Chief Technology Officer. "Further improving our world-record CdTe conversion efficiencies remains a strong lever to reduce the cost of solar energy. We evaluated Intermolecular's HPC platform and technical team in a trial collaboration, and this experience confirmed the suitability of the platform for our purposes."

First Solar set a world record for CdTe PV solar module efficiency in January 2012, achieving 14.4 percent total area efficiency. In July 2011, the company set a world record for CdTe PV cell efficiency at 17.3 percent. Both records were confirmed by the U.S. Department of Energy's National Renewable Energy Lab (NREL).

Craig Hunter, Intermolecular's senior vice president of Global Sales & Marketing, comments, "Leveraging our HPC platform to accelerate the PV roadmap is central to our mission at Intermolecular. Today's announcement with First Solar - a market leader in PV and the undisputed champion in thin film PV - represents tremendous validation of that proposition, particularly given the extensive technical due diligence the First Solar team conducted prior to entering into this agreement."

Intermolecular's mission is to improve R&D efficiency in the semiconductor and clean-energy industries through collaborations that use its HPC

platform, which allows R&D experimentation to be performed at speeds up to 100 times faster than traditional methods.

First Solar to provide 159 MW in Australian solar program

The firm will provide its cadmium telluride modules to AGL Energy

First Solar intends to design, construct and maintain two utility-scale solar photovoltaic (PV) power projects totalling 159 megawatts AC (MW) for AGL Energy Limited as part of Australia's Solar Flagships Program.

AGL was selected as the successful proponent in the solar PV category of the program and will receive federal and state government funding to help deliver on its commitment to greater investment in renewable electricity generation.

The Australian Government's Solar Flagships Program is one of a number of programs and market mechanisms providing unprecedented support for the development of a broad range and scale of solar energy projects and technologies in Australia. The Solar Flagships Program is offering funding to support the construction and demonstration of large-scale, grid connected solar (PV and thermal) power stations in Australia.

Under the program, AGL will develop a 106 MWAC project in Nyngan and a 53 MWAC project in Broken Hill, both in New South Wales. First Solar will design and construct the integrated PV power plants, using its engineering, procurement and construction services and its advanced thin-film PV modules for both projects.

First Solar will also maintain both projects for AGL Energy for their first five years of commercial operation. The electricity produced by the projects will be sold under power purchase agreements to AGL Hydro Partnership, a wholly owned subsidiary of AGL.

The projects will be supported with funding provided by the federal government and the state government of New South Wales under separate funding agreements.

"This is a significant step forward for the utility-scale solar industry in Australia—an order of magnitude increase in project size - and a testimony to the confidence our customers have in First Solar technology and its performance in some of the hottest and harshest conditions in the world," says Jim Hughes, First Solar Chief Executive Officer.

"These projects demonstrate First Solar's ability to apply its vertically integrated capabilities to deliver competitive, comprehensive, utility-scale solar solutions in future sustainable markets. We look forward to working with AGL on more projects like this in the future."

On an annual basis, the projects will produce enough electricity to meet the needs of at least 30,000 Australian homes. The projects are expected to provide approximately 350 GWh of energy annually.

The projects are expected to create approximately 450 jobs at peak construction. Construction is expected to begin on both projects in 2014, with commercial operation in 2015. AGL will be the majority owner of the project vehicle.

"AGL is delighted to be working with the Commonwealth and New South Wales Governments, the people of Broken Hill and Nyngan, and our project partner First Solar to deliver these significant renewable energy projects. These projects represent a tremendous opportunity for AGL and the broader solar industry to begin the roll-out of solar power as a meaningful source of generation supply in Australia," adds Michael Fraser, AGL's Managing Director.

Global Solar Energy considering sales process

The flexible CIGS manufacturer has initiated an investor process which could lead to partial or total change in ownership and control of the company

Global Solar Energy, Inc. has engaged investment banking firm FTI Capital Advisors, LLC (FTICA), to pursue new investor participation.

The company is considering opportunities for the USA and EU operations.

Global Solar Energy currently has 75 MWp of installed thin-film photovoltaic production capacity in the USA and EU.

The firm sells its products into special applications such as weight-restricted roofs, integrated building products, military markets and various emerging applications. The company currently supplies interconnected solar cells for the DOW POWERHOUSE Solar Shingle roofing product line.

Commenting on the decision to pursue new investors, CEO, Jeffrey Britt states, "Global Solar's owners have accomplished their plan of developing leading CIGS thin-film technology and being the first company to reach commercial-scale production. The time has come to consider financial alternatives that will help enable the company to reach its strategic objectives."

"The process offers new investors an opportunity to participate in the fastest-growing segment of the solar industry, flexible thin-film. Global Solar is differentiated from the broader solar industry as its products are specially designed to target high growth, niche markets that require flexible, lightweight solar solutions," continues Britt.

The company does not anticipate any disruption in production or service to its customers during this process.

Diving into the benefits of GaInP solar cells

Gallium indium phosphide cells have high quantum efficiency in wavelengths between 400 and 700 nm and an intrinsically low dark current. They provide high efficiency in lowlight conditions, such as underwater

Scientists at the U.S. Naval Research Laboratory, Electronics Science and Technology Division have developed high bandgap solar cells capable of producing sufficient power to operate electronic sensor systems at depths as much as 9 metres.

Underwater autonomous systems and sensor platforms are severely limited by the lack of long endurance power sources. To date, these systems must rely on on-shore power, batteries or solar power supplied by an above water platform. Attempts to use photovoltaics have had limited success, primarily due to the lack of penetrating sunlight and the use of solar cells optimized more towards the unimpeded terrestrial solar spectrum.

"The use of autonomous systems to provide situational awareness and long-term environment monitoring underwater is increasing," says Phillip Jenkins, head, NRL Imagers and Detectors Section. "Although water absorbs sunlight, the technical challenge is to develop a solar cell that can efficiently convert these underwater photons to electricity."

Even though the absolute intensity of solar radiation is lower underwater, the spectral content is narrow and thus lends itself to high conversion efficiency if the solar cell is well matched to the wavelength range. Previous attempts to operate solar cells underwater have focused on crystalline silicon solar cells and more recently, amorphous silicon cells.

Unlike silicon cells, high-quality GaInP cells are well suited for underwater operation. GaInP cells have high quantum efficiency in wavelengths in the visible light region, (between 400 and 700 nm) and exhibit an intrinsically low dark current. Both properties are critical for high efficiency in lowlight conditions.

The filtered spectrum of the sun underwater is biased toward the blue/green portion of the spectrum and thus higher bandgap cells such as GaInP perform much better than conventional silicon cells, notes Jenkins.

Power density of GaInP and crystalline silicon cells, underwater, as a function of depth

Preliminary results at a maximum depth of 9.1 m reveal output to be 7 W/m2 of solar cells, sufficient to demonstrate there is useful solar power to be harvested at depths commonly found in near shore littoral zones.

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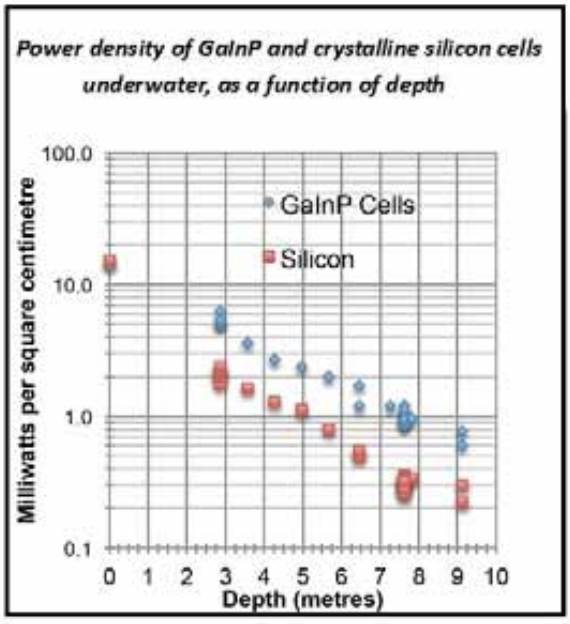

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Calyxo boosts CdTe solar capacity to 85 MW

The German firm expects to own the largest cadmium telluride solar module facility in Europe by the end of 2012

Calyxo is investing in a second production line with a capacity of 60 MW at its home facility in Bitterfeld, Wolfen.

The firm currently operates a 25 MWp production line with over 150 employees at the manufacturing plant in Germany and will ramp the total capacity at the end of 2012 to 85 MW.

The capital for the expansion will be provided by a bank loan and cash contributions from the technology inventor Solar Fields, LLC, who took over ownership of Calyxo in February 2011 from its former partner Q-Cells SE. Solar Fields invented the technology while a resident at the University of Toledo Incubation Centre.

"Based on recent good results in production

with modules of 80 Wp and higher we decided to increase the capacity of our the low-cost atmospheric deposition process. We are confident, that Calyxo will reach costs clearly below 0,8 USD/Wp end of 2012 and that a CdTe production in the core of Europe will make sense for our customers", says Florian Holzapfel, CEO.

The production line will produce the 2011-introduced CX3 product, which was especially designed for hot and humid environments and differentiates substantially from competing CdTe offerings, ensuring long-term stable energy output even under extreme conditions.

Calyxo CX module

In these conditions, installation of the same size (MWp or KWp) with the Calyxo technology can provide up to 10% more energy than crystalline installations, driven by the superior temperature behaviour of Calyxo modules. "Recently we have published data showing the excellent performance and stability of the Calyxo product under hot and humid conditions based on our unique laminate design" adds Michael Bauer, Calyxo's CTO.

These advances will lead to midterm production costs of less than 0.50 USD/Wp which may be the lowest in the world. Costs this low allow for an LCOE forecast of less than 0.10 USD/KWh for electricity generated by Calyxo PV systems.

Based on current market information,

Calyxo believes it is going to be the only meaningful CdTe producer in Europe from 2013 on. Besides the anticipated growth, Calyxo will keep the complete set of services open for all customers (simulations, project design, planning, installation and after sales services).

New high performance CIGS modules unveiled by HelioVolt

The copper indium gallium di-selenide panels are suited to commercial roof top, ground mount and BIPV applications

HelioVolt has announced successful completion of testing of its next series of high efficiency thin film solar modules. The firm now offers a range of solar panels based on the company's proprietary CIGS technology platform. The new series of high performance modules features HelioVolt's frameless glass-glass construction and monolithic integration offering customers outstanding energy yield, cost, and reliability. "Our unique technology and manufacturing capabilities allow HelioVolt to continue to rapidly expand our product portfolio. We are also pleased that our panels offer industry leading narrow power distributions to deliver higher system performance to our customers," says BJ Stanbery, HelioVolt's founder and Chairman of the Board.

AQT Solar shows off CZTS solar module prototype

CIGS innovator, AQT Solar, in conjunction with partners, has developed a prototype CZTS solar module capable of 60 W power output.

A prototype of AQT Solar's CZTS solar module

AQT believes this is a significant power-density milestone for the company and the solar industry.

CZTS has received increasing interest since the late 2000s. The material offers favourable optical

and electronic properties similar to CIGS, over conventional crystalline silicon solar cells.

But unlike CIGS and CdTe based materials, CZTS is composed of only abundant and non-toxic elements.

AQT has had its CZTS modules "under-sun" testing since early this year.

The firm says that its research to-date demonstrates that in addition to very low manufacturing costs, its latest CZTS solar cells have the potential to deliver a wide range of benefits to solar module manufacturers.

For one, energy harvesting compared to crystalline silicon is superior. AQT says CZTS technology also yields minimal mechanical losses during module assembly due to superior durability of glass substrates.

What's more, the process is also flexible and scalable modules, available in standard power sizes, can be manufactured using conventional materials and equipment, lowering manufacturing costs.

Hanergy to acquire Q.CELLS' CIGS subsidiary Solibro

Solibro will benefit from network and investment, while allowing Hanergy access to its core CIGS solar cell technology

Hanergy Holding Group Limited is to acquire Q.CELLS' thin-film subsidiary Solibro, at Hanergy's headquarters in Beijing.

After exploring various available thin-film investment opportunities, Hanergy has decided to invest in the CIGS co-evaporation technology that Solibro has developed over the last 25 years.

After the completion of the acquisition, Solibro will ramp up to a yearly production capacity of 100 MW in Thalheim to supply Hanergy's European customers.

Jason Chow, CEO of Hanergy Global Investment & Sales Pte. Ltd., and Johannes Linde, Head of Strategy for Q.CELLS, sign a cooperation agreement to mark Hanergy's acquisition of Q.CELLS subsidiary Solibro at its Beijing headquarters

"This acquisition is not solely about consolidating our position on a global and competitive market. It is also about creating synergies between our two organisations in order to provide our respective customers with added value," says Li Hejun, Chairman of Hanergy.

Jason Chow, Senior Vice President of Hanergy Industrial PV Group adds, "Solibro has a proven track record in thin-film CIGS technologies. Hanergy will provide the extensive network, the strong production capacity and the long term R&D investment. We are confident that the acquisition will enhance Solibro's performance and capacity despite the industry's current downturn."

Q.CELLS evaluated several potential partners that would be able to fully develop the potential of CIGS thin-film technology and make best use of its Thalheim-based facilities. Solibro's technology and manufacturing capacity, combined with Hanergy's photovoltaic strategy, resulted in a fast and successful conclusion of the transaction.

What's more, Hanergy will not shrink Solibro's workforce or change the company's leadership. Solibro's operations will remain unaffected, as will its after-sales service provided to customers.

"Since the first meeting with the Hanergy management, a perfect strategic fit was obvious to us all," concludes Nedim Cen, CEO of Q.CELLS

SE. “With Hanergy as a partner, the potential of Solibro’s CIGS thin-film technology and existing production capacity can be fully realised. We are even more pleased with the fact that Hanergy intends to retain our current workforce in Thalheim.”

Apple iPhone charged up by Ascent Solar CIGS power

The solar firm has broken into a new market. It intends to provide its CIGS modules in other chargers for other smart phones, including the latest Samsung Galaxy, very soon

Ascent Solar, a developer of flexible thin-film photovoltaic modules, has launched a charger for the Apple iPhone 4/4S smart phone.

Branded under Ascent’s new “EnerPlex” line of consumer products, the charger incorporates the company’s ultra light CIGS solar cells in a sleek, protective iPhone 4/4S case, along with a thin battery. Ascent says the charger adds minimal weight and size to an iPhone smart phone, yet provides significantly improved battery life by harnessing sunlight for electric power.

Enerplex charger powered by CIGS technology

This is the first product in a forthcoming line of smart phone chargers from Ascent. The company also plans to introduce similar chargers for other smart phones, including the newly launched Samsung Galaxy S III, in the near future.

Ascent Solar’s President and CEO, Victor Lee, comments, “The EnerPlex charger is the first protective iPhone case to leverage the lightweight qualities and superior aesthetics of our CIGS solar technology. It will extend the usage time of iPhone smart phones while preserving the high level of design quality that consumers demand. Apple customers can now incorporate green technology into their everyday life, improving the performance of their smart phone without compromising style.”

Lee continues, “The growth of the smart phone market has been tremendous and is expected to continue for several years to come. Apple has sold over 175 million iPhone smart phones. Samsung is introducing new products in a competitive market where the number of smart phones in use globally is expected to reach 1 billion in the next 4 years. 144 million smart phones were sold globally in the first quarter of this year alone. Ascent’s EnerPlex line is focused on providing millions of smart phone customers with a product that prolongs battery life, increases mobility and allows them to be ‘green’, all without adding significant size or weight to the phone.”

Working with strategic partners, including China-based TFG Radiant Investment Group Ltd, the company plans to ship EnerPlex chargers to customers and partners in Asia within weeks. Ascent’s partners have already begun receiving purchase orders for this product for shipments beginning in the third quarter. Global shipments will follow in the fourth calendar quarter of this year

Nanosolar secures a whopping $70 million in funding

The cash will be used to support the expansion of production and drive commercialisation of the firm’s CIGS thin film solar technology

Nanosolar has raised $70 million in new capital.

The financing will be used to expand production of thin film solar cells and panels, support research and development designed to deliver greater efficiency, and drive faster commercialisation of the company’s solar technology. The over-subscribed round was funded by current and new investors, including OnPoint Technologies, Inc., Mohr Davidow Ventures, and Ohana Holdings LLC, and international Family Offices.

"We strongly believe in Nanosolar's technology and the company's ability to deliver the most cost-efficient solar electricity for utility scale and defense installations," says John Trbovich, of Arsenal Venture Partners, the manager of OnPoint Technologies, Inc.

"We are pleased to see the continued trust that our investors place in our company. The Family Offices that joined the round have a long-term view of the solar market and will help Nanosolar scale its business faster," adds Guido Polko, executive chairman of Nanosolar's board of directors.

"With this latest round of funding, Nanosolar will be able to continue ramping up its production capabilities and achieve a faster time-to-market with its products. The money also will allow us to deepen our R&D efforts aimed at achieving even greater efficiency, and significantly expand our employee base in both Europe and the United States."

By printing CIGS inks on low-cost aluminum foil, Nanosolar is utilising its proprietary roll-to-roll printable semiconductor technology to enable low cost thin-film solar panels. The firm says this approach minimises the use of expensive, high vacuum manufacturing equipment, and enables Nanosolar solar cells and panels to reach efficiencies competitive with crystalline silicon panels.

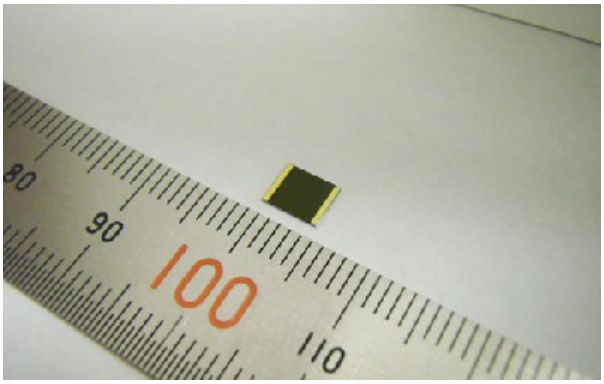
Nanosolar currently has manufacturing capacity in excess of 100 MW, with committed deliveries to multiple international customers in the 2 to 11 MW range. The company has achieved lab-tested top cell efficiency of 17.1 percent as certified by the National Renewable Energy Laboratory (NREL).

"Nanosolar has proven that it continues to effectively execute on its product roadmap and has established itself as a provider of world-class solar solutions," concludes Eugenia Corrales, CEO of Nanosolar.

Sharp III-V solar cell equals conversion efficiency record of 43.5%

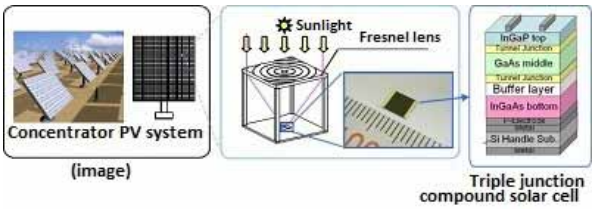
The firm's concentrator triple-junction indium gallium arsenide compound solar cell has matched the conversion efficiency achieved by Solar Junction in 2011

Sharp has achieved what it claims is the world's highest solar cell conversion efficiency of 43.5% using a concentrator triple-junction compound semiconductor solar cell. The result is reported for May 30th, 2012, for concentrator solar cells at the research level, based on a survey by Sharp. The conversion efficiency was confirmed by the Fraunhofer Institute for Solar Energy (ISE) in April 2012 under a light-concentrating magnification of 306 times. With a cell surface of approximately 0.167 cm2, the conversion efficiency is the same as that achieved by U.S. firm Solar Junction in March 2011. These III-V based solar cells are used in a lens-based concentrator system that focuses sunlight on the cells to generate electricity.



Sharp's concentrated triple-junction compound semiconductor solar cell with conversion efficiency of 43.5%

Compound solar cells utilise photo-absorption layers made from compounds consisting of two or more elements, such as indium and gallium. The basic structure of this latest triple-junction compound solar cell uses Sharp's proprietary technology that enables efficient stacking of the three photo-absorption layers, with InGaAs as the bottom layer.



To achieve this latest increase in conversion efficiency, Sharp capitalised on the ability of this cell to efficiently convert sunlight collected via three photo-absorption layers into electricity. The firm also optimised the spacing between electrodes on the surface of the concentrator cell and minimised the cell's electrical resistance. This latest Sharp breakthrough came about through research and development efforts that are part of the "R&D on Innovative Solar Cells" project promoted by Japan's New Energy and Industrial Technology Development Organisation (NEDO). NEDO is one of Japan's largest public management organisations for promoting research and development as well as for disseminating industrial, energy, and environmental technologies. ISE also participates on this project. Their superior conversion efficiency make compound solar cells ideal for use in space satellites, which is their primary application. Sharp's aim for the future is to apply this latest development success into concentrator photovoltaic power systems that can efficiently generate electricity using small-surface-area solar cells and make them practical for terrestrial use.

Ascent Solar's Joe Armstrong Joins Bye Aerospace Strategic Advisory Council

Joe Armstrong, Ph.D., Chief Technology Officer of Ascent Solar Technologies, has joined the Strategic Advisory Council of Bye Aerospace.

Ascent Solar is a developer of flexible CIGS solar panels and Bye Aerospace is applying clean energy solutions to innovative aircraft designs for the business aviation and defense markets.

Armstrong has spent the majority of his 30+ year career in photovoltaics (PV), including with Martin Marietta Corporation (now Lockheed Martin) and ITN Energy Systems before becoming a founding member of the ASTI team in 2005. Dr. Armstrong has been on the forefront in the development of lightweight, flexible photovoltaics for terrestrial, aeronautics, near-space, and space applications. He is a named inventor on five U.S. patents in areas including shape memory alloys, fuel cells, electronic circuit assembly, and thin-film PV technology, and on numerous pending patent applications. Armstrong has a bachelor's degree from Lewis University in Illinois and received his masters and doctorate degrees in Physics from the University of Denver, Colorado. Dr. Armstrong previously served as a member of the Advisory Board for the State of Colorado Center for Revolutionary Solar Photoconversion and was the Chair of the Steering Committee, as well as Chairman of the Board of Directors of the Colorado Advanced Materials Institute.

"I am honored to be invited to join the Strategic Advisory Council at Bye," said Dr. Armstrong. "As business aviation and defense markets envision solar energy as a compliment to traditional power sources, with purposeful integration into systems and structures, numerous performance advantages can be realized. I believe that Ascent Solar and Bye Aerospace are uniquely positioned in these markets."

"It is an absolute honor to welcome Dr. Armstrong to our impressive group of strategic advisors," said George Bye, Chairman and CEO of Bye Aerospace. "Clean energy provided by thin-film PV technology is critical to the performance of several of Bye Aerospace's internal programs, including the solar-electric hybrid Silent Guardian unmanned aerial vehicle and the StarLight™ solar-electric powered airship.

Power Electronics

UCSB awarded $500,000 for GaN research

The university has been awarded to develop the use of gallium nitride in electronics and solid state lighting

UC Santa Barbara's Solid State Lighting & Energy Centre (SSLEC), has received the half million dollar endowment from Seoul Optodevice Company to further its research on GaN for use in electronics and solid state lighting.

James Speck, a professor of materials at UCSB, member of SSLEC's Executive Committee, and director of the Interdisciplinary Centre for Wide Band-Gap Semiconductors, has been named the campus's first Seoul Optodevice Chair in Solid State Lighting.

James Speck

"Mr. Chung Hoon Lee and the Seoul Optodevice Company are leaders in the field, and have been longstanding supporters of UC Santa Barbara's Solid State Lighting and Energy Centre, which is advancing the frontiers of research in energy-efficient solid state lighting, and helping to create a more sustainable future for us all," says Chancellor Henry T. Yang.

"We are deeply grateful for their vision and generosity in establishing the Seoul Optodevice Chair in Solid State Lighting, and we are very proud that Professor Jim Speck will be the inaugural chair holder. Professor Speck is world-renowned for his pioneering research in electronic materials and physical properties, and is the ideal choice to hold this prestigious endowed chair."

The endowment represents an important partnership between UCSB and the Seoul Optodevice Company. Established in Korea in 2002, the company is a global leader in engineering products with a variety of applications, including outdoor and architectural lighting, LCD technology, and both V- and UV-LED products.

"Under the visionary leadership of Mr. Chung Hoon Lee, Seoul Semiconductor and Seoul Optoelectronic Device Companies are leading the transformation to solid state lighting," Speck comments. "UCSB and the Solid State Lighting and Energy Centre have greatly benefited from the strong support from these two companies. I am honoured to serve as the first Seoul Optodevice Chair at UCSB and extend my personal thanks to Mr. Lee."

Most silicon-based semiconductors in today's electronics, such as those found in computer microprocessor chips and transistors, are highly inefficient in their use of energy. New processors that use GaN as a wide band-gap semiconductor offer increased data processing capabilities while using minimal power. GaN is one of the most important next-generation semiconductor materials because it can be used for high-frequency, high-power transistors capable of operating at high temperatures.

"This endowment by Seoul Optodevice Company is critically important because our research in gallium nitride semiconductors places the college at the forefront of energy efficiency technology," adds Rod Alferness, dean of the College of Engineering. "Professor Speck is leading this charge and understands how our relationship with industry is a driving force behind discoveries in solid state lighting."

Speck's research focuses on the relationship between thin-film electronic materials growth, and microstructure, as well as the link between

microstructure and physical properties. He has worked extensively on the materials science of GaN and related alloys, and has consistently been lauded for his research.

Among his honours, Speck received the Quantum Device Award from the International Symposium on Compound Semiconductors in 2007. In 2010, he received the IEEE Photonics Society Aron Kressel Award for his work on nonpolar and semipolar GaN-based materials and devices.

"Jim Speck is the world's leading expert in gallium nitride materials and crystal growth," concludes Steven DenBaars, co-director of SSLEC, a professor of materials, and of electrical and computer engineering, as well as the Mitsubishi Chemical Professor in Solid State Lighting & Display. "SSLEC is very fortunate to have him."

Gaas Labs acquires GaN RF innovator Nitronex

With this move, Nitronex hopes to expand its market presence in the rapidly growing, high performance, GaN RF power device market using its gallium nitride on silicon technology

Gaas Labs, LLC, a private investment fund targeting the communications semiconductor market, has acquired privately-held Nitronex Corporation.

Nitronex designs and manufactures GaN based RF solutions for high performance applications in the defence, communications, cable TV, and industrial & scientific markets.

Founded in 1999 and headquartered in Durham, North Carolina, Nitronex provides high-performance GaN-on-Silicon semiconductor solutions using its proprietary SIGANTIC manufacturing process.

The Nitronex process combines the superior power, efficiency and bandwidth performance of GaN with the reliability, ease of use and low-cost advantages of industry standard silicon substrates. Financial terms of the transaction were not disclosed.

"We are excited to add Nitronex, a leading innovator in GaN-based RF solutions, to our portfolio of RF semiconductor companies," says John Ocampo, Co-Founder and President of Gaas Labs. We look forward to helping Nitronex further leverage its products and technologies and extend its RF market leadership."

Charles Shalvoy, CEO of Nitronex comments on the acquisition, "John Ocampo and Gaas Labs have demonstrated their ability to build and develop companies that realise their full growth potential. Partnering with Gaas Labs is an important milestone for Nitronex, which will enable us to deliver greater value to our customers in the rapidly growing, high performance, GaN RF power device market. We are thrilled to continue advancing our GaN-on-Silicon technology and expanding our market presence with Gaas Labs' backing and the aid of their strategic and operational expertise."

Toshiba unveils Ka-band high power GaN MMIC for SATCOM

The gallium nitride device is suited to applications such as high definition video broadcast and broadband data communication

Toshiba America Electronic Components, Inc. (TAEC), a company that collaborates with technology companies to create breakthrough designs, has unveiled a Ka-Band High Power GaN microwave monolithic integrated circuit (MMIC) featuring one of the highest power and efficiency performances in its class. Toshiba is planning to release a complete family of Ka-Band products to support SATCOM applications. Ka-Band SATCOM has been on the rise, and is continuing to show steady growth to support broadband communication and increasing demand for higher bandwidth in SATCOM frequencies. Due to the limited availability of high power microwave Solid-State devices, replacing tube-base amplifiers with Solid-State Power Amplifiers for Ka-Band has not been a cost-effective design option. Toshiba's new Ka-Band MMIC will provide a solution to support the anticipated surge of solid-state amplifiers to the millimetre wave frequency range for SATCOM applications. "As a longtime supplier of high-performance GaN and gallium arsenide microwave devices for wireless applications in various

frequency bands, Toshiba plans to continue efforts to expand the product line with new solutions," says Homayoun Ghani, business development manager, microwave devices, for TAEC's Discrete Business Unit. A datasheet for Toshiba's new MMIC will be available in Q4 2012, with sampling beginning Q1 2013.

Hybrid GaN IC for X-band revealed by Toshiba

The gallium nitride HIC is optimised for high gain and high powerand is suited to AESA, and PESA radar applications

Toshiba America Electronic Components, Inc. (TAEC) is introducing a new GaN hybrid IC (HIC), which is optimised for high gain and power.

Available in small hermetically-sealed packages, the gain-enhanced HIC is targeted to transmitter and receiver modules (TRMs) used in radar applications - such as active electronically scanned array (AESA) and passive electronically scanned array (PESA).

The new X-Band hybrid IC, the TGM9398-25, operates in the 9.3 to 9.8 GHz range, and has output power at 1dB of 25W, or 44.0dBm (typ.), linear gain of 25dB (typ.) and power added efficiency of 35 percent.

Toshiba commercially launched the 50W discrete GaN internally-matched HEMT for the band, the TGI8596-50, in 2008 and the TGI0910-50, in 2010. The new device is in a package that is footprint-compatible with the existing discrete internally-matched GaN HEMT, to support easy upgrades for legacy designs.

"The high power density of GaN technology makes this possible," says Homayoun Ghani, business development manager, microwave devices, for TAEC's Discrete Business Unit. "With the energy-saving features associated with higher gain, this hybrid IC will help our customers design more advanced telecommunication systems."

Samples of Toshiba's GaN hybrid IC will be available in Q4 2012.

GaN HEMT incorporated in the first ever single-chip transceiver

The 10 GHz gallium nitride device reduces chip footprint by over 90%, enabling more compact radars and wireless communications equipment

Fujitsu Laboratories has announced that it has successfully developed the world's first single-chip transceiver using GaN high electron mobility transistor (HEMT) technology that features an output of 6.3 W and that operates at a frequency of 10 GHz. In order to simultaneously handle strong transmission signals and weak incoming signals in the same chip, you need to efficiently switch between outgoing and incoming signals, while reducing the impact that outgoing signals have on incoming signals. However, until now, it has been difficult to accomplish both of these objectives in tandem.

Fujitsu Labs has resolved this issue by developing a duplexer with low signal loss using a GaN-HEMT, and through high-output circuit integration design technology that controls signal interference between the outgoing and incoming signals. The result is a transceiver chip with a footprint that is less than 10% of the size of the multiple chips that have been needed until now. With this technology, it is now possible to configure a high-output transceiver using just one chip, enabling systems such as radar equipment and wireless communications equipment to be made more compact. Details of this technology were presented at the IEEE MTT International Microwave Symposium (IMS 2012) held in Montreal. GaN is used as a material in blue LEDs. Compared to the conventional semiconductor materials of silicon and GaAs, GaN features a high electron transfer rate and a relatively high breakdown voltage. Given these characteristics, GaN HEMTs, or field-effect transistors that use GaN, show promise for high-output, exceptionally efficient operations. They are ideally suited to a wide range of core technologies for IT applications, including satellite transceivers, mobile phones, GPS-based navigations systems, and broadband wireless networking systems.

Background

In line with the advancement of a network-based

society, radio wave demand in a variety of wireless systems is expected to increase even further. For example, aircraft radar uses the 10 GHz frequency band, which is able to measure the distance and direction of physical objects with high precision. Existing radars are configured with separate equipment for transmitters and receivers. A transceiver chip that integrates both function, would allow more compact systems.

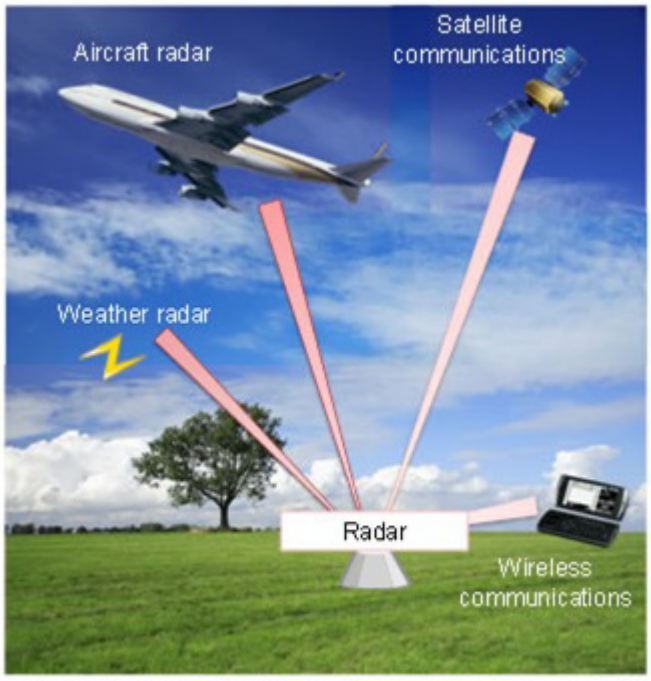


Figure 1: Typical uses of the 10-GHz band

Technical Issues

The transceiver chips necessary to make radar and other equipment more compact must deliver high-capacity communications and high output in order to cover a large area. Transmitting high-power signals using the same chip that receives low-power signals requires high-efficiency switching in the outbound signal and reduced impact of outbound signals on inbound signals. Achieving both of these goals has been a problem.

Newly Developed Technology

Now, Fujitsu Labs has what it says is the world's first single, compact transceiver chip that uses GaN-HEMT and operates in the 10-GHz band. Its key features are as follows:

1. Ultra-compact transmit/receive switch

A new duplexer was developed that uses GaN-HEMT (Figure 2, right). Measuring a compact 1.8 mm × 2.4 mm, with 1.1 dB transmission loss in the 0–12 GHz range. This is far smaller and lighter than earlier switches using magnetic materials (Figure 2, left), less than 10% the size.

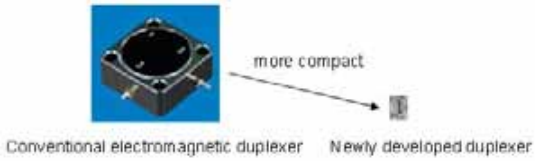


Figure 2: Comparison of conventional transmit/ receive switches and the newly developed one

2. High-output circuit integration design technology

Via holes for grounding are arrayed around the transistors, shielding against the release of unwanted signals. What's more, the locations and layouts of signal wiring and circuitry were optimised using three-dimensional analysis of electromagnetic radiation to suppress unwanted signal interference (Figure 3). This technology ensures stable operation, preventing the oscillations of high-power circuitry from causing malfunctions.

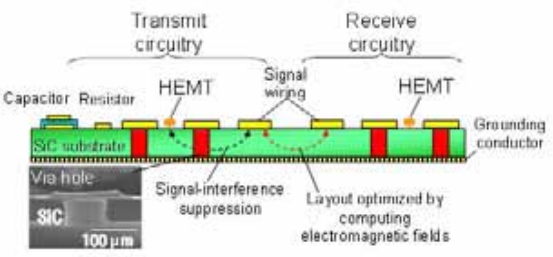


Figure 3: Technologies to suppress unwanted signal interference These technologies were integrated into a single prototype chip that combines a duplexer, a transmitting amplifier, and a receiving amplifier (Figure 4). The chip operates at 6.3 W in the 10-GHz band and measures 3.6 × 3.3 mm, less than one-tenth the size of earlier multi-chip systems.

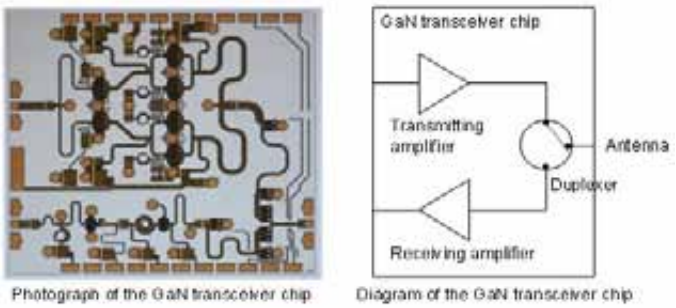


Figure 4: Photo and diagram of the newly developed GaN transceiver chip

The result shows that these technologies make it possible to design a high-output transceiver around a single chip, with applications in radar and broadband communications, promising smaller, lighter systems. In the future, Fujitsu Labs intends for this technology to be put to use in a wide range of applications that require compact modules with high output, including wireless communications and radar systems.

New Freescale GaAs RF power device raises the performance bar

The MMDS25254H 2300-2700 MHz device employs a gallium arsenide MMIC and indium gallium phosphide HBT technology

Freescale Semiconductor has introduced new Airfast transistors engineered to boost the efficiency, peak power and signal bandwidth of next-generation base stations.

With the new offerings, Freescale's flagship Airfast RF power product line now includes at least one solution for each cellular band and supports both small and large cell base station deployments.

The cost-effective, small-configuration Airfast RF power solutions are designed to help network equipment manufacturers and operators support multiple wireless standards, manage escalating data transmission rates and keep capital and operating costs low.

To complement the new Airfast devices, Freescale is also announcing a new class of control products called advanced Doherty alignment modules (ADAM) that enables real-time adjustment of phase and amplitude for the optimisation of traditional Doherty power amplifiers. The modules are designed to work with Airfast devices to boost overall system performance, including increased power efficiency, output power and linearity across the frequency band.

The firm has released a number of LDMOS solutions.

Another module, the MMDS25254H ADAM, is a new class of highly integrated GaAs MMIC control circuits designed specifically to optimise the performance of today's Doherty amplifiers. ADAM provides the ability to align and optimise the RF performance in the carrier and peaking paths of a Doherty amplifier thus providing improved overall BTS performance. The 2300-2700 MHz device also employs E-*p*HEMT and InGaP HBT technology.

When combined with Airfast power transistors, this sophisticated technology provides increased manufacturing yields and power added efficiency. Available for frequency bands spanning 700 MHz to 2800 MHz. Product families for 700-1000 MHz and 1800-2200 MHz are also in development.

The RoHS compliant device is manufactured in a cost-effective industry standard QFN 6x6 mm package. It also has digital control of amplitude and a phase and constant 90 degree phase offset between port 2 and port 3 versus frequency (500 MHz bandwidth). Freescale also says it displays excellent over temperature amplitude and phase performance and digital adjustment precision and excellent repeatability.

RFMD flexes its muscles with new GaN transistors for pulsed-radar

The gallium nitride matched power device extends range, reduce size and weight, and improves overall ruggedness in new and existing radar designs

RF Micro Devices has just released a highly-efficient 280 W pulsed GaN RF matched power transistor, the RFHA1025.

The RFHA1025 delivers superior performance versus competing silicon power technologies.

RFMD's RFHA1025 complements the recently released 380 W RF3928B, the highest output power S-Band device in RFMD's matched power transistor family.

RFMD says its GaN matched power transistors extend range, reduce size and weight, and improve overall ruggedness in new and existing radar architectures. The RFHA1025 operates over a broad frequency range (0.96-1.2GHz) and delivers 280 W pulsed power, a gain of over 14dB, and peak efficiency of over 55%.

What's more, the RFHA1025 incorporates internal matching to simplify and shrink designers' circuits. Packaged in a hermetic, flanged ceramic package, the RFHA1025 leverages RFMD's advanced heat sink and power dissipation technologies, delivering excellent thermal stability and conductivity. RFMD's RF393x unmatched power transistors (UPT) can be used as drivers to the RFHA1025.

Jeff Shealy, general manager of RFMD's Power Broadband Business Unit, says, "RFMD is pleased to expand our GaN-based product portfolio, offering industry-leading power performance in support of diverse end markets. RFMD's GaN product portfolio demonstrates our commitment to technology and product leadership, and we look forward to introducing additional GaN devices in the near term that feature superior power density, high power efficiency, and rugged dependability."

Samples and production quantities are available now through RFMD's online store or through local RFMD sales channels.

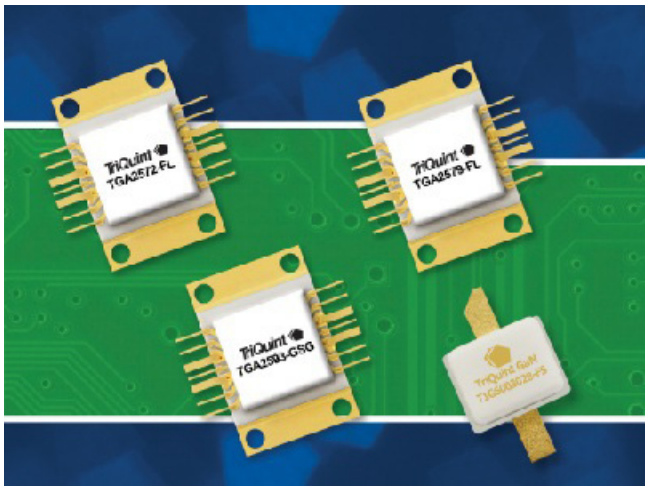
TriQuint unleashes new GaN products on the defence & commercial markets

The new gallium nitride solutions are claimed to increase RF performance and enable smaller circuits, as well as better-performing low voltage and high power systems

TriQuint Semiconductor released four new GaN devices at the IMS / MTT-S Symposium in Montreal, Canada. TriQuint says its GaN solutions improve RF efficiency, reduce overall costs and enhance system ruggedness.
RF designers attending IMS / MTT-S can access public forums where TriQuint will explore high performance GaN capabilities and ways this technology can enable smaller circuits, as well as better-performing low voltage and high power systems. GaN-based integrated circuits outperform silicon, gallium arsenide and other semiconductor technologies. GaN devices are also seen by the industry as key to future 'green' RF and DC-DC power solutions that can reduce network electrical consumption, enable greater range in electric vehicles or extend smartphone battery life.

"TriQuint is advancing state-of-the-art high frequency / high power GaN research. Our internal product development programs are creating new commercial and defense lower-voltage devices. Today we are announcing four new GaN products enabled by TriQuint's high performance technology leadership," says TriQuint Defence Products and Foundry Services Vice President and General Manager, James L. Klein.

TriQuint has also revealed three new GaN power amplifiers that deliver greater efficiency, wideband coverage and excellent performance for communications, defence and civilian radar. These are the TGA2572-FL (14-16 GHz), now available; as well as the TGA2579-FL (14-15.5 GHz) and the TGA2593-GSG (13-15 GHz), which will be available in July.



TriQuint is also announcing the availability of the T1G6003028-FS, a 30W wideband GaN packaged

transistor that can cut the number of driver circuits in a typical power amplifier design by 50%.

TriQuint will also be describing its gallium nitride, gallium arsenide, SAW and BAW solutions for networks, defence and aerospace products at IMS / MTT-S 2012 at booth #1815.

Cree qualifies GaN-on-SiC processes for telecoms and radar systems

The high power gallium nitride-on-silicon RF MMIC processes allow telecom system operators and military system providers to leverage efficiency for operational cost savings

Cree is announcing the qualification and production release of two new GaN processes.

The first is the G40V4, a 0.25µm process with operating drain voltage up to 40V. The second process is known as G50V3 which is a 0.4µm process with operating drain voltage up to 50V.

The increased operating voltage and RF power density of these new processes enable smaller die and more compact, higher efficiency amplifiers than possible with conventional technologies. Both technologies are compatible with Cree's GaN MMIC technology on 100mm diameter SiC wafers with a full complement of passive circuit elements and non-linear models.

The new processes are now available for development and full-rate production. With these processes, Cree offers numerous foundry service options to facilitate the rapid development of custom circuits, including full and dedicated mask sets.

The G40V4 process has been qualified at both 28V and 40V operation with RF power densities up to 6W/mm of FET periphery with operation up to 18GHz. The G50V3 process has been qualified for 50V operation and RF power densities up to 8W/mm with operation through 6 GHz.

Both of these processes are derivatives of Cree's previously released G28V3 28V, 0.4µm process that has been in production since 2006 and exhibits one of the lowest field failure rates of any microwave technology in the industry (Failure in Time rate of 9 device failures per billion hours of operation).

Cree estimates that for a typical 3-sector, multi-band LTE/4G telecom remote radio head (RRH) installation, simply switching to GaN from conventional transistor technology could reduce RRH power consumption by up to 20 percent. This translates directly into lower operating costs and reduced energy consumption.

Beyond operational cost savings, there can also be a significant savings in the initial cost of the system. The GaN benefits of higher voltage and higher efficiency allow smaller heat sinks and enclosures, less complex RF amplifiers and lower- cost AC-to-DC and DC-to-DC converters. Systems that previously required large fans to cool can now be air cooled. All of these improvements can reduce the system bill of material cost by up to 10 percent resulting in significantly lower system acquisition costs.

Similar benefits are seen for military radar systems where the improved efficiency from Cree's GaN processes can not only reduce operational power consumption but also dramatically improve system life cycle cost via reduced maintenance.

The G40V4 and G50V3 processes can operate at a junction (channel) temperature of 225ºC with a median life time of over two million hours (228 years). This outstanding reliability can dramatically lower the cost of radar system repair and upkeep over its operating life.

"Our customers have been asking for a reliable, higher-frequency process to exploit the advantages of GaN for applications greater than 6 GHz, including Satcom, radar and electronic warfare markets, and we believe our new G40V4 process successfully satisfies their needs," says Jim Milligan, director of RF and microwave, Cree.

To address our customers' need for lower cost GaN solutions, the 50 V operating voltage of our new G50V3 process has been specifically engineered to provide an extremely low price in terms of dollars per watt of RF output power. The cost-performance of our G50V3 process is designed to rapidly accelerate the adoption of GaN in extremely cost-sensitive markets such as telecom infrastructure

where GaN can now provide performance advantages not realisable in silicon LDMOS."

"The higher operating voltage and higher efficiency possible with these new processes are key to rapid adoption," adds Cengiz Balkas, vice president and general manager power and RF, Cree. "Switching to GaN for upcoming LTE/4G macro-cell base stations could save telecom operators over $2 billion annually in reduced energy costs. Fortunately, the telecom industry is beginning to recognize these potential savings. Cree is targeting to deliver more than 75 million watts of GaN transistors into telecom base stations this calendar year."

At 40 volt operation, Cree's G40V4 process exhibits up to 6 Watts/mm PSAT at 18 GHz. Typical device characteristics at 10 GHz are 65 percent power added efficiency (PAE) and 12 dB of small signal gain. At 50 V operation, the G50V3 process demonstrates up to 8 watts/mm PSAT at 6 GHz. Typical device performance at 3.5 GHz is 70 percent PAE with 12 dB of small signal gain. Both GaN processes are qualified for maximum operating channel temperature of 225ºC with a median time to failure of greater than 2E6 hours. In addition,

Cree is releasing MMIC design kits with proprietary scalable non-linear HEMT models suitable for operation with Agilent's Advanced Design System (ADS) and AWR's Microwave Office simulator platforms. The design kits also contain a full suite of passive components—resistors, capacitors, spiral inductors and substrate ground vias that can be used to simulate full MMIC performance and provide significantly reduced des

How to 'heal' plasma-damaged GaN with hydrogen radical treatment

Exposing plasma-damaged GaN to high doses of H radicals, restores the photoluminescence to almost the level of unetched GaN

Gallium nitride (GaN) is a highly promising material for a wide range of optical and high-power electronic devices, which can be fabricated by dry etching with plasmas.

However, the plasma-induced defects and surface residues that remain after such processes tend to degrade the optical and electrical properties of the devices.

Now, a team of Japanese researchers has developed and tested a new way to "heal" such defects.

The team exposed plasma-damaged GaN to hydrogen (H) radicals at room temperature. After testing various doses of H radicals, the researchers evaluated the optical properties of the GaN. The intensity of light emitted when electrons near the edge of the valence shell in GaN absorbed and then re-emitted photons drastically decreased after chlorine plasma-beam etching. After treatment with the higher-level doses of H radicals, however, the photoluminescence was restored to almost the level of unetched GaN.

The researchers say it is likely that the H radicals terminated the dangling bonds of gallium on the GaN surface, as well as desorbed the surface residues and that these two factors led to the recovered optical performance. A key characteristic of the new healing process is that it is performed *in situ*, immediately after the etching process. This is important because unwanted surface oxidation can easily occur on plasma-damaged GaN that is exposed to air.

Further details of this work have been published in the paper, "Photoluminescence recovery by in-situ exposure of plasma-damaged *n*-GaN to atomic hydrogen at room temperature," by Shang Chen *et al, AIP Advances*, 2, 022149 (2012).

Cree reveals breakthrough GaN-based solid-state amplifier platform

The firm claims its breakthrough gallium nitride technology platform provides twice the efficiency of conventional gallium arsenide solutions

Cree is introducing a new 40 Volt, 0.25µm GaN-on-SiC HEMT process die product family to deliver revolutionary power and bandwidth capabilities through the Ku Band.

The innovative product family enables the replacement of Travel-Wave Tubes with solid-state amplifiers for improved efficiency and reliability.

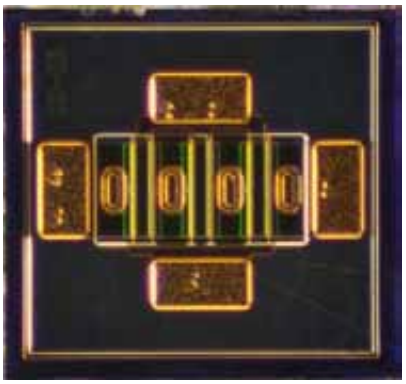
"Cree's 0.25µm GaN HEMT die product family offers significant improvements in gain, efficiency and power density compared to GaAs transistors over the same frequency range," says Tom Dekker, director RF sales and marketing, Cree. "The higher gain allows for more effective power combining schemes and enables solid-state power amplifiers to be produced with hundreds to multi-kilowatts at C-Band, X-Band and Ku Band."

Market applications include marine radar, medical imaging, industrial and satellite communication. Compared to GaAs transistors, solid-state amplifiers can improve reliability, reduce costs and boost efficiency while shrinking the size of not only the power amplifier but also the power supply. The higher efficiency of GaN HEMT power amplifiers can result in reduced transmitter power consumption.

"Cree's 0.25µm GaN HEMT products demonstrate breakthrough performance in improved efficiency and bandwidth by enabling new classes of transistor operation not achievable with GaAs based transistors," explains Ray Pengelly, RF business development manager, Cree.

"Good examples are switch-mode HPAs which have been reported to offer greater than 80 percent power-added efficiency at microwave frequencies. GaN HEMT HPAs have been produced with instantaneous bandwidths from 6 to 18GHz at power levels exceeding 10W. These 0.25µm GaN performance levels provide system engineers leapfrog advantages to re-invent their GaAs and tube transmitters," adds Pengelly.

The new GaN HEMT die products (CGHV1J006D, CGHV1J025D and CGHV1J070D) are rated at 6W, 25W and 70W of output power at 40V of drain voltage with an operating frequency range through Ku Band.



CGHV1J006D (6-W, 18.0-GHz, GaN HEMT Die)

This latest die family release is supported by Cree's proprietary scalable large signal device models that are compatible with Agilent's Advanced Design System and AWR's Microwave Office simulator platforms.

This should enable RF design engineers to accurately simulate advanced RF amplifier circuits which can significantly reduce design cycle times – a most desirable requirement for the higher microwave frequencies. The 0.25µm GaN-on-SiC HEMT process has been qualified to operate up to a drain voltage of 40V. Cree says the mean time to failure exceeds more than one million hours at channel temperatures up to 2250C.

Cree updates process design kit update for GaN-on-SiC HEMTs

Cree has released an updated, advanced process design kit (PDK) based on Agilent Technologies' Advanced Design System (ADS) software. The PDK will provide microwave and RF design engineers with a comprehensive suite of design and simulation tools for developing GaN-on-SiC HEMT devices. The free PDK integrates the latest version of Agilent ADS with Cree's GaN-on-SiC process technology parameters and design rules. Cree says engineers can now more quickly develop monolithic microwave integrated circuits (MMICs). "The latest version of this PDK enables RF design engineers to access the Cree GaN-on-SiC MMIC foundry capabilities through Agilent's 2011 release of ADS – an industry-leading electronic design automation tool," says Jim Milligan, director, Cree

RF and microwave. “This integrated front-to-back design system provides highly accurate, scalable nonlinear models, parametric layout cells, design rule checking, seamless layout interoperability and a streamlined design cycle to help accelerate time-to-market for our customers.” “With the joint release of this PDK, our mutual customers now have access to Cree’s proven GaN-on-SiC MMIC process technology, along with the Agilent integrated design system, which is uniquely suited to producing reliable, leading edge, high-power HEMT devices for today’s most challenging applications,” comments Juergen Hartung, foundry program manager, Agilent EEsof EDA.

Copper laminate packages for high power III-V devices unveiled

The new copper-moly-copper packages dissipate heat in gallium nitride, gallium arsenide and silicon carbide power devices

StratEdge Corporation is introducing a new family of high power laminate packages.

The LL family of leaded laminate copper-moly-copper (CMC) base packages dissipates heat from high power compound semiconductor devices, such as those based on GaN, GaAs and SiC. These packages handle applications through 6 GHz for use in RF radios for communications, radar, and high power millimetre-wave signals.

The series includes two laminate power packages, both with a ratio of 1:3:1 CMC, which provides a good thermal match for alumina-based materials and a GaN chip.

The LL802302 is 0.8” (20.32mm) long x 0.39” (9.91mm) wide with 2 leads and a raised lid with an epoxy seal. This is a flange package with a bolt hole on each end so the package can be bolted to the printed circuit board.

The LL362302 is a flangeless, fully hermetic version of the LL802302 package, and has a flat ceramic lid. StratEdge offers both flange and flangeless styles to accommodate manufacturing processes to either bolt down or solder the package. Hermeticity is especially critical in aerospace and defense applications.

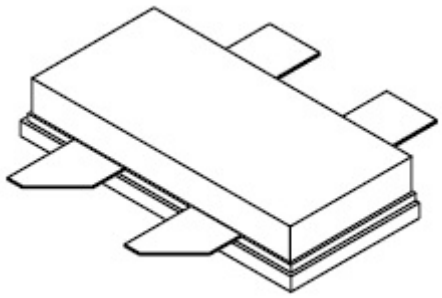
“StratEdge’s new laminate power packages solve thermal problems encountered when using GaN devices,” explains Tim Going, StratEdge president. “The excellent thermal conductivity of the CMC base enables use of GaN devices in high power applications, and the flange package facilitates manufacturing. StratEdge is continuing to develop packages to handle the requirements of today’s new materials and devices.”

Freescale breaks into GaN power RF market

Suitable for cellular infrastructure applications, the RF power innovator adds the efficiency, performance and bandwidth advantages of gallium nitride technology to its portfolio

Freescale Semiconductor has revealed its first RF power amplifier product built using GaN technology.

The company’s RF power GaN products will initially target the cellular infrastructure market, with potential future applications including avionics, radar, ISM and software-defined radio.



AFG25HW355S schematic

Freescale's first GaN product, the AFG25HW355S device, is the latest addition to its power amplifier portfolio. Current Freescale RF power offerings include 12V, 28V and 50V silicon LDMOS products, 5V GaAs HBT, 5V and 12V GaAs pHEMT solutions, and high-frequency SiGe technology featuring operation up to 100 GHz and beyond.

"Freescale's GaN RF power solutions underscore our technology-agnostic approach to the RF power market," says Ritu Favre, vice president and general manager of Freescale's RF Division. "Working with GaN in development since the mid-2000s, we have established an ideal blend of cost-efficiency, performance and reliability, and the time is now right to add GaN-based products to our broad array of RF power amplifier solutions."

The AFG25HW355S is a 350W, high-performance-in-package, 2:1 asymmetric device operating between 2.3 GHz and 2.7 GHz. With 56 dBm peak power and 50 percent efficiency, the device has a gain of 16 dB and comes in NI-780 packaging.

Advantages of using GaN technology in power amplifiers include smaller product form factors, low parasitic loss, elevated power density and higher-frequency operation. Potential GaN cellular applications include quasi-linear, high efficiency (Doherty), high-powered pulsed (non-linear) applications, broadband PAs and switch-mode amplifier configurations.

The AFG25HW355S will be available soon to select customers in sample quantities, with full qualification and volume shipping planned by Q2 2013.

Revolutionising displays with indium, gallium and zinc oxide technology

A new material should enable even higher resolutions, lower power consumption, and higher performance touch screens, as well as narrower bezel widths for LCD display panels used in mobile devices such as smartphones

Sharp Corporation and Semiconductor Energy Laboratory (SEL) have jointly developed a new oxide semiconductor (IGZO) technology with high crystallinity.

This jointly developed new IGZO technology imparts crystallinity in an oxide semiconductor composed of indium, gallium and zinc. Compared to current amorphous IGZO semiconductors, Sharp says this new material enables even smaller thin-film transistors to be achieved and provides higher performance.

Sharp believes that IGZO will be adopted for use in LCD displays for mobile devices such as smartphones where the trend toward higher screen resolutions is growing increasingly strong. What's more, it can also be adapted for use in organic EL displays which hold out high expectations for the future.

Although challenges to commercialisation remain in terms of both service life and production, the two companies will continue to push ahead with R&D in anticipation of future market needs.

Aiming towards early commercialisation in LCD displays using this new IGZO technology, the two companies will also be pursuing R&D to expand the use of this material in non-display devices and to develop applications other than displays in the future.

The LCD display will have a screen size of 4.9 inch by 6.1 inch and a pixel resolution of 720 x 1280 and 2560 x 1600. The pixel density will be 302 ppi and 498 ppi. Envisioned applications include mobile devices, in particular smartphones.

During the development of the oxide semiconductor, Sharp and SEL found a new crystalline structure

and have named it CAAC (*C*-Axis Aligned Crystal) structure.

Single crystal IGZO is characterised by having a hexagonal structure when seen from the *c*-axis direction and a layered form when seen from the direction perpendicular to the*c*-axis (see Figs. 1 (a) and (b)).

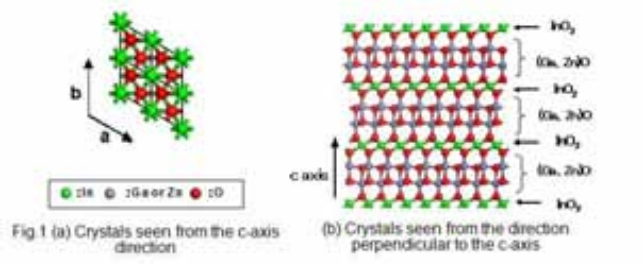


Fig.1 (a) Crystals seen from the c-axis direction

(b) Crystals seen from the direction perpendicular to the c-axis

The researchers found the IGZO layer is a crystalline hexagonal structure, as shown in a plane TEM image and cross-sectional TEM image, depicted in Figs. 2 (a) and (b)

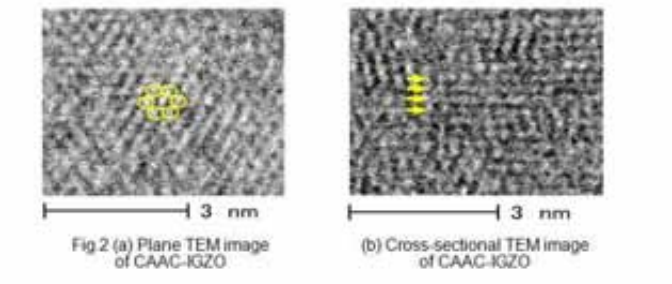


Fig.2 (a) Plane TEM image of CAAC-IGZO

(b) Cross-sectional TEM image of CAAC-IGZO

Another cross-sectional TEM image shows the relationship between a surface of the layer and the *c*-axis: the *c*-axis of the IGZO crystal is aligned in a perpendicular direction to the surface of the layer see Fig. 3(a), (b)□The name of the structure, the*C*-Axis Aligned Crystal□CAAC□structure, comes from this relation.

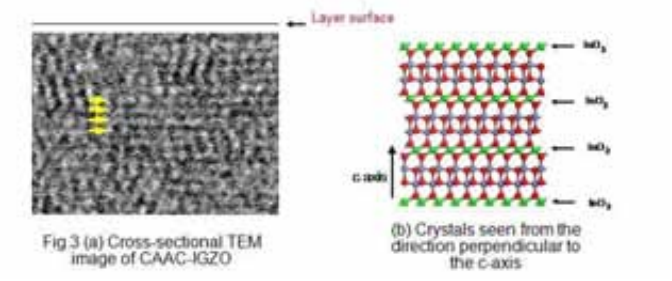


Fig.3 (a) Cross-sectional TEM image of CAAC-IGZO

(b) Crystals seen from the direction perpendicular to the c-axis

A conventional amorphous IGZO TFT has had a problem of shift in electrical characteristics in the gate bias temperature (BT) stress tests, especially in the gate BT stress tests with light irradiation. Meanwhile, a CAAC-IGZO TFT is less influenced by (is resistant to) the gate BT stress tests with light irradiation and has high reliability (see Fig. 4(a), (b)), which means that the TFT can be stable with CAAC-IGZO.

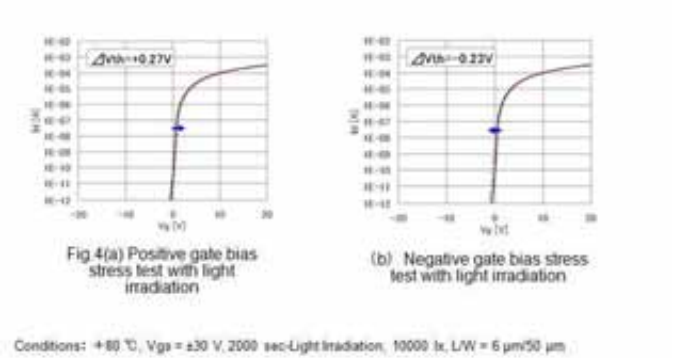


Fig.4(a) Positive gate bias stress test with light irradiation

(b) Negative gate bias stress test with light irradiation

Conditions: +80 °C, Vgs = ±30 V, 2000 sec-Light Irradiation, 10000 lx, L/W = 6 μm/50 μm

II-VI Incorporated to purchase up to $25 million of its common stock

The innovator in MOCVD crystal growth technology which manufactures many compounds including silicon carbide for high-power electronic and microwave applications, has announced a new share repurchase program

The purchases, which will be made in the open market or in privately negotiated transactions as permitted by Securities Exchange Act Rule 10b-18, could begin immediately and may occur from time to time in the future. The Company says it may suspend or discontinue this purchase program at any time.

Shares purchased by the Company will be retained as treasury stock and will be available for general corporate purposes. The Company expects the repurchase of shares to at least partially offset the dilutive effect of the issuance of shares from the Company's Omnibus Incentive Plan.

Francis J. Kramer, president and chief executive officer of II-VI Incorporated says, "The Board's decision to implement a new share repurchase program reflects their belief in the long-term growth prospects of the Company and our desire to enhance shareholder value while maintaining

adequate liquidity to execute our strategic plans."

Two new projects target GaAs imaging and GaN power

The two ventures will look at developing gallium arsenide imaging and sensing and gallium nitride-on-silicon power devices

A couple of new projects which centre on the use compound semiconductors are to be funded through the Technology Inspired Innovation competition for collaborative research & development funding. They are described below.

Project title: System development of novel CW OPO for hyperspectral imaging and sensing

Project outline: SYNOPOSIS will develop an active, long-wave mid-infrared (LWIR) imaging system capable of catering for a wide range of applications including the detection of explosives, oil and gas prospecting and medical diagnostics.

To date, active imaging systems operate mostly in the short-wave mid-infrared spectral region. Moving the technology to longer wavelength will enable access to the so-called molecular fingerprint region where the interaction with light and molecules is significantly stronger, therefore enabling higher sensitivity and specificity.

The limiting factor in the context of LWIR active imaging technology has so far been the availability of practical LWIR light sources. SYNOPOSIS will address this issue by advancing the continuous-wave, intracavity-pumped, optical parametric oscillator into the LWIR by employing novel nonlinear materials such as orientation-patterned gallium arsenide and zinc germanium diphosphide.

Partners in the project are M Squared Lasers Ltd , based in Glasgow, who will lead the project. Other collaborators include Solus Technologies Ltd and the Institute of Photonics based in the University of Strathclyde.

Project title: PEARGaN - Power Electronics Applications for Reliability in GaN

Project outline: GaN-on-Silicon is a hot topic at the moment. One of its applications is in discrete devices for high-voltage power electronics applications, with the potential to deliver superior performance in breakdown voltage, on-state resistance and higher switching speeds. This material system also promises to reduce system losses and enable greater levels of efficiency at lower cost than current solutions.

The PEARGaN project has assembled a consortium of world class partners from UK industry and academia, to develop new system level concepts and circuit architectures, evaluate advanced manufacturing process technologies and create device demonstrators to fully understand the device behaviour and failure mechanisms, proving that these devices are robust and can deliver the required levels of life-time reliability that is demanded by the early adopters in a broad range of power management and control applications.

The lead partner is NXP Semiconductors UK Ltd based in Stockport. Also involved in the project are IQE (Europe) Ltd, Bristol University – Device Reliability Centre, Manchester University – Power Conversion Group and Liverpool University – Materials & Structures Centre.

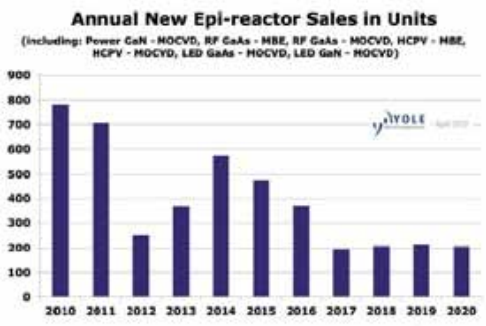
The offer of funding to these projects is conditional and remains subject to the successful completion of Technology Strategy Board, Scottish Enterprise and BBSRC compliance and financial review processes

Veeco, Aixtron and Riber still rule the roost in epitaxy

Although there are another fifteen players in the MOCVD and MBE markets, they have had trouble establishing themselves due to the dominance of the other three firms

A new report , "III-V Epitaxy Equipment & Applications Market", from Reportlinker.com says that MOCVD and MBE are the techniques used to grow practically all III-V wafers. OK, but tell us something we didn't know. So what else has been revealed in the study? Well, apparently, the MBE and MOCVD market combined is predicted to hit

around $6.1 billion between 2012 and 2020.



LED is by far and away the single largest application for MOCVD. In 2010 and 2011, the MOCVD market experienced the largest investment cycle in its history driven by a combination of drivers. These included demand for LED backlit LCD TVs, subsidies by the Chinese central and local governments and expectation in the general lighting market. On the down side, this has put the market into a significant overcapacity situation that could take 12 to 18 months to absorb.

The next investment cycle driven by lighting applications and expected to start in 2013, will be more limited than the previous cycle due to improvements in equipment throughput and yields. Following this cycle, further Cost of Ownership (COO) improvements offered by the next generation of MOCVD reactors should justify the replacement of 2nd generation-old reactors installed during the 2010-2011 boom and drive a last small equipment cycle in the second half of the decade. By that time, power GaN will also represent a substantial upside for reactor makers. All in all, MBE use is heavily driven by R&D systems (over 50% of the total market) and laser applications (telecom, industrial, medical, research) that are not covered in the report. Regarding applications covered in the report, the MBE market is predicted to be essentially driven by the continuous growth in the cell phone and wireless applications that are making heavy use of GaAs based RF components.

Emerging applications like smart grid and the trend towards increasing connectivity and “intelligence” incorporated in many consumer products will provide further opportunities. But, alternative technologies such as silicon CMOS, LDMOS, SoS, HR SOI represent a potential threat; they could capture shares of the GaAs RF market and reduce the opportunity for MBE. What’s more, MOCVD is making progress in HEMT manufacturing. HCPV, however, could provide a small potential upside for MBE makers. MOCVD and MBE equipment market are duopolies but many emerging players could change the landscape: Aixtron and Veeco are the leaders in MOCVD, and together represented 96% of the market in 2011. Production MOCVD reactors are complex systems. Design and optimisation require expertise in multiple fields including flow dynamics, thermodynamics, chemistry, mechanical and electrical engineering. This makes technological barriers into the market pretty high. More than fifteen emerging players have been identified but so far, have been struggling to capture any sizeable share of the market. But the pressure is mounting and established MOCVD makers will need to maintain that technology gap to keep emerging competitors at bay. The main battlefield is that of total cost of ownership. Established MOCVD makers all have technology roadmaps to enable COO reduction of three to four times more within the next 5 years through a combination of improved yields, throughputs and precursor utilisation efficiency.

For MBE, Riber and Veeco are the only two players offering large capacity / large throughput MBE production tools for volume manufacturing. Reportlinker.com expects they will maintain this dominancy. However, there are about ten other MBE manufacturers offering R&D or pilot production systems that also have a strong presence on the general MBE market (DCA, SVT, Eiko among others). Potential overcapacity in MO precursor supply: The Metal Organic precursor market will also be essentially driven by LED applications. But MOCVD reactor technology improvements ; yield, consumption and wafer size to name but a few, will lower the amount of TMGa and TMIn needed per cm² of epiwafer. The 2010 metal organic shortage ended mid 2011 thanks to aggressive capacity expansion by leading suppliers. Further capacity expansion plans from established and emerging suppliers could come online within the next 3

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

Silicon switching to SiC for high power electronics

Due to its superior thermal and electrical properties, the power electronics industry is moving towards silicon carbide based devices. However, material defects in SiC, higher manufacturing costs and packaging issues could hamper growth. Gallium nitride is another contender in this market, but this material also suffers from similar problems

It has become apparent that the wide band gap material SiC has emerged as a key semiconductor; it has the potential to displace silicon based insulated gate bipolar transistors (IGBTs), MOSFETs, diodes and rectifiers .

The main applications of SiC would be in high power electronics area for applications in photovoltaic panels, hybrid/electric cars, high-power industrial drives, motor drives, smart grids and power utilities.

Frost & Sullivan's latest report, "Silicon Carbide Electronics -Technology Market Penetration and Roadmapping", says that SiC-based power electronics are well positioned to meet some of the key performance criteria. These include decreased overall system costs and enhanced system efficiency, for emerging applications such as hybrid vehicles and inverters for solar energy.

"Silicon carbide electronics exhibit superior thermal resistance, low conductivity losses and higher material strength than silicon," says Technical Insights Industry Analyst Avinash Bhaskar. "Thus, silicon carbide-based power electronics such as diodes and transistors can potentially reduce the size and also switch losses in power systems by 50 percent."

Encouraged by their superior material properties, major automotive manufacturers involved in developing hybrid and electric vehicles are currently testing SiC-based MOSFETs and other transistors as a viable alternative to silicon-based transistors, particularly for under the hood applications where the operating conditions are challenging.

"Defence agencies are also driving the research on using silicon carbide for developing power electronic devices," notes Technical Insights Industry Manager Kasthuri Jagadeesan. "A commercial volume market in the renewable sector, industrial sector and automotive sector could present a big market opportunity for silicon carbide power electronics."

The future of SiC will lie in developing reliable transistors such as MOSFETs and bipolar junction transistors. While SiC-based diodes have made their way into a number of applications, end-users are truly interested in a reliable SiC-based MOSFET that can challenge the dominance of silicon-based IGBTs.

Hybrid electric cars will greatly benefit from having SiC or MOSFETS under the hood, as SiC has a better thermal resistance than silicon-based IGBTs. This will reduce the overall system cost in electric cars, as adopting SiC devices will lead to eliminating the use of heat sinks and other cooling devices.

"However, silicon carbide material defects, higher cost of manufacturing wafers and packaging issues could hamper the growth of silicon carbide power electronics," cautions Bhaskar. "The research efforts in developing reliable silicon carbide-based transistors in the higher power realm have been sluggish, slowing down the time to market."

Strong collaborations and alliances along with increased investments will accelerate developments in the SiC power electronics technology space. Several companies have started sampling SiC MOSFETs and DMOSFETs, which will aid in rapid deployment of silicon carbide power electronics in the commercial market.

Handset RF device market to hit $5 billion in 2016

The market size of handset gallium arsenide based RF devices is predicted to balloon from its current $3.8 billion

Unlike traditional silicon semiconductors, GaAs is mainly used in handset RF front end modules like power amplifiers (PAs). According to Research and Markets, the RF front end of 4G devices costs around $9-11, twice that of those in 3G systems and 6 times of that in 2G systems. The handset RF system mainly consists of a transceiver, PA, filter and antenna switch. The market size of handset RF devices hit about $3.8 billion and is expected to reach as much as $5 billion in 2016. Much of this is down to the 4G era, where the handset RF front end has had to become even more sophisticated. For example, the 4G iPad has as many as 19 RF front-end components. These include 7 PAs, 1 transceiver and 2 antenna switch modules (ASMs). Three of the PAs in the device are provided by Avago and correspond to three LTE frequency bands; two PAs are supplied by Skyworks and correspond to two 3G frequency bands. Another PA is offered by TriQuint, which contains three separate PA dies and corresponds to four 2G frequency bands. The final PA is in the ASM and is supplied by Japan-based Murata. The two ASMs are also made by Murata. The 4G iPad is integrated with 802.11/Bluetooth/FM and supported by Broadcom's BCM4330, and its SIP IC contains GaAs *p*HEMT PA provided by Skyworks. According to Research and Markets' "Global and China GaAs-based Device Industry Report, 2011-2012", Murata is the largest MLCC manufacturer, the largest communication module (including Bluetooth module and WLAN module) producer, the second largest SAW filter manufacturer and the largest antenna switch producer in the world. On March 1st, 2012, Murata completed the acquisition of the PA Division of Renesas, empowering the company to possess one of the most complete product lines in the handset RF market. Kopin, VPEC and IQE are the world's top three GaAs epilayer manufacturers, together accounting for over 60% market share. Kopin and VPEC adopt the MOCVD process and IQE applies MBE as well as MOCVD growth techniques.

Industry's first fully-automated high-power wafer measurement tool

There is now a new fully-integrated solution for testing silicon, silicon carbide, gallium nitride and GaN-on-silicon power device wafers

Cascade Microtech, a manufacturer of precision measurements of integrated circuits at the wafer level, has unveiled the new APS200TESLA.

APS200TESLA Wafer Power Device Testing System

The turn-key system combines the capabilities of its Tesla on-wafer power device characterisation measurement technology with Cascade Microtech's BlueRay production automation technology. Cascade boasts the system is industry's first complete on-wafer production solution to address the test challenges of discrete power devices.

As power semiconductors grow with the demand for energy-efficient and environmentally-friendly products, power device manufacturing will shift from silicon substrates to SiC, GaN, and GaN-on silicon These new substrate technologies offer improved efficiency and enable higher levels of power, and faster switching, in many applications using insulated gate bipolar transistors (IGBTs) and MOSFETS, such as automotive and consumer electronics, electrical power distribution and large

data centres.

Fast-growing applications in renewable energy and industrial power will challenge power device manufacturers to develop more efficient devices at a lower cost, driving the need for test solutions specifically designed for high-voltage and high-current probing.

This latest addition meets this challenge and is claimed to be the first fully-automatic on-wafer probe system for high-power device measurement. Rated up to 10k V/400 A, the APS200TESLA delivers excellent electrical performance for high-voltage and high-current device characterisation at production levels.

The system comes with a high-voltage, high-current probe card, a high-voltage, high-power chuck port, and the patent-pending MicroVac high-power chuck that can handle wafer thicknesses down to 50 µm, such as ultra-thin Taiko wafers.

An optimised electrical connection easily integrates the APS200TESLA with a variety of test instruments, and the interlock-enabled safety shield provides a safe environment for the operator. The arc-suppression feature allows the customer to optimise device layout to achieve better yields.

Auto-discharging and the unique probe-pin touch sensing capability prevent device damage due to high-voltage discharge during die-to-die moves. The APS200TESLA also offers advanced prober control software for automatic wafer and die stepping.

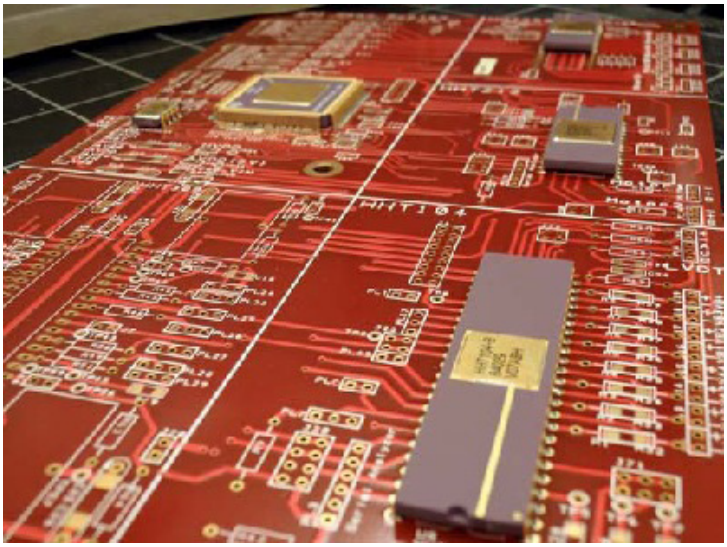
“The new APS200TESLA leverages our experience in achieving accurate on-wafer measurement. It is an advanced, turn-key power device measurement system that will help our customers improve cost-of-ownership, increasing test throughput and improving yields,” comments Michael Burger, president and CEO, Cascade Microtech, Inc.

“It allows our customers to save time by avoiding unnecessary dicing and packaging prior to final test. By testing on-wafer in a production environment, the APS200TESLA enables our customers to reduce test costs and get their products to market faster.”

Integrated SiC sensors handle 600 degrees C

New silicon carbide technology should enable more accurate monitoring and safer control in high-temperature operations

A team of Case Western Reserve University engineers has designed and fabricated integrated amplifier circuits that operate under extreme temperatures.



The sensors can handle up to 6000C, a feat that the scientists say was previously impossible. The SiC amplifiers have applications in both the aerospace and energy industries. For example, the devices can take the heat of collecting data inside nuclear reactors and rocket engines. Steven L. Garverick, a professor of electrical engineering and computer science, described the team’s work in a paper he presented May 31st at the 2012 IEEE EnergyTech conference, held at Case Western Reserve. These integrated circuits are constructed on a wide-band-gap semiconductor. According to Garverick, “Most semiconductors are made out of silicon, but silicon will not function above 3000C, and there are some important applications above that range.” His team’s solution is to use SiC, which at high temperatures, the material begins to act as a semiconductor. Engineers at NASA Glenn Research Centre, in Cleveland, pioneered techniques used to manufacture these circuits.

Team members at Case Western Reserve have used them to fabricate complete circuits by depositing three distinct SiC layers on top of SiC

wafers, which altogether measure just one-tenth of the thickness of a human hair. These circuits are designed to replace the “dumb” sensors currently used in high-temperature applications. The simple sensors can’t take the heat and instead require long wires that connect them to the high-temperature zone. These circuits can experience considerable interference, which makes signals unclear and difficult to decipher. The physical enclosures and wiring used in the manufacture and installation of non-integrated sensors introduces additional error. Integrating the amplifier and sensor into one discrete package and placing the package directly where data is being collected improves signal strength, clarity and produces more reliable information. The researchers believe this will ultimately result in more accurate monitoring and safer control over a jet engine, nuclear reactor or other high-temperature operations. The team has built a suite of circuits ranging from simple low-accuracy versions to more complex models that return far better data. Garverick says the team will continue developing the technology and believes that commercial production is about five to ten years away.

Equipment and Materials

Riber receives order for Compact 21 research system in Germany

The MBE reactor will be used in the development of III-V epitaxial nanostructures for applications in nanoelectronics and photonics

At the end of June, Riber completed the sale of a Compact21 MBE system to a research institute in Germany.

The MBE reactor will be devoted to the growth of III-V epitaxial nanostructures for applications in nanoelectronics and photonics. This order will significantly increase the institute’s applied technology research and development capabilities.

Riber says its Compact 21 MBE research system has sold the most units in the world. It is highly flexible and offers great adaptability to meet the most demanding specifications of applied research on compound semiconductor materials.

Praxair Asia increases gas prices

The price increase is due to escalating raw material and production costs for electronic process gases used in compound semiconductor growth

Praxair Asia has notified its electronic gases customers of a price increase of 10%-20% which became effective on July 1, 2012, on select electronic process gases as contracts permit.

The company says this increase will allow Praxair Asia to sustain the highest standard of product quality and make ongoing investments to support the continuous growth of our customers. Praxair Asia also continues to implement a variety of productivity programs to improve the overall cost structure.

Praxair Asia’s electronics business supplies customers in the LED, and Photovoltaic (PV) segments. Products to these segments include process gases, such as precursors, dopants, reactants, etchants, inerts, as well as bulk, on-site, and associated distribution equipment.

Praxair acquires Canadian Cylinder & Gases

The manufacturer of gases used in MOCVD growth has expanded in Canada

Praxair Canada Inc., a subsidiary of Praxair, Inc. has acquired Canadian Cylinder & Gases Inc. (CCG), an independent distributor of industrial and specialty gases and welding equipment.

The business is located in Prince George, British Columbia, where it has been in operation for over 15 years. Financial terms of the transaction were not disclosed.

"The addition of CCG enhances Praxair Canada's growth platform in Northern British Columbia and increases our capabilities and resources to meet the needs of our current and future customers in this high growth region of Canada," says Matt White, president of Praxair Canada. "We welcome the CCG employees to our Praxair team."

Praxair is one of the largest industrial gases company in North and South America, and one of the largest worldwide, with 2011 sales of $11 billion. The company produces, sells and distributes atmospheric, process and specialty gases used in MOCVD growth.

Femto Science appoints Uvotech as U.S. representative

The Korean manufacturer of CVD systems will use the U.S. based distributor to market and support its products

Femto Science has chosen Uvotech Systems as its U.S. Sales and Support representative, to further enhance its service to customers throughout the United States.

Uvotech is a scientific equipment distributor with the expertise to provide a full range of technical and support services. Headquartered in Newark, California, Uvotech specialises in UV-Ozone and Plasma Cleaning systems as well as Plasma Etching, Reactive Ion Etching and Chemical Vapour Deposition systems used in MEMS, Optoelectronics, Biotechnology and Semiconductor industries.

Femto Science is a manufacturer of Plasma Cleaning systems, etching (RIE and ICP) as well as Parylene coating systems (CVD) which is located in South Korea.

"With more than 12 years of industry experience, Uvotech Systems was selected to represent Femto Science based on their experience, knowledge, customer support and responsiveness," says Chang, Founder and President of Femto Science.

"We are building a complete support operation in the United States while increasing our presence among new customers. The addition of Uvotech Systems as our US distributor will greatly benefit this effort by providing excellent service to educational, government and private institutions."

LED MOCVD tools to experience turbulent investment cycles

In the coming years, lithography, plasma etching, PECVD & PVD tools will also experience an upheaval

According to the report, "LED Front-End Manufacturing", by Yole Développement,to be published on 16th July, the packaged LED market still presents significant opportunities for growth in the next 5 years, but is expected to saturate in value by the end of the decade.

Driven by MOCVD reactors, the equipment market experienced an unprecedented investment cycle in the 2010-2011 period. The cycle was driven by demand in LCD backlight displays, anticipation of the general lighting market and generous subsidies offered by the Chinese central and local governments in a bid to stimulate the domestic chip production and create world leading chip companies.

This has resulted in a significant overcapacity situation that will take 12 to 18 months to absorb. The next investment cycle driven by lighting applications will start in 2013 and will be more limited in value than the previous cycle due to improvements in equipment throughput and yields. The MOCVD equipment market is anticipated to represent a $4.3 billion opportunity in the 2012-2017 period.

Together, lithography, plasma etching, PECVD and PVD tools represent a $650 million opportunity and will essentially follow a similar trend with some exceptions.

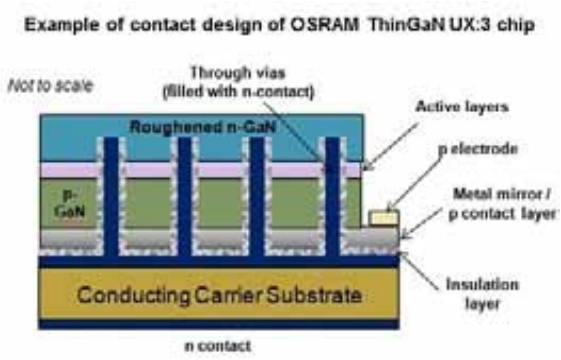
The market for dry etching tools is still growing in 2012 due to increasing adoption for PSS (Patterned Sapphire Substrate). The market for most lithography tools will however decrease as the

industry transitions to larger diameter substrates and the number of wafer starts initially increases moderately but starts decreasing in 2015.

PVD equipment will also experience moderate growth during the next investment cycle. E-beam evaporators have turned into commodities, with systems available from dozens of vendors at very low cost. But opportunities exist in promoting sputtering for ITO deposition and sputtering could also gain some traction in metal deposition if the industry adopts large diameter wafers and moves from batch to single wafer processing. Sputtering equipment could then offer improved cost of ownership.

To enable massive adoption in general lighting applications, significant technology and manufacturing efficiency improvements are still needed to reduce the cost per lumen of packaged LEDs. Front-End LED manufacturing typically represents about 50% of the total cost of a packaged LED and offers significant opportunities. Continuous progress is being made in terms of LED structures and materials to improve performance, manufacturability or reduce cost.

MOCVD represents the single largest opportunity for front end cost reduction. Downstream, the emergence of LED dedicated tools has already contributed significantly to cost reduction in lithography, plasma and PVD processing.



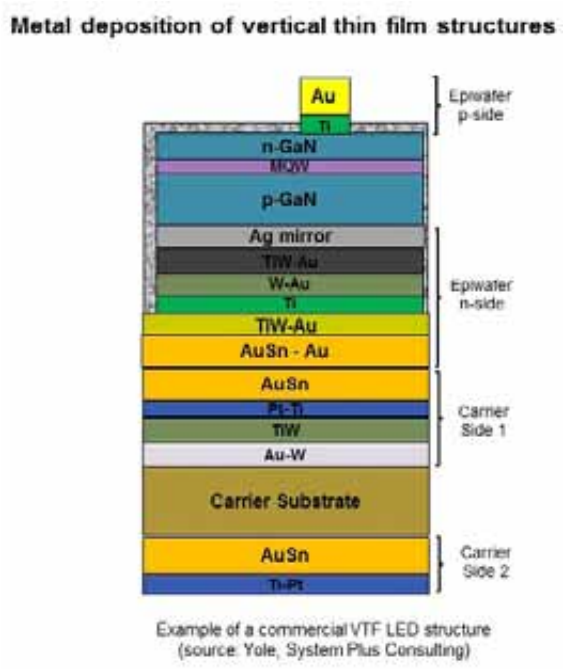
Traditional large semiconductor equipment suppliers are mostly absent from the LED manufacturing equipment markets. For MOCVD, the tools are very different than the epitaxy tools used in mainstream semiconductor manufacturing. Designing and building such equipment requires significant and unique expertise that Aixtron, Veeco and Tiyo Nippon Sanso, the leading companies in the sector, have acquired through almost 2 decades.

Other front end LED manufacturing tools are similar in essence to those used in mainstream semiconductor production.

For example, Applied Materials, a dominant force in the silicon sector, has been working with imec on the design of an 8” reactor for the growth of GaN-on-Silicon LEDs.

However, as experienced by AMAT, the reactors often require a full redesign in order to deliver optimum performance and cost of ownership for LEDs.

This has opened the door to smaller companies eager to capture the opportunity offered by this niche market. These companies are now offering LED dedicated tools delivering significant COO improvements.



Example of a commercial VTF LED structure (source: Yole, System Plus Consulting)

MOCVD is still a key factor in reducing manufacturing costs.

With close to 100 companies involved in front end LED manufacturing, the industry is too fragmented to generate significant economies of scale. Yole expects massive consolidation within the next 3 years (2012-2015) which should eventually speed up process and tool standardisation and allow economy of scale.

LED manufacturing still uses methods that would be considered outdated in most semiconductor industries. Consolidation and emergence of LED "giants" will also facilitate and speed up adoption of manufacturing paradigms coming from the IC industry.

Adoption of silicon substrates for LED manufacturing could speed up those trends by rapidly moving LED epiwafer processing into existing, highly automated and fully depreciated CMOS fabs. This would also give LED makers access to extended "process toolboxes" which could pave the way for entirely new LED structures.

Rotary sputtering targets for CIGS materialise

New targets incorporating copper, gallium and if wanted, indium, for solar cell manufacturing have just come on the market

Indium Corporation will feature its enhanced copper-indium-gallium (CuInGa) and copper-gallium (CuGa) rotary sputtering targets at Intersolar North America.

The conference is taking place between July 10th and 12th, 2012 in San Francisco, California, USA.

The targets are now available in lengths up to 3.2 metres, and with the thicknesses of the monolithic source layer up to 22 millimetres.

The targets are made by Indium Corporation's vertically integrated proprietary process utilising aerospace powder metallurgy technology. The production process output produces a consistently homogeneous alloy with low ppm (parts per million) contamination levels and uniform density throughout the target, resulting in very consistent sputtering film properties.

The CuInGa ternary alloy targets and CuGa targets can be produced in chemistry ranges standard to the CIGS industry, and unique chemistries for the R&D and engineering community. Both are produced as a monolithic material, bonded onto the backing tube during Indium Corporation's unique hybrid consolidation process.

A new vacuum pump specially for LED & CS epitaxy

Edwards' new iXH645H dry vacuum pump has been designed with nitride LEDs and III-V compound semiconductor MOCVD growth in mind. The company says it requires minimal maintenance and maximises uptime in harsh manufacturing environments

Edwards is introducing a new iXH645H dry pump which has been optimised for MOCVD processes used in LED manufacturing.

The pump is also suited for use in the growth of III-V materials in gate stacks.

Edwards' iXH645 pump

The iXH645H delivers very high gas flow capability and is able to operate continuously at the high loads required for the latest-generation LED manufacturing tools. Edwards says the advanced technology of the iXH pump minimises maintenance requirements and maximises pump uptimes, helping to lower cost-of-ownership.

"This new addition to our iXH family of dry pumps is designed to address the needs of two rapidly growing segments of high technology manufacturing," saysWei Shao, Edwards' LED market sector manager. "Due to their superior lighting efficiency, LEDs are increasingly being seen as an environmentally-friendly alternative to incandescent lighting, as shown by recent legislation passed in China, Korea, Japan and the U.K to phase out traditional high power lighting."

Shao adds, "At the same time, the use of III-V materials in compound semiconductor manufacturing is enabling the continuation of Moore's Law to next-generation design nodes."

Both LED and compound semiconductor manufacturing processes typically use high flows of light hydrogen and highly-corrosive ammonia gasses. The iXH645H has been designed to support these requirements with superior hydrogen pumping performance and a corrosion-resistant design, including a patented nitrogen purge barrier to protect the pump seals.

The high-temperature capabilities of the pump help prevent condensation of the phosphorous compounds which may be present.

What's more, its advanced oil lubrication and seal technology eliminate periodic maintenance requirements, while its thermal and motor design prevent overheating, motor overloads or zones of limited operation. The pump's optimised temperature control system ensures the pump is ready for process within approximately 30 minutes of start-up.

Lake Shore releases Hall kit for compound semiconductor characterisation

The new model can be used to assess electrical properties of solar cells as well as many III-V based device such as those based on gallium arsenide, indium phosphide and III-nitrides

Lake Shore Cryotronics, a manufacturer of scientific sensors, instruments, and systems for precise measurement and control, will be featuring its range of cryogenic and cryogenic-free probe stations and 8400 Series Hall Effect Measurement System at SEMICON West 2012, taking place between July 10th and 12th.

The conference is being held at the Moscone Centre in San Francisco, California, and Lake Shore will be exhibiting its latest products in booth

#6458. Also on display at the booth will be the Model TTPX cryogenic probe station, as well as information on Lake Shore's new 8400 Series Hall Effect measurement system.

Model 8404 AC/DC HMS

Lake Shore has ten distinct probe station models, including four cryogen-free probe stations and six cryogenic models. Featured at the booth will be Lake Shore's lower cost Model TTPX cryogenic micro-manipulated probe station, used for non-destructive testing of devices on full and partial wafers up to 51 mm (2 in) in diameter.

The TTPX measures electrical, electro-optical, parametric, high Z, DC, RF, and microwave properties of materials and test devices. A wide selection of probes, cables, sample holders, and options makes it possible to configure the TTPX to meet specific measurement applications. Other models are available to meet a variety of parameters, including magnet field, maximum number of probe arms, standard temperature range, high and low temperature options, maximum sample size, vacuum, and sample stage rotation. Lake Shore will also be highlighting the new lower-cost cryogen-free probe station, the Model CRX-6.5K.

What's more, Lake Shore will be spotlighting the new 8400 Series Hall effect measurement system (HMS). The AC Hall effect measurement provides better solutions for researchers exploring the electronic and magneto-transport properties of low mobility electronic materials.

Lake Shore's 8400 Series Hall effect measurement system, which features an optional AC field measurement capability, can measure Hall mobilities down to 10-3 centimetres squared per volt second (cm2/Vs). Applications for the system include measurement of solar cell materials, organic electronics, transparent conducting oxides, III-V and III-VI semiconductors, magnetoresistors, as well as others.

Lake Shore's product experts will be at the show to answer questions and to discuss features and benefits of Lake Shore's probe stations and Hall effect measurement systems.

Jeffrey R. Lindemuth, a Lake Shore senior scientist, will present a paper, "Variable Temperature Hall Measurements on Low-Mobility, High-Resistivity Materials." This paper will be part of Session 4: Novel PV Materials and Characterisation Methods, on Sunday August 12th, from 3:30 to 5:10 p.m.

The results presented in this paper were achieved using the Lake Shore Model 8404 Hall effect measurement system and reflect breakthrough characterization capabilities that are important to developers of novel photovoltaic materials. The new Model 8404 has an optional AC field measurement capability that enables measurement of Hall mobilities down to 0.001 cm2/V s, lower than ever possible using traditional DC field Hall measurement techniques. The system comes with optional variable temperature assemblies for temperatures from 15 K to 1273 K.

Lake Shore will also be at the exhibition centre, with product experts on hand to discuss the Model 8404 as well as the advantages of the company's new cryogen-free probe stations, including the newest low cost CRX-6.5 K probe station.

The 8404 HMS is suited to the characterisation of many materials including CdTe and CIGS solar cells and II-VI and III-V semiconductors such as InP, InSb, InAs, GaAs, GaN, GaP, GaSb, AlN based devices SiC and SiGe materials and HBTs and FETs.

These easy-to-operate cryogenic platforms enable convenient and versatile testing of optical devices, providing superior results and productivity when compared to traditional methods requiring manual immersion of test devices in liquid nitrogen.

Rubicon ranked number 13 on Chicago 2012 "Fast 50 List"

The provider of sapphire substrates and products to the LED, RFIC, semiconductor, and optical industries has seen a 546 percent five-year revenue growth, with $134 million in revenue in 2011

Rubicon Technology, was ranked #13 on Crain's Chicago Business' 2012 Fast 50.

This is an annual list of the fastest growing public and private companies in the Chicago area.

Crain's ranks the fastest-growing public and private companies in the Chicago area based on five-year revenue growth. Rubicon has seen a 546 percent five-year revenue growth, reporting $134 million in revenue in 2011 up from $21 million in revenue in 2006.

"Rubicon's growth over the past five years reflects our leadership in the market for sapphire substrates, the essential building block for LED chips and Silicon on Sapphire (SoS) RFIC chips," says Raja M. Parvez, President and Chief Executive Officer of Rubicon.

"Throughout our 11 year history, Rubicon's focus on continuous innovation has helped us develop proprietary crystal growth technology that enabled us to be first-to-market with high quality, large-diameter polished sapphire wafers. Customers rely on Rubicon because of the purity and low defect density of our product and because, as a vertically integrated supplier, we are a highly reliable partner. We look forward to continued growth as LED technology is adopted in the general lighting market and as product developers find additional applications for commercial sapphire."

Rubicon is one of the world's largest provider of large-diameter sapphire wafers. As a vertically integrated supplier, Rubicon perfected the process to grow large sapphire crystals from raw materials in custom-built, proprietary furnaces replicating the organic sapphire creation process found in nature.

As a result, Rubicon says it has been able to scale the growth of bulk crystal from 30 kg to 85 kg to 200 kg without compromising high quality or high yield. The company completes the final stage of vertical integration with high precision core drilling, wafer slicing, surface lapping, large diameter polishing and wafer cleaning in its Penang, Malaysia facility. To date, Rubicon has shipped more than 230,000 large diameter wafers to the LED and SoS markets

Tim Wang recruited as GM of Aixtron China

Wang has been working in the semiconductor industry in the US and China for many years and most recently held the position of Regional President of Novellus Systems in China

Aixtron SE has appointed Tim Wang.asGeneral Manager of its subsidiary, Aixtron China Ltd.

Bernd Schulte, Executive Vice President and Chief Operating Officer of Aixtron SE, comments, "The Chinese MOCVD market has become increasingly important over recent years and China is expected to play a major role in future LED business. We are therefore delighted to have Tim on board, to not only strengthen our local strategic involvement, but also to underline China's significance as a key market within Aixtron."

Tim Wang, General Manager, Aixtron China Ltd.

Tim Wang adds, “Aixtron offers great technology in a rapidly growing market. We have a clear commitment to China as one of our largest markets; our mission is to provide our customers with the most productive and cost-effective technology and professional support, as well as to involve them in our future development. I look forward to working as part of Aixtron’s strong global team and to expanding the local leadership through Aixtron China Ltd.”

Miniature positioning stages for compound semiconductor characterisation

Two new stages from Aerotech are ideal for use in mapping applications used to determine photoluminescence, thickness and reflectance uniformity in materials such as PINs, lasers and VCSELs

Aerotech’s MPS-GR series rotary stages provide accurate, repeatable positioning in a miniature, low profile and economical package.

MPS-GR series rotary stages

Available in two sizes, the MPS50GR and MPS75GR are engineered for the confines and requirements of a laboratory or research and development setting. The MPS-GR stages are ideal for optics, measurement, alignment, inspection and other similar applications.

They would be suited for use in the construction of characterisation equipment used for mapping wafers in the compound semiconductor industry. Such techniques include spectroscopic ellipsometry, optical microscopy, atomic force microscopy, photoreflectance, sheet resistance, photoluminescence and reflectance mapping.

The MPS-GR stages incorporate precision worm-gear drive and bearing components for accurate and repeatable positioning. They are available with DC servo or stepper motors and either a 20 mm (MPS50GR) or 30 mm (MPS75GR) clear aperture. The clear aperture allows the MPS-GR series to address applications requiring a through-hole or accommodations to mount an optic, including articulation of beam polarising lenses, through-holes for cabling or air lines, or vision/camera/inspection applications. The DC servomotors for the MPS-GR stages are equipped with a square-wave rotary encoder and the MPS75GR includes a manual adjustment knob.

The stages provide performance of up to 80 arc seconds accuracy, 1 arc second resolution, 6 arc seconds repeatability and 180 degrees per second maximum speed. Top load capacity is 12 kg and tilt error motion is 40 arc seconds.

Both stages are available with optional vacuum preparation to 10-6 torr including a vacuum-rated motor/feedback connector. An optional breadboard mounting plate provides direct mounting to both English and metric optical tables and a Lens Mount Option (LMO) permits easy mounting of standard lenses over the stage aperture.

The MPS50GR and MPS75GR are members of Aerotech’s MPS (Miniature Positioning Stage) family of linear, rotary, goniometer and vertical-lift stages. It is easy to mount two or more stages together in numerous combinations using standardised mounting patterns with adapter plates and brackets. Aerotech also manufactures a wide range of positioning stages, drives and controls to provide a fully integrated and optimised motion solution.

MicroSense acquires compound semiconductor metrology innovator SigmaTech

With this acquisition, MicroSense adds wafer inspection tools to its portfolio of innovative metrology solutions

MicroSense, LLC, a provider of high resolution capacitive position sensors used in compound semiconductor characterisation systems, has acquired SigmaTech, Inc. of Tempe, Arizona.

SigmaTech develops high-sensitivity metrology tools for LED, MEMS and semiconductor manufacturing.

SigmaTech systems integrate multiple sensing technologies such as optical spectrometry, interferometry and the firm's patented auto-positioning back pressure (APBP) technology. MicroSense will integrate its capacitance sensors into SigmaTech's metrology platforms.

"This acquisition makes excellent sense as it marries our leading capacitance sensing technology with SigmaTech's field-proven, highly reliable metrology platform to provide highly stable and repeatable wafer metrology systems for targeted applications", according to James Pelusi, Chairman and CEO of MicroSense. "SigmaTech's customers and prospects will continue to be supported by the existing SigmaTech employees, all of whom will stay with the combined business, and will also benefit from the additional resources, infrastructure and the decades of metrology experience that MicroSense will bring to the business."

"We are excited to join the MicroSense team as their high resolution capacitive sensor technology provides an ideal path to increasing throughput of our metrology systems and expanding the field of applications," says Jacques Fauque, semiconductor industry veteran and founder of SigmaTech who will remain with the business and continue to lead its development.

MicroSense's patented capacitive sensors are used to make very precise, high bandwidth measurements of precision products such as solar wafers and precision X-Y stages in equipment used to characterise compound semiconductor wafers. Equipment manufacturers use MicroSense capacitive sensors in solar wafer sorters, autofocus mechanisms, nanopositioning stages and other metrology tools.

SigmaTech offers automated metrology solutions for a broad range of standard and specific applications in the field of compound semiconductor wafers, materials and optics.

Lithuanian firm Brolis bags €2.5 million for MBE facility

The provider of custom structures grown on gallium arsenide, indium phosphide, gallium antimonide and indium arsenide substrates will use the financing to develop the high-tech infrastructure in the field of compound semiconductor technology

The Lithuanian Ministry of Economy has confirmed that Brolis Semiconductors is to receive a lucrative grant of more than €2.5 million for the development of the high-tech infrastructure in the field of semiconductor technology.

Brolis says the cash it received was the largest sum of money allocated to one company in Lithuania.

"The company is investing the money into the state-of-the-art MBE facility for growth of advanced semiconductor materials, which will be used to create beyond state-of-the-art components for the global market", says Kristijonas Vizbaras, CTO of Brolis Semiconductors.

MBE reactor

Brolis Semiconductors Ltd. was established in 2011, by Augustinas, Kristijonas and Dominykas Vizbaras. The three brothers specialise in long-wavelength semiconductor lasers and MBE. The manufacturing facility and the company headquarters were established in Vilnius, the capital city of Lithuania.

Brolis provides MBE services for custom structures on GaAs, InP , GaSb and InAs substrates up to 6 inch (150 mm) in diameter. Possible applications include IR detectors, focal plane arrays, laser diodes, quantum cascade lasers, HBTs and Hall sensors.

Brolis Semiconductors also offers both multimode Fabry-Perot and single-mode DFB lasers. Possible applications include various gas sensing, combustion control, environmental monitoring applications.

The company aims to become the leading global provider of complex epitaxial structures based on arsenides and antimonides for the electronic and optoelectronic world market. In particular, the company is focused on long-wavelength optoelectronics. The firm says its MBE expertise has enabled it to deliver the world's only room-temperature GaSb laser diodes in the wavelength range for 2µm – 3.8 µm range.

Business booming at Oxford Instruments with revenues up 28.6%

The supplier of plasma process tools, for research into and production of a number of key compound semiconductor applications has also seen improvements in sales and in its order book

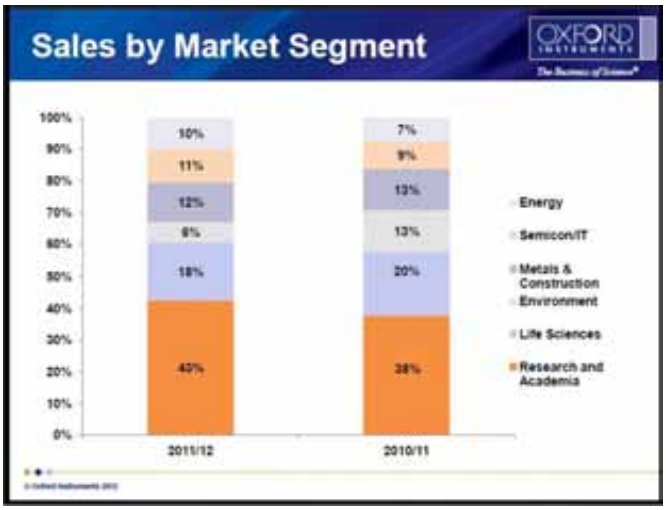
Oxford Instruments has announced its preliminary results for the year up to 31st March 2012.

The company is a provider of high technology tools and systems for research and industry. It designs and manufactures equipment that can fabricate, analyse and manipulate matter at the atomic and molecular level.

Oxford Instruments has discrete business groups operating in three sectors; nanotechnology, industrial products and service. Among other things, the firm manufactures microanalysis systems and etching and deposition and growth tools used in the compound semiconductor industry.

Revenue was up 28.6% over last year from £262.3 million to £337.3 million. Adjusted profit before tax was also up 60.3% from £26.2 million in 2011, to £42.0 million. Adjusted EPS also increased by 48.4% to 61.6 pence.

The firm also experienced a 23.5% increase in order intake to £337.8 million (in 2011 it was £273.5 million). Oxford Instruments says it achieved record performance across all three business sectors, with strong organic growth in all territories.



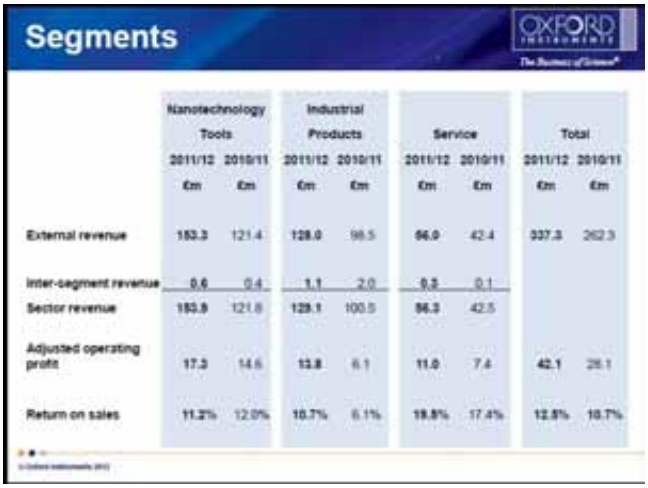
Three acquisitions were made during the year; Omicron Nanotechnology, Omniprobe and Platinum Medical Imaging. The company strengthened its new product pipeline, with 44% of revenue from products launched or acquired in the last three years, up from 34% in 2011.

Proposed final dividend increased by 11.6% to 7.23 pence, giving a total dividend for the year of 10.0 pence (2011: 9.0 pence)

Jonathan Flint, Chief Executive of Oxford Instruments plc, comments, "We are now two months into the second year of our 14 Cubed plan. Trading to date has been in line with our expectations and our markets remain strong despite continued economic uncertainty, particularly in Europe."

"A healthy pipeline of new product introductions is in place and we are investing across the business to increase efficiency, strengthen our market positions and drive further profitable growth. We are well positioned to build on the opportunities presented by emerging markets and to take advantage of new applications and technologies as they arise. We continue to look for bolt-on acquisitions to complement our existing businesses," he adds.

"A changing market presents interesting opportunities as well as challenges and we are confident that we have the structure, products and talent in place to make further progress in the current year and beyond."



Indium Corporation's Ploessl promoted to Compounds Product Manager

In this new position, Ploessl will work with Indium's global team of engineering, sales, operations, and R & D professionals to capitalise on the growth of LEDs, metal organic precursors, power storage systems, fibre optics, and next generation OLED displays

Indium Corporation has appointed Robert Ploessl as Product Manager for indium, gallium, germanium and tin compounds.


Robert Ploessl, PhD

He will develop Indium Corporation's marketing strategies, while bringing insights learned from their technical team to further product development efforts.

Indium Corporation's compounds business includes indium trichloride (InCl3), gallium trichloride (GaCl3), germanium tetrachloride (GeCl4), as well as a full range of oxides.

Robert Ploessl joined Indium Corporation in 2010. He holds a doctorate in physics from the University of Regensburg in Germany and an MBA from the S.C. Johnson Graduate School of Management at Cornell University. He is based at Indium Corporation's Global Headquarters in Clinton, NY, and resides in New Hartford.

Indium Corporation is a materials supplier to the global electronics, semiconductor, solar, thin-film, and thermal management markets. Products include solders, preforms, and fluxes; brazes; sputter targets; indium, gallium, germanium and tin compounds, and high purity metals; and Reactive NanoFoil. Founded in 1934, Indium Corporation

has global technical support and factories located in China, Singapore, South Korea, the United Kingdom, and the USA.

Nanotronics enhances IQE's III-V test and measurement capabilities

The system, which has automated wafer loading will be used to scan semiconductor wafer products including gallium arsenide and indium phosphide based materials. The tool has built in intelligence to enable repeatable and quantifiable object recognition to identify, categorise and record wafer features in real-time

IQE has enhanced wafer inspection capabilities at its Cardiff facility with the acquisition of a new automated wafer inspection tool supplied by Ohio based Nanotronics Imaging.

The nSPEC tool enhances existing manual microscopy inspection by allowing automated loading and scanning of III-V semiconductor wafer products including GaN, GaAs and InP based materials. The tool has built in intelligence to enable repeatable and quantifiable object recognition to identify, categorise and record wafer features in real-time.

The acquisition of the tool by IQE for use in its cleanroom facilities in Cardiff, UK, follows an extensive six month evaluation where the reliability and repeatability was compared with existing inspection techniques. This is the second nSPEC tool to be installed at IQE, the first unit having been commissioned and in use at the Group's manufacturing facility in Somerset, New Jersey.

The latest tool adds to the firm's KLA Tencor Surfscan 6220 and Leica optical microscope system which is equipped with Normarski imaging; both of these are based in the Cardiff Fab 2 cleanroom. The new system will save a lot of time in wafer inspection, particularly for 6 inch HBT wafers. I remember spending much of my time inspecting the morphology of these wafers at IQE on the optical microscope. A few years back, many of the HBT customer had a specification of less than one 100µm defect per wafer and if you were lucky, it took about 20 minutes to assess each wafer. At that time, it was difficult if not impossible to set up a Surfscan menu to assess defects of this size.

Eliot Parkinson, General Manager of IQE's III-V manufacturing facility in Cardiff comments, "The new automated inspection system offers a compelling alternative to manual microscope inspection, with greater repeatability and significantly reduced chance of human error."

Matthew Putman, CEO of Nanotronics Imaging, adds, "Rapid inspection that gives repeatable and useful results needs to be thought of as a modern technology like the personal computer used to be, and the smart phone is now. What has traditionally been too expensive, too complicated, and provided too little relevant information now needs to have all required features and more so that all companies using wafer inspection tools can have best in class technology that is affordable."

"We are at a point of technological convergence, where our engineers can develop such a tool. We are also pleased to have worked with a global leader IQE to evaluate our tool in a high volume, semiconductor wafer manufacturing environment," he concludes.

RFMD to outsource MBE and MOCVD wafer manufacturing

The transfer of RFMD's MBE growth facility to IQE should cut manufacturing costs

As previously announced, RF Micro Devices has entered into a definitive agreement to transfer its MBE wafer growth facility in Greensboro, North

Carolina, to IQE.

RFMD's MBE growth facility supplies MBE wafer starting material to its wafer manufacturing facilities. The firm will continue to own and operate in Greensboro, and Newton Aycliffe, UK.

RFMD's GaAs semiconductor products incorporate transistor layers grown using either an MBE or MOCVD process. RFMD outsources all MOCVD-based starting material, and will now also begin to outsource MBE-based starting material with the completion of the transfer.

Now, RFMD has announced that IQE will supply RFMD with both MBE- and MOCVD-based starting materials.

The transfer and supply agreement will lower RFMD's manufacturing costs, beginning in the September 2012 quarter. In the June 2012 quarter, RFMD currently estimates the transaction will result in a non-cash GAAP charge of approximately $0.02 to $0.03 related to equipment and inventory write-offs and will be approximately neutral to non-GAAP operating results.

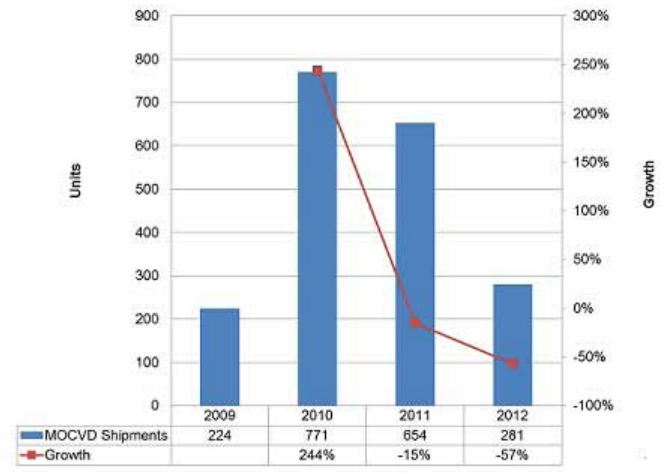
Bob Bruggeworth, president and CEO of RFMD, states, "We believe this is a mutually beneficial transaction for both RFMD and IQE. Of note, we expect this transaction will provide RFMD with lower MBE and MOCVD pricing, higher return on invested capital (ROIC), and more predictable operating results."

Veeco to overshadow Aixtron in GaN MOCVD LED equipment market

Due to overcapacity, projected shipments of reactors used in the growth of gallium nitride based LEDs have been downgraded for 2012. Veeco will also have a clear lead over Aixtron for GaN LED tools for the full year 2012

IMS Research has cut its forecast for 2012 GaN MOCVD shipments to 281, according to the second quarter 2012 MOCVD update of its "GaN LED Quarterly Supply and Demand" report.

IMS Research Analyst Jamie Fox comments, "The decline in 2012 is due to sufficient tools being in place for backlighting, lighting not yet fully taking off and expiring subsidies in China. The revision to our forecast is due to an analysis of the latest supplier earnings calls and our latest surveys of manufacturers which showed that some companies' purchase plans have been cut back more than expected in recent months, particularly in China. We have heard about capacity utilisation moving up in Taiwan this quarter, but we don't see this as a worldwide trend at the moment."



The graph above shows that 2012 shipments will be much lower than 2010 and 2011, but will still be higher than in 2009.

2012 will be a quiet year as, in terms of equipment installation, it will be the low point between the backlighting and lighting cycles. After a huge rush to buy in China in 2011 (it peaked at 92 percent of shipments in the fourth quarter), sales here are dropping significantly in 2012.

The entire worldwide market in the first quarter of 2012 was about the same size as the one largest order in China in the fourth quarter of 2011. However IMS Research believes the market has bottomed out in the first half of 2012 and that modest growth should return in the second half of 2012.

While the industry is currently in an overcapacity situation which will continue in the short term, longer term projections show that many more reactors will be needed over the coming years to meet the demand in lighting.. At present, big changes to the long term outlook are not anticipated.

Last quarter IMS reported on a strong quarter for Aixtron, which regained the lead in the fourth quarter of 2011. However, as anticipated, this has not lasted, and Veeco was well ahead again in the first quarter with an estimated 59 percent market. Veeco will also have a clear lead over Aixtron for GaN LED tools for the full year 2012, according to surveys with end customers.

What's more, with Veeco having very recently released three new MOCVD systems for LED growth , this may further improve the firm's market share.

According to IHS, China came top in terms of shipments in the first quarter, followed by Taiwan. With typical tool prices remaining at about $2 million, Veeco's K465i, used for the growth of gallium nitride based LEDs, was the most popular tool in the first quarter. Also, according to IHS, Epistar is the leader in cumulative tools installed, while Elec-Tech is ranked top in projected 2012 customers.

5N Plus completes $40 million equity financing

The provider of group III materials such as indium and gallium, used in the MOCVD industry, has issued of an aggregate of 12,903,613 units at a price of $3.10 per unit

Canadian based firm, 5N Plus Inc., has completed its previously announced "bought deal" public offering and concurrent private placement announced on 16th May.

Each of the units is comprised of one common share and one half of a common share purchase warrant. Each full warrant entitles the holder to purchase one additional common share at a price of $5.00 for 24 months.

The warrants are listed on the Toronto Stock Exchange under the trading symbol "VNP.WT" and have already begun trading.

In the "bought deal" public offering, 5N Plus issued and sold 6,452,000 units for gross proceeds of $20 million to a syndicate of underwriters led by National Bank Financial Inc. and including GMP Securities L.P., TD Securities Inc., HSBC Securities (Canada) Inc., CIBC World Markets Inc., Cormark Securities Inc., M Partners Inc., NCP Northland Capital Partners Inc., Stonecap Securities Inc. and Versant Partners Inc.

The offering was made by way of short form prospectus dated May 30th, 2012 filed with the securities commissions of each of the provinces of Canada.

In the concurrent private placement, 5N Plus issued and sold a further 6,451,613 units to Investissement Québec for gross proceeds of $20 million. The common shares and warrants issued to Investissement Québec are subject to restrictions on resale for four months under applicable securities legislation.

5N Plus will use the net proceeds from the "bought deal" public offering and concurrent private placement to reduce indebtedness incurred under its revolving credit facility with a syndicate of financial institutions.

Following the closing of the public offering and concurrent private placement, there are 83.9 million common shares of 5N Plus issued and outstanding.

VLSIresearch rates Plasma-Therm as one of the best for 13th consecutive year

The equipment manufacturer has been honoured for its chip making and wafer processing prowess, much of it used in the compound semiconductor industry

Plasma-Therm, a global supplier of plasma process equipment, was voted by VLSIresearch's 2012 "Customer Satisfaction Survey" as one of the world's best semiconductor equipment suppliers. This distinction is given to the top performers in this semiconductor segment and is based on being voted one of "10 BEST Focused Suppliers of Chip Making Equipment" and one of "THE BEST Small Suppliers of Wafer Processing Equipment". Plasma-Therm also came top in the "Etch & Clean Equipment" category.

According to the recent VLSIresearch survey, which considers customer satisfaction in the semiconductor equipment sector, "Plasma-Therm moved up five slots to the third position with a rating of 8.18. Customers applauded this etch & clean supplier as the highest in commitment of all Focused Suppliers as well as tying in spares support." "We are pleased that our continuous efforts and dedication to customer satisfaction and equipment performance are recognised in this prestigious survey by those that are most important – our customers," comments Rich Gauldin, Director of Customer Focus at Plasma-Therm. He continues, "Every year we strive to improve our ratings and being acknowledged each of the last 13 years as being among the very best semiconductor equipment providers is motivating."

New suite of GaN LED MOCVD tools revealed by Veeco

The three new reactors, suited to the growth of gallium nitride based LEDs, come in 2, 4, 6 and 8" wafer configurations

Veeco Instruments has introduced three new models of its TurboDisc MOCVD systems for the production of high brightness LEDs.

These are the TurboDisc MaxBright M, TurboDisc MaxBright MHP and TurboDisc K465i HP.

MaxBright MHP reactor

The MaxBright M is a modular and more compact version of Veeco's multi-reactor system. It is claimed to provide easier serviceability and up to 15% improved footprint efficiency compared to Veeco's MaxBright tool. It also features improved layout configuration flexibility to accommodate various fab spacing requirements.

The MaxBright MHP, is a high performance version of the new modular "." described above. Veeco says this model provides as much as 20% within-wafer wavelength uniformity improvement over the MaxBright. Higher yields are achieved from technology advancements that result in improved thermal and flow capability. The MaxBright MHP also provides lower cost of ownership as compared to MaxBright.

The final reactor is the K465i HP, which a high performance option for Veeco's single-reactor MOCVD system . It apparently delivers up to 20% within-wafer wavelength uniformity improvement compared to the K465i and a lower cost of ownership.

These new systems are available in 2, 4, 6 and 8" configurations.

Veeco says existing MaxBright and K465i

systems are easily field-upgradeable to the high performance HP option. All of Veeco's MOCVD systems feature its TurboDisc technology, which enable very good throughput.

William J. Miller, Ph.D., Executive Vice President, Veeco Process Equipment, comments, "This new suite of products provides our customers with tremendous flexibility to make the most of their capital investments and choose the system that works best in their unique production environment. The innovation in the MaxBright M, MaxBright MHP and K465i HP was accomplished by listening to our customers and focusing on system improvements that could drive their productivity and yield – two critical factors in our customers' success."

John R. Peeler, Chairman and Chief Executive Officer of Veeco adds, "This new product line-up, all based on our industry leading technology and automation expertise, can help to accelerate worldwide adoption of LED lighting by reducing manufacturing costs. Veeco remains committed to providing the industry's highest capacity, highest throughput and lowest cost of ownership MOCVD systems available."

According to IMS Research, the K465i, introduced in 2010, was the top selling MOCVD tool that year, and the MaxBright, launched in 2011, was the top seller last year.

Earlier this year, Compound Semiconductor Magazine awarded Veeco the "Compound Semiconductor Manufacturing Award, stating "MaxBright was the biggest breakthrough in compound semiconductor manufacturing over the last 12 months."

Veeco, Aixtron and Riber still rule the roost in epitaxy

Although there are another fifteen players in the MOCVD and MBE markets, they have had trouble establishing themselves due to the dominance of the other three firms

A new report , "III-V Epitaxy Equipment & Applications Market", from Reportlinker.com says that MOCVD and MBE are the techniques used to grow practically all III-V wafers. OK, but tell us something we didn't know. So what else has been revealed in the study? Well, apparently, the MBE and MOCVD market combined is predicted to hit around $6.1 billion between 2012 and 2020.

LED is by far and away the single largest application for MOCVD. In 2010 and 2011, the MOCVD market experienced the largest investment cycle in its history driven by a combination of drivers. These included demand for LED backlit LCD TVs, subsidies by the Chinese central and local governments and expectation in the general lighting market. On the down side, this has put the market into a significant overcapacity situation that could take 12 to 18 months to absorb. The next investment cycle driven by lighting applications and expected to start in 2013, will be more limited than the previous cycle due to improvements in equipment throughput and yields. Following this cycle, further Cost of Ownership (COO) improvements offered by the next generation of MOCVD reactors should justify the replacement of 2nd generation-old reactors installed during the 2010-2011 boom and drive a last small equipment cycle in the second half of the decade. By that time, power GaN will also represent a substantial upside for reactor makers. All in all, MBE use is heavily driven by R&D systems (over 50% of the total market) and laser applications (telecom, industrial, medical, research) that are not covered in the report.

Regarding applications covered in the report, the MBE market is predicted to be essentially driven by the continuous growth in the cell phone and wireless applications that are making heavy use of GaAs based RF components. Emerging applications like smart grid and the trend towards increasing connectivity and "intelligence" incorporated in many consumer products will provide further opportunities. But, alternative technologies such as silicon CMOS, LDMOS, SoS,

HR SOI represent a potential threat; they could capture shares of the GaAs RF market and reduce the opportunity for MBE. What's more, MOCVD is making progress in HEMT manufacturing. HCPV, however, could provide a small potential upside for MBE makers. MOCVD and MBE equipment market are duopolies but many emerging players could change the landscape: Aixtron and Veeco are the leaders in MOCVD, and together represented 96% of the market in 2011. Production MOCVD reactors are complex systems. Design and optimisation require expertise in multiple fields including flow dynamics, thermodynamics, chemistry, mechanical and electrical engineering. This makes technological barriers into the market pretty high. More than fifteen emerging players have been identified but so far, have been struggling to capture any sizeable share of the market. But the pressure is mounting and established MOCVD makers will need to maintain that technology gap to keep emerging competitors at bay. The main battlefield is that of total cost of ownership. Established MOCVD makers all have technology roadmaps to enable COO reduction of three to four times more within the next 5 years through a combination of improved yields, throughputs and precursor utilisation efficiency.

For MBE, Riber and Veeco are the only two players offering large capacity / large throughput MBE production tools for volume manufacturing. Reportlinker.com expects they will maintain this dominancy. However, there are about ten other MBE manufacturers offering R&D or pilot production systems that also have a strong presence on the general MBE market (DCA, SVT, Eiko among others). Potential overcapacity in MO precursor supply: The Metal Organic precursor market will also be essentially driven by LED applications. But MOCVD reactor technology improvements ; yield, consumption and wafer size to name but a few, will lower the amount of TMGa and TMIn needed per cm^2 of epiwafer. The 2010 metal organic shortage ended mid 2011 thanks to aggressive capacity expansion by leading suppliers. Further capacity expansion plans from established and emerging suppliers could come online within the next 3 years. If executed as announced, Reportlinker.com expects significant oversupply starting from 2012 that could continue through 2016 and beyond. This situation could put pressure on prices. Further MO synthesis technology improvements could provide opportunity for cost reductions. However, the usually volatile prices of raw indium and gallium also have a significant impact on cost.

Industry's first fully-automated high-power wafer measurement tool

There is now a new fully-integrated solution for testing silicon, silicon carbide, gallium nitride and GaN-on-silicon power device wafers

Cascade Microtech, a manufacturer of precision measurements of integrated circuits at the wafer level, has unveiled the new APS200TESLA.

APS200TESLA Wafer Power Device Testing System

The turn-key system combines the capabilities of its Tesla on-wafer power device characterisation measurement technology with Cascade Microtech's BlueRay production automation technology. Cascade boasts the system is industry's first

complete on-wafer production solution to address the test challenges of discrete power devices.

As power semiconductors grow with the demand for energy-efficient and environmentally-friendly products, power device manufacturing will shift from silicon substrates to SiC, GaN, and GaN-on silicon These new substrate technologies offer improved efficiency and enable higher levels of power, and faster switching, in many applications using insulated gate bipolar transistors (IGBTs) and MOSFETS, such as automotive and consumer electronics, electrical power distribution and large data centres.

Fast-growing applications in renewable energy and industrial power will challenge power device manufacturers to develop more efficient devices at a lower cost, driving the need for test solutions specifically designed for high-voltage and high-current probing.

This latest addition meets this challenge and is claimed to be the first fully-automatic on-wafer probe system for high-power device measurement. Rated up to 10k V/400 A, the APS200TESLA delivers excellent electrical performance for high-voltage and high-current device characterisation at production levels.

The system comes with a high-voltage, high-current probe card, a high-voltage, high-power chuck port, and the patent-pending MicroVac high-power chuck that can handle wafer thicknesses down to 50 µm, such as ultra-thin Taiko wafers.

An optimised electrical connection easily integrates the APS200TESLA with a variety of test instruments, and the interlock-enabled safety shield provides a safe environment for the operator. The arc-suppression feature allows the customer to optimise device layout to achieve better yields.

Auto-discharging and the unique probe-pin touch sensing capability prevent device damage due to high-voltage discharge during die-to-die moves. The APS200TESLA also offers advanced prober control software for automatic wafer and die stepping.

“The new APS200TESLA leverages our experience in achieving accurate on-wafer measurement. It is an advanced, turn-key power device measurement system that will help our customers improve cost-of-ownership, increasing test throughput and improving yields,” comments Michael Burger, president and CEO, Cascade Microtech, Inc.

“It allows our customers to save time by avoiding unnecessary dicing and packaging prior to final test. By testing on-wafer in a production environment, the APS200TESLA enables our customers to reduce test costs and get their products to market faster.”

JENOPTIK expands high power laser production with MOCVD AIXTRON system

AIXTRON SE today announced a new MOCVD systems order from existing customer JENOPTIK Diode Lab GmbH in Germany.

The contract is for one AIX 2600G3 ICMOCVD reactorin a 12x4-inch wafer configuration to form the basis of a new capacity expansion for high power semiconductor laser diode epitaxial materials at JENOPTIK’s Lasers & Material Processing Division.

The order was placed in the fourth quarter of 2011 and delivery will take place in the second half of 2012. AIXTRON Europe support team will install and commission the new reactor in JENOPTIK’s brand new dedicated production facility in Berlin-Adlershof.

A spokesman from JENOPTIK Diode Lab GmbH comments, “Due to increasing demand as a result of high levels of customer satisfaction, particularly from Asia, it is likely that our existing production facility in Berlin will soon reach the limits of its capacity, and it is therefore being expanded. As the new facility will more than double our production capacities, we need to introduce more MOCVD capability. AIXTRON equipment has served us very well, and we now wish to bring in the AIX 2600G3 ICMOCVD reactor in order to better respond to high levels of customer satisfaction and demand. The quality of technology and the efficiency of service we receive from AIXTRON are second to none. Having them working closely with us will guarantee the success of our expansion plans.”

Production of laser bars is a field in which JENOPTIK is considered a leading supplier and acknowledged world leader with regard to quality. From its own production facility in Berlin-Adlershof, which has been operating since 2006, optoelectronic base materials are developed in cooperation with the Ferdinand-Braun-Institut, Leibniz-Institut for Ultra High Frequency Technology (FBH). Laser bars from Berlin-Adlershof are processed to create high-power diode lasers at JENOPTIK in Jena as part of the complete technology chain through to laser systems for material processing. The new manufacturing facility will be automated and equipped with state-of-the-art production technology.

Teledyne Technologies to Acquire LeCroy Corporation

Teledyne Technologies and LeCroy Corporation have jointly announced that they have entered into a definitive agreement that provides for the merger of LeCroy Corporation with a wholly-owned subsidiary of Teledyne.

Pursuant to the transaction, Teledyne will acquire all of the outstanding common shares of LeCroy for $14.30 per share payable in cash. The aggregate value for the transaction is approximately $291 million, taking into account LeCroy's stock options, stock appreciation rights and net debt as of March 31, 2012. The transaction was unanimously approved by the Boards of Directors of Teledyne and LeCroy. In addition, LeCroy directors and executive officers, including founder Walter LeCroy, have agreed to vote their shares in favor of the transaction.

Founded in 1964 and headquartered in Chestnut Ridge, N.Y., LeCroy is a leading supplier of oscilloscopes, protocol analyzers and signal integrity test solutions with approximately 500 employees worldwide. For its fiscal year ended July 2, 2011, LeCroy had sales of approximately $178.1 million.

"LeCroy will broaden our portfolio of analytical instrumentation businesses by adding a leader in electronic test and measurement solutions," said Dr. Robert Mehrabian, Chairman, President and Chief Executive Officer of Teledyne. "We are particularly impressed with LeCroy's strength in the market for high-performance oscilloscopes. Furthermore, I am excited about the potential for LeCroy to provide an ideal commercial outlet for our unique Indium Phosphide process technology and ultra high frequency mixed signal design capabilities developed at Teledyne Scientific Company, our R&D laboratories."

"This transaction provides a substantial premium for our shareholders and provides exciting opportunities for our customers and employees," said Mr. Thomas Reslewic, President, Chief Executive Officer and Director of LeCroy. "We believe Teledyne can help us accelerate our high-end oscilloscope programs to deliver real-time bandwidth well beyond 100GHz by utilizing Teledyne's leading InP technology. Furthermore, through a combination of Teledyne's microwave and mixed signal design capabilities with LeCroy's signal processing expertise, as well as our respective market channels, we envision growing our markets and adding new products such as signal generators and multi function instruments."

Stifel Nicolaus Weisel is acting as exclusive financial advisor and Bingham McCutchen LLP and Fish & Richardson are acting as legal counsel to LeCroy. Needham & Company is acting as exclusive financial advisor and McGuireWoods LLP is acting as legal counsel to Teledyne.

Novel Devices

Rewriting quantum chips with a ray of light

Illuminating a sample of gallium arsenide with a pattern of light aligns the spins of all the electrons simultaneously, creating a spintronic circuit

The promise of ultrafast quantum computing has moved a step closer to reality with a technique to create rewritable computer chips using a beam of light.

Researchers from The City College of New York (CCNY) and the University of California Berkeley (UCB) used light to control the spin of an atom's nucleus in order to encode information.

The technique could pave the way for quantum computing, a long-sought leap forward toward computers with processing speeds many times faster than today's.

Current electronic devices are approaching the upper limits in processing speed, and they rely on etching a pattern into a semiconductor to create a chip or integrated circuit. These patterns of interconnections serve as highways to shuttle information around the circuit, but there is a drawback.

"Once the chip is printed, it can only be used one way," explains Jeffrey Reimer, UCB professor of chemical and biomolecular engineering and the study co-author of a paper recently published on the work.

The team, including CCNY Professor of Physics Carlos Meriles and Ph.D. graduate students Jonathan King of UCB and Yunpu Li of CCNY, saw a remedy for these problems in the emerging sciences of spintronics and quantum computing.

They have developed a technique to use laser light to pattern the alignment of "spin" within atoms so that the pattern can be rewritten on the fly. Such a technique may one day lead to rewritable spintronic circuits.

Digital electronics and conventional computing rely on translating electrical charges into the zeros and ones of binary code. A "spintronics" computer, on the other hand, would use the quantum property of electron spin, which enables the electron to store any number between zero and one.

Imagine this as if the electron were a "yin-yang" symbol in which the proportions of the dark and light areas, representing values from zero to one, could vary at will. This would mean that multiple computations could be done simultaneously, which would speed up processing power.

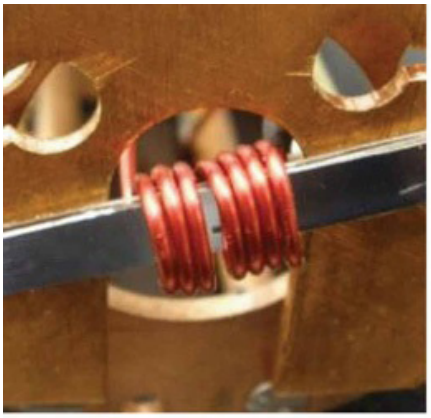
Attempts at using electrons for quantum computing have been plagued, however, by the fact that electron spins switch back and forth rapidly. This makes them very unstable vehicles to hold information. To suppress the random switching back and forth of electrons, the UCB and CCNY researchers used laser light to produce long-lasting nuclear spin "magnets" that can pull, push, or stabilise the spins of the electrons.

They did this by illuminating a sample of GaAs with a pattern of light, much as lithography etches a physical pattern onto a traditional integrated circuit. The illuminated pattern aligned the spins of all the atomic nuclei, and, thus, their electrons, at once, creating a spintronic circuit.

The probe head used to send radio-frequency pulses onto the coil used for pulsed spin manipulation of a GaAs sample. (Credit: Yunpu Li)

"What you could have is a chip you can erase and rewrite on the fly with just the use of a light beam," said Meriles. Changing the pattern of light altered the layout of the circuit instantly.

"If you can actually rewrite with a beam of light and alter this pattern, you can make the circuit morph to adapt to different requirements," he added. "Imagine what you can make a system like that do for you!"



Close up of the mount used to hold a GaAs sample, showing the radio-frequency coil used for pulsed spin manipulation. (Credit: Yunpu Li)

This work was supported by the National Science Foundation.

Further details of this research has been published in the paper, "Optically Re-Writable Patterns of Nuclear Magnetization in Gallium Arsenide", by J. P. King *et al*, *Nature Communications*, published online on 26th June 2012. DOI: http://dx.doi.org/10.1038/ncomms1918

InGaAs technology sorts the good berries from the bad

By using indium gallium arsenide technology, more efficient shape and colour sorting in berries is possible. This increases productivity, improves quality and reduces labour costs

Buhler has revealed the SORTEX E, a new optical sorter for berries

SORTEX E optical sorter

Employing advanced InGaAs technology, smaller volume processors can improve performance and reduce costs even more than was possible previously. The need for manual sorting by hand pickers is reduced dramatically. The SORTEX E has been trialled successfully in Europe and the USA. Two units are currently installed at a customer's plant in the North West region of United States to sort blueberries, loganberries, raspberries and other berry varieties. David Adams, Buhler Sortex Business Manager reports that the customer is delighted with the results. "The volume handled maximises productivity. After one pass some hand picking is still required but by putting our two SORTEX Es in line, this requirement will be minimised so that the number of pickers needed will be reduced by 80pc," he says.

The physical characteristics of berries vary. Blueberries, for example, are cultivated commercially in the United States and so are larger than the wild berries that are harvested in Eastern Europe and Scandinavia. With cultivated varieties, most extraneous vegetable matter, or EVM, is extracted by mechanical pre-cleaning equipment prior to sorting. As a result the sorting process is primarily concerned with identifying discoloured berries and, of course, eliminating any residual EVM. Wild berries undergo a similar process but EVM contamination is at a higher level than with cultivated varieties. The challenge at the sorting stage therefore is to extract a higher level of EVM such as pine needles, stems, leaves and stick fragments. So the sorting process focuses on both colour and shape. The SORTEX E sorts

EVM primarily by shape but is also successful in identifying colour defects. Blueberries, whether discoloured or unripened, can show green or yellow and raspberries, similarly, can be white, pink or brown. InGaAs technology performs a vital function in identifying plastic or wood fragments, cardboard and both light and dark coloured stones.

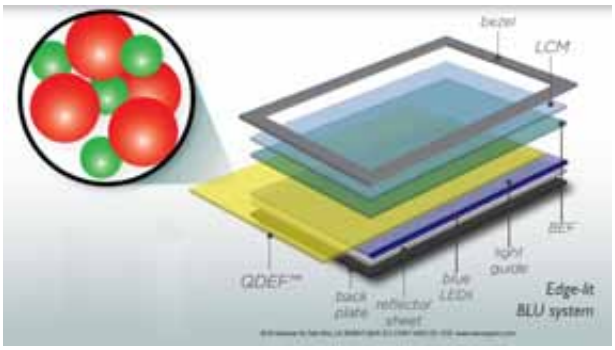
Nanosys and 3M to brighten up LCDs with QDEF technology

The companies will further develop quantum dot technology for consumer displays

Nanosys and the Optical Systems Division of 3M Company are unting to provide wide colour gamut technology for consumer electronic displays, allowing Liquid Crystal Displays (LCDs) to display 50 percent more colour.

3M and Nanosys will work together to commercialize Nanosys' Quantum Dot Enhancement Film (QDEF) technology.

The QDEF drop-in film's active material is composed of Nanosys' proprietary, high efficiency quantum dot phosphors. These tiny phosphors convert blue light from a standard GaN LED into different wavelengths based upon their size.



Larger dots emit longer wavelengths (red), while smaller dots emit shorter wavelengths (green). Blending together a mix of dot colours allows the engineering of a new spectrum of light.

LCD manufacturers can integrate QDEF with existing production processes. It utilises the light emitting properties of quantum dots to create an ideal backlight for LCDs, one of the most critical factors in the colour and efficiency performance of LCDs.

"Combining the world class-technology and materials expertise of Nanosys with the engineering, design and supply chain capabilities of 3M will unlock a powerful new colour viewing experience for consumers," says Jim Bauman, Vice President of the Optical Systems Division at 3M.

Over the years, 3M technologies have improved LCD performance. However, colour performance of LCD's has gone largely unchanged. Current LCDs are limited to displaying 35 percent or less of the visible colour spectrum. This means the viewing experience on an LCD is vastly different than to what a person sees in the real world. Wide colour gamut displays will allow consumers to enjoy more visceral, more immersive and truer to life colour.

"We are working together to improve an area of display performance that has been largely neglected for the last decade," adds Jason Hartlove, President and CEO of Nanosys. "Improving colour performance for LCDs with drop-in solutions will bring a stunning new visual experience to the consumer and a competitive advantage to the LCD manufacturer against new display technologies such as OLED. Working together with 3M and utilising their outstanding design and supply chain capabilities will allow our QDEF technology to be widely deployed across all product segments and will ensure availability to all customers."

A quantum dot, which is 10,000 times smaller than the width of a human hair, can emit light at a very precise wavelength. The ability to control the spectral output of a quantum dot allows QDEF to create an ideal white backlight specifically designed for LCDs.

Trillions of these quantum dots are packaged into a thin film that fits inside an LCD backlight unit. QDEF replaces a similar film already found inside LCD backlights, which means that adding QDEF to manufacturing processes requires no new equipment or process changes for the LCD manufacturer