ISSN 1752-2935 (online)

semiconductorTODAY

COMPOUNDS & ADVANCED SILICON

Vol. 6 • Issue 9 • November/December 2011 www.semiconductor-today.com

ZnO microwires improve GaN LED performance

GaN-on-Si for efficient energy management

First fully qualified SiC MOSFETs • SPTS forms Japan JV
First Solar lay offs • Soraa raises $88m • Stion raises $130m

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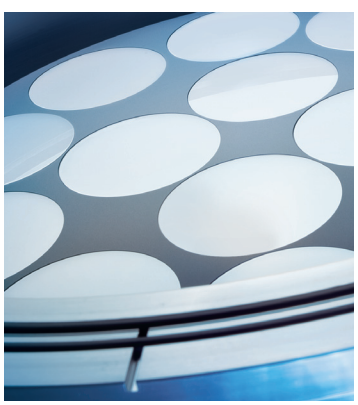

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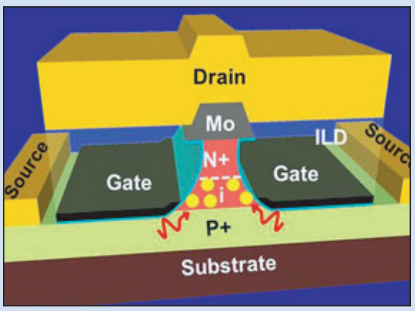
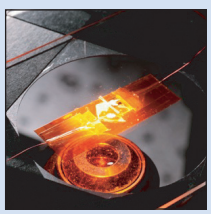


p18 An As/Sb vertical tunnel FET, presented by IQE and Penn State University at IEDM in Washington.

p51 Groundbreaking ceremony for Jenoptik's GaAs high-power laser production expansion in Berlin.

p64 South Africa's President Dr Jacob Zuma opens South Africa's first CPV power plant, which is equipped with modules made by Soitec.



Cover: Researchers led by professor Zhong Lin Wang at Georgia Institute of Technology have used ZnO microwires and the piezo-phototronic effect to significantly improve the efficiency at which GaN LEDs convert electricity to ultraviolet light. **p72**

editorial

CIGS PV goes East

As we approach 2012, the hope will be for a better year financially after healthy growth early this year turned to a slowdown in many sectors in second-half 2011. Inventory corrections at LED manufacturers (due to the slowdown in LED TV demand) has fed back up the supply chain. Meanwhile, the photovoltaic sector has been similarly affected.

Unfortunately, in these times of general financial crisis and slowing economic growth, non-essential government spending, such as investing in developing new technologies (even if it is for ultimately cost-saving technology through increasing energy efficiency), is coming under pressure. Although stimulus spending in the US is still in effect, elsewhere subsidies such as solar feed-in tariffs have become controversial.

In the UK, for example, rising energy bills and falling solar panel prices (making the feed-in tariff increasingly generous) have produced a boom in installations, leading to fears of a 'solar bubble' that may lead to a bust. While the UK solar industry agrees that a reduction in the tariff is justified to ensure that the economics of the sector remain sustainable, it argues that the speed and magnitude of the reduction (more than halving, at just a few weeks notice) threatens to kill ongoing business.

While this may apply mainly to the dominant silicon PV sector (and mainly home installations), compound semiconductor PVs are also affected by such economic and governmental factors. Most significantly, US cadmium telluride-based PV firm First Solar —one of the world's biggest solar panel makers — has once again reduced its guidance for full-year 2011 revenue. However, this time it has also laid off 100 staff (although this is less than 1.5% of its workforce) — see page 66. While the firm expects a return to robust growth for 2012, it is "recalibrating our business to focus on building and serving sustainable markets rather than pursuing subsidized markets," says interim CEO Mike Ahearn. "By channeling our core strength in utility-scale PV systems to markets with immediate need for mass-scale renewable energy, our goal is to earn substantially all of our new revenues from sustainable markets by the end of 2014," he adds. The firm has also consolidated its Utility Systems and Components business groups (in order to focus on global business development) and reorganized its finance and accounting groups (to optimize efficiency), comprising changes that "support our broader effort to reposition First Solar to lead the industry through the current market turbulence".

Despite such traumas for high-volume manufacturing, it is still possible for start-ups developing new technology to raise significant funding, such as $130m for CIGSSe PV maker Stion (see page 69). However, this latest funding comes only partly from existing US investors; most comes from Korean firms (led by vacuum-based thin-film coating equipment maker AVACO, which is expanding from flat-panel display manufacturing into thin-film PV technology). As well as funding the expansion at Stion's US plant, it will also fund the establishment of a Korean plant. Similarly, while CIS PV firm Avancis' second manufacturing plant in Germany has begun operation, it too is building a Korean plant (in a joint venture with Hyundai) — see page 68). Previously, in August, US CIGS PV maker Ascent Solar agreed a $450m deal with China's TFG Radiant to establish a manufacturing plant in East Asia. A sign of further things to come, perhaps.

Mark Telford, Editor
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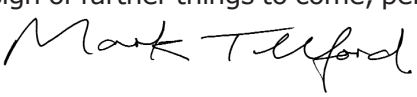

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***Semiconductor Today* covers the R&D and manufacturing of compound semiconductor and advanced silicon materials and devices** (e.g. GaAs, InP and SiGe wafers, chips and modules for microelectronic and optoelectronic devices such as RFICs, lasers and LEDs in wireless and optical communications, etc).

Regular issues contain:
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- feature articles (technology, markets, regional profiles);
- conference reports;
- event calendar and event previews;
- suppliers' directory.

***Semiconductor Today* (ISSN 1752-2935) is published free of subscription charge** in a digital format 10 times per year by Juno Publishing and Media Solutions Ltd, Suite no. 133, 20 Winchcombe Street, Cheltenham GL52 2LY, UK. See: www.semiconductor-today.com/subscribe.htm

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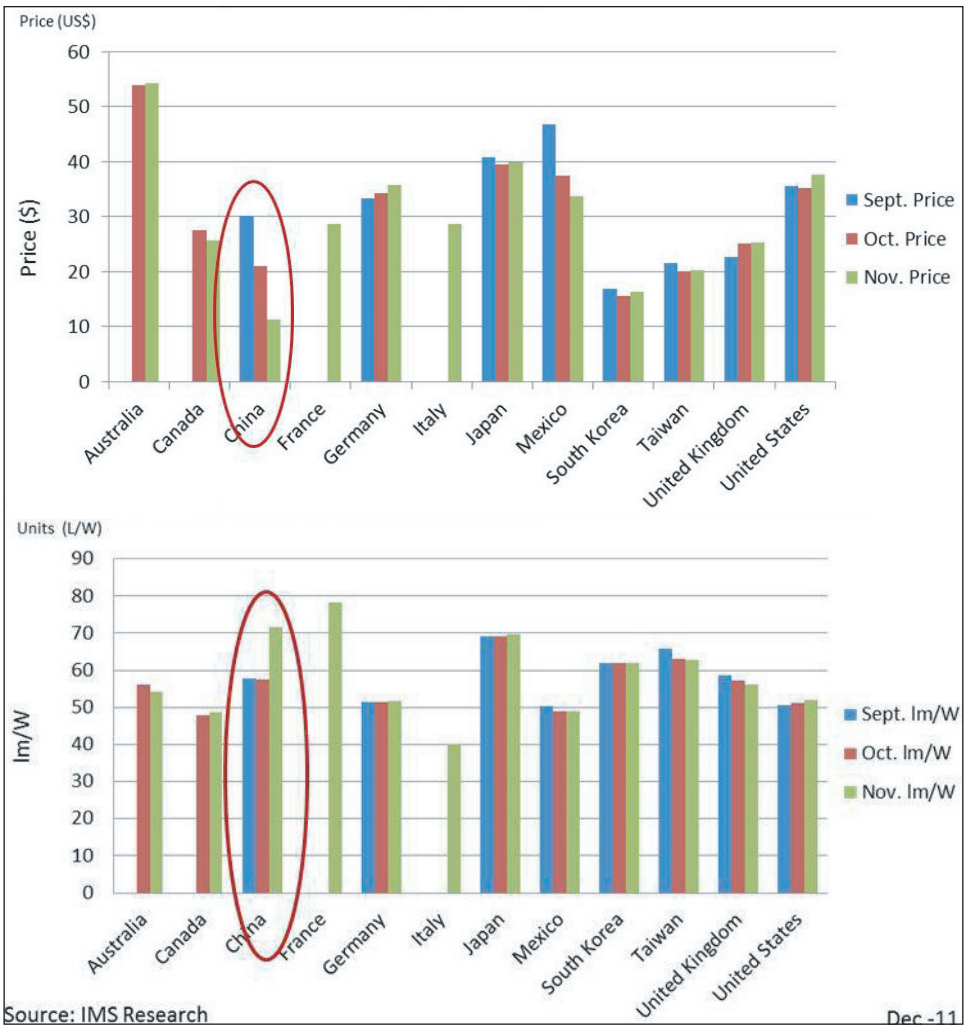
China's LED lamp prices fall to $11 in November

Efficiency rises 24% from September to November, says IMS

The global average retail price for LED lamps has fallen steadily on a monthly basis from $30 in September to $28 in November, according to IMS Research in its updated 'Global Monthly LED Lamp Retail Price Tracker', which currently covers more than 480 different lamp models from 47 different brands available via 27 different retailers in 12 countries (Australia, Canada, China, France, Germany, Japan, Italy, Mexico, South Korea, Taiwan, the UK and the USA).

In particular, says the market research firm, highlighting regional differences shows how the retail LED lamp market is evolving across the globe:

- China — The biggest decline in LED lamp prices was seen in the Chinese market, where the average price fell 62% from $30 to $11. The price of 60W replacement A19 lamps fell by 38%, while the price of 20W MR16 replacement lamps fell by 52%. Chinese manufacturers have also been pushing to increase the efficiency of their lamps, with lumens/Watt rising 24% from September to November.
- USA — November was the first month in which Samsung lamps have been sold in Lowe's home improvement stores. The firm has seven new PAR (parabolic aluminized reflector) and MR (multifaceted reflector) replacement lamps available and one 50W incandescent replacement. It appears that Samsung is delaying the introduction of its other incandescent replacement lamps available in other countries.
- Japan — November was the first month that a 40W incandescent replacement lamp has been priced under 1000 Yen ($13). The average price of 40W replacement lamps in Japan is still over $30.



Retail price for all replacement LED lamps by country and month (top); and monthly lm/W for all replacement lamps by country (bottom).

- South Korea — Of the 31 incandescent replacement lamps tracked in South Korea, 26 were mis-labeled with regards to their wattage replacement. The average luminous output of LED lamps labeled as 60W replacements was 505 lumens, almost 200 lumens below the threshold used by IMS for a 60W replacement.
- World — Of the more than 480 LED lamps tracked by IMS in 12 countries, only 32 (7%) were for 60W and 75W replacements, with no 100W replacement lamps (using IMS metrics) on the market. Achieving omnidirectional light distribution while keeping costs low, generating enough lumens and dealing with heat dissipation are the biggest constraints for lamp manufacturers to penetrate main-stream applications.

The biggest decline in LED lamp prices was seen in the Chinese market, where the average price fell 62% from $30 to $11. The price of 60W replacement A19 lamps fell by 38%

www.imsresearch.com

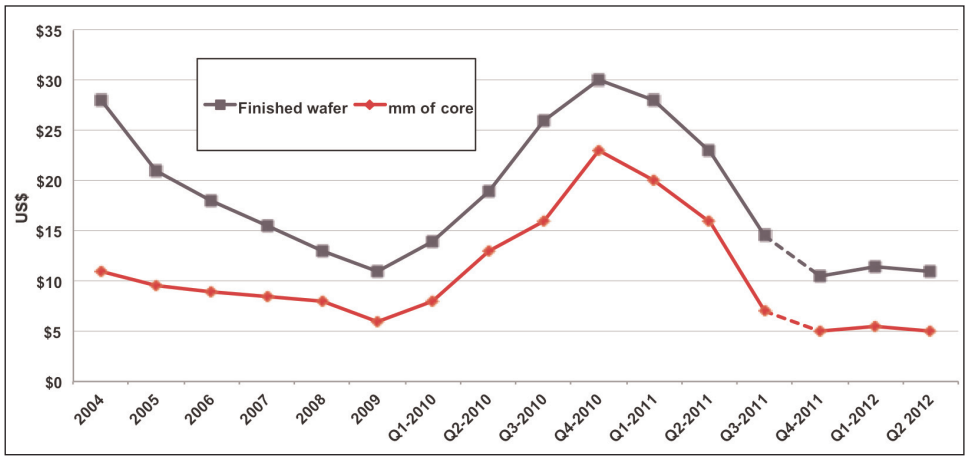
Sapphire supply and demand back in balance

Potential oversupply looming, but market should self correct as new entrants scale back, says Yole Développement

Following the massive material shortage in 2010, sapphire material and finished wafer prices remained high through early 2011, says Yole Développement in its latest 'Sapphire Market' report.

The situation was aggravated as wafer and LED manufacturers preparing for a massive intake of LEDs in the LCD TV market started building up sapphire inventory, fearing that supply might remain short. However, a softer-than-expected LED TV market and increasing sapphire capacity at established suppliers combined to rapidly bring supply and demand back into balance this summer, says Yole. This has triggered a fast drop in wafer prices that have now returned to pre-shortage levels.

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



Trend in 2-inch sapphire pricing, for both finished wafers and 1mm of core.

Few new entrants will succeed

Coupled with significant volume growth, the sapphire material shortage experienced through 2010 and early 2011 has created a window of opportunity for new entrants. In the last 18 months, more than 50 firms have announced their intention to enter the industry. These would bring the total number of potential participants in this market to nearly 100. More than 40 of those new entrants are located in China. Looking at the mid-term, adding up the capacity plans announced by those newcomers leads to a figure corresponding to almost three times the actual demand. However, this situation is unlikely to actually materialize, reckons Yole.

Most of the new entrants have little to no prior experience in sapphire crystal growth and wafer manufacturing. While the availability of 'turn-key solutions' from various growth equipment suppliers has lowered the barrier to entry, reaching and sustaining high quality and high yields in sapphire crystal growth still requires significant expertise, notes Yole. The learning curve can be steep for newcomers to reach yield levels on a par with established tier-one manufacturers. Wafer finishing also requires unique expertise and could prove challenging for companies with no prior experience. In addition, beyond wire saw manufacturers offering efficient slicing solutions and process, no turnkey solution are available for wafer finishing.

The pricing environment in 2010 was very forgiving and allowed some new entrants to achieve comfortable margins despite low yields and sub-par technology. Yole calculates that many of those new companies have production costs of $6–10 per millimeter of 2" core, and that these firms will therefore lose money at the current market price. At the same time, established vendors with higher yields, large volumes and a more favorable product mix (including large-diameter wafers) can achieve production cost below $5, which will allow them to maintain positive margins and weather the storm. Mid term, Yole expect that this situation will weed out the weakest players and trigger the withdrawal of many potential new entrants.

Transition to large diameters well underway

"The sapphire substrate industry, driven by LED applications, was initially developed based on a 2"-diameter platform," says Yole's Eric Virey. "Companies like Lumileds and Nichia were the first to move to 3" around 2003, while Osram pioneered the adoption of 4" shortly after," he adds. "Due to the large concentration of MOCVD [metal-organic chemical vapor deposition] capacity in Taiwan, and the current ramp in China, 2" is expected to remain the dominant platform through 2012."

However, many established Taiwan-based epitaxy companies are transitioning from 2" to 4", while some technology leaders in Korea, the USA and Europe have already made great strides in the their 6" conversion. Long term, a question mark remains regarding the economics of 8" sapphire, comments Yole. Nevertheless, R&D has already started and Yole believes that recent improvements in sapphire growth and slicing technologies could enable a cost of ownership that, in time, will be compatible with the adoption of the platform.

www.yole.fr

SiC industry consolidation and reshaping has started

Market research firm Yole Développement has released its latest 'SiC Market' report, which analyzes the structure of the silicon carbide industry and the evolution of the industry food chain.

SiC device makers are now able to offer the two most expected devices in the power electronics industry: the diode and the transistor. In particular, 2011 has been the year when the first SiC MOSFETs were introduced, with simultaneous launches by both Rohm and Cree.

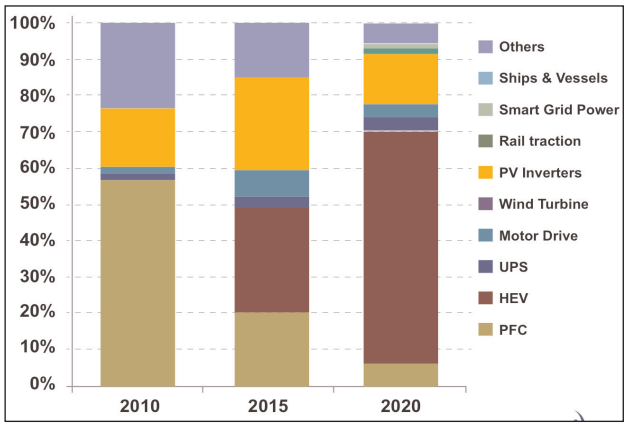
These devices are used in real-life systems (air conditioners, motor drives, PV inverters…) and much effort is being directed toward the packaging side in order to capture all the added-value that SiC offers (e.g. a high temperature coefficient, T°; high frequency, etc).

Excluding defense-related products and R&D contracts, the merchant SiC device market exceeded $50m in 2010. In particular, there has been unexpectedly high penetration into the photovoltaic (PV) inverter segment, where SiC Schottky diodes have now been implemented in many systems, amounting to about 15% of all SiC device sales. However, PFC (power factor correction) systems are still the top SiC device sales.

The investment level in the SiC industry has never been so big: over 2010 and early 2011, more than $100m has been invested in mergers & acquisitions (M&A), R&D programs, and private and public funding.

In particular, recently the SiC industry has started to consolidate through M&As, large investments and license agreements. Over the last 18 months, the most significant of these have been:

- Rohm – SiCrystal, acquisition;
- Power Integration – SemiSouth, large investment;
- Fairchild – TranSiC, acquisition;
- Cree – Nippon Steel Corp, license agreement;
- SKC – Crysband, acquisition; and
- Infineon – SiCed, 100% acquisition.



SiC device market share (to 2020) by application.

However, the question remains: will SiC be implemented in electric vehicles and hybrid electric vehicles (EV/HEV), and when? Here, several scenarios can be envisioned. In Yole's optimistic scenario, the automotive-related business will begin by 2014 with a fast ramp-up and will capture more than 65% of the SiC device market in 2020. On the other hand, in a pessimistic scenario, SiC could be skipped by auto makers, who may prefer to use either gallium nitride (GaN) or incumbent silicon technology.

Is SiC self-protected against GaN market penetration?

In most of of Yole's investigations, GaN is always mentioned as *the* competing technology that can disrupt the expected natural and organic growth of the SiC business. Yole says that originally it thought that GaN devices could have created turbulence in the SiC area (starting from 2010) by offering 600V devices, with a tipping-point at 1.2kV. But it seems that technical progress has been delayed compared to the previous roadmap, and only 200V GaN device are available in volume currently. Hence, at the moment, the 600V region (where SiC and GaN are supposed to compete) is safe for SiC, as no other device can yet challenge it.

High voltage; huge potential, but few players

Yole assumes that the safest sector for SiC technology will be high- and very-high-voltage applications (1.7–10kV+), where GaN cannot easily go and where incumbent silicon technologies are slowly reaching their limits. At 10kV and more, SiC could be the dominant solution. However, paradoxically, few players are targeting this high-voltage region, probably because the existing market is small — a total addressable market (TAM) of just $2bn — the time-to-market is unclear, and the number of applications is limited.

6" is ready, but not accessible in volume

Although 6" SiC wafer capacity is now ramping up for LED production at Cree, the power industry is not yet able to access 6" substrates in volume. However, Yole expects that 2012 will be the starting point for wide adoption of this 150mm substrate, which should act as an incentive for the remaining reluctant companies, which argue that SiC wafers are not compatible with their existing tool-kit.

China the new Eldorado for SiC business establishment?

"Of the seven new entrants listed in the last 12 months, four were established in China and three of them were dedicated to material (raw wafer and/or epi)," says Yole's Alexandre Avron. "Epiworld, TianYue and TYSTC have invested extensively in top-class equipment to produce both SiC wafers and epi-wafers. Kingway Technology will be active in the device area with a double entry: SiC and GaN from epi to device," he adds. Also, two start-ups have ambitions in SiC device manufacturing: Anvil Semiconductors in the UK and Ascatron (a spin-off from ACREO in Sweden). "On the exit side, we have noticed the NeoSemiTech decision to cut its SiC activity as well as the 100% acquisition of SiCed by Infineon (formerly owned jointly with Siemens)."

www.i-micronews.com

Wireless infrastructure drives RF power semiconductor markets over $1bn in 2011

GaN to gain market share in 2012 and be a significant force by 2017

Spending on RF power semiconductors for the wireless infrastructure market has experienced significant growth in 2011, according to the new study 'RF Power Semiconductors', which has been issued as part of market research firm ABI Research's RF Power Devices Research Service. Other markets — notably the military — are seeing some moderation in growth as the global economic picture and political factors come into play. Also, gallium nitride (GaN) — long seen as the promising new 'material of choice' for RF power semiconductors — is continuing to capture share.

"GaN has the promise of increased market share in 2012 and is forecast to be a significant force by 2017," notes Lance Wilson, research director, mobile networks. "It bridges the gap between two older technologies, exhibiting the high-frequency performance of GaAs combined with the power-handling capabilities of silicon LDMOS," he adds. "It is now a mainstream technology that has achieved measurable market share, and in the future will capture a significant part of the market."

The vertical market showing the strongest uptick in the RF power semiconductor adoption business (outside of wireless infrastructure) is commercial avionics and air-traffic control, which Wilson describes as now being "a significant market". While the producers of these chips are located in the major industrialized countries, this sub-segment market is now so global that end-equipment buyers can be from anywhere, he adds.

The study examines RF power semiconductor devices that have power outputs of greater than 4W and operate at frequencies of up to 3.8GHz, representing the bulk of applications in use today. With the current release of the report, analysis of the six main vertical segments (wireless infrastructure; military; industrial, scientific, and medical (ISM); broadcast; commercial avionics and air traffic control; and non-cellular communications) — which were previously subdivided into 24 sub-segments — are expanded to 29 sub-segments.

www.abiresearch.com

New materials to impact packaging & cooling systems

In 2016, almost 25 million cars manufactured will be electrified, most of them micro-HEV (hybrid electric vehicles) with a low level of electrification. However, some 5 million will be full HEV, plug-in HEV, or EV, according to the report 'Power Electronics for Hybrid & Electric Vehicles' from market research firm Yole Développement.

EV/HEV will hence represent the biggest accessible market for power device and system makers, reckons Yole. Without becoming completely mature, the EV/HEV industry has seen its first steps toward standardization. Electrical configuration shows a preference for parallel and split structures. Following the same logic, DC/DC boost converters and DC/AC inverter architectures for full HEV and EV have been adopted. However, getting the best switch at the lowest cost is a must: silicon-based insulated-gate bipolar transistors (IGBTs) will hence continue to have a bright future in hybrid and electric cars. Yole expects the power module market to be near $5bn (with most made from IGBTs), changing the game in the power electronics market.

However, new materials for active components will greatly impact packaging & cooling systems. Silicon carbide (SiC) will be part of the game, but not for today, says Yole. It will bring high efficiency, but at even higher cost. Yole expects the market to reach $41.3m, which is small but with huge potential through an estimated compound annual growth rate (CAGR) of 39% for 2015–2020). Gallium nitride (GaN) will struggle at lower power, being the high-end part of the micro-HEV. The technology will face advanced silicon devices such as super-junction MOSFETs. However, the future of compound semiconductors in power electronics depends on new developments, and a sudden breakthrough could easily make any existing roadmap obsolete, reckons Yole.

Another point of interest observed in all power electronics domains concerns packaging and module assembly, which is even more important for EV/HEV. Indeed, EV/HEV makers can gain market share through proprietary innovations, and IP, applicable to a full range of cars, forecasts Yole.

Toyota started field testing flip-chip modules with double-sided cooling in 2008, but in 2010 they went back to classical assembly (DBC one-sided cooling) with some small improvements (Al ribbon bonding and direct cooling). All other players are working hard, says Yole: Delphi with its Viper module and Mitsubishi is developing intelligent power modules (IPMs).

Yole reckons that, over the next 10 years, amazing things will be achieved in power module packaging for EV/HEV. In particular, it expects new technologies to quickly and readily transfer to other energy conversion markets (PV, wind, etc).

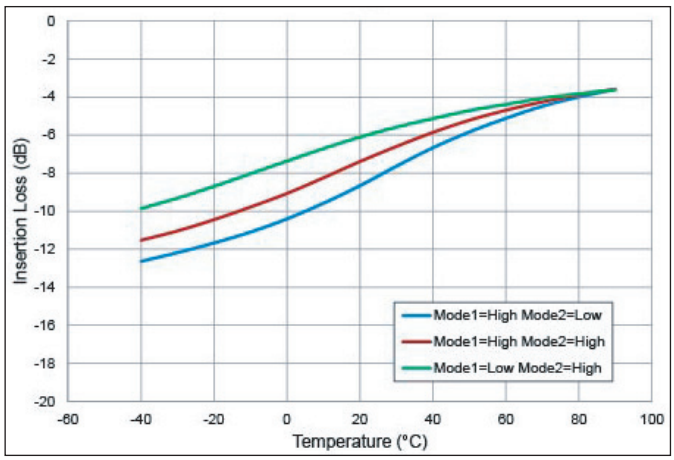
www.yole.fr

RF Micro Devices launches monolithic analog temperature-compensating attenuators

RF Micro Devices Inc of Greensboro, NC, USA says that its new RFSA4013 and RFSA4023 are fully monolithic analog temperature-compensating attenuators (TCAs) with what is claimed to be exceptional linearity over their entire gain control range.

The TCAs are designed to offset the gain reduction of an RF component over temperature without the need for closed-loop feedback. Three customer-selectable temperature coefficients make the TCAs a flexible solution for RF lineups, says RFMD.

It is claimed that each attenuator incorporates new circuit architecture that solves a long-standing industry problem regarding attenuator architecture: high IP3, low DC current, and broad bandwidth. Traditional approaches for linear temperature-compensating devices require expensive co-fired ceramics with temperature-sensitive materials or current-hungry PIN diodes with elaborate area-consuming control circuits. The RFSA4013 and RFSA4023 require just a single supply voltage (5V for the RFSA4013 and 3.3V for the RFSA4023) and two logic bits to set the control attenuation slope versus temperature.



Insertion loss vs temperature (RF 2GHz, V_{DD}=5V).

Each TCA draws a very low supply current of typically just 1mA and is packaged in a small 3mm x 3mm QFN. The attenuators are internally matched to 50Ω over their rated control range and frequency (50–4000MHz).

Applications include cellular/3G infrastructure; WiBro, WiMax and LTE; microwave radio; and high-linearity level control.

Pricing begins at $3.94 each for 100 pieces.

RFMD's PowerSmart platform and RF724x 3G/4G PAs power next-generation smartphones

RF Micro Devices has started volume production of multiple 3G/4G power amplifiers (PAs) in support of two smartphone families produced by a leading North America-based smartphone maker. The two most recent smartphones supported by RFMD feature its PowerSmart power platform and RF724x family of ultra-high-efficiency power amplifiers.

The first smartphone, featuring PowerSmart, is an all-touch handset featuring a 3.2" high-resolution display, a 5MP camera with flash and video recording, and pre-installed social networking apps. The second smartphone, featuring RFMD's RF7241, RF7242, RF7244, RF7245 and RF7258 PAs, is a full-featured smartphone with a high-resolution touch display, a highly tactile keyboard, and a precise optical trackpad. It will be available in multiple triple-band 3G versions featuring RFMD's 3G/4G PAs exclusively.

"RFMD's industry-leading 3G/4G products continue to gain design momentum with the world's leading smartphone manufacturers," claims Eric Creviston, president of RFMD's Cellular Products Group (CPG). "Similar to calendar 2011, we believe RFMD will be a clear share gainer during calendar 2012, not only in UMTS/HSPA+, but also in 4G LTE," he adds.

RFMD's RF724x UMTS/HSPA+ power amplifiers are single-mode 3G/4G components used in smartphones, tablets and other high-performance data-centric connected devices. They deliver high peak efficiency of 48-51% (significantly above current competitive offerings, it is claimed). The product family currently covers WCDMA bands 1, 2, 4, 5 and 8, addressing the most common UMTS/HSPA+ frequency bands and band combinations.

RFMD's PowerSmart power platform is a new product category for multi-mode, multi-band cellular RF architectures. It features a new RF Configurable Power Core that delivers multi-band, multi-mode coverage of all cellular communications modulation schemes, including GSM/GPRS, EDGE, EDGE Evolution, CDMA, 3G (TD-SCDMA or WCDMA) and 4G (HSPA+, LTE or WiMAX). The RF Configurable Power Core (which performs all power amplification and power management functionality) is compliant with all current and known future 4G data standards (HSPA+, LTE QPSK, LTE 16QAM, and LTE 64QAM).

The PowerSmart power platform also includes all necessary switching and signal conditioning functionality in a compact reference design, providing smartphone makers a single scalable source for the entire cellular front end.

www.rfmd.com

IN BRIEF

TriQuint earns 'Excellent Supplier' award from Yulong

TriQuint has received the 'Excellent Supplier' award from Shenzhen-based smartphone handset maker Yulong Telecommunication (a subsidiary of China Wireless Technologies Ltd).

"TriQuint is now an important RF front-end supplier of Yulong; this award represents our recognition and appreciation to TriQuint," says Yulong's senior VP of supply chain Xiaohui Xu. "We hope our co-operation with TriQuint can be extended to becoming strategic partners," he adds.

According to Strategy Analytics' vice president David Kerr, in first-quarter 2011 Yulong and two other Asian micro-vendors outperformed major international handset brands in China and India. "Yulong Coolpad is on track to becoming a known player in the China 3G market, supplying affordable, mid-tier 3G smartphones to suburban and urban users," he says. "Yulong Coolpad is growing relationships with all three Chinese mobile carriers, tapping the growing 3G boom in this important handset market." Coolpad handsets are the main products of Yulong, and TriQuint has supplied the firm with cellular power amplifier (PA) modules and WLAN PAs for its broad smartphone portfolio.

"Yulong is one of the leaders in the field of 3G technology, so earning this 'Excellent Supplier' award from Yulong Coolpad highlights TriQuint's significant contributions to mobile handset designs in China," says TriQuint vice president Glen Riley. "As a global supplier, TriQuint will continue to grow its portfolio of wireless broadband solutions for mobile devices, helping phone manufacturers improve the performance and lower their cost."

www.yulong.com.cn

TriQuint extends high-linearity 3G/4G BTS driver amplifier range to 1 & 2W

RF front-end product and foundry services provider TriQuint Semiconductor Inc of Hillsboro, OR, USA has launched two linear RF amplifier family members that lower power consumption while protecting mobile networks from disruption and service failures.

TriQuint says that patent-pending integrated protection features can guard against electro-static discharge (ESD) and DC over-voltage electrical spikes. Also, integrated RF over-drive protection reduces the chance of damage from high signal levels often seen in systems employing digital pre-distortion linearization techniques commonly utilized in 3G/4G base transceiver stations (BTS) network transceivers.

With high gain of 16.6dB and 15.8dB, output IP3 (OIP3) of 45dBm and 49.5dBm, and 29.1dBm and 32.8dBm of compressed 1dB power (P1dB) at 2.1GHz respectively, the new 400-4000MHz 1 Watt TQP7M9103 and 700-4000MHz 2 Watt TQP7M9104 high-linearity driver amplifiers suit 3G/4G wireless infrastructure applications including base transceiver stations, repeaters, boosters, remote radio heads (RRHs), defense/aerospace and other wireless systems requiring high linearity and gain with low power consumption. TriQuint says that the new devices help designers to simplify RF connectivity through reduced bills of materials, increased efficiency, and packaged design convenience.

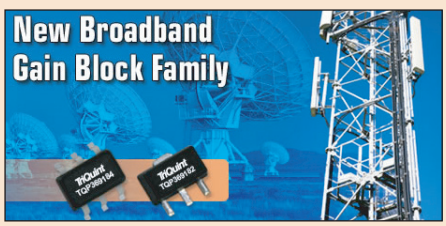
By lowering the current draw for the 1W TQP7M9103 (to only 235mA with a 5V supply), TriQuint can offer the device in an easy-to-use, industry-standard SOT-89 package that simplifies manufacturing. The TQP7M9104 (which consumes just 427mA with a 5V supply) is packaged in an industry-standard 4mm x 4mm QFN that allows good thermal attachment to a PCB due to its large backside contact area.

Samples and evaluation boards for the TQP7M9103 and TQP7M9104, as well as the existing 0.25W TQP7M9101 and 0.5W TQP7M9102 (launched in June), are available.

TriQuint launches broadband Darlington-pair cascadable gain block family

TriQuint has launched the new TQP36918x-Series of high-efficiency Darlington-pair cascadable gain block amplifiers that delivers cost-effective, broadband solutions in base-station transceiver, repeater, CATV, SATV and defense/aerospace applications. The 50 ohm general-purpose gain blocks are internally matched to help cut bill of materials (BOMs) while reducing current consumption to just 45mA.

The new devices provide two gain levels (15 and 20dB) as well as 29dBm OIP3 across DC–6GHz. Offered in RoHS-compliant, industry-standard SOT-363 or SOT-89 packages, the new gain blocks also provide very robust Class 1C HBM ESD performance.



TriQuint's TQP36918x gain blocks.

TriQuint exhibited the devices with distributor Richardson RFPD at the 2011 Microwave Workshops & Exhibition (MWE) in Yokohama, Japan (30 November–2 December).

www.triquint.com

Anadigics expands 4G range with high-linearity WiMAX/LTE PA

RF and mixed-signal semiconductor maker Anadigics Inc of Warren, NJ, USA has expanded its mobile 4G power amplifier (PA) family. The new AWM6268 WiMAX/LTE power amplifier provides linearity and integration similar to that of Anadigics' current WiMAX solutions, while increasing output power to deliver greater range and throughput in the 2.5–2.7GHz frequency band. This device also delivers what is claimed to be exceptional linearity and output power for LTE applications. Anadigics' 4G PAs are optimized for high-data-rate broadband wireless devices such as smartphones, notebook PCs, netbooks, data cards, and Wi-Fi hotspots.

"While LTE technology continues to gain traction, mobile broadband system operators around the world continue to deploy and expand WiMAX networks, offering new WiMAX-enabled devices to support the rapidly increasing demand for wireless data," says Glenn Eswein, director of product marketing for broadband RF products. "Anadigics remains at the forefront of WiMAX RF performance by providing power amplifiers that enable longer range and higher throughput, while maximizing battery-life," he claims. "These performance advantages have been validated by volume shipments of our existing WiMAX PA products, and through design wins with the new AWM6268," Eswein adds.

"As 4G applications evolve, it is becoming more evident that the performance of the PA affects network performance and the user experience directly," comments Joe Cozzarelli, senior director of broadband RF products. "The new AWM6268 power amplifier enables a wider range of these applications by delivering enhanced linear output power and efficiency."

In WiMAX applications, the PA provides what is claimed to be best-in-class linearity of 2.5% error vector magnitude (EVM) and high power-added efficiency (PAE) of 25% at +26dBm output power to help maintain battery-life under demanding, data-intensive usage. In LTE applications, the PA delivers high linearity and 33% power-added efficiency at +28dBm output power. The AWM6268 meets WiMAX spectrum emissions mask limits at +26dBm output power and UTRA adjacent channel power limits at +28dBm output power.

Anadigics' AWM6268 WiMAX/LTE PA..

With a high level of integration (including an integrated step attenuator and RF input and output impedance matching circuits), the AWM6268 uses a package footprint (4mm by 4mm by 1mm), a pin-out and controls that are compatible with the earlier AWT6264 PA.

Anadigics' complete family of 4G PAs is manufactured using the firm's InGaP HBT MMIC technology, which offers reliability, temperature stability, and ruggedness. As well as the 2.3–2.7GHz AWT6264 (which has a PAE of 24% at 25dBm output power), Anadigics' WiMAX PA family also includes the 3.3–3.8GHz AWT6283 (which has a PAE of 22% at 25dBm output power).

Samples of Anadigics' new WiMAX power amplifiers are available now.

www.anadigics.com

IN BRIEF

GigOptix adds 30GHz GaAs MMIC distributed PA

GigOptix has expanded its MMIC power amplifier (PA) line with the addition of the iT2012, a 0.25W wideband distributed PA for military electronic warfare (EW), radar, test & measurement equipment, and broadband telecom equipment applications. The amplifier augments GigOptix's broad line of power amplifiers with frequency coverage extending up to 90GHz.

Key features of the iT2012 include:

- performance from DC to 30GHz;
- internally matched RF input and outputs to 50Ω;
- up to +26dBm typical saturated output power up to 15GHz and higher than 22dBm up to 30GHz;
- 35dBm typical output IP3 for a drain voltage of +8V_{DC};
- supply current of 220mA from a +8V supply; and
- small-signal gain of 16dB typical with a gain flatness of ±0.5dB across band.

The iT2012 is GigOptix's first new microwave product since its acquisition in June of San Jose-based Endwave Corp (a designer and manufacturer of high-frequency RF solutions and semiconductor products for the wireless mobile backhaul communications, satellite communications, electronic instruments, and defense & security markets). "We have blended the skill sets of both design groups," says chief technology officer Andrea Betti-Berruto. "This product release further demonstrates our successful and synergistic integration under the GigOptix umbrella."

The iT2012 is available in bare die form and is designed to enable straightforward integration into subsystems and MCMs by requiring few extra components for bias decoupling. Engineering samples are available.

www.gigoptix.com

Skyworks opens design center in Korea

Facility to support growing demand for 3G and 4G front-ends

Skyworks Solutions Inc of Woburn, MA, USA (which makes high-reliability analog and mixed-signal semiconductors) has opened a design center in Korea to support increasing demand for 3G and 4G front-end solutions. In fiscal 2011 (to end September), Skyworks' 3G front-end module shipments grew by more than 150% year-on-year. The site will support IC and MCM designs and layouts, RF laboratory work, and customer support through early manufacturing.

Skyworks is hence placing more of its skilled engineering teams closer to customers, says Gregory L. Waters, executive VP & general manager, front-end solutions. "Our customers' success depends upon the performance and reliability of our products, and the strength of our service," he adds. "We are committed to meeting the market's need for the smallest and highest-performance device architectures, as well as strengthening our local support for leading smart-phone providers and handset manufacturers."

Global adoption of 3G and 4G devices, including smart-phones, tablets and an array of new applications, continues to be robust, says the firm. The proliferation of embedded wireless functionality is driving a tremendous rise in RF content and the number of connected devices, it adds, citing GSMA research suggesting that the number of mobile connected devices should double to 12bn units by 2020.

www.skyworksinc.com

Skyworks and AnalogicTech amend merger agreement

Skyworks Solutions and Advanced Analogic Technologies Inc (AATI) of Santa Clara, CA have amended their merger agreement. Skyworks will acquire AnalogicTech for $5.80 per share in cash. The firms expect the transaction to be completed in January.

In May, Skyworks agreed to buy AnalogicTech for a nominal price of $6.13 per share ($3.68 per share in cash plus 0.08725 of a share of Skyworks' common stock for each outstanding share of AnalogicTech common stock).

AnalogicTech is an analog semiconductor firm focused on enabling energy-efficient devices for the application-specific power management needs of feature-rich consumer electronic devices (such as mobile handsets, digital cameras, tablets, notebooks, TV and LCD displays) as well as devices in a broad range of computing, industrial, medical and communications applications. The firm also licenses device, process, package, and application-related technologies. Assets include design centers in Santa Clara and Shanghai, as well as Asia-based operations and logistics.

Skyworks intends to finance the tender offer with cash on hand. The tender offer will not be subject to financing and, among other things, will be conditioned upon a majority of the shares of AnalogicTech common stock outstanding being tendered and no injunctions being issued prohibiting the offer or the merger. AATI has addressed and satisfactorily clarified all issues previously raised by Skyworks. As part of the settlement, the firms have agreed to voluntarily dismiss the claims asserted against each other in the Delaware Chancery Court. Skyworks and AnalogicTech have mutually determined that their respective claims were insignificant in light of the overall value of the transaction.

"This transaction will enable Skyworks to further capitalize on our strong smart-phone, tablet, set-top box and infrastructure positions with an expanded and differentiated product portfolio while accelerating our entry into new vertical markets," believes Skyworks' president & CEO David J. Aldrich. "Analog power management semiconductors represent a strategic growth market for Skyworks as our customers increasingly demand both ubiquitous wireless connectivity and power optimization across seemingly every kind of electronic platform. With AnalogicTech, Skyworks will be well positioned to address these twin market opportunities by leveraging our broad customer relationships and innovative product portfolios, and increasing operational scale," he adds.

"The revised agreement with Skyworks provides AnalogicTech stockholders with immediate value and certainty for their investment in the company, while providing important benefits to AnalogicTech's employees and customers," believes AnalogicTech's president, CEO & chief technical officer Richard K. Williams. "We share Skyworks' vision of the enormity and growth potential of the analog semiconductor market and continue to believe that, together, we can better address customers' demand for highly integrated power management solutions across a broader range of markets and applications," he adds.

Skyworks noted that the Registration Statement on Form S-4 that had been filed with the US Securities & Exchange Commission (SEC) on 17 June and withdrawn on 3 November will not be resubmitted.

In light of the revised merger agreement, AnalogicTech's Annual Meeting of Stockholders (previously scheduled for 16 December) has been postponed until further notice.

www.AnalogicTech.com

Skyworks begins shipping analog control ICs for Siemens Healthcare's MRI scanners

Skyworks capitalizing on increasing RF content in medical market

Skyworks Solutions has begun volume shipments of analog control switches to Siemens Healthcare for its MAGNETOM magnetic resonance imaging (MRI) scanners.

Skyworks says that its devices allow Siemens to manufacture scanning equipment that is 50% more productive and easier for medical technicians to maneuver. The switches deliver low insertion loss, positive voltage operation and very low direct-current power consumption (all critical elements for MRI). Each scanner requires hundreds of switches.

Skyworks' portfolio of low-noise amplifiers, Schottky and varactor diodes, attenuators and multi-throw switches are also supporting other wireless medical applications including blood sugar and heart monitors, pacemakers, and patient telemetry devices.

According to research and advisory firm Nerac, the number and variety of wireless medical devices is growing rapidly, driven by the expansion of wireless communication technology and the medical needs of an aging population. Wireless medical devices that monitor patients range from defibrillators to infusion pumps. According to Nerac's 'Wireless Medical Devices: Security Issues, Market Opportunities and Growth Trends' article, by 2020 at least 160 million Americans alone will be monitored and treated remotely for at least one chronic condition. The market for such remote monitoring of patients is forecast to reach $5.1bn by 2013, up from $3.6bn in 2007.

"This design win is yet another example of how Skyworks' analog portfolio is gaining traction across a wide array of end markets, demonstrating Skyworks' success in diversifying into highly profitable, adjacent segments," says Liam K. Griffin, executive VP & general manager of high-performance analog.

Skyworks' product portfolio supporting medical applications switches such as the SKY13267-321LF (a GaAs T/R diversity switch), SKY13268-344LF (a GaAs SPDT switch) and SKY14151-350LF (a high-power SP4T switch with decoder); the SKY67014-396LF 1.5–3.0GHz low-power, active-bias low-noise amplifier (LNA); the SKY12348-350LF (a GaAs IC 4-bit digital attenuator); the SMV1233, SMV1236 and SMV1237 Series of hyperabrupt junction tuning varactor diodes for discrete devices; and the SMV1763-079LF (a silicon hyperabrupt junction varactor diode for 3V platforms).

www.skyworksinc.com

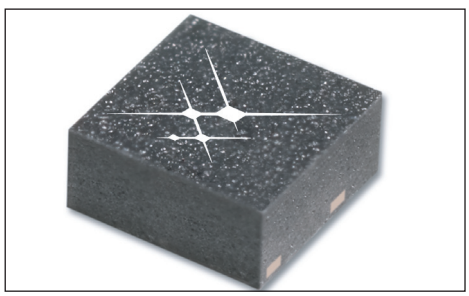
Skyworks launches high-power, high-linearity surface-mount PIN diode

Skyworks has launched a high-power series PIN diode for transmit and receive RF switching applications.

The SMP1325-087LF is a discrete surface-mountable PIN diode available in an exposed-pad high-thermal-dissipative package. It combines very low-insertion (0.04dB) loss, high linearity (90dBm), good isolation, excellent power handling (35W) and low distortion in a very small 2.0mm x 2.0mm x 0.9mm QFN package (MSL1, 260°C per JEDEC J-STD-020).

The device has a 2W dissipation power rating, which makes it capable of handling up to 50W continuous wave (CW) and 500W peak (1µs pulse, 1% duty cycle) in a shunt-connected transmit/receive (T/R) switch.

Maximum resistance at a current of 100mA is just 0.55Ω and maximum capacitance at 20V is just 0.6pF. The combination of low capacitance, low parasitic inductance, low thermal resistance, and nominal 100µm I-region width, makes the SMP1325-087LF useful in large-signal switching and attenuation applications.



The SMP1325-087LF PIN diode.

Target markets include handsets, infrastructure, military and others applications that may require high-power switching.

IN BRIEF

High-linearity LNA

Skyworks Solutions has introduced a new single-stage GaAs pHEMT LNA that offers low noise figure (0.60dB), very high linearity (23dBm IIP3) and excellent return loss (14dB) in a small 2mm x 2mm DFN package. On-die active bias design ensures consistent performance and enables unconditional stability.

The 0.6–1.2GHz SKY67001-396LF is designed for cellular infrastructure applications including tower mounted amplifiers, remote radio units, repeaters and base stations.

The LNA suits cost sensitive yet demanding situations that require a highly efficient amplifier with high gain and low noise figure.

IN BRIEF

M/A-COM names WIN 'Foundry Supplier of the Year'

M/A-COM Technology Solutions Inc of Lowell, MA, USA (which makes analog semiconductors, components and subassemblies for RF, microwave and millimeter-wave applications) has honored Taiwan's WIN Semiconductors Corp (the world's largest pure-play GaAs wafer foundry) with its Foundry Supplier of the Year Award for 2011.

From its ISO9001/14001-certified 150mm-wafer fabrication plant in Tao Yuan Shien, Taiwan, WIN provides M/A-COM Tech with GaAs monolithic microwaver integrated circuit (MMIC) foundry services across a broad range of HBT and pHEMT process technologies. The level of support and comprehensive technology portfolio provided by WIN's foundry services has facilitated M/A-COM Tech's development and introduction of new products in many of its markets. The award recognizes WIN for its "outstanding performance in quality and service, technology development, and strategic collaboration".

"Our close collaboration with WIN enhances the performance and quality of our products and greatly reduces time to market," comments M/A-COM Tech's chief operating officer Bob Donahue. "We thank WIN for its continued dedication to high quality, fast cycle times, and collaborative engagement with our team," he adds.

"Our successful foundry relationship with M/A-COM Tech is a testament to our commitment to provide WIN's customers with superior foundry services that leverage the best possible technology for their products," says WIN's CEO Yu-Chi Wang.

www.macomtech.com

GaAs foundry WIN to list on Taiwan's OTC market

Revenue up 21% year-on-year in first three quarters of 2011

Taiwan's WIN Semiconductors Corp (the world's largest pure-play GaAs foundry) is scheduled to be listed on Taiwan's over-the-counter (OTC) market on 13 December at NT$32 (US$1.05) per share, according to a Chinese-language cnYES report, reports Digitimes. The firm is currently traded on Taiwan's Emerging Stock Board (ESB).

WIN provides foundry services for GaAs components used in handsets including smartphones. The firm has reportedly penetrated the supply chain for Apple devices. AvagoTechnologies and Skyworks Solutions Inc are among its major clients. WIN has hence seen the visibility of its orders extend through 2012, says chairman Dennis Chen, according to the report.

For the first three quarters of 2011, WIN reported net profit of NT$661m (US$21.7m) on revenue of NT$6.26bn, or US$206m (up 21.1% year-on-year).

www.winfoundry.com
www.digitimes.com

Hittite launches 3mm² MMIC band-pass filter tunable from 19 to 38GHz

Hittite Microwave Corp of Chelmsford, MA, USA (which designs and supplies analog, digital and mixed-signal RF, microwave and millimeter-wave ICs, modules and subsystems as well as instrumentation) has launched the HMC899 tunable MMIC band-pass filter (BPF), which suits hybrid and microwave integrated circuit (MIC) applications in wideband test & measurement equipment, communication systems and electronic warfare (EW) subsystems to 38GHz. The analog voltage-tuned, solid state MMIC filter is insensitive to environmental conditions, and represents a space-saving alternative to mechanically tuned and MEMS-based filter solutions.

The HMC899 features a user-selectable pass band frequency range of 19–38GHz. The 3dB filter bandwidth is about 18%, while the 20dB bandwidth is about 35%. The pass-band center frequency is controlled by an analog tune voltage between 0 and 14V with a tuning speed of 200ns. The HMC899 exhibits what is claimed to be excellent microphonic immunity due to the monolithic design, and provides a dynamically adjustable filtering solution in advanced communications applications.

Compared to physically large switched filter banks and cavity tuned filters the 3mm² HMC899 can reduce the required filtering circuit area by up to 90%. Return losses are typically 10dB, while residual phase noise is as low as –157dBc/Hz at 1MHz offset.

Compared to physically large switched filter banks and cavity tuned filters the 3mm² HMC899 can reduce the required filtering circuit area by up to 90%

For applications that a require a surface-mount-compatible solution, the filter is available in an RoHS-compliant 4mm x 4mm QFN SMT package as the HMC899LP4E. Samples and evaluation PC boards for all SMT-packaged products are available from stock.

www.hittite.com

Avago named best financially managed semiconductor firm by Global Semiconductor Alliance

Avago Technologies, a supplier of analog interface components for communications, industrial and consumer applications, has been named the 'Best Financially Managed Semiconductor Company' for 2011 by the Global Semiconductor Alliance (GSA). Avago was presented with the award on 8 December at the GSA Awards Dinner Celebration, which recognizes semiconductor firms that have demonstrated excellence through their success, vision, strategy and future opportunities in the industry.

Determining the top company, the GSA and selected financial analysts reviewed the overall performance and financial health of the industry's semiconductor companies. Avago was named the best financially managed semiconductor company among its peers based on a number of financial metrics, such as growth rates, margins, cash flow, profitability ratios, efficiency ratios and return on capital.

"Being recognized by the GSA as the industry's best financially managed company is outstanding validation of our business model and our execution," says Doug Bettinger, Avago's senior VP of finance and CFO. "This award serves as a tribute to Avago's exceptional technologies and to the tremendous work ethic of our employees."

The GSA's mission is to accelerate the growth and increase the return on invested capital of the global semiconductor industry by fostering a more effective fabless ecosystem through collaboration, integration and innovation. It addresses the challenges within the supply chain including IP, EDA/design, wafer manufacturing, test and packaging to enable industry-wide solutions. Providing a platform for meaningful global collaboration, the Alliance identifies and articulates market opportunities, encourages and supports entrepreneurship, and provides members with comprehensive and unique market intelligence. Members include companies throughout the supply chain representing 25 countries across the globe.

● Avago Technologies has been added to the NASDAQ-100 Index, which is composed of the 100 largest non-financial stocks listed on the Nasdaq Stock Market based on market capitalization.

"Avago's inclusion is another milestone in our evolution as a public company," says Doug Bettinger, Avago's senior VP finance & CFO.

The NASDAQ-100 Index reflects companies across major industry groups including computer hardware and software, telecoms, retail/wholesale trade and biotechnology.

www.nasdaq.com

IN BRIEF

Amalfi wins Global Semiconductor Alliance's 'Start-up to Watch' award

Amalfi Semiconductor of Los Gatos, CA, USA, a fabless firm developing highly integrated CMOS RF and mixed-signal integrated circuits (ICs), has been recognized with the 2011 Global Semiconductor Alliance (GSA) Start-up to Watch Award at this year's annual GSA awards banquet.

The GSA award's committee — consisting of members of the Emerging Company CEO Council, venture capitalists and select serial entrepreneurs in the industry — selected Amalfi as the winner by identifying it as having the highest potential to positively change its market or the semiconductor industry in general through innovative use of semiconductor technology or a new application for semiconductor technology.

"From a business perspective we have eclipsed some significant milestones, recently surpassing 50 million units shipped while seeing a 100% increase in revenues over 2010," says Amalfi's CEO Mark Foley. "We would like to thank the GSA Council and venture capitalist community for recognizing our vision, strategy and technology."

The award follows the launch in late August of Amalfi's second-generation AdaptiveRF power amplifier architecture. Leveraging a proprietary CMOS-based linear power amplifier core, AdaptiveRF provides a cost-effective, high-performance platform that extends battery life while decreasing the front-end costs, size and power consumption of cellular handset and data terminal designs, the firm claims.

www.amalfi.com

IQE and Penn State present As/Sb vertical tunnel FETs

Record drive current of 190μA/μm and 100μA/μm at V_{DS}=0.75V and 0.3V

At the 2011 IEDM International Electron Devices Meeting (IEDM) in Washington, DC (5–7 December), epiwafer foundry and substrate maker IQE plc of Cardiff, Wales, UK and Pennsylvania State University presented a joint paper on recent developments in compound semiconductor device technologies for low-voltage transistor applications.

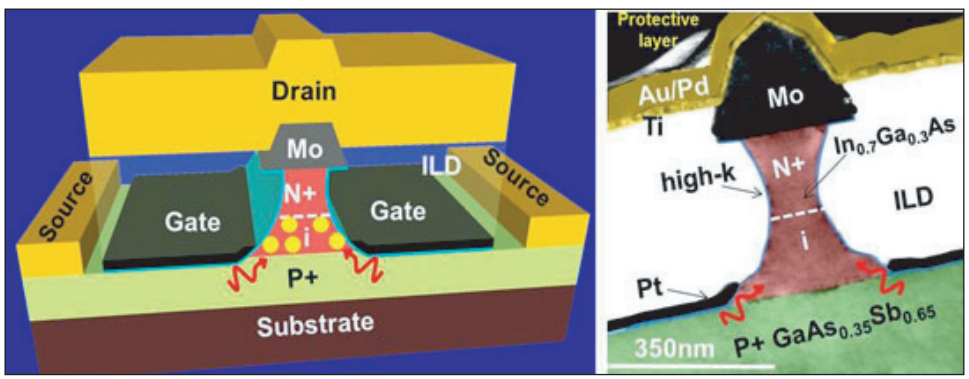
Presented by Penn State's Dheeraj Mohata, the paper 'Demonstration of MOSFET-Like On-Current Performance in Arsenide/Antimonide Tunnel FETs with Staggered Heterojunctions for 300mV Logic Applications' describes a vertical hetero tunnel field-effect transistor (HTFET) with a record high drive current (I_{ON}) of 190μA/μm and 100μA/μm at V_{DS}=0.75V and 0.3V, respectively.

The research measured, simulated and benchmarked the performance of tunnel-FET (TFET) with 40nm strained silicon MOSFET performance for low-voltage (0.3V) logic applications, demonstrating the potential for arsenide/antimonide (As/Sb)-based materials for integration into future ultra-low-voltage electronic devices where high performance and low power consumption is a critical factor.

The TFET is an emerging transistor concept being explored by many groups around the world. In traditional MOSFETs the transistor channel is turned on by injecting carriers over a gate-controlled p-n junction. This results in a gradual turn-on of the transistor and works well as long as the supply voltage of operation is not reduced too much. In tunnel FETs, the transistor channel is turned on by injecting carriers through a gate-controlled tunnel junction. This results in abrupt turn-on of the transistors, which allows the supply voltage to be reduced and hence significant power saving to be achieved.

The biggest hurdle facing the adoption of tunnel FETs by the mainstream semiconductor industry is that the drive current demonstrated to date is quite low due to limitation of the band-to-band tunneling rate in known semiconductors. However, by carefully selecting the appropriate combination of two different semiconductors and adjusting their composition such that their band alignment results in a staggered configuration, one can significantly increase the tunneling rate and enhance the drive current of the tunnel FET. This has been achieved in the vertical HTFET discussed in the paper and offers the potential to enable a new generation of electronics that can operate in highly energy-constrained environments, says IQE.

www.ieee-iedm.org
www.ee.psu.edu
www.iqep.com



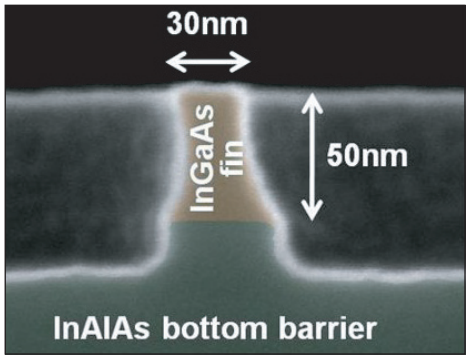
Schematic and cross-section TEM image of a fabricated vertical HTFET.

Intel and IQE present joint papers on III-Vs-on-silicon

QW-FETs & TFETs improved; MOVPE QW-FET material matches MBE

At the IEEE International Electron Devices Meeting (IEDM 2011) in Washington DC in December, Intel and epiwafer foundry and substrate maker IQE plc of Cardiff, Wales, UK presented a series of joint papers on recent key developments in compound semiconductor device technologies.

Presented by Intel's M. Radosavljevic, 'Electrostatics Improvement in 3-D Tri-gate Over Ultra-Thin Body Planar InGaAs Quantum Well Field Effect Transistors with High-K Gate Dielectric and Scaled Gate-to-Drain/Gate-to-Source Separation' demonstrated for the first time 3D tri-gate InGaAs devices with much improved electrostatic parameters compared with equivalent ultra-thin-body planar quantum-well field-effect transistors (QW-FETs). The work shows that the 3D tri-gate architecture is an effective way to improve the scalability of III-V FETs for future low-power logic devices.



SEM of 3D tri-gate InGaAs device structures perpendicular to fin direction, after fin and gate recess etches and before high-k/metal gate deposition, with a 30nm fin-width and 50nm height.

Presented by Intel's Gilbert Dewey, 'Fabrication, Characterization, and Physics of III-V Heterojunction Tunneling Field Effect Transistors (H-TFET) for Steep Sub-Threshold Swing' demonstrated the steepest subthreshold swing (SS < 60mV/decade) ever reported in a III-V TFET by using thin gate oxide, heterojunction engineering and high source doping. Overall TFET device performance is improved compared with homojunction TFETs due to the decreased source-to-channel tunnel barrier height.

Presented by Intel's Niloy Mukherjee, 'MOVPE III-V Material Growth on Silicon Substrates and its Comparison to MBE for Future High Performance and Low Power Logic Applications' demonstrated for the first time that the material quality of MOVPE III-V quantum-well FET (QW-FET) structures on silicon can be matched to that of the best MBE III-V QWFET structures on silicon, using 75mm-diameter silicon substrates. The research suggests that MOVPE can be a promising technique for III-V material growth on silicon substrates for future logic device applications.

www.intel.com
www.iqep.com

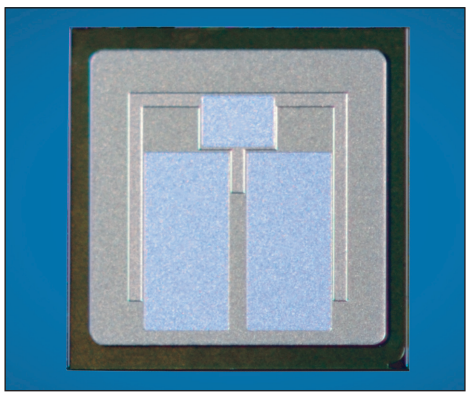
Cree launches first fully qualified SiC MOSFETs in chip form to enable more efficient power electronic modules

1200V MOSFET and Schottky diode chips can be combined in high-efficiency 'all-SiC' power modules

Cree Inc of Durham, NC, USA has launched what it claims is the first fully qualified silicon carbide (SiC) MOSFET power devices in 'bare die' or chip form for use in power electronics modules. The firm's SiC Z-FET MOSFETs and diodes can be used in power electronics circuits to achieve significantly higher levels of energy efficiency than is possible with conventional silicon devices.

Power modules typically combine a number of discrete power switching devices (MOSFETs and diodes) in a single integrated package for high-voltage power electronics applications such as three-phase industrial power supplies, telecom power systems, and power inverters for solar and wind energy systems. In traditional MOSFET packaging technologies, the parasitic inductance of the long leads can limit the switching capability of SiC MOSFETs. By offering bare die alternatives, circuit designers can now take full advantage of the switching performance of SiC technology by reducing the effects of the package-parasitic inductance, says Cree.

"With the availability of fully qualified SiC MOSFETs as unpackaged chips, manufacturers of power modules can realize the performance advantages of SiC devices (better high-temperature operation, higher switching frequencies and lower switching losses) without the limitations imposed by conventional



Chip of Cree's new 1200V SiC MOSFET.

plastic packaging of discrete devices," says Cengiz Balkas, Cree's VP & general manager, power and RF. "The design advantages of implementing SiC power devices in power electronic modules include the ability to achieve higher current and voltage ratings with fewer components, which in turn can enable maximum power density and increased reliability," he adds.

"Power module manufacturers can now combine Cree's 1200V SiC power MOSFET and Schottky diodes in chip form to create an 'all-silicon carbide' module design for ultra-high-efficiency power electronics systems," continues Balkas. "These new modules provide the proven benefits of silicon carbide - zero reverse recovery losses, temperature-independent switching, higher frequency operation with low electromagnetic interference (EMI), and significantly higher avalanche capability - and deliver switching frequencies that are five to eight times higher compared to conventional silicon solutions," he adds. "The higher switching frequencies enable smaller magnetic and capacitive elements, thereby shrinking overall system size, weight and cost."

The new power MOSFET devices are initially available in two versions: the CPMF-1200-S080B measures 4.08mm x 4.08mm and is rated at 1200V/20A with a nominal on-resistance ($R_{DS(ON)}$ of 80mΩ; and the CPMF-1200-S160B measures 3.1mm x 3.1mm and is rated at 1200V/10A with a nominal on-resistance ($R_{DS(ON)}$ of 160mΩ. The operating junction temperature for both is rated at –55ºC to +150ºC.

The two versions of the 1200V MOSFET die are fully qualified and released for production use and available to Cree's customers, as well as through Cree's Power die distributor Semi Dice. Cree has published specifications and detailed design guidelines, including recommendations on die attach and bonding, to assist power module makers in the use of the new devices and optimizing their designs. In addition, Cree is offering the availability of a SiC MOSFET Model, created to help with early simulation and evaluation.

www.cree.com/power

EPC's eGaN FET wins EDN China Innovation Leading Product Award

Efficient Power Conversion Corp (EPC) of El Segundo, CA, USA, which makes enhancement-mode gallium nitride on silicon (eGaN) power field-effect transistors (FETs) for power conversion applications, has been recognized with a Leading Product Award by EDN China Innovation Award 2011 in its Power Device and Module category. In its seventh year, the EDN China Innovation Award recognizes product innovation by China's electronics design engineers and managers.

"The EPC2010 is one member of our family of eGaN FETs being adopted by customers as higher-performance replacements for silicon-based MOSFETs," notes EPC's CEO Alex Lidow.

Launched in June, EPC2010 is EPC's second-generation 200V eGaN FET.

www.ednchina.com
www.epc-co.com

Nippon Steel develops Japan's first 6" SiC single-crystal wafer

At the Advanced Technology Research Laboratories of its Technical Development Bureau, Japan's Nippon Steel Corp has developed 6" silicon carbide (SiC) single-crystal wafer, which the firm describes as key for the mass production and adoption of future high-performance power semiconductor devices.

Compared with silicon wafers used for diodes, transistors and other semiconductor devices, SiC can halve power-conversion loss when used in various electronic devices. It also has excellent high-voltage and heat resistance properties, suiting high-voltage, high-temperature photovoltaic power generation, automotive (EV, HEV etc) and other power electronics applications.

With such features, the broad spread of power semiconductors using SiC wafers raises expectations of significant reductions in power loss and hence a great impact on energy conservation and CO_2 emission reduction.

High-quality SiC wafers currently on the market are predominantly 3" and 4", and semiconductor manufacturers' development and commercialization of devices is based on the availability of such SiC wafers. However, there is great need for higher efficiency in device production and also for the development and commercialization of SiC devices for large currents and high voltages, calling for large-diameter SiC wafers.

Nippon Steel says 6" SiC wafers should increase the efficiency and lower the cost of SiC device manufacturing. They should also make it possible to manufacture large-area devices for controlling larger current and higher voltage, extending possible applications to automobiles (EV/HEV), rapid-transit railways etc.

Due to this potential, 6" SiC wafers have also been the focus of R&D in a national project of Japan's Ministry of Economy, Trade and Industry, as a next-generation material capable of enhancing industrial competitiveness through energy-saving technology.

Single-crystal SiC is usually manufactured using the sublimation-recrystallization method. In equipment heated to temperatures of more than 2500ºC, vapor sublimated from SiC material in powder form is recrystallized on top of seed crystals. Using its own sublimation-recrystallization method established over many years of R&D efforts, in 2007 Nippon Steel developed a technique for the mass production of high-quality 4" SiC wafers, which Nippon Steel Materials Co Ltd began selling in 2009.

In the sublimation-recrystallization method, the growth of crystals of compounds at ultra-high temperatures introduces difficulties in process control. The major problem is that, with an increase in crystal diameter, there is an increasing tendency for crystals to become susceptible to cracking induced by crystal defects and thermal stress.

By accelerating R&D efforts to resolve these problems, and based on numerical simulation, Nippon Steel has developed a mechanism for using ultra-high-temperature equipment and process operating conditions, suitable for 6" wafers. By restricting crystal defects and crystal cracks in the growth of large-diameter crystals, the firm has made Japan's first 6" SiC wafer.

Part of the R&D program was subsidized under the 'Novel Semiconductor Power Electronics Project Realizing Low Carbon Emission Society' of Japan's New Energy and Industrial Technology Development Organization (NEDO).

Nippon Steel says that, to establish 6" wafer manufacturing technology, it will continue its efforts to achieve further product stability (in order to develop technology for productivity improvement). It also aims to develop 6" SiC epitaxial film manufacturing technology.

www.nsc.co.jp

IN BRIEF

TriQuint launches 18W, 28V, 6GHz GaN-on-SiC RF power transistor

At the IRSI conference in Bangalore, India (1–4 December), RF front-end product and foundry services provider TriQuint Semiconductor Inc of Hillsboro, OR, USA — together with Indian-based Tecnomic Marketing Services — exhibited gallium nitride (GaN) and gallium arsenide (GaAs) amplifier solutions for radar, communications and related defense systems.

In particular, fabricated with TriQuint's proven 0.25µm production process (which features advanced field-plate techniques to optimize power and efficiency at high drain bias operating conditions), the new T1G6001528-Q3 is a discrete gallium nitride on silicon carbide (GaN on SiC) high-electron-mobility transistor (HEMT) operating from DC to 6GHz that offers 18W output power (P3dB) at greater than 50% efficiency. Gain is 15dB. The optimization can potentially lower system costs in terms of fewer amplifier line-ups and lower thermal management costs, says the firm.

The T1G6001528-Q3 GaN-on-SiC HEMT.

TriQuint says that the multi-faceted device suits defense and civilian radar systems and a wide variety of related applications needing high power, efficiency and wideband performance.

www.triquint.com

Northrop Grumman awarded DARPA Microscale Power Conversion contract

Three-year, $8.9m program to develop high-efficiency transmitters with GaN Class E PAs

US defense contractor Northrop Grumman Corp of Linthicum, MD, USA has been awarded a contract by the US Defense Advanced Research Projects Agency (DARPA) to develop more efficient RF transmitter technology through the Microscale Power Conversion program.

Under the three-year, $8.9m contract, Northrop Grumman will conduct research on high-efficiency transmitters with gallium nitride Class E power amplifiers (PAs) in conjunction with RF wideband contour modulation and sub-banded switching supply modulation. The aim of the program is to develop RF power amplifier designs that incorporate supply modulation and control enabled by novel power switch technology.

The key to the research is to broaden the RF power amplifier's supply modulation bandwidth up to 500MHz with composite efficiency of no less than 75% by employing the contour modulation to maintain efficiency performance of the amplifier. Contour modulation is a technique in which a phase-modulated signal waveform and amplifier output impedance work together to maintain higher efficiency over a sizable output power back-off. When supply modulation and contour modulation are working in concert, the dynamic range and efficiency of the power amplifier can be further improved. Microscale integration and packaging with thermal design considerations is critical in achieving the efficiency.

"With more innovative RF power amplifier designs, we can produce much more efficient RF transmitters without increasing their size," says Pat Antkowiak, VP & general manager of Northrop Grumman's Advanced Concepts & Technologies Division. "This technique can open the door to creating more powerful electronic systems for a wide variety of applications."

The design work will be performed by Northrop Grumman and its subcontractors, the University of California at Los Angeles (UCLA) and TriQuint Semiconductor Inc of Hillsboro, OR. The final integration and demonstration will be done by Northrop Grumman in Linthicum. UCLA will work on system architecture and co-design, design of the complementary metal oxide semiconductor (CMOS) circuit and other elements, controls and test support. TriQuint will work on GaN and related process technologies.

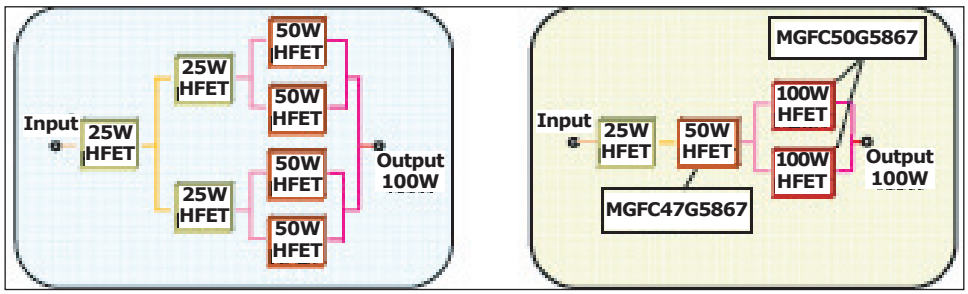
www.northropgrumman.com

Mitsubishi Electric develops 50W and 100W C-band GaN HEMTs for satellite earth stations

Tokyo-based Mitsubishi Electric Corp has developed two GaN HEMT C-band (4–8GHz) amplifiers for satellite earth stations.

Featuring power outputs of what is claimed to be an industry-leading 100W and 50W respectively, and operating at a frequency of 5.8–6.7GHz, the MGFC50G5867 and MGFC47G5867 will ship on a sample basis from 10 January.

Mitsubishi Electric notes that, although GaAs amplifiers have commonly been employed in microwave power transmitters, in recent years GaN amplifiers have become increasingly popular due to their high breakdown voltage and power density, high saturated electron speed, and ability to contribute to power saving and the downsizing of power transmitter equipment.



Simplified schematics for (left) GaAs HFET and (right) GaN HEMT amplifiers.

The firm first began sample shipments of high-output GaN HEMT amplifiers for C-band space application in March 2010.

Operating at a high drain-to-source voltage of 40V with quiescent drain currents (I_{DQ}) of 1.15A and 0.58A respectively, output power at 3dB compression (P3dB) is typically 50dBm (100W) for the the MGFC50G5867 and 47dBm (50W) for the MGFC47G5867. Power-added efficiency (at P3dB, and 6.4GHz) is typically 43% and 45%, respectively. Linear power gain (at 6.4GHz) is typically 10dB. Also, the internally impedance-matched amplifiers have low distortion, with output power meeting 3rd-order inter-modulation (IM3) of –25dBc at 46dBm.

www.MitsubishiElectric.com

IN BRIEF

RFMD's GaN CATV hybrids win Platinum Awards

RF Micro Devices Inc of Greensboro, NC, USA has been honored with two Platinum Awards from Communications Technology magazine, an engineering publication in the CATV industry and the official trade journal of the Society of Cable Telecommunications Engineers (SCTE). The awards were presented formally on 8 December during an awards ceremony in New York City.

Platinum Awards from Communications Technology magazine recognize the broadband industry's most innovative hardware, software, service, and marketing initiatives, as judged by a panel of industry experts. RFMD's GaN CATV hybrids received dual honors in the categories of Energy-Savings ('Green') Technology and RF/HFC Technology.

"We believe our GaN CATV hybrids help our customers to maximize RF performance in cable networks while also minimizing energy consumption — two very important priorities in the broadband industry," says Alastair Upton, general manager of RFMD's Broadband Components business unit.

RFMD offers a broad range of CATV products, including packaged amplifiers, MMICs, modules, frequency modulation components, and passive components. The firm's GaN technology delivers superior performance versus competing GaAs and silicon power technologies, while also supporting 'green' architectures that reduce energy consumption, improve thermal management and optimize network efficiency for network operators.

www.rfmd.com
www.ct-magazine.com

Cree licenses key Doherty amplifier patents to South Korea's RFHIC

Cree Inc of Durham, NC, USA has announced a non-exclusive worldwide license agreement with RFHIC Corp of Suwon, South Korea, which makes gallium nitride (GaN)- and gallium arsenide (GaAs)-based active RF & microwave components and hybrid modules for telecom and broadcast markets), that provides access to Cree's Doherty amplifier-related patents.

Cree says that its novel Doherty architecture can serve as the foundation for advanced 4G base stations that are substantially more efficient than conventional designs. 4G mobile data networks are being deployed around the world to address the burgeoning demand for mobile broadband services.

"From our early work in maximizing the efficiency of silicon LDMOS amplifiers to our current initiatives using GaN-based devices, Cree has successfully developed innovative circuits that enhance the performance of the classic Doherty architecture," says Jim Milligan, Cree's director of RF.

Cree says that, with its advanced circuits, amplifier efficiency can be increased by as much as five percentage points when conventional silicon LDMOS or GaAs transistors are used. The improved performance can help to meet the stringent efficiency and linearity requirements of upcoming 4G LTE base stations, and related wireless systems, that use high peak-to-average ratio signal modulation.

When these circuit innovations are implemented using Cree's high-frequency, high-power GaN high-electron-mobility transistors (HEMTs) and the latest-generation digital pre-distortion systems, the resulting efficiency improvements can be up to 15 percentage points greater than that achieved by a conventional Doherty amplifier implemented with silicon LDMOS, says the firm.

The Doherty amplifier is a fundamental RF amplifier architecture invented by William Doherty in 1936 using vacuum tubes, but modern implementations use power transistors. The Doherty architecture uses two parallel, equal power split transistors, a carrier amplifier transistor for low-level signals and a peaking amplifier transistor for high-level signals. The fundamental, equal power split Doherty architecture offers up to a 40% improvement in efficiency over traditional non-Doherty Class A/B approaches. Cree says that interest in Doherty amplifiers has grown with increased demand for higher-efficiency systems employing digital modulation formats, such as those used for 3G W-CDMA networks. Online applications including video chat and streaming video are driving a need for still higher-efficiency amplifiers to support 4G LTE systems.

"Cree innovations in Doherty amplifier technology can set the standard for the newest generation of 4G network deployments requiring high-efficiency macro and pico cell base stations," Milligan says.

Improved performance can help to meet the stringent efficiency and linearity requirements of upcoming 4G LTE base stations

"Cree's advancements on the fundamental two-transistor, parallel Doherty architecture can yield significant efficiency improvements," he adds.

Cree says that the non-exclusive license agreement with RFHIC underscores each firm's commitment to developing products that enhance the telecoms infrastructure, while respecting the value and importance of intellectual property.

www.rfhic.com
www.cree.com/licensing

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TECDIA's Scribing Tool Selection

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TD-3P
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For Semiconductor Wafers (Si, etc.)

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For Semiconductor Wafers (GaAs, etc.), Glass Wafers

TD-4L
Mostly for silicon, GaAs, or glass wafers

TD-2P
For Semiconductor Wafers (Semi-Custom)

TD-8P
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WWW.TECDIA.COM

IN BRIEF

Taiwan's National Tsing Hua University unveils compound semiconductor lab

Taiwan's National Tsing Hua University (NTHU) has unveiled a new compound semiconductor laboratory that it hopes will contribute to the development of new chips supporting alternative green energy sources, according to the country's Central News Agency.

The lab represents the first project in Taiwan to fully integrate semiconductor component research, commented Cheng Keh-yung, dean of NTHU's College of Electrical Engineering and Computer Science, at the inauguration ceremony.

Cheng said the lab will cover passive and active component development from the epitaxy stage of the process through to chip component manufacturing and testing.

The new lab, a collaboration between the NTHU's Center For Nanotechnology, Materials Science, and Microsystems and the Institute of Electronics Engineering, is hoping to develop components that will help to generate green energy and reduce reliance on fossil fuels.

Among the components targeted are high-brightness LEDs and high-power, high-voltage transistors, which Cheng described as key to developing next-generation lighting systems, electric-powered cars and communications equipment.

Cheng said that he also hopes the lab will create a research environment that brings out the innovating potential of students.

www.nthu.edu.tw/english

Agilent ships EMPro 2011.11 release of 3D EM modeling platform, enhancing RF simulation speed

Agilent Technologies Inc of Santa Clara, CA, USA has shipped the latest release of its Electromagnetic Professional software, EMPro 2011.11. The updated 3D modeling and simulation platform features enhancements to further speed and improve RF design and verification.

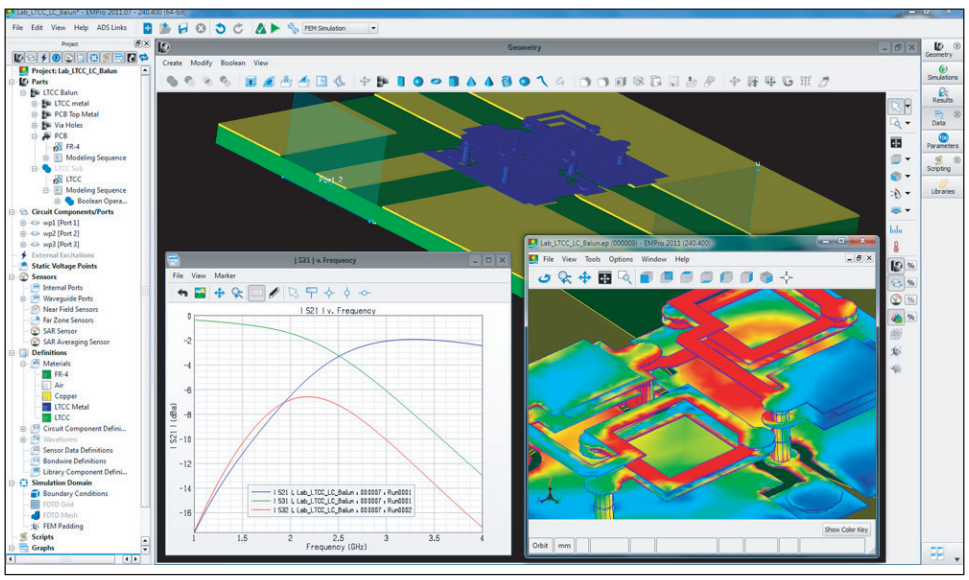
Tightly integrated with Agilent's Advanced Design System (ADS), EMPro is used to create 3D models and analyze electrical performance of packages, connectors, antennas and other RF components. The EMPro 2011.11 release builds on advances made available in the 2011.07 release, introducing key improvements to the finite-element method (FEM) simulator:

- A fast FEM iterative solver that doubles the speed of simulations that include internal ports (which had already been doubled in the previous release).
- A user-defined passive loads capability that aallows users to include ideal passive loads directly in an FEM simulation to represent matching circuits and surface-mount components. (The loads are defined in the EM setup environment, which consists of common series and parallel RLC network topologies, enabling accurate field visualization results and radiation patterns that take into account passive loads.)
- A fast, two-dimensional port solver that simplifies FEM simulation port setup, allowing users to quickly and easily determine the number of modes, as well as reference impedance and optimum impedance line placement.

The EMPro 2011.11 release is now available for download. Pricing for the EMPro environment starts at $7000. Interested parties can evaluate the software by applying for a trial version. They can also download application examples covering a wide range of topics including packaging, antennas, RF PCBs, RF modules, connectors and radar applications.

EMPro is used to create 3D models and analyze electrical performance of packages, connectors, antennas and other RF components

www.agilent.com/find/eesof-empro-downloads-and-trials



Screenshot from Agilent's EMPro 3D EM simulation software.

5N Plus reports record quarterly results

For the four-month period to end-September 2011, 5N Plus Inc of Montreal, Quebec, Canada, a producer of specialty metal and chemical products, has reported record revenue, earnings, EBITDA and funds from operations, largely exceeding corresponding numbers for previous quarters even when results for the period are pro-rated to a quarterly basis. Numbers for the comparable period to end-August 2010 have been restated to reflect changes resulting from the implementation of IFRS and the adoption of the US dollar as the firm's functional and reporting currency.

Founded in 2000, 5N Plus focuses on specialty high-purity metals such as tellurium, cadmium, selenium, germanium, indium and antimony and also produces related II-VI semiconducting compounds such as cadmium telluride (CdTe), cadmium sulphide (CdS) and indium antimonide (InSb) as precursors for the growth of crystals for electronic applications, including solar photovoltaic, radiation detector and infrared markets. The firm owns materials subsidiaries including: 5N PV GmbH (Eisenhuttenstadt, Germany), Firebird Technologies Inc (Trail, BC, Canada), 5N Plus Corp (DeForest, WI, USA) and Sylarus Technologies LLC (St George, UT, USA). However, 5N Plus now operates and reports operating performance under two business segments, namely Electronic Materials and Eco-Friendly Materials.

In addition, on 11 April, 5N Plus acquired MCP Group SA of Tilly, Belgium, a producer and distributor of bismuth and bismuth chemicals as well as other specialty metals (including gallium, indium, selenium and tellurium).

Consequently, revenue for the four-month period to end-September 2011 is up by 1243% to $242.3m compared with $18m for the quarter to end-August 2010.

"Contributions from both of our business units were approximately equal and very much in line with expectations as demand for our products remained strong for most of the period," says president & CEO Jacques L'Écuyer. "No single customer represented more than 10% of total revenues during the period, confirming the success of our diversification strategy," he adds.

"This is the first reporting period following the acquisition of MCP for which we operated throughout the period as a combined entity with the corresponding positive impact on revenues and earnings, which reached record levels," says L'Écuyer.

Net earnings attributable to equity holders of 5N Plus for the four-month period to end-September were $15.6m, up on $2.8m for the quarter to end-August 2010. Earnings before interest, taxes, depreciation and amortization (EBITDA) rose to $29.5m, up from $5.4m for the quarter to end-August 2010. Funds from operations (cash generated from operating activities before changes in non-cash working capital) were $17m, up on $3.6m for the quarter to end-August 2010.

At the end of September, the backlog of orders expected to translate into sales over the following 12 months was $212.1m, almost quadruple the $54m at the end of August 2010.

We are closely monitoring recent developments in Europe and expect some softening in demand in the coming months, which may be compounded by the usual year-end seasonality. Negative developments in the solar market resulting from large module oversupply are equally monitored

The firm increased its financial flexibility after closing a new CA$250m (USD$250m) senior secured multi-currency revolving credit facility with a banking syndicate on 12 August. The financing was finalized in October and, as a result, the firm has the ability to borrow an additional $82m.

Corresponding growth initiatives announced in the period to end-September (or shortly thereafter) include acquiring the outstanding 40% stake in joint venture firm Lao Industrial Resources Co Ltd, and plans for setting up a new gallium chemicals plant in Korea, and a new primary gallium facility (for which the company has signed a memorandum of understanding with Rio Tinto Alcan).

"The integration of the former MCP activities is progressing in accordance with our initial plan," L'Écuyer says. "We have rebranded under one single name, 5N Plus, and made progress towards complete organizational alignment. In this respect, we have integrated former MCP executives into our senior management team... Most of our activities now fall into one of our two customer-centric business units with complete integration of our procurement activities, where we expect to develop significant synergies," he adds.

"We are closely monitoring recent developments in Europe and expect some softening in demand in the coming months, which may be compounded by the usual year-end seasonality," L'Écuyer notes. "Negative developments in the solar market resulting from large module oversupply are equally monitored, even though this market now contributes less than 10% of our total revenues," he adds.

"We are now well diversified in terms of markets, customers and geographic footprint, and have yet to reap the full benefits of the recent acquisition of MCP," L'Écuyer concludes. "We therefore remain cautiously optimistic for the coming quarters, despite the current economic uncertainty."

www.5nplus.com

UK to fund materials R&D for energy generation, transmission, distribution and storage technologies

Opto foundry Compound Semiconductor Technologies Global to lead one of seven projects

UK Government funding of £3m is to be made available — through its Technology Strategy Board — to back seven industry-led R&D projects that aim to demonstrate materials to support the development of future energy technologies. The collaborative projects will apply and demonstrate materials technologies for use in energy generation, transmission, distribution and storage.

The firms leading the projects include optoelectronics device foundry Compound Semiconductor Technologies Global Ltd (CSTG) of High Blantyre , Scotland, as well as Alstom Grid UK Ltd, C-Tech Innovation Ltd, Cella Energy Ltd, Intrinsiq Materials Ltd, Johnson Matthey Fuel Cells Ltd and Sharp Laboratories Europe.

The Technology Strategy Board says that, because of the need to reduce both national and global CO_2 emissions, the UK faces a number of challenges around energy supply, cost and security, requiring the UK to adopt a balanced portfolio of energy technologies. UK industry now has an opportunity to examine transferable materials solutions and methods that will be needed to support the development of future energy technologies, it adds.

The projects will hence support the research, experimental development and application of materials that address challenges in scaling up technologies, from proof-of-concept to small-scale technology demonstrations and pilots. The projects will be in areas such as:

- Catalyst and membranes to establish hydrogen storage infrastructure;
- Fuel cells incorporating nanomaterials;
- High-grade waste heat recovery photovoltaic materials; and
- Composite insulation for power transmission applications.

The funding awards by the Technology Strategy Board follow successful application by the companies to the Materials for Energy competition for R&D funding. Including match-funding by the participating businesses, the total value of the projects is more than £6.5m.

www.compoundsemi.co.uk
www.innovateuk.org

Air Products brings onstream first on-site high-purity ammonia plant in China to support LED market

Air Products of Lehigh Valley, PA, USA has brought onstream a large-scale, on-site ammonia (NH_3) plant in China's Anhui Province to supply ultra-high-purity NH_3 to Anhui Sanan OptoElectronics Co Ltd (a subsidiary of Sanan Opto-Electronics).

The plant, at Sanan's new high-brightness LED manufacturing facility in the Wuhu Economic and Technological Development Area, is claimed to be the largest on-site high-purity NH_3 facility in the world, with a supply capacity of over 2000 metrics tons per year.

Sanan is the largest high-quality LED maker in China. To support its expansion plan, Air Products is also building a second high-purity NH_3 plant with the same capacity, which is expected to come onstream in mid-2012.

On 12 December an opening ceremony was held at Sanan's Wuhu facility to celebrate the milestone. Attendees included Steve Jones, Air Products' China president and senior VP & general manager of Global Tonnage Gases, Energy and Equipment; and Joseph Stockunas, director of electronics materials for Air Products; plus representatives from Sanan.

"Air Products has a long and proven record of building large-scale, on-site industrial gas plants around the world," says Jones. "We are pleased Sanan OptoElectronics chose Air Products for their high-purity ammonia supply to support its increased LED production. By working closely together, we successfully brought the world's first and largest on-site facility onstream."

www.airproducts.com/electronics

IN BRIEF

IQE wins Elektra 2011 Manufacturer Export Award

On 14 December at an industry ceremony in London, UK, epi-wafer foundry and substrate maker IQE plc of Cardiff, Wales, UK received the 2011 Manufacturer Export Award at this year's Elektra European Electronics Industry Awards.

The Manufacturer Export Award category identifies original equipment manufacturers (OEMs), sub-contractors and electronic manufacturing services (EMS) firms with business achievements and success in export markets during the last 12 months.

Now in its ninth year, the Elektra Awards recognize the achievements of individuals and companies across Europe.

www.elektraawards.co.uk
www.iqep.com

IN BRIEF

P+E to launch 2nd-generation purifier

Building on the global launch in May 2010 of its PE9000MZ series purifiers, Power+Energy Inc (P+E) of Ivyland, PA, USA, which makes palladium-membrane-based hydrogen purifiers , has now finalized specifications for a second-generation version, to be introduced in early 2012. The unit will continue to offer what is claimed to be the smallest footprint for a Class 1, Div. 2-compliant palladium alloy hydrogen purifier, along with a number of improvements to simplify installation, service and user access.

Key new features for the PE9000MZ Series 2.0 include a modified interior layout featuring a Z-purged control panel and AC power box mounted on the door to allow access to the process cabinet without disrupting the purge on the electrical boxes. There is a simplified valve layout providing easier access to the purifier cells and increased interior room for optional features including pre-treatment modules for the removal of oxygen or sulfur impurities, a mass flow meter, a pressure regulator and CDA ventilation. There is also a dedicated port for sampling of the purified hydrogen and a port for testing the internal hydrogen leak sensor without having to open the cabinet or disrupt operation.

The new series will continue to feature P+E's micro-channel palladium membrane technology, providing high-reliability, consistent 9–9's purity hydrogen for a flow range of 2–176NM^3/hr (32–2900slpm or 68–6144scfh) under nominal conditions. The firm claims that the combination of consistent purity, low cost of ownership and range of flow capacities is unmatched across all types of hydrogen purifiers.

www.powerandenergy.com/

Dow develops stannic chloride as tin precursor for GeSn films

Dow Electronic Materials, a business unit of Dow Advanced Materials, has introduced a stannic chloride precursor, which it claims is the first industrially viable, electronic-grade tin precursor for the generation of germanium tin (GeSn) films for electronics. Until now, production of GeSn by chemical vapor deposition (CVD) has been limited to R&D-scale use because only specialized and cost-prohibitive precursors have been available, says the firm.

Tin-containing materials are currently in demand as the electronics industry seeks ways to increase transistor speeds. In response, Dow Electronic Materials has introduced an electronic grade of the tin CVD precursor stannic chloride, which has been used by the nanoelectronics research center Imec of Leuven, Belgium for the growth of GeSn for use in stressors, high-mobility channels, and other features of future semiconductor devices.

"We found a tin precursor that enables the industrial production of GeSn for future-generation electronic devices," says Egbert Woelk, technology and applications manager at Dow Electronic Materials. "Together with our VAPORSTATION Central Delivery System, we have a turn-key solution to deliver our new tin precursor to any CVD tool on the market," he adds. "This removes all barriers to using the new GeSn CVD process on a large scale in the latest-generation CVD tools." In the past, GeSn CVD was limited to using deuterated stannane (SnD_4), which is costly to make and not available on a commercial basis.

Silicon germanium (SiGe) is a desirable material for electronics and optoelectronics manufacturers, and the addition of tin increases the speed of transistors made from this material, says Dow Electronic Materials. There is a growing interest in thin germanium or germanium-silicon materials containing tin to enhance semiconductor structures, such as the high-mobility channel that conducts current in transistors, and photonic devices such as LEDs.

Dow says that the viability of its material has been confirmed in a new CVD process developed by Imec. Using stannic chloride supplied by Dow Electronic Materials, Imec has demonstrated the material's viability in an industrial CVD process, overcoming the barrier of tin's propensity to etch deposited material. Imec has produced high-content germanium tin epitaxial films (>8% tin content) with outstanding electronic and structural quality (B. Vincent et al., Appl. Phys. Lett. 99 (2011), 152103). According to Imec, the CVD-grown GeSn layer can also be used as a high-mobility channel material on germanium. A strained GeSn channel on germanium is also a possible candidate to be used in the device channel of future Ge-based metal-oxide semiconductor field-effect transistor (MOSFET) devices.

"The CVD growth of GeSn with commercially available precursors will boost the research on high-mobility MOSFETs," says Imec's R&D manager Roger Loo. "Besides, it opens new routes for group-IV semiconductors research in other fields, such as photonics (having an indirect-to-direct-bandgap transition expected for about 10% Sn incorporated in monocrystalline GeSn alloys) and photovoltaics (ternary SiGeSn alloys)," he adds. "The good results that we achieved with stannic chloride precursor convince us to continue our successful collaboration with Dow Electronic Materials."

Imec presented the results of the development work at The 2nd GeSn Workshop: GeSn Developments for Future Applications, held in late August in conjunction with the 7th International Conference on Si Epitaxy and Heterostructures 2011 (ICSI-7) in Leuven.

www.dow.com

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IN BRIEF

Arima Changzhi to ramp HB-LED capacity with Aixtron G4 systems

Aixtron says that Arima Changzhi, a joint venture LED manufacturing company involving Changzhi High Tech Industry Investment Co China and Arima Optoelectronics of Taiwan, has order three AIX 2800G4 HT MOCVD systems in 42x2" wafer configuration and three AIX 2800G4 HT MOCVD systems in 11x4" wafer configuration.

All reactors have been installed and commissioned by a local Aixtron service support team and will be used for the production of high-brightness (HB) LEDs.

"We have been very actively preparing our epitaxy process development and production of LEDs for HB-LED wafers and chips," says Changzhi High Tech's general manager Mr Chen. "Underpinning this strategic plan will continue to be the equipment we receive from Aixtron... Through our long-standing ISCAS (Institute of Semiconductors of Chinese Academy of Sciences, Bejing) collaborations and more recently with Arima Changzhi, they have impressively shown us how easy it is to achieve outstanding results in a very short time," he adds.

"Repeat orders are particularly important to us and we will be with our customer every step of the way," comments Dr Bastian Marheineke, Aixtron's VP sales. "As usual, we will ensure the highest performance and best utilization of Aixtron equipment. We know how crucial these six reactors are to them and are pleased to work closely with their highly knowledgeable staff for a smooth and rapid ramp to full production," he adds.

www.aixtron.com

Forepi converts Aixtron CRIUS II order to new 19x4" CRIUS II-XL tool

Aixtron SE of Herzogenrath, Germany says that in fourth-quarter 2011 it will deliver a CRIUS II-XL MOCVD reactor in 19x4" configuration to Taiwan's Forepi Ltd. The order was received in third-quarter 2011, initially for the CRIUS II-L version, but was immediately converted into an order for the new XL-configuration following its launch.

The CRIUS II-XL reactor has been acquired for the volume production of InGaN-based blue high-brightness (HB) LED epiwafer materials. One of Aixtron's local support teams will install and commission the system.

"The acquisition of this 4" wafer capable Showerhead system reflects a milestone for Forepi," notes Forepi president Dr Fen-Ren Chien. "Initially, we had been considering the CRIUS II-L to be a candidate tool for the next stage in our expansion plans. When the XL version was introduced recently, we were impressed by the performance of the 19x4" configuration," he adds.

"The CRIUS II-XL system offers the world's highest throughput and productivity," says Aixtron's chief operating officer Dr Bernd Schulte. "Any existing process on CRIUS II can be smoothly transferred to CRIUS II-XL. Changing from one wafer size to another only requires a simple carrier plate exchange without further hardware or process adjustment," he adds. "All these aspects greatly assist wafer manufacturers seeking to keep InGaN LED manufacturing costs under tight control."

Forepi was incorporated in November 1999 as a dedicated pure-play manufacturer of InGaN HB-LED wafers and chips. Currently, it offers a product range that covers the full spectrum of LEDs including InGaN blue, green and near-ultraviolet HB-LEDs for markets in Taiwan as well as South Korea, Hong Kong, the USA and China.

www.forepi.com.tw

WIN adds reactors to boost production

The world's largest pure-play GaAs foundry WIN Semiconductors Corp, an existing Aixtron customer and a leading maker of microwave devices in Taiwan, has ordered two MOCVD systems: another AIX 2600G3 system in 7x6" wafer configuration as well as its first AIX 2800G4 system in 8x6" wafer configuration.

WIN is a designer, developer and manufacturer of GaAs microwave ICs and became one of the first Taiwanese firms to recognize the opportunities in the market for terrestrial compound semiconductor solar cells. In 2007, it installed a dedicated AIX 2600G3 IC reactor as the foundation for its diversification into solar cell manufacturing.

The new reactors was being delivered in fourth-quarter 2011 then installed and commissioned by a local Aixtron service support team at WIN's facility in Kuei Shan Hsiang. WIN will use the systems to develop and mass produce various high-performance devices.

"This is the first Aixtron G4 MOCVD system for us so it is especially important for our further business development," says WIN. "To expand our production throughput we have decided that, based on very good reactor experience and with an eye on the future, we would not only acquire another G3 but also our first G4," the firm adds. "As well as bigger wafer capacity, this will give us top performance across all the parameters, coupled with features we are familiar with such as ergonomics, versatility plus seamless process compatibility with our existing reactors."

www.winfoundry.com

Deloitte ranks LayTec 144th in 500 fastest-growing tech firms in EMEA

LayTec AG of Berlin, Germany (which makes in-situ metrology systems for thin-film processes, focusing on compound semiconductor and photovoltaic applications) has received Deloitte's Technology Fast 50 Award for Germany and Deloitte's Technology Fast 500 EMEA Award for the third year in succession. With sales growth of 1062% during the period 2006–2010 LayTec ranked 8th in Germany and 144th among the 500 fastest-growing technology companies in Europe, the Middle East and Africa.

"To receive this award three years in succession shows that we have successfully positioned LayTec in the market," comments LayTec's CEO, president & founder Dr Thomas Zettler. "We have created an organization which is able to adapt to the dynamic market requirements and to develop innovative products within a short time," he adds. LayTec has overcome the challenges that accompany fast growth, Zettler continues. "We owe this to the engaged and unremitting commitment of our staff, their excellent knowledge and our close collaboration with our national and international partners."

Founded in October 1999 as a spin-off of the Technical University Berlin, LayTec quickly established itself in compound semiconductor process metrology, especially for LED production but also for laser and high-power electronics production. Since 2009, its integrated metrology solutions have also been applied to solar cell production as well as other large-area deposition processes.

LayTec claims that implementation of its metrology systems in production processes can significantly shorten development cycles and enable efficient quality control, helping to reduce production and development costs considerably. New developments are generated in close cooperation with customers. Supported by a global distribution and service network, the firm's products are also used worldwide in leading research institutions and industrial enterprises.

www.laytec.de
www.deloitte.co.uk/fast500emea

Nantong Tongfang boosts capacity with multiple Aixtron G5 reactors

Aixtron says that in first-quarter 2011 it received an order from existing customer Nantong Tongfang in China for multiple AIX G5 HT MOCVD systems in 56x2-inch and 14x4-inch configurations.

Delivery of the systems began in second-quarter 2011 and will be completed in fourth-quarter 2011. A local Aixtron support team will install and commission the new reactors, which will be dedicated to the growth of high-brightness LEDs.

"With the new reactors we will be able to achieve the capacity increase needed for our high-brightness LED products," says Mr Wang, vice president of the Tsinghua Tongfang Group. "They will augment our two existing AIX 2800G4 systems that continue to serve us well, having very quickly provided high-quality LED materials with excellent characteristics," he adds. "The systems are reliable and economic and their back up service is first rate," Wang comments. "For the future we are convinced that the G5 systems will deliver the best throughput and performance to support our manufacturing plans."

www.aixtron.com

IN BRIEF

Plasma-Therm wins repeat multi-module VERSALINE order from wireless chip maker

Plasma process equipment maker Plasma-Therm LLC of St Petersburg, FL, USA has sold another multi-chamber VERSALINE production system for etch and deposition to a leading North American wireless compound semiconductor manufacturer.

The process modules include an inductively coupled plasma (ICP) etcher for additional capacity for backside gallium arsenide (GaAs) via formation. A second module uses plasma-enhanced chemical vapor deposition (PECVD) for highly controllable, low-damage, low-stress silicon nitride deposition for demanding applications such as capacitors and passivation. Each process chamber includes Plasma-Therm's End-PointWorks technology to ensure maximum via etch yield and real-time film thickness monitoring. The orders complement an installed base of Plasma-Therm VERSALINE and Versalock equipment at the site.

"Plasma-Therm has been an integral equipment supplier for wireless chip manufacturers for many years," says senior VP of marketing Ed Ostan. "Repeat orders based on a history of reliable, superior performance affirm our abilities to providing outstanding solutions to challenging compound semiconductor manufacturing issues," he adds. "Our wireless device manufacturing customers are attracted by the breadth and depth of our technology spanning etch and deposition processes and our collaborative efforts with customers to ensure maximum value."

www.plasmatherm.com

SPTS establishes joint venture with former parent SPP for Japan market

Plasma etch, deposition and thermal processing equipment maker SPTS Technologies Ltd of Newport, Wales, UK has announced the launch of a new joint venture to serve the Japanese market with its former parent company, Sumitomo Precision Products Co Ltd (SPP).

SPP historically supplied certain SPTS systems in Japan through its Micro Technology Division, with local manufacturing under license from SPTS and custom development and support tailored to the Japanese market. In addition, with the cooperation and support of SPP, SPTS sold spare parts and other systems in Japan through its subsidiary SPTS K.K.

As planned since the acquisition of SPTS from SPP in June, a new subsidiary of SPP, SPP Technologies Co Ltd (SPT) has been launched with co-investment from SPTS. SPT combines the businesses of SPP Micro Technology and SPTS K.K. to provide comprehensive solutions to meet the requirements of Japanese customers through the wide range of SPTS products.

"We are very pleased to announce the final step in our MBO process, with the formation of a new relationship with SPP to better serve Japanese customers," says SPTS' president & CEO Dr William Johnson. "SPP has been a leader in MEMS manufacturing equipment for 30 years, and SPTS looks forward to expanding our relationship with SPP as our markets evolve and grow in the future."

"From 1992 when SPP began distributing Surface Technology Systems (STS) products in Japan and subsequently acquired STS in 1995, SPP has been dedicated to providing Japanese customers with products suited to their unique requirements," adds SPP president Susumu Kaminaga. "The formation of the joint venture ensures the continuation and broadening of that focus by increased cooperation with SPTS"

SPT combines the businesses of SPP Micro Technology and SPTS K.K. to provide comprehensive solutions

www.spp.co.jp
www.spts.com

SPTS wins Technology Prize at inaugural Made in Wales awards

SPTS Technologies Ltd of Newport, Wales, UK has been recognized as the Technology category winner at the inaugural 2011 'Made in Wales' awards.

Organized by media organization Wales Business Insider, the award recognizes Wales-based companies that have achieved business excellence in eight categories. SPTS "impressed judges with the international reach of its product range and the way it has adapted to changing markets over the past three years," stated the judging panel When announcing the Technology winner.

SPTS "impressed judges with the international reach of its product range and the way it has adapted to changing markets over the past three years

"This result honors SPTS' market-leading products that have been developed here in Newport," says SPTS' chief operating officer Kevin Crofton. Over 240 staff work in SPTS' Newport division, across technical, manufacturing, R&D and operational departments.

Altatech enters LED inspection market with system for fast defect detection and classification

Altatech Semiconductor S.A. of Montbonnot, near Grenoble, France, which makes wafer inspection and analysis, liquid-vaporization chemical vapor deposition (CVD) and inkjet nanoprinting equipment, has entered the LED inspection market by introducing the AltaSight LEDMax system, its first product designed specifically for detecting, classifying and characterizing defects on wafers used in manufacturing LEDs.

AltaSight LEDMax is claimed to improve production yields for LED devices by accurately detecting process-induced defects, including those that can result during metal-organic chemical vapor deposition (MOCVD) of epitaxial layers, subsequent patterning processes and final inspection. Using patented sensor technology that filters out all background noise, the non-contact system generates images of surface imperfections with resolution down to 1 micron and a unique depth-of-focus capability approaching 500μm.

An integrated review station performs real-time analysis of the gathered inspection data. It can stitch together images from different perspectives, generate 3D renderings and measure defect sizes. All defect-detection results are stored within the system, and can be output to an operator in standard file formats.

"With its multi-class defect reporting and high accuracy, our newest inspection system meets the unique needs of LED manufacturers," claims president Jean-Luc Delcarri. "Altatech is entering this market by providing a defect-detection solution that traditional semiconductor-inspection tools cannot match in terms of reliability and cost-efficiency," he reckons.

The flexible design allows AltaSight LEDMax to combine up to three inspection modules, enabling its use in volume manufacturing, process development or R&D applications.

As well as handling the full range of compound semiconductor wafers on which LEDs are currently produced, AltaSight LEDMax also has the versatility to meet other III-V inspection requirements, accommodating sapphire, silicon, silicon carbide and other transparent surface substrates. The system's flexibility and reliability extends to its ability to inspect thin and thick wafers as well as significantly bowed substrates. Also, it can handle 4–8" wafers without any hardware changes, and a field-upgradeable option for handling 2" substrates will be available in the coming months.

Production units will be shipped to customers in first-quarter 2012.

www.altatech-sc.com

Rubicon marks first anniversary of Batavia sapphire growth facility

Rubicon Technology Inc of Bensenville, IL, USA, which makes monocrystalline sapphire substrates and products for the LED, RFIC, semiconductor and optical industries, has marked the first anniversary of its next-generation sapphire crystal growth facility in Batavia, IL. The 135,000ft2 facility is used for the production of sapphire crystals which are further processed into sapphire ingots and large-diameter sapphire wafers used in products such as LED-based lighting, HDTVs, laptops, netbooks, smart-phones and tablets, and automotive lighting.

As a vertically integrated supplier, Rubicon grows large sapphire crystals in Batavia from raw materials in custom-built, proprietary furnaces replicating the organic sapphire creation process found in nature. The firm completes the process to make large-diameter wafers in its cutting and polishing facility in Penang, Malaysia.

"Rubicon's proprietary crystal growth technology, as exemplified by our Batavia plant, has been refined over the past 11 years to provide consistently high yield and the highest-quality sapphire for our customers," says president & CEO Raja Parvez. "Rubicon's Batavia plant is the cornerstone of our market leadership in providing large-diameter sapphire wafers to the LED industry," he claims.

To date, Rubicon has shipped more than 200,000 six-inch sapphire wafers to the LED manufacturing and RFIC industries. The transition to larger-diameter wafers in LED production has started at the LED manufacturing level. Several key LED chip makers have announced plans to migrate to and/or test large-diameter wafers in 2011/2012. The process and cost efficiencies brought by large-diameter sapphire wafers are instrumental to driving prices down in the LED industry, says Rubicon.

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

www.rubicon-es2.com

MicroTech Systems launches wet station for etching patterned sapphire substrates

MicroTech Systems of Fremont, CA, USA, which provides engineering, manufacturing and applications support for wet process and chemical distribution tools, has developed a wet process station for the etching of PSS (patterned sapphire substrate) wafers (which are used to increase light extraction and efficiency in high-brightness LEDs). The firm claims that its wet station can improve manufacturing throughput (a major stumbling block to making LEDs price competitive with fluorescent lighting).

As LED makers look to decrease costs, the use of PSS is becoming more important, MicroTech says. The average light output power is reported to be up to 37% larger on a patterned sapphire substrate than a standard sapphire wafer. Their use reduces the dislocation density in the gallium nitride layer and enhances the light extraction efficiency (LEE) from the LED chip.

Traditional dry etching on PSS produces highly efficient, very bright light, but throughput is slow and scalability is impacted as wafer sizes increase. Also, typically, more dry etch tools are needed to keep throughput up as wafer size increases.

In the wet etch process in the MicroTech system, gallium nitride (GaN)- or indium gallium nitride (InGaN)-coated wafers are submerged in the etch tank with a mixture of etching and buffering agents. Prior to submersion, a silicon dioxide mask is patterned using plasma-enhanced chemical vapor deposition (PECVD). A lithography step exposes the desired pattern to etch. The sapphire etch process takes place at 260–300ºC. This ultra-high temperature etches the wafers exponentially more quickly than the standard 150–180ºC process and therefore speeds throughput.

MicroTech says that independent customer evaluations show a significant improvement in light extraction and efficiency in the substrates and a considerable cost savings, even if polishing work is performed on the wafers after etch to increase efficiencies. Development work is also being undertaken to improve the dome shapes created on the wafers using a chemical mechanical polishing (CMP) process. New non-cone shapes are also under development.

MicroTech recently announced the delivery of a similar concept process station to the solar industry that delivers high throughput and lower cost-of-ownership benefits by moving from a dry CVD process to an efficient, production-proven, environmentally friendly wet process.

www.microtechprocess.com

Sumitomo Metal Mining to commercialize large-diameter sapphire substrates

6-inch furnace to be installed at subsidiary Okuchi Electronics

Sumitomo Metal Mining Co Ltd of Tokyo, Japan has decided to start commercializing large-diameter sapphire substrates and to establish a mass-production line within its subsidiary Okuchi Electronics Co Ltd of Isa City, Kagoshima Prefecture.

Demand for white LEDs is growing for use in applications such as backlighting in large-screen LCD TVs, and is also expanding rapidly in the general lighting market due to the LED's benefit in saving energy and reducing environmental impacts. Accordingly, the market for sapphire (as a substrate for fabricating gallium nitride for use in white and blue LEDs) is expected to see further growth.

Having planned its entry into the large-diameter sapphire substrate market for some time, Sumitomo Metal Mining has decided to install a new large fabrication furnace at Okuchi Electronics and to mass produce 6" sapphire substrates. The planned value of the capital investment is about ¥1.2bn (including investment already completed). Through the investment, Sumitomo Metal Mining will construct a continuous production system extending from the fabrication of large sapphire crystals to substrate processing.

At present, 2–4" sapphire substrates are prevalent in the market. However, due to LED makers' demands for cost reductions, the market for larger-diameter substrates is forecast to expand. The production of 6" substrates requires the fabrication of large-size crystals, but production is technically difficult and can be performed stably by only a small number of manufacturers worldwide, says the firm. Sumitomo Metal Mining says it has therefore secured a mass-production capability based on its crystal fabrication technology built over many years.

In the future, the firm aims to enhance its development of materials in the environmental and energy sectors and to advance growth strategies in its materials business.

www.smm.co.jp/E

NGK introduces LPE-grown GaN substrate for UHB-LED applications

At SEMICON Japan 2011 in Chiba, Japan (7–9 December), NGK Insulators Ltd of Nagoya, Japan exhibited samples for the first time of its newly developed wafer products for electronic device applications, including ultra-high-brightness (UHB) LEDs, after targeting wafer products as a major R&D theme in the electronics field.

The firm says that, due to its original liquid phase epitaxy (LPE) growth technology, its new gallium nitride (GaN) single-crystal substrate features low defect density and colorless transparency over the whole wafer surface.

NGK also claims that its GaN wafer has unprecedentedly highly efficient luminescence, enabling the growth of UHB-LEDs applicable to business projectors and automotive headlamps. Application to power devices for hybrid and electric vehicles (HEV) is also anticipated.

In addition, the firm says that it has accelerated its development of wafer products including wafers for next-generation semiconductors that do not include rare metals.

www.ngk.co.jp/english

Brewer Science and SUSS MicroTec jointly commercialize ZoneBOND technology for thin wafer handling

Brewer Science Inc of Rolla, MO, USA (which provides specialty materials and equipment for the microelectronics industry), and equipment and process solutions provider SÜSS MicroTec AG of Garching, near Munich, Germany, are joining forces in commercializing ZoneBOND technology for thin wafer handling.

SUSS MicroTec, which provides room-temperature debonding process equipment, is now offering the Brewer Science ZoneBOND process on the XBC300 and XBS300 platforms, targeted for high-volume bonding and debonding of 200/300mm wafers using silicon or glass carriers.

Brewer Science offers products specifically designed for the implementation of the ZoneBOND process including materials for carrier preparation, adhesives, removers, as well as small-scale debonding equipment.

ZoneBOND technology is a solution for wafer handling that provides what is claimed to be excellent total thickness variation (TTV) control, high-temperature stability, and low-stress debonding. Users can benefit through higher yield at debonding, higher throughput, and lower cost of ownership.

The joint effort between Brewer Science and SÜSS MicroTec combines both firms' expertise to provide a complete material, equipment and process solution, optimized for each customer's process needs, the companies add.

www.suss.com
www.brewerscience.com

Optogan partners with Ledison Patan to open Turkish sales hub for LED lamps and luminaires

After partnering with Ledison Patan Ltd (which has broad experience in interior and exterior LED lighting for hotels, hospitals, shipyards as well as for bridges and street lighting), European LED chip and luminaire maker Optogan says that more than 200 invited guests and members of the Turkish parliament attended the grand opening of its new sales office in Koceali, close to Izmit, Turkey.

Grand opening ceremony (from left to right): Dr Resul Patan, mayors and members of parliament, Optogan GmbH senior sales director Ove Sörensen, and Ledison Patan Ltd managing director Ahmet Patan.

Founded in Helsinki, Finland in 2004 by Russian entrepreneurs and scientists from Ioffe Institute in St Petersburg, Optogan is a vertically integrated develoer and manufacturer of HB-LEDs for applications including solid-state lighting. In addition to having an R&D facility in Helsinki, since founding Optogan GmbH in Germany in 2005 it has established epitaxy and chip R&D plus a pilot line in Dortmund and, last year, its Fab1 chip fabrication plant in Landshut. Also, after founding CJSC Optogan in Russia in 2009, in 2010 it acquired an industrial facility in St Petersburg, where it has established LED component and luminaire production lines.

In September, as well as signing a pan-European distribution agreement with Germany's Atlantic Elektronik GmbH, Optogan partnered with Bucharest-based KDF Energy for the distribution of its products in Romania, Greece and Bulgaria.

"For Turkey, we estimate a hundreds of millions Euro market for solid-state lighting (SSL) luminaries within the next two years," says Ove Sörensen, senior director sales & business development at Optogan. "Turkey, being the bridge between Europe and Asia, is a key hub for Optogan," he adds. "With its strong labour force, biggest GDP growth rate in Europe, and a continuously growing population (with currently over 73 million inhabitants), we expect especially strong growth in our retrofit lamps."

In addition to the retrofit business, Optogan and Ledison will focus on market segments such as street lighting, canopy, shop lighting, and lighting for hotels and restaurants.

"LED lighting will become one of the most important technologies of the 21st century," believes Ahmet Patan, general manager of both Ledison and parent firm Patan Ltd. "Therefore we plan to invest about 3.2m Euros for the year 2012 to create and develop the distribution network," he adds.

Ledison Patan will distribute Optogan's SSL LED lamps and luminaires not only in Turkey but also in the Middle East and North Africa. Further possible steps will be investigated such as siting final assembly lines for LED lamps and luminaires in Turkey.

www.optogan.com
http://patan.com.tr/en

Kyma expands AlN template manufacturing capacity

Volume PVDNC reactor qualified for sapphire- and Si-based products

Kyma Technologies Inc of Raleigh, NC, USA, which provides crystalline gallium nitride (GaN), aluminum nitride (AlN) and aluminum gallium nitride (AlGaN) materials and related products and services, has announced the expansion of its AlN template manufacturing capacity for both sapphire- and silicon-based AlN template products.

Kyma says that market demand from blue, green and white LED makers is growing for its AlN templates as a replacement for bare and patterned sapphire substrates. The AlN templates are manufactured using the firm's patented plasma vapor deposition of nanocolumns (PVDNC) technology, which provides LED makers with throughput, cost and performance benefits, it is claimed.

The expansion in AlN PVDNC template manufacturing capacity is based on customer qualification of products fabricated in Kyma's newest high-volume PVDNC reactor, the commissioning of which was announced earlier this year.

Kyma says that LED customer feedback indicates significant improvements in LED brightness, reverse voltage, and electro-static discharge (ESD) yield. Similar benefits have been verified previously using the firm's lower-volume manufacturing tools (used since Kyma was founded in 1998). However, the design of the new tool is totally new compared with earlier designs. Key design changes target improved tool uptime, shorter process cycle time, and better process repeatability and uniformity.

Key design changes target improved tool uptime, shorter process cycle time, and better process repeatability and uniformity

As well as sapphire-based LED applications, Kyma has also qualified the tool for the production of PVDNC AlN on silicon wafers. Several customers have reported improved device properties for both RF and power-switching applications.

"We are pleased to qualify our new reactor for both sapphire- and silicon-based PVDNC AlN template products," says chief operating officer Heather Splawn. "Doing so represents not only a significant boost to our manufacturing capacity; it also validates our improved tool design approach, which should prove beneficial for our continued expansion plans going forward."

www.kymatech.com

Philips and Seoul Semi enter into cross-license agreement

South Korea's Seoul Semiconductor Co Ltd and Netherlands-based Royal Philips Electronics have agreed to settle their pending legal cases and to enter into a cross-license agreement covering patents related to specific LED technology areas. Each party will gain access to a substantial part of the other party's patent portfolios for various LED level technologies.

"As cross-license agreement details are usually kept confidential, we have agreed not to disclose any of the terms," says Seoul Semiconductor vice president John Bae. "We will continue to focus our attention towards innovative LED technology and driving adoption through quality and value," he adds. By entering into this cross-license agreement with Philips, Seoul Semiconductor expects to expand its flexibility, the firm says.

Seoul Semiconductor also holds patent agreements regarding LED technology with many leading other LED makers.

www.philips.com
www.seoulsemicon.com/en

Seoul Semiconductor's new Acrich 2 boosts power efficiency by 90%

Seoul Semiconductor has launched Acrich 2, the latest versions of its AC-driven Acriche family of LEDs, offering long life time, low energy consumption and design convenience.

Introduced in 4W, 8W, 12W and 16W modules, Acrich 2 can provide a bulb replacement LED solution replacing not only 40W, 60W and 100W incandescent bulbs but also MR16 halogen lamps and down-lights.

The Acrich 2 boosts power efficiency by more than 90% by improving the power factor up to 97% compared with the previous version of Acrich. Also, the THD (total harmonic distortion) is now less than 25% to comply with the requirements of various countries, e.g. the US Department of Energy (DOE). Due to its IC technology, lighting manufacturers can plug Acrich 2-based products directly into the wall without considering electrical conditions.

4W, 8W and 12W Acrich 2 modules

Conventional LED bulbs use electrolytic condensers, resulting in temperatures of more than 70ºC, which can shorten product lifetime to less than 10,000 hours. Other well known brand products have power factors in the range of 0.5, i.e. just half the lamp efficiency despite the same 100lm/W efficiency at the LED level, it is claimed.

"High cost, low efficiency and short lifetime — which are critical issues of LED bulb — can be resolved through Acrich 2," claims John Bae, vice president. Seoul Semiconductor will continue to focus on technology and product development to facilitate customers' LED product development and provide full support in a variety of applications, he adds. As a global brand company, Seoul Semiconductor says that it is licensing Acrich to leading firms worldwide, and additional licensing deals are under negotiation.

Seoul Semiconductor launches ZC chip-on-board DC LED

South Korean LED maker Seoul Semiconductor Co Ltd has launched Z-Power COB (ZC), its chip-on-board (COB) type of direct current (DC) LED. Developed on the basis of the firm's Z-Power LEDs, the ZC series can be used as a high-brightness, high-power light source, to both decrease thermal resistance and increase LED lighting product life expectancy. The ZC series also allows manufacturers to conveniently install and design price-competitive products, the firm claims.

Designed as a COB product, the ZC Series eliminates the need for the LED to be surface-mounted onto a metal plate, allowing manufacturers to bypass the chip connection process before use. Companies can trim manufacturing and management costs and improve the end product, Seoul Semiconductor claims.

The use of highly reflective aluminium substrates in the ZC Series also greatly improves the brightness and significantly prolongs LED bulb life-span. Using a single ZC chip permits the development of an LED light bulb that allows light to be distributed more evenly than lighting that connects several LED packages to a single module.

ZC will be offered in 6W, 10W and 16W versions, as replacements for 40W and 60W incandescent light bulbs and 100W down-lights, respectively.

"The ZC Series will enable manufacturers to easily produce LED light designs that ultimately afford consumers with longer-lasting LED lights at decreased electricity costs," says Seoul Semiconductor VP Sunghoon Bae. "As with the recent release of our AC LED, Acrich2, the launch of the ZC Series is aligned with Seoul Semiconductor's commitment to providing consumers with a diverse and innovative product portfolio rooted in research and development investment," he adds.

The ZC Series is entering mass production this month.

www.seoulsemicon.com/en

Philips Lumileds receives 'Best Technology Innovation Award' from China's OFweek, recognizing LUXEON's development and stimulation of LED industry in China

LED maker Philips Lumileds of San Jose, CA, USA has received three individual awards for its technology and market work in China over the last year at the 8th LED Forward-Looking Technology and Market Seminar and the 2011 LED Industry Outstanding Enterprises & Products Annual Award Ceremony of OFweek (a web portal for the optoelectronic industry in China).

The awards include:

- Technical Innovation Award for LUXEON A, LUXEON S, and Freedom From Binning;
- Best LED Application for the Guangzhou TV Tower (lit with LUXEON LEDs);
- Most International Influence Award.

"Lumileds has invested a lot of work into providing the best technical innovations," commented OFweek. "They have also greatly stimulated the LED illumination industry in China, thus receiving the recognition of industry experts and the online audience," it added. Lumileds was selected for these awards from more than 100 firms by over 20,000 voters.

Philips Lumileds receives Technical Innovation Award for LUXEON (one of three awards given to the firm).

Philips Lumileds global distribution partner Future Lighting Solutions was also recognized with two awards for its work in China:

- Best LED Application for the Pearl River installation; and
- Best LED Service Provider.

"Lumileds' commitment to our customers in China and the Chinese lighting industry has never been stronger," says Steve Barlow, Lumileds' senior VP of sales & marketing. "Our Illumination Grade LUXEON innovation delivers unmatched quality of light and reliability and simplifies design-in with breakthroughs like Freedom From Binning," he claims. The company has continued to invest in its China operations, adding technical experts, investing in educational seminars for lighting companies making the move to LED technology, and opening new China headquarters in Shanghai earlier this year.

www.philipslumileds.com
www.luxeon.com

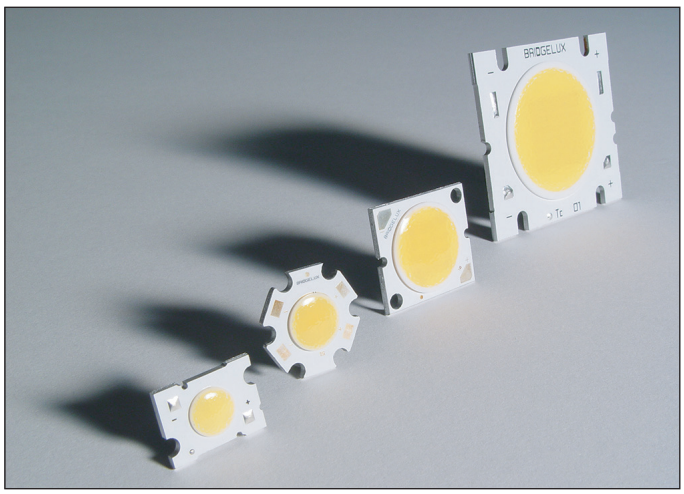
Bridgelux announces commercial availability of latest-generation LED arrays

LED chip and lighting array maker Bridgelux Inc of Livermore, CA, USA (which claims to be the only vertically integrated maker of LED solid-state light sources specifically for the lighting industry) has announced commercial availability of its latest generation of LS, ES and RS product families, delivering an increase in efficacy of up to 30% and a reduction of up to 30% in cost per lumen compared to previous generations.

Featuring what is claimed to be the largest portfolio of LED arrays in the lighting industry, Bridgelux offers products for applications ranging from the light output equivalent of a 20W decorative lamp to that of a 300W high-intensity discharge (HID) city streetlight.

Bridgelux's latest generation of LED arrays offers optical and mechanical compatibility with previous product generations, allowing users to incorporate all performance enhancements with a simple upgrade path, minimizing design efforts, the firm says.

Further, the new arrays offer greater system design flexibility to achieve Energy Star, Title 24, Part L and other global energy efficiency standards. All Bridgelux arrays are configured to align with industry-standard drive currents to simplify the electronic driver selection process for new lamp and luminaire product development, enabling accelerated time to market, the firm adds.



Bridgelux's range of LED array products.

"Bridgelux's commitment to rapid technology innovation while maintaining the product design characteristics of their LED arrays dramatically reduces our development risk, and ensures an easy design-in process," comments Jeff Spencer, director of product management – commercial for Juno Lighting Group by Schneider Electric, which is using Bridgelux's latest generation of arrays in its new Indy Performance Series LED downlights being launched later this month. "As LED technology continues to rapidly evolve, Bridgelux has been a terrific strategic partner because they understand that, by providing platform stability with the LED array products we can easily adopt the latest technology improvements and rapidly pass these innovations on to our customers without significant product redesigns," he adds.

The new arrays offer greater system design flexibility to achieve Energy Star, Title 24, Part L and other global energy efficiency standards

Bridgelux arrays are available in color temperatures ranging from 2700K to 5600K with 3 SDCM color control options to enable clean and consistent lighting installations. Multiple color rendering index (CRI) options are available, providing increased design flexibility for lamp

Bridgelux ranked 58th in Forbes list of America's 100 most promising companies

LED chip and lighting array maker Bridgelux Inc of Livermore, CA, USA (which claims to be the only vertically integrated maker of LED solid-state light sources specifically for the lighting industry) has been named to Forbes' list of America's Most Promising Companies (AMPC). Bridgelux was ranked 58th on the list of 100 privately held companies selected from 22 industries for their innovative business models, strong management teams, notable customers, strategic partners and precious investment capital.

To sharpen its search, Forbes teamed up with CB Insights, a Manhattan-based data firm that tracks investment in high-growth private companies. Forbes also notes that Bridgelux revenue grew 168% during 2008-2010.

"Our technology breakthroughs and innovative product designs have helped drive rapid adoption of our industry-leading array architecture in the general illumination market," claims Bridgelux's CEO Bill Watkins, who expects continued rapid growth in the years ahead as mass adoption of solid state lighting accelerates.

"Sizing up younger, privately held companies is hard: their fortunes can change very quickly and there's a dearth of public data," notes Forbes executive editor Brett Nelson. "We took a more comprehensive approach to evaluate their health and potential," he adds.

www.forbes.com/ampc

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Cree adds thermal simulation and photometric testing to TEMPO design and evaluation services

Extending the support services offered to LED lighting manufacturers that were launched this fall, Cree Inc of Durham, NC, USA has added two new Cree TEMPO offerings to its design and evaluation services. The new TEMPO (Thermal Electrical Mechanical Photometric Optical) Thermal Simulation and photometric testing options are designed to remove barriers for LED lighting manufacturers and accelerate broader market adoption of LED lighting.

"No other LED manufacturer has the same level of end-to-end development support for lighting OEMs," claims Mark McClear, Cree's director of global applications engineering. "Cree Services can remove design, engineering and manufacturing barriers for manufacturers — extending Cree's expertise and equipment to the developers of LED luminaires and lamps," he adds.

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

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

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

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

Cree currently provides TEMPO Services out of its Cree Technology Centers in Research Triangle Park, NC and Santa Barbara, CA, USA. Future TEMPO Service locations in Shenzhen, Munich, Shanghai and Taiwan are targeted to open in 2012.

www.cree.com/services

Cree launches LMH2 LED module family, featuring TrueWhite technology, 90+CRI and 80lm/W system efficacy

Cree has announced commercial availability of the new LMH2 LED module family, which is designed to speed time-to-market for high-quality LED luminaires. The LMH2 is claimed to be the only LED module delivering 80-lumens-per-watt system efficacy combined with a color rendering index (CRI) greater than 90. Featuring Cree TrueWhite technology, the modules deliver high efficiency with what are claimed to be beautiful light characteristics and color accuracy while maintaining color consistency over the life of the product.

The compact, two-piece module optimizes design flexibility, enabling manufacturers to incorporate their luminaire design into the thermal management system and potentially eliminating the need, and cost, of secondary thermal management. Separating the light source and power supply gives luminaire designers a broad range of options for mounting, wiring and reflector design, says Cree. Optimized for more than downlights and spots, the LMH2 makes Cree TrueWhite technology easily available in many lighting applications, including wall sconces, pendant lights, ceiling fans and other common fixtures in residential, retail, museums, hospitality and restaurant environments.

"The new Cree LMH2 modules make the benefits of Cree TrueWhite technology affordable and widely available," says Mike Watson, senior director of marketing, Cree LED components. "Only Cree enables our customers with the latest LED modules that combine 80lm/W efficacy with 90+ CRI."

The LMH2 is available with outputs of 850 and 1250 lumens and in color temperatures of 2700K, 3000K, 3500K and 4000K with a CRI of more than 90. Designed for 50,000 hours of operation and dimmable to 5%, it comes with Cree's new five-and-a-half year warranty. The LMH2 is also UL-recognized and complies with multiple international regulatory and safety standards. Fixture makers seeking ENERGY STAR qualification will have access to specification and performance data, including LM-80 reports, which can speed regulatory approvals.

www.cree.com/modules

Luminus launches first single-chip LED replacement for 300W xenon and 175W metal halide lamps

Luminus Devices Inc of Billerica, MA, USA, which manufactures PhlatLight (photonic lattice) LEDs for illumination applications, says that its next-generation CBT-90 white LED is breaking new ground by providing equivalent system-level light output within specialty lighting applications (including medical and entertainment lighting) that formerly used 300W xenon and 175W metal halide lamps.

The CBT-90, consisting of a single 3mm x 3mm chip mounted on a metal core PCB, is now 25% brighter and capable of producing more than 2200 lumens at its top-end input current. "The new CBT-90 performance has never been achieved before by an LED," claims Chuck DeMilo, global director of product marketing for the Lighting Business Group at Luminus Devices. "The lumen density and brightness of the Luminus CBT-90 are unmatched in the marketplace, and are ideal for our customers working on exceptionally demanding specialty lighting applications," he adds. "For example, our customers developing endoscopy light boxes, now for the first time, have an LED that produces system-level light intensity that rivals the gold standard for endoscopy — the 300W xenon lamp."

In entertainment lighting, spot and wash fixtures are converting from specialty high-intensity discharge lamps (such as 175W metal halide) to the CBT-90. "We expect the new-generation CBT-90... will open new doors for the adoption of LEDs in some of the world's most challenging lighting applications that have been, until now, unable to reap the benefits of solid state lighting," concludes DeMilo.

Luminus is now shipping the new CBT-90 from stock.

www.luminus.com

Luminus' Woburn facility goes green; 100% of annual electricity use to be from Renewable Energy Certificates

Luminus Devices has entered into a contract with Constellation Energy of Baltimore, MD, USA to purchase Renewable Energy Certificates (RECs) to match 100% of its electricity use at its facility in Woburn, MA from October 2011 through October 2012.

The RECs supplied by Constellation are Green-e Energy Certified and sourced from wind energy facilities throughout the USA. Throughout the term of the contract, 100% of the electricity at Woburn will be matched with RECs. Each REC represents the positive environmental attributes of 1MWh of electricity generated by a renewable power plant, and is retired on behalf of customers wishing to promote their environmental commitment. Through the purchase of RECs, Luminus and Constellation are supporting the operation and development of facilities that generate clean, renewable energy.

"This purchase of Renewable Energy Certificates improves the sustainability of our manufacturing processes," comments Jim Gallo, facility manager at the Luminus Woburn operation. Woburn's annual electricity consumption for wafer fabrication is about 2,000,000kWh; with the purchase of RECs, Luminus helps to avoid 946 metric tons of CO_2 emissions.

www.constellation.com

IN BRIEF

Lighting installed at Marine Corps Base

Cree says that more than 930 LR6 six-inch LED downlights and LR24 LED lay-in luminaries have been installed at Camp Pendleton Marine Corps Base as part of an overall renovation. Located outside San Diego, Camp Pendleton is the major West Coast base of the US Marine Corps, serving as its prime amphibious training base for nearly 100,000 Marines.

Prior to installation, electrical contractor Accelerated Electric Inc and general contractor RA Burch commissioned third-party testing of the LR24 luminaries against the proposed linear fluorescent lighting to evaluate the amount of heat distributed and the impact on air conditioning. The study found that the LED luminaires put out 44% less heat than the proposed fluorescents and contributed a 15ºC rise in ambient temperature rather than the 25ºC from fluorescents when compared to a baseline of no lighting.

"Based on the results from our model, we were able to demonstrate the efficacy of Cree LED fixtures, which use 31% less energy than traditional fluorescent lighting, for the Camp Pendleton installation," says Accelerated Electric's president William Porges. "Utilizing these fixtures can significantly reduce building electrical loads and result in dramatically lowered energy costs. We also found that additional energy savings can be attributed to the decrease in air-conditioning usage," he adds.

"With the increased focus on greening government facilities, Camp Pendleton is a great example of how easy it is to achieve both energy and maintenance savings with LED lighting," says David Elien, Cree's VP of LED lighting adoption.

www.CreeLEDLighting.com

Osram Oslon Square LED's reflective package optimizes light usage and versatility

Osram Opto Semiconductors GmbH of Regensburg, Germany says that its new Oslon Square LED opens up a wide range of possible uses, including designer luminaires for the home or office, retrofits and street lights. Available in many different versions with different color temperatures, the LED can be operated with different currents, aiding versatility. Also, its reflective package makes better use of the emitted light and increases system efficiency in all versions, the firm claims.

The Oslon Square can be used in applications ranging from designer luminaires to bright street lights, says Osram Opto. Also, by being small, powerful and capable of operating at different currents, the new LED enables widespread use because there is no need to change the manufacturing process for the lamps. This one LED can therefore be used for manufacturing different products for different target markets.

Like the Oslon SSL LED, the Oslon Square measures just 3mm x 3mm, has a low thermal resistance of 4–3.8K/W, and is accommodated in a robust package that is suitable for outdoor use. In particular, the versatility of the LED enables high system efficiency. The chip is enclosed by a reflective package that reflects light emitted at the side or at the back so that this light

Oslon Square's reflective package makes use of light emitted at the side between the chip and lens.

is usable. Light that is reflected back to the LED within a system (e.g. from a diffuser) can also be used in this way.

The Oslon Square EC is suitable for indoor applications in which a high quality of light is needed, for example in offices. With a color temperature of 3000K it provides a warm-white light and also offers high color stability over a wide viewing angle (120°). The color rendering index (CRI) is at least 80. If the lighting needs to be particularly uniform, a 'fine-bin' order can be placed. At an operating current of 700mA it achieves a luminous efficiency of more than 90lm/W and a luminous flux of at least 200lm. At 350mA its efficiency surpasses 100lm/W. The EC version is also suitable for retrofits. Due to its small dimensions of 3mm x 3mm it can be closely clustered and, like all LEDs in this series, it benefits from its reflective package, both individually and within a system.

The Oslon Square PC and UW are designed for outdoor applications, e.g. in street lighting. They can be operated on currents of 200mA to 1.5A, suiting other applications such as downlights and spotlights. The LEDs produce light from neutral-white to cold-white, with color temperatures of 4000K and 6000K. Also, with a luminous efficiency of 130lm/W from an operating current of 350mA, they are more efficient than the warm-white version. With a CRI of at least 70 (4000K) and 65 (6000K), the LEDs combine good quality of light with high efficiency, says the firm.

"Every application places different demands on lighting, and with the Oslon Square we are providing a platform for tailor-made solutions," says Ivo Ivanovski, product manager for the Oslon Square series. "The LED is available in different color temperatures with different CRIs and can be operated with different currents. By the end of the year we will have added further color temperatures to the portfolio," he notes. "In addition to product features, we are offering logistical concepts with the Oslon Square that will make it easier for customers to develop luminaires."

www.osram-os.com/oslon-square

Osram Opto appoints VP of worldwide sales & CEO of Asia business

Louis Lam has taken over as Osram Opto Semiconductors' VP for worldwide sales as well as CEO of Osram Opto Semiconductors Asia Ltd. His predecessor Dr Alfred Felder will in future be responsible for global sales of the General Lighting business unit at parent firm Osram AG.

Lam has more than 25 years of experience in marketing and sales, as well as business development experience in the opto-semiconductor industry. His responsibilities have included the expansion of regional business in Asia in the fields of mobile devices, solid-state lighting (SSL), automotive lighting, and various other sectors of industry.

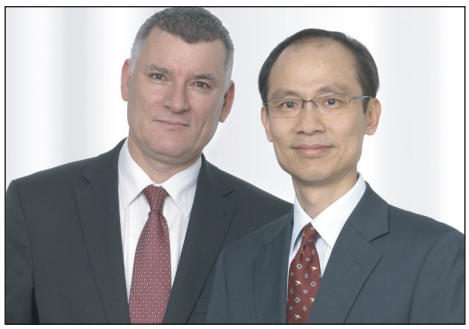
From 2007–2010, Lam was VP of APAC sales for Osram Opto Semiconductors Asia Ltd. Most recently, he was president & managing director of National Semiconductor Asia Ltd in 2010–2011, but previously (in 1986–1992) he was head of the Microsystems Asia business unit at National Semiconductor (H.K.) Ltd.

"With his know-how and many years of experience in market development and in building up customer loyalty, Louis Lam is an outstanding choice, particularly with a view to the important Asian market," says Osram Opto's CEO Aldo Kamper.

Osram Opto Semiconductors appoints vice president of worldwide sales & CEO of Asia business

Osram Opto Semiconductors GmbH of Regensburg, Germany says that at the beginning of December Louis Lam has taken over as its VP for worldwide sales as well as CEO of Osram Opto Semiconductors Asia Ltd. His predecessor Dr Alfred Felder will in future be responsible for global sales of the General Lighting business unit at parent firm Osram AG.

Lam has more than 25 years of experience in marketing and sales, as well as business development experience in the opto-semiconductor industry. His responsibilities have included the expansion of regional business in Asia in the fields of mobile devices, solid-state lighting (SSL), automotive lighting, and various other sectors of industry.



Dr Alfred Felder (left) has moved to Osram AG, while Louis Lam (right) has taken over as VP sales and new CEO of Osram Opto Semiconductors Asia Ltd in December.

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www.osram-os.com

Asia-Pacific power firm CLP installs LED lighting

CLP Group (one of the largest investor-owned power businesses in Asia-Pacific) is launching a program to retrofit its premises with LED lamps. The installation of 90W floodlights in three of its carparks and substations marks the first stage of the program. Using lamps incorporating Osram Opto Semiconductors' Golden Dragon Plus LEDs is expected to reduce CO_2 emissions by 13 tons per year.

LED floodlights are installed in indoor and outdoor premises of three locations in Hong Kong, including Shamshuipo, Taipo and Sheung Shui. They replace 250W low-pressure sodium (LPS) lamps, and this will be followed by more replacement installations in other CLP properties. The current installation represents part of CLP's efforts to minimize the environmental impact of its operations.

"We understand that CLP has a variety of premises, ranging from indoor office to outdoor stations. So a versatile solution is needed," says Edmond Liu, Lighting Consultant at East Universal Technology Ltd, the company which is making the LED floodlights for CLP.

Floodlight with Golden Dragon Plus installed in CLP's Shamshuipo Car Park as part of its program to reduce its carbon footprint.

"We chose Osram Opto Semiconductors' Golden Dragon Plus LEDs as the light source due to its long life span and its high reliability. Our floodlights powered by these LEDs can provide a brighter and more even illumination of a defined area," Liu adds.

"The Golden Dragon Plus LED has a full white colour temperature range and can be used with reflectors as well as secondary lenses," says Kai-chong Cheng, marketing director Asia Pacific of Osram Opto Semiconductors. "These features enable much flexibility for applications in different conditions," he adds. "We will be delighted to see these LED floodlights continue to replace the traditional lighting fixtures in CLP premises as the program rolls out."

CLP is one of the signatories of the Carbon Reduction Charter organized by the Environmental Protection Department of the Hong Kong Government. "Caring for the environment is one of our core values," says a representative of CLP. "We set annual targets for reducing greenhouse-gas emissions for our buildings.," he adds "With this replacement program, we are looking at exceeding our targets and reducing our carbon footprint significantly."

www.clpgroup.com
www.osram.com.hk

Osram Pointled chosen as light source in Lumidigm's Mercury and Mariner fingerprint sensors

Osram Opto Semiconductors GmbH of Regensburg, Germany says its Pointled has selected by Lumidigm as the illumination source in its Mercury and Mariner Fingerprint Sensors (Lumidigm M-Series).

Lumidigm, which develops and commercializes personal biometric identification products and services, has long been at the forefront of the fingerprint sensor market with its proprietary multispectral imaging technology. Osram says that the recent adoption of its compact, bright and efficient Pointled has enabled Lumidigm to reduce the size and cost of its sensors and expand the reach of fingerprint authentication into new applications.

Lumidigm provides fingerprint scanning with a particular emphasis on high performance in real-world conditions. Its patented multispectral fingerprint technology closes a 20% performance gap often seen with conventional technologies because it illuminates both surface and subsurface fingerprint features, ultimately collecting more biometric information from the finger than conventional sensors can.

"We chose the Pointled product from Osram Opto Semiconductors for our Mercury and Mariner product lines because of the unique combination of small package size, symmetric radiation pattern, long lifetime and the ability to operate in high ambient temperatures," comments Lumidigm's chief engineer Steve Corcoran. "These attributes made it possible for us to design a compact illumination system that produces a highly uniform and efficient lighting profile at the fingerprint reader platen," he adds. "Thanks to the excellent output of the Osram Pointled, Lumidigm is able to leverage our multispectral technology in a compact fingerprint sensor series."

The Pointled is a combination of advanced package and chip technologies, says Osram. The firm claims it is the smallest LED with an integrated reflector and is suitable for both surface-mount technology (SMT) and zero-height mounting. Its compact dimensions (2mm diameter x 0.775mm high) allow the mini light source to be sunk completely into the printed circuit board, suiting applications such as Lumidigm's M-Series fingerprint sensors where space is at a premium. The typical brightness of the white mini LED is currently 800mcd at a beam angle of 120°, suiting the unique imaging application.

www.lumidigm.com

3S Photonics' lasers in Curiosity rover launched aboard NASA's Mars Science Laboratory spacecraft

3S Photonics Group of Nozay, France, which makes chips, optical discrete modules and passive components for the laser, sensing and telecom markets, has provided laser technology for NASA's MSL (Mars Science Laboratory) mission, which aims to land and operate the rover Curiosity (a mobile robot equipped with 10 instruments) on the surface of Mars, to find out if the planet has ever been inhabited.

The MSL (carrying Curiosity) was launched on 26 November from Cape Canaveral Air Force Station in Florida onboard an Atlas V rocket.

The CNES, French Space Agency, in partnership with Quantel group and the CESR (French Space Research Institute based in Toulouse) have designed and built two of the 10 instruments on board Curiosity, including the ChemCam (CHEMistry CAMera).

ChemCam is an elementary instrument that analyzes the rocks and the ground around the vehicle up to 9m away. It uses a spectroscopic analysis technique led by laser ablation. A laser shot fires at a target, causing the material to melt and plasma to emerge, which can be detected from a distance via UV-visible spectroscopy. This new technology, which has never been used before, will enable the first selective analysis of Mars' rocks to be carried out without the need to move the rover. Based on the information retrieved from ChemCam, the rover can reposition itself near to any rock in order to carry out further analysis.

3S says that, in 2004–2005, its laser diodes were selected and integrated into ChemCam's laser for spectroscopy specifically because of the process control and performance and the high reliability of its products (key criteria for the mission).

www.3sphotonicsgroup.com

UCSB spin-off Soraa raises $88.6m

Soraa Inc of Fremont, CA, USA, which is commercializing nitride-based LEDs and laser diodes for application in general illumination and projection display, has raised $88.6m of a $90.3m round, according to a regulatory filing with the US Securities and Exchange Commission (SEC).

Soraa was founded in 2008 by University of California Santa Barbara (UCSB) professors Shuji Nakamura, Steve DenBaars, and James Speck. The CEO is former Intel and Samsung executive Eric Kim. Soraa is funded by Khosla Ventures and New Enterprise Associates (NEA), whose general partner Ravi Viswanathan (a director of Soraa) is listed in the SEC filing in relation to the investment.

Soraa's laser diodes are based on indium gallium nitride (InGaN) technology and are fabricated on non-polar and semi-polar GaN substrates. The firm says that its direct-diode green and blue lasers offer improvements in performance, size, weight and cost over conventional gas or solid-state lasers for consumer projection displays, defense pointers and illuminators, biomedical instrumentation and therapeutics, and industrial imaging applications.

Most recently, in January, Soraa demonstrated 4W blue laser diodes operating at a wavelength of 450nm, claimed to be the highest-power blue laser reported from a monolithic chip. The devices are designed to enable >500 lumen bulb-free projection displays.

Soraa operates vertically integrated fabrication facilities in Silicon Valley and Santa Barbara. Presumably the new investment will fund either product development and commercialization or production capabilities.

www.soraa.com

http://sec.gov/Archives/edgar/data/1436627/000149667111000001/xslFormDX01/primary_doc.xml

Intel veteran appointed as Soraa VP & general manager of Laser Products

Soraa has appointed Wilfred Martis as VP & general manager of Laser Products.

"Wilfred brings a wealth of experience in managing semiconductor businesses for the consumer electronics and embedded markets," says CEO Eric Kim. "He has chosen to join our world-class team and help us fulfill the potential of our laser products for the display and lighting markets," he adds.

Prior to joining Soraa, Wilfred was general manager of Retail Consumer Electronics in the Digital Home Group at Intel Corp, responsible for the digital TV, Blu-ray and OTT business. His team established the smart TV category through the launch of several Google TV products from Sony and Logitech, and Boxee products from DLink and Iomega. Martis spent 13 years at Intel, in several engineering, business & management roles, focused primarily on the consumer electronics and embedded markets.

Martis has a BSEE from Bangalore University in India, an MSEE from the South Dakota School of Mines & Technology, and an MBA from the Wharton School of the University of Pennsylvania.

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Jenoptik lays foundation stone for Berlin expansion

High-power semiconductor laser capacity to double from 2013

In a ceremony attended by about 80 invited guests (including representatives from business, politics and industry), Jenoptik Group of Jena, Germany has laid the foundation stone for the €10m expansion that will more than double capacity at its gallium arsenide (GaAs)-based high-power semiconductor laser production site in Berlin-Adlershof technology park.

"Germany is and remains a location for high-tech manufacturing even though we in the Jenoptik Group are currently pushing forward the process of internationalization in Asia and North America," said Jenoptik chairman Dr Michael Mertin, emphasizing the need for investment primarily in technology-intensive fields. "Our local industry knows how to position itself as a supplier of high-tech to the world," he added.

The existing production facility in Berlin has reached its capacity limit and is being expanded due to rapidly increasing demand (particularly from Asia), as well as for future projects, including the progressing internationalization of the firm's Lasers & Material Processing division.

The expansion will increase total floor area by 1400m^2 to about 3400m^2. The production area, including cleanroom, will grow from 540m^2 to 930m^2. A topping-out ceremony is scheduled for 5 March 2012, prior to building handover from Stuttgart-based general contractor YIT Germany GmbH in the Summer. The plant should be available for production from 2013.

Groundbreaking ceremony in Berlin.

After the manufacturing facility has been equipped with production and automation technology, 4" GaAs wafers will be structured and processed to create high-power laser bars in a typical semiconductor manufacturing process. The various work areas will be fitted out with Class 100–1000 cleanroom facilities (depending on the requirements of the specific process step). The complete process line — from epitaxy, wafer processing and facet coating through to the manufacture of GaAs components — will be installed in the cleanrooms.

A total of about €10m is being invested in the extension. Financing for the building will be provided by the Hoesch Dortmund pension fund. The internal fittings (including cleanrooms) as well as the production equipment will come from Jenoptik. Including the existing production facility, total investment at the Berlin-Adlershof site will be about €24m.

Laser bars from Berlin-Adlershof will be shipped to customers worldwide and will also be processed to create high-power diode lasers by Jenoptik in Jena, where it has the entire technology chain at its disposal — from the manufacture of high-power diode lasers (the most energy-efficient of all lasers), through to laser processing systems for material processing.

Jenoptik has had a production plant in Berlin-Adlershof since 2006. The optoelectronic base material and its efficient production are being developed by Jenoptik in collaboration with the Ferdinand-Braun-Institute, Leibniz Institute for High Frequency Technology (FBH) in Berlin-Adlershof. Currently Jenoptik has 70 staff in Berlin, mainly in the Lasers & Material Processing and Optical Systems divisions. As a result of the investment, staffing will rise by 2013, in accord with expected future growth.

www.jenoptik.com

Jenoptik opens China subsidiary office in Shanghai

After combining its activities in China into the subsidiary Jenoptik (Shanghai) Precision Instruments and Equipment Co Ltd, Jenoptik has opened new premises in the presence of about 100 guests.

Jenoptik employs over 60 staff in China, mostly at the Shanghai site in Pudong Industrial Zone, which covers 3000m^2 over two floors. Other sites in China are in Beijing, Chongqing and Wuhan.

Since taking up his post in 2007, Jenoptik chairman Michael Mertin has pushed expanding Jenoptik to give it a direct presence in key markets in Asia and North America. "By having our own structures, we are better placed to meet the requirements of our customers worldwide," he says. "We must have a local presence and break down barriers. In future a company's success will depend more than ever before on its ability to adapt quickly and flexibly to customer needs on the international level," Mertin adds.

Teams from the Industrial Metrology, Lasers & Material Processing and Optical Systems divisions now have a local presence "creating advantages in the internal processes along the entire value-added chain," says Mertin.

An Application Center for the Lasers & Material Processing division will open in 2012. Jenoptik also has local production facilities for assembling electronic components and customer-specific systems.

www.jenoptik-china.com

IN BRIEF

BinOptics raises $13.3m in funding

BinOptics Corp of Ithaca, NY, USA, which makes lasers and monolithically integrated optoelectronic components, has raised $13.3m in a new funding round involving five new investors Advantage Capital Partners, Enhanced Capital Partners, Gefinor Ventures, Onondaga Venture Capital Fund and Rand Capital, plus existing investors ArrowPath Venture Partners, Cayuga Venture Fund, Draper Fisher Jurvetson, and FA Technology Ventures. Advantage Capital senior VP Reid Hutchins joins the board of directors.

Founded in 2000 and ISO certified in August 2010, BinOptics uses proprietary processes to make lasers and integrated photonic devices at low cost. In recent years, it has established a global market presence by shipping more than 25 million Fabry–Perot (FP) and distributed feedback (DFB) lasers in high-growth markets such as EPON (Ethernet passive optical networks) and GPON (Gigabit passive optical networks).

The new funding will be used to continue expansion of product lines and accelerate development of new products. "This funding enhances our ability to meet strong demand for our current 2.5Gbps and 10Gbps distributed feedback laser products," says chairman & CEO Alex Behfar.

"The current funding will enable BinOptics to leverage its patented laser structures and manufacturing processes to move into new materials and markets," notes Chris Davis of Gefinor Ventures.

"BinOptics has great potential to create new jobs here in upstate New York," says Rand Capital's president Allen 'Pete' Grum. It currently has over 50 staff, with plans to hire additional engineers and technicians in 2012.

www.binoptics.com

Singapore's A*STAR Institute of Microelectronics to commercialize silicon photonics chips

Work with Alcatel-Lucent and Globalfoundries targets fab readiness in next few years

The Institute of Microelectronics (IME), a research institute of Singapore's Agency for Science, Technology and Research (A*STAR), plans to commercialize key innovations in silicon chips that have been developed as part of IME's Silicon Photonics research platform and are designed to support high-speed, high-bandwidth optical communications. Further enhancements to the chips have been enabled through strategic collaboration with Alcatel-Lucent Bell Laboratories.

IME and Alcatel-Lucent plan to bring silicon component designs from research to commercial fabrication readiness within the next few years, by working with Globalfoundries Inc of Milpitas, CA, USA (which claims to be the first full-service semiconductor foundry with a global manufacturing and technology footprint). Globalfoundries was formed in March 2009 through a partnership between microprocessor manufacturer AMD and the Advanced Technology Investment Company (ATIC). As well as having manufacturing operations in Dresden, Germany and a new fab under construction in Saratoga County, NY, USA, in January 2010 Globalfoundries acquired Singapore-based silicon foundry Chartered Semiconductor Manufacturing Ltd.

The scalable, cost-effective silicon building blocks will be made accessible to photonics developers, with the aim of creating new products and propagating the benefits of dramatically increased data rate and processing power, at a reduced cost to the industry.

The collaboration leverages Bell Labs' design experience and research capability with the development expertise of IME to create a library of silicon photonics devices with the requisite process control monitors (PCMs) and process design kits (PDKs). These photonic devices (ranging from next-generation high-speed optical modulators, germanium photo-detectors, waveguides and other common photonic circuits found in networking equipment) will be offered as a result of the collaboration.

"This milestone reflects the rapidly growing commercial significance of silicon photonics," comments IME's executive director professor Dim-Lee Kwong. "IME will continue to enhance our silicon photonics technology platform and work with our strategic partners to bring the benefits of silicon photonics to the industry worldwide," he adds.

Silicon photonics holds promise for use in communication systems, believes Alice White, chief scientist at Alcatel-Lucent Bell Labs. "Bell Labs has been actively engaging leading microelectronics research institutes in silicon photonics research - it is exciting to see these efforts moving forward into the commercial realm," she adds.

"Globalfoundries is excited to partner with IME to deliver photonics solutions to customers such as Alcatel-Lucent," says Raj Kumar, senior VP for Globalfoundries' 200mm business unit & general manager for Singapore. "Through innovative design kits and advanced materials fabrication techniques, the Globalfoundries-IME team intends to expand the photonics design and manufacturing portfolio to our existing and future customers who are looking for reliable high-volume manufacturing service."

www.ime.a-star.edu.sg
www.globalfoundries.com
www.alcatel-lucent.com

k-Space Associates, Inc.

www.k-space.com

2182 Bishop Circle East, Dexter, MI 48130 USA | tel: 734-426-7977 | fax: 734-426-7955 | requestinfo@k-space.com

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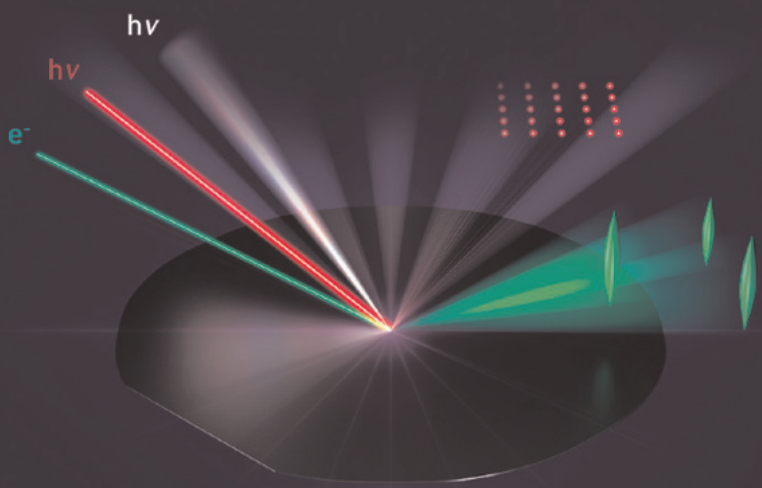
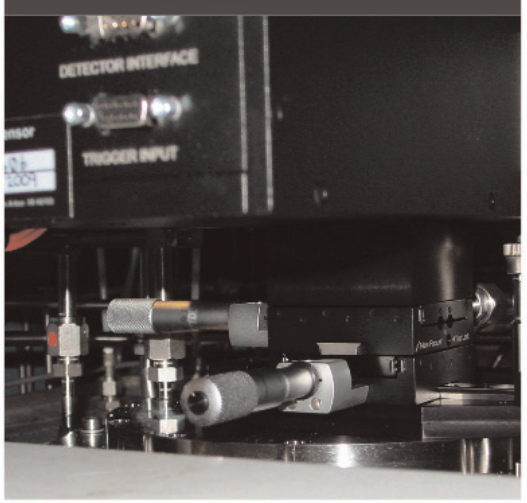
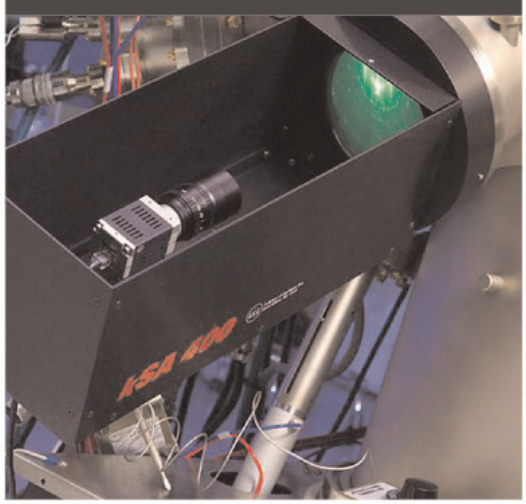


kSA BandiT Wafer Temperature

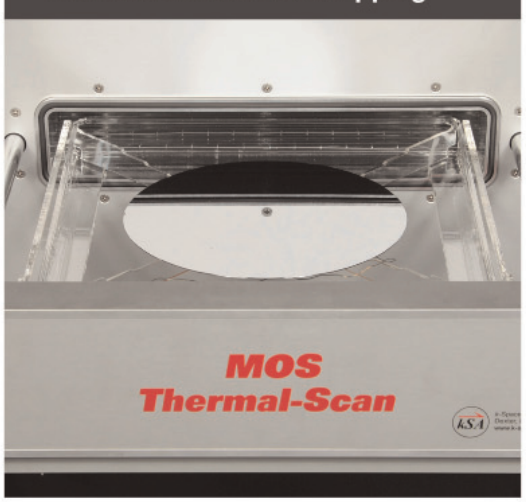
kSA MOS and kSA Mini-MOS Thin-Film Stress



kSA 400 Analytical RHEED



kSA MOS Ultra-Scan and Thermal-Scan Stress Mapping



kSA Rate Rat Pro Thickness & Deposition Rate

kSA BandiT PV Process Tuning

NeoPhotonics doubles capacity of narrow-linewidth tunable lasers for coherent DWDM systems

Extra capacity to come on-line in Q1/2012

NeoPhotonics Corp of San Jose, CA, a vertically integrated designer and manufacturer of photonic integrated circuit (PIC)-based modules and subsystems for bandwidth-intensive, high-speed communications networks, says that it is in the process of doubling capacity for the production of narrow-linewidth tunable lasers, with minimal expected additional capital expenditures. The firm offers these lasers in an OIF multi-source agreement (MSA) standard ITLA (integrable tunable laser assembly) form factor, and they are designed to provide the low noise and narrow linewidths required for 40 and 100Gbps coherent applications.

The products are compact, widely tunable laser assemblies designed to be optimized for narrow linewidth with launch powers of up to 35mW in the C band and 20mW in the L band. The narrow linewidth and frequency stability are enabled by a NeoPhotonics phase-shifted DFB (distributed feedback) laser chip and proprietary packaging technology, while the ITLA assembly also includes an integrated wavelength locker as well as industry-standard electrical and firmware interfaces. The narrow-linewidth tunable laser has been available to customers since April 2010 and has become one of the leading lasers used in coherent systems, the firm claims.

"Our narrow linewidth tunable lasers are key components for coherent transport in telecommunications systems, which we believe is rapidly emerging as a dominate architecture for 40 and 100Gbps networks," says CEO Tim Jenks. "We believe there is currently a shortage of these critical products while demand continues to grow." The extra capacity is expected to come on-line in first-quarter 2012.

www.neophotonics.com

Finisar's sales grow 5.8% quarter-on-quarter to $241.5m

Growth driven by WSS/ROADM line-cards & tunable XFP transceivers

For its fiscal second-quarter 2012 (to end-October 2011), Finisar Corp has reported revenue of $241.5m, roughly level with $240.9m a year ago but up 5.8% on $228.2m last quarter. The increase is driven mainly by growth in sales of WSS/ROADM line-card products and tunable XFP transceiver products, as well as the consolidation of a full quarter of results from the Scandinavia-based subsidiary Ignis ASA (which provides optical components and network solutions for fiber-optic communications) acquired on 18 May.

Compared to last quarter, datacom product revenue fell by $0.6m (0.4%) but telecom product revenue rose by $13.8m (13.9%). "We continued to execute well on our product development plan and have delivered to customers a number of innovative products in the WSS and pluggable product lines," says CEO Eitan Gertel. "Production of our tunable XFP transceiver products began to ramp during the second quarter of fiscal 2012," he adds.

On a non-GAAP basis, gross margin was 32.1%, down from 35.5% a year ago but level with last quarter as the benefits of increased revenue were offset by consolidating a full quarter of financial results of Ignis, which has lower average gross margin than Finisar's corporate average.

Although down on $40.9m (operating margin of 17% of revenue) a year ago, operating income rebounded to $23.6m (9.8% margin), up from $20.9m (9.2% margin) last quarter as revenue grew faster than operating expenses (up from $44.6m a year ago and $52.4m last quarter to $53.8m). This was despite the consolidation of a full quarter of Ignis' operating expenses. Although down from $38.3m a year ago, income from continuing operations rebounded to $21.6m, up from $19.5m last quarter.

During the quarter, cash and cash equivalents fell from $238.1m to $228m, due mainly to the repayment of $5.6m of Ignis debt and increases in accounts receivable and inventory.

Datacom product revenue fell by 0.4%; telecom product revenue rose by 13.9%

At the end of the quarter, Finisar had about $40m in principal amount of convertible notes outstanding with a conversion price of $10.675 per share. Ignis also had outstanding debt equivalent to $4.3m. Under Finisar's $70m secured credit facility with Wells Fargo Foothill, LLC, no borrowings were outstanding and $66.6m was available to borrow at the end of the quarter. "Tunable XFPs were qualified at several additional customers during the second quarter and we expect more qualifications in the third quarter," says Gertel. For fiscal third-quarter 2012, Finisar expects revenue of $235–250m and operating margin of 8.5–10.0%. "In addition, we have qualified our next-generation edge or access WSS modules with multiple customers and expect revenue from these products to continue to ramp in the first half of calendar 2012," adds Gertel.

www.finisar.com

Infinera showcases latest products at SCTE Cable-Tec

At the SCTE Cable-Tec Expo 2011 in Atlanta (15–17 November), Infinera Corp of Sunnyvale, CA, USA, a vertically integrated manufacturer of digital optical network systems incorporating its own InP-based photonic integrated circuits (PICs), showcased the latest release of its DTN metro and long-haul DWDM digital ROADM, ATN WDM metro edge platform, and its DTN-X (the industry's first multi-terabit packet-optical transport platform, to be generally available in early 2012).

DTN Release 7.0 offers new capabilities including 40 and 100 Gigabit Ethernet (GbE) service interfaces to support high-bandwidth applications and a new DWDM line-card supporting 40Gb/s per wavelength coherent optical transmission, enabling the DTN platform to scale up to 6.4Tb/s of transmission capacity per fiber.

ATN Release 3.0 enhances the capabilities of the ATN by adding Ethernet Add Drop Multiplexing (ADM) on a blade functionality, extending the ATN regional reach up to 700km, and supporting 4G Fiber Channel services, making the ATN platform suitable for cable operators' edge aggregation and commercial services. The ATN platform continues to support Ethernet, SONET/SDH, OTN, video services and multi-service aggregation to 10Gb/s wavelengths and fully automated optical power management.

DTN-X offers cable operators a cost-effective multi-terabit DWDM transport and switching platform by being designed with 500Gb/s super-channel PICs. It is interoperable with the DTN platform and is planned to support 10/40/100Gb/s Ethernet and OTN as well as 10/40Gb/s SONET/SDH and 8/10Gb/s Fibre Channel.

Also, in a live demonstration on Infinera's Express truck at the SCTE Cable-Tec Expo, Infinera delivered a 100GbE signal from an EXFO test set to a DTN network with a 100GbE service module, and back to the test set to confirm signal integrity. Infinera's 100GbE interfaces are available and fully compliant with IEEE 802.3ba. Testing and verification of transmission was performed with an EXFO FTB-85100G Packet Blazer tester (the first compact portable 40/100GbE and OTN testing solution).

"Infinera solutions are valued by cable MSOs for their ability to accelerate and simplify service turn-up while delivering enhanced scalability and flexibility to meet customer demands," says Gaylord Hart, director of CATV marketing.

http://expo.scte.org
www.infinera.com

Oclaro launches 100G coherent transponder module, joining existing 40G coherent transponder module

Oclaro Inc of San Jose, CA, USA has added to its coherent product portfolio by launching a second coherent transponder module. The low-power 100Gbps MSA-compliant MI 8000XM (to ship in April) joins the 40Gbps MI 5000XM (now shipping in volume). Oclaro says the transponders leverage its history of delivering coherent solutions, its competencies in indium phosphide (InP) and lithium niobate ($LiNbO_3$) materials, its vertical integration in optical components, and its production and application expertise.

Both modules use a PM-QPSK modulation format combined with coherent detection (the leading technology for enabling 100Gbps and higher optical transmission, delivering the scalability and flexibility needed for transmitting more bandwidth cost efficiently over fiber-optic networks, says Oclaro).

Complementing this family, Oclaro claims leadership in the high-bit-rate direct detection transponder market with 40Gbps transponders providing DPSK and DQPSK modulation formats, after starting volume shipments in 2007. It also provides a full range of the optical components necessary to implement complete transponder solutions. Oclaro says that, by providing both coherent and direct detection module families and the key associated components, it enables network equipment makers to develop cost-effective transponders for both new next-generation network implementations as well as upgrades on existing networks.

"The 100Gbps MI 8000XM leverages Oclaro's expertise in module design combined with a deep understanding of high-bit-rate propagation challenges in optical fiber networks," says Dr Terry Unter, president & general manager of Oclaro's Optical Networks Solutions business unit. "The MI 8000XM transponder integrates the latest-generation DSP with an advanced control and management implementation to deliver state-of-the-art performance in a module that is easy for our customers to integrate into their network equipment," he claims.

"Merchant coherent transponders are critical for mass deployment of 100Gbps DWDM systems," notes Ron Kline, principal analyst at market research firm Ovum. "We continue to see strong growth of coherent technology for both 40G and 100G applications. The availability of standardized modules will help lower system costs and increase market competitiveness of vendors offering high-capacity bandwidth solutions," he adds.

The MI 8000XM transponder integrates the latest-generation DSP with an advanced control and management implementation

The MI 8000XM fully complies with the OIF's 100Gbps MSA Implementation Agreement including specifications on power consumption. The transponder employs a low-power DSP-LSI digital signal processor large-scale integrated circuit supplied by NEL (NTT Electronics Corp). The DSP-LSI was an outcome of the 'R&D on High Speed Optical Transport System Technologies' project, which was supported by Japan's Ministry of Internal Affairs and Communications. The DSP offers correction of chromatic dispersion as well as polarization mode dispersion, which enables the transponder module to adapt automatically to the dispersion properties of a wide range of new and existing optical networks. The inclusion of soft-decision forward error correction (SD-FEC) further broadens the MI 8000XM's application space.

The MI 8000XM is targeted at optical network solutions from metro through ultra-long-haul (including submarine networks) to support the growth of bandwidth-intensive services such as video, cloud computing, and wireless broadband data services. The automatic chromatic dispersion and polarization mode dispersion compensation properties suit the next-generation optical network architecture with extensive optical routing and richer mesh network topologies. High spectral as well as physical density (the latter enabled by reduced power dissipation) are key characteristics for deployment in those networks, which will serve to meet the ever-increasing bandwidth demands over the coming years, says Oclaro.

www.oclaro.com

JDSU stockholders approve proposals at Annual Meeting

JDSU of Milpitas, CA, USA , which makes optoelectronic chips and modules as well as communications test & measurement equipment, says that, at their Annual Meeting of Stockholders on 16 November, all proposals presented for consideration were approved.

First, stockholders re-elected Penelope A. Herscher, Masood Jabbar and Thomas Waechter to serve on JDSU's board of directors for three-year terms ending in 2014.

Second, stockholders ratified the appointment of Pricewaterhouse-Coopers LLP as JDSU's independent registered public accounting firm for the fiscal year to end-June 2012.

Finally, JDSU's stockholders approved an advisory resolution on executive compensation, as well as recommending an annual advisory vote on executive compensation.

www.jdsu.com

GigOptix ships full-production 14G parallel VCSEL drivers and receiver amplifier arrays for next-gen AOCs to tier-1 customers

GigOptix has started high-volume production and shipment to tier-1 customers of its parallel vertical-cavity surface-emitting laser (VCSEL) drivers and receiver amplifier arrays for short-reach 14Gb/s serial optical interconnects.

GigOptix is now in full production with its 4- and 12-channel 14Gb/s link chip-set solutions for next-generation Infiniband Fast Data Rate (FDR) active optical cables (AOCs) operating up to 168Gb/s as well as 40G and 100G Ethernet transceivers. The easy-to-use, compact designs address the datacom, avionics and consumer markets.

GigOptix's chip-set consists of a 4-channel HXT5104 VCSEL driver and HXR5104 receiver amplifier chip-set and a 12-channel HXT5112 VCSEL driver and HXR5112 receiver amplifier chip-set. These chip-sets are designed to enable ultra-low power consumption of less than 450mW for a 40G link over 100m as well as to minimize the components required to implement a transceiver, resulting in lower costs. The HXT/R5 family incorporates programmable equalization and pre-emphasis circuitry to facilitate various trace lengths, in addition to providing full programmable control via fully integrated analog-to-digital convertors (ADC) and digital-to-analog convertors (DAC) through an industry-standard 2-wire interface.

"This year has brought exciting progress of our parallel optics line," says Dr Raluca Dinu, general manager & VP of the Optics Product Line at GigOptix. "After successful design wins into major tier-1 customers, we have finally gone into full production with the HXT/R51 series chipset. The requirements from our customers for reliable, high-performance, low-power and cost-effective solutions have been fulfilled by our unique chip-set solution that addresses current and future datacom short reach needs," he claims.

Market research firm Lightcounting forecasts that AOC volume shipment of 250,000 units in 2012 and 400,000 units in 2014.

The production HXT/R51 series chip-set is available for evaluation with VCSEL and photodiodes on an evaluation board.

www.gigoptix.com

GigOptix doubles Silicon Valley Bank credit

GigOptix Inc of San Jose, CA, USA (which supplies semiconductor and optical components including modulator and laser drivers and transimpedance amplifier ICs based on III-V materials) has revised its credit agreement with Silicon Valley Bank (SVB).

The revision to the original agreement (of April 2010) provides double the size of the line of credit (up from $3m to $6m), lower interest rates, less restrictive covenants, and more flexibility with respect to its borrowing base.

"We are constantly impressed by the innovations our clients, like GigOptix, are creating to enable development and economic growth in the tech sector," says Megan Willard, relationship manager at Silicon Valley Bank (a provider of diversified financial services to emerging growth and established technology companies). "Working together with GigOptix, we were able to put together a financing solution that will support the company in its next phase of growth," she adds.

IN BRIEF

JDSU opens China broadband network development center

After establishing its R&D presence in Shenzhen in 2000, JDSU of Milpitas, CA, USA has opened a new broadband network development center in the Shenzhen High-Tech Industrial Park, China.

Representing a commitment of more than RMB20m, the facility includes 6000m^2 of floor space and currently has over 250 staff, with space to expand to over 400.

"The new Shenzhen site demonstrates JDSU's commitment to China and other high-growth markets in the Asia-Pacific region," says David Heard, president of JDSU's Communications Test & Measurement business segment. "The Shenzhen center, together with its other research facilities worldwide, position JDSU close to its customers for effective collaboration that drives the innovation needed for the development and deployment of next-generation broadband networks," he adds.

The Shenzhen site designs various optical components and communications test solutions needed by communications network equipment manufacturers and service providers for the development and deployment of self-aware networks.

The site includes communications test & measurement and optical communications labs equipped with research equipment and network infrastructure. Its R&D efforts drive solutions that simplify network management, reduce deployment and operating costs, and improve the quality of communications services.

Components developed at the site support a recently introduced portfolio of self-aware optical network solutions to be rolled out in second-half 2012.

www.jdsu.com

IN BRIEF

Emcore solar panels powering cruise stage of Mars Science Laboratory spacecraft

Solar panels made by Emcore of Albuquerque, NM, USA were successfully launched on 26 November onboard the Mars Science Laboratory (MSL) spacecraft.

The panels, delivered earlier this year under contract to NASA's Jet Propulsion Laboratory (JPL) Center in Pasadena, CA, will power the MSL during its cruise stage to Mars. The spacecraft is designed to carry the MSL rover 'Curiosity' and communicate with the entry vehicle that will carry the rover to the surface of the planet. The solar panels for this mission were designed and manufactured exclusively by Emcore's Photovoltaic Division in Albuquerque.

"We are committed to supporting NASA with other future missions," says chief operating officer Christopher Larocca. "Emcore has previously delivered, or is in the process of delivering, solar panels for several other NASA missions including the Lunar Atmosphere and Dust Environment Explorer (LADEE), Commercial Resupply Services (CRS) to the International Space Station, Lunar Reconnaissance Orbiter (LRO), and the Magnetospheric Multi-Scale (MMS) missions," he adds.

Emcore manufactures radiation-hard solar cells for space power applications. With a beginning-of-life (BOL) conversion efficiency nearing 30% and the option for a patented, onboard monolithic bypass diode, its multi-junction solar cells provide power to interplanetary spacecraft and earth orbiting satellites.

www.nasa.gov/msl
www.emcore.com.

Magnolia Solar receives $750,000 Phase II award from AFRL

Two-year SBIR program to develop flexible, lightweight multi-junction cells

Magnolia Solar Corp of Woburn, MA and Albany, NY, USA says that its subsidiary Magnolia Solar Inc has received a $750,000 Phase II award from the US Air Force Research Laboratory as part of the Small Business Innovative Research (SBIR) program. The award will fund a two-year project to develop flexible, lightweight, ultra-high-efficiency multi-junction solar cells for space power applications.

The award follows a Phase I program that demonstrated Magnolia's approach to simultaneously increasing the current and voltage output of photovoltaic devices for space power applications. The Phase II award aims to optimize the device and apply advanced anti-reflective coatings to build ultra-high-efficiency flexible solar power solutions for defense applications.

Magnolia is building a patent portfolio around its proprietary technologies for this award and other work with government funding from the New York State Energy Research and Development Authority (NYSERDA) and the US National Aeronautical Space Administration (NASA). Recently Magnolia announced demonstration of several significant milestones, and this award provides a pathway to support its ultimate goal of developing low-cost, high-efficiency, thin-film solar cells for commercial and defense requirements.

"Photovoltaic devices can provide a mobile source of electrical power for a variety of military applications in space and terrestrial environments," says Magnolia Solar Corp's president & CEO Dr Ashok K. Sood. "Many of these applications can directly benefit from enhancements in the efficiency of the photovoltaic devices. In particular, flexible, lightweight, high-efficiency solar cells are needed to maximize the power-generating capability of space, ground-based, and air-based defense applications," he adds. The patent-pending technology developed during this program is expected to have immediate market opportunities for defense applications.

Ultimately, our approach provides a pathway for obtaining thin, flexible, multi-junction solar cells with efficiency approaching 40%

"We look forward to continuing our partnerships with MicroLink Devices and Rensselaer Polytechnic Institute during this Phase II program," continues Sood.

"Current approaches to increase the efficiency of multi-junction structures typically used for space power generation are reaching practical limitations due to fundamental constraints in conventional multi-junction device design," notes Magnolia's chief technical officer Dr Roger E. Welser. "By combining wide- and narrow-bandgap material within each p-n junction, quantum-structured solar cells can overcome these constraints and increase the current and the voltage output of each subcell within a multi-junction solar cell," he adds.

"The Phase I effort leveraged the epitaxial liftoff process developed at MicroLink Devices in Niles, IL, and has demonstrated the validity of Magnolia's extended heterojunction photovoltaic device concept," Welser notes. "Ultimately our approach provides a pathway for obtaining thin, flexible, multi-junction solar cells with efficiency approaching 40%."

www.MagnoliaSolar.com

ATK awards Emcore solar panel contract for Orbital's Commercial Resupply Services cargo missions to ISS

Emcore Corp of Albuquerque, NM, USA, which makes compound semiconductor-based components and subsystems for the fiber-optic and solar power markets, has been awarded a solar panel manufacturing contract by aerospace, defense, and commercial products firm ATK of Arlington, VA, USA to utilize ZTJ triple-junction solar cells in the new lightweight and highly efficient ATK Ultraflex solar arrays. The solar panels will be used to power cargo delivery spacecraft for Orbital Sciences Corp's Commercial Resupply Services (CRS) missions to the International Space Station (ISS).

Under contract with NASA, Orbital will provide cargo logistics support services to the ISS, beginning in 2012. Emcore's solar panels will be assembled into deployable solar arrays by ATK's Solar Arrays and Deployables business in Goleta, CA. The arrays will then be delivered to Orbital Sciences Corp for integration into its Cygnus space vehicles.

"Coupling Emcore's heritage of providing highly efficient and reliable photovoltaics with ATK's lightweight Ultraflex solar array design will result in a winning solution to produce the most advanced and reliable power to ensure Orbital's Cygnus spacecraft is the long-term solution for the automated transport of goods to the International Space Station for many years to come," reckons Dave Messner, general manager of ATK's Solar Arrays and Deployables business.

"Emcore values our long-standing business relationship with ATK," comments Emcore's chief operating officer Christopher Larocca. "We look forward to working with ATK to support Orbital and NASA for these important missions," he adds.

With a beginning-of-life (BOL) conversion efficiency nearing 30% and the option for a patented, onboard monolithic bypass diode, Emcore's multi-junction solar cells provide the highest available power to interplanetary spacecraft and earth-orbiting satellites, it is claimed.

www.atk.com

Southwest Solar demonstrates CPV system technology

Southwest Solar Technologies Inc has announced the successful on-sun testing and proof of concept of a concentrating photovoltaic (CPV) solar power technology that leverages other core competencies of the company and will be a new addition to its product portfolio. Product development and testing is conducted at the firm's headquarters and operations facility at Southwest Solar Research Park in Phoenix, AZ.

Southwest Solar says that CPV technology is widely acknowledged to have the potential to be less costly than current flat-panel and thin-film PV products by exploiting the very high efficiency of CPV cells, and hence producing electricity at a lower cost per kWh. CPV cells have reached over 40% efficiency in production, and are expected to achieve in excess of 50% according to current development efforts. Also, in sunny climates the two-axis tracking of CPV systems increases annual energy production by up to 30% or more, compared with standard non-tracking PV systems.

The firm says that the new patent-pending design uses currently available multi-junction solar cells combined with what are claimed to be innovative approaches to concentrator optics, thermal management, power electronics, and ease of manufacturing.

The product demonstrates what is claimed to be a unique flux management capability that enables non-uniform light intensity to be used, enabling integration with a variety of optical systems including conventional concentrating solar power (CSP) solar dishes and heliostat systems, instead of being limited to special purpose-built optics and lenses. This can create broad market potential, it is reckoned. The system translates CSP concentrated light to efficiently deliver 1200 suns to the CPV cells.

The new patent-pending design uses currently available multi-junction solar cells combined with what are claimed to be innovative approaches to concentrator optics, thermal management, power electronics and ease of manufacturing

Additionally, the new CPV system uses internal liquid-to-air cooling, which can also deliver free heat for on-site customer use, enabling combined heat and power (CHP) applications.

The primary factors that should lead to lower cost per kWh power include high efficiency, a design focus on low-cost components and manufacturing processes, the ability to configure the product to leverage a variety of CSP optics, and the CHP potential, reckons Southwest Solar.

"This new product introduction utilizes the company's core competencies in our solar dish concentrator designs and structures, thermodynamics, optics, and electronics," says CEO Brad Forst. "Leveraging our competencies into a diverse product portfolio is key to our business strategy," he adds.

www.swsolartech.com

Fraunhofer and CEA-LETI researchers receive Franco-German Business Award

Research team awarded for developing reusable substrates for III-V multi-junction solar cells

On 5 December in Paris, a team of researchers from the Fraunhofer Institute or Solar Energy Systems ISE in Freiburg, Germany and the Carnot-Institut Laboratoire d'électronique des technologies de l'information (CEA-LETI) in Grenoble, France were honored for their international research in developing reusable substrates for III-V multi-junction solar cells by being presented with the Franco-German Business Award 2011 by the Franco-German Chamber of Commerce and Industry AHK.

The award is presented in recognition of best practices over the past two years. Patrons of the award are the French Minister of Economy, Finance and Industry François Baroin and the German Federal Minister for Economics and Technology Dr Philipp Rösler.

Multi-junction solar cells are particularly efficient as they can achieve efficiencies of up to 43% (twice that of conventional solar cells made of crystalline silicon). The technology is used in concentrator photovoltaics (CPV), where lenses focus the light of the sun 500 times onto small solar cells. Concentrator systems produce solar electricity on a large scale, particularly in power plants in areas rich in sunlight. Among the producers of such CPV systems is Freiburg-based SOITEC Solar GmbH, which was spun off from the Fraunhofer ISE in 2005 as Concentrix Solar GmbH before being acquired in December 2009 by SOITEC of Bernin, France, which makes engineered substrates including silicon-on-insulator (SOI) wafers (and III-V epiwafers through its Picogiga International division).

The multi-junction solar cells consist of about 30 semiconductor layers built up layer by layer on germanium or gallium arsenide substrates. However, these materials are very costly. So, in a joint Franco-German project, researchers at ISE and CEA-LETI are developing new, reusable substrates for multi-junction solar cells. Until now the solar cells had to remain in place atop the germanium or GaAs crystals, but now they are removable from the new substrate, which can be recycled several times. This can reduce the cost of producing solar cells by up to 20%, it is reckoned.

Fraunhofer researchers receive the Franco-German Business Award 2011, from right to left: Guy Maugis (president Deutsch-Französische Industrie- und Handelskammer), Jos Lenferingk (president VEKA), Bruno Bouygues (director general GYS), and Patrick Schnell (Total Deutschland).

"In the Solar-Bond project, two high-tech institutes have combined their skills," says Dr Frank Dimroth, head of Department III-V - Epitaxy and Solar Cells at Fraunhofer ISE. "CEA-LETI is a leader in the microelectronics field and Fraunhofer ISE in photovoltaics," he adds. CEA-LETI develops the substrate and adapts its properties to the requirements of growing multi-junction solar cells; Fraunhofer ISE then applies the cells to these substrates and processes them to create ready-to-use devices. The researchers are also working closely with SOITEC: in future, the new solar cells will be used in their concentrator modules.

Solar-Bond is one of 26 projects sponsored under the Programme Inter Carnot Fraunhofer (PICF), which is jointly run by Germany's Federal Ministry for Education and Research (BMBF) and France's National Research Agency (Agence Nationale de la Recherche, ANR) for collaborative research and innovation projects between Fraunhofer Institutes (FhI) and Carnot Institutes (IC). The PICF aims to establish strategic partnerships between French and German research and industrial organizations.

www.leti.fr/en
www.ise.fraunhofer.de
www.programme.inter.carnot.fraunhofer.org

GreenVolts raises $35m in funding

ABB takes stake in utility-scale CPV system maker

As part of a $35m financial round raised by concentrating photovoltaic (CPV) system maker GreenVolts Inc of Fremont, CA, USA that includes existing GreenVolts investor Oak Investment Partners, global power and automation technology group ABB of Zurich, Switzerland is to invest about $20m in exchange for a substantial minority stake.

Made through ABB's venture capital arm ABB Technology Ventures, the investment gives ABB access to GreenVolts' proprietary technology and enables it to offer turnkey solutions for CPV power plants in addition to its existing capabilities in solar thermal and conventional photovoltaic power plants.

GreenVolts says that its CPV system is more efficient than traditional photovoltaic and thin-film modules. By optimizing and integrating field-proven, high-performance components such as proprietary optics and tracking technology into a complete system, energy yields can be 30–40% higher than traditional panel-based systems.

"Every component was carefully designed to work together in a turnkey solution that dramatically reduces the cost and complexity of solar projects," says president & CEO David Gudmundson. "With ABB's global presence and expertise, these benefits will now be available to customers worldwide," he adds.

"The technology combines simplicity and precision with unmatched performance, fast installation, easy operation and low cost of production," comments Peter Leupp, head of ABB's Power Systems division. "Our extensive footprint, which covers all key solar markets in the world, will help us to make this technology globally accessible," he reckons.

GreenVolts solar systems are designed to meet the operational requirements of a wide range of applications for utilities and industries as well as commercial, agricultural, and public sector customers. The technology complements ABB's recent acquisition of a stake in Novatec Solar, a provider of linear Fresnel concentrating solar power technology.

ABB's portfolio for the photovoltaic industry comes from across the entire spectrum of ABB's power and automation technologies and services and includes solar inverters, components for module tracking systems, low-voltage components and accessories, products and solutions for solar module and cell manufacturing plants, as well as for total solar fields and grid connections.

www.abb.com

GreenVolts claims first fully integrated solar system

GreenVolts has unveiled what it claims is the first complete and fully integrated solar system, including modules, trackers, inverters, energy management software, networking, AC and DC disconnects, and all DC wiring. The firm says that, through control of the entire system design, it has improved performance, simplified project engineering and installation, and reduced costs in all stages of the project lifecycle.

"Customers get simplicity, elegance and precision in a utility-scale solar system that delivers higher performance and richer energy management," claims president & CEO David Gudmundson.

Traditional PV systems consist of parts sourced from different suppliers, including solar panels, inverters, trackers and monitoring. These are not designed to work specifically with each other, so overall system performance suffers, says GreenVolts. In contrast, the firm is providing a complete and fully integrated solar system, with installations producing 30–40% more energy than traditional PV, it is reckoned.

The GreenVolts solution includes ISIS energy management software, which was designed with, and fully integrated into, the complete solar system and hence offers deeper access and more sophisticated capabilities than are available in third-party software products, the firm claims. ISIS includes: real-time monitoring of site conditions and energy production; extensive fault isolation and diagnostics at the site, system or component level; inventory and asset management; operation and maintenance logs; hundreds of alerts and alarms; extensive and programmable reporting capability; and remote access and control of the entire system. ISIS is Internet-based, secure, fast and accessible from a PC or mobile device, the firm adds.

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

"Having built numerous solar projects from various solar vendors, we appreciate the fast and efficient installation of the GreenVolts system, which minimizes the possibility of mistakes, thus providing better cost estimates and on-time schedules," comments Brian Bothman, VP at Robert A. Bothman Construction Inc. "Their approach simplifies everything, from logistics and site engineering, training and installation, to final commissioning," he adds.

www.greenvolts.com

Soitec buys San Diego manufacturing site

New facility to produce 200MW of Concentrix modules per year

Soitec of Bernin, France, which makes engineered substrates including silicon-on-insulator (SOI) wafers (as well as III-V epiwafers through its Picogiga International division), has acquired (from Sony Electronics Inc) a manufacturing facility in Rancho Bernardo, CA, USA (within San Diego City limits), where it will produce Soitec's fifth-generation Concentrix concentrator photovoltaic (CPV) modules for the US market.

The project represents an investment of more than $150m, and will create 450 on-site jobs and more than 1000 indirect jobs at the full annual manufacturing capacity of 200MW of modules per year. Future expansion will double the capacity to 400MW per year. The investment includes acquiring a 176,000ft^2 manufacturing center on 14.8 acres of land within the campus of Sony Electronics' US headquarters. Soitec will begin extensive upgrade of the facilities in early 2012 and plans to have its first-phase (100MW) production line operational by Q4/2012. M+W US Inc, a subsidiary of the M+W Group (a global engineering and construction partner for technology-based clients and renowned in constructing solar cell manufacturing facilities), has been selected as general contractor for the facility construction work.

Sited inside the San Diego factory will be the joint venture Reflexite Soitec Optical Technology LLC (announced in November), which will operate its own 100-person operation, developing and manufacturing silicone-on-glass (SOG) Fresnel lens plates for the modules.

"Bringing Soitec's solar manufacturing business here has been an example of successful collaboration between the city, the non-profit CleanTECH San Diego, the San Diego Regional Economic Development Corporation, San Diego Gas & Electric (SDG&E) and the University of California, San Diego," says San Diego mayor Jerry Sanders.

"This year we have signed a half-dozen renewable energy contracts with solar developers that will use Soitec's highly efficient technology," says SDG&E's chairman & CEO Jessie J. Knight Jr. "We will continue to make great strides in securing contracts for utility-scale renewable projects to leverage the ideal solar, geothermal and wind resources in the San Diego County, Imperial County and Baja California region," he adds.

"Having already announced our solar projects contracted with San Diego Gas & Electric, it makes perfect sense for us to launch our US manufacturing operations here," says Soitec chairman & CEO André Jacques Auberton-Hervé. "With strong support from the mayor and the City of San Diego, we look forward to taking part in the local economy amid the area's large pool of trained and educated high-tech employees, the vibrant business community and the strong cluster of renewable-energy companies," he adds. "We want to help California meet its Renewable Portfolio Standard, which calls for a third of the state's utility-scale energy production to be generated by renewable sources by 2020."

Soitec's CPV systems have enabled the firm to plan for more than 300MW in solar power plant projects throughout the Southwest USA, including 155MW in power purchase agreements with SDG&E (enough to serve more than 60,000 households per year), approved by the California Public Utilities Commission (CPUC) in November. Also approved on 15 December was a power purchase agreement for up to 150MW (enough to supply 55,000 homes) for the Imperial Solar Energy Center West project, which SDG&E in March contracted out to project developer Tenaska Solar Ventures (an affiliate of independent energy company Tenaska).

www.soitec.com

Soitec wins its first Chinese order for CPV systems

Fulfilling its first order for solar systems from China, Soitec has shipped its Concentrix CPV systems to renewable-energy power plant developer Focusic (China) New Energy Holding Co Ltd of Zhengzhou as part of a partnership deal between the two firms.

"We are impressed by the ultra-high efficiency of Concentrix technology and by the experience that Soitec has amassed through extensive R&D work, dating back to the technology's origin at Fraunhofer ISE," comments Focusic's managing director Ma Wenxing.

"The renewable-energy market in China presents exciting prospects," says Hansjörg Lerchenmüller, senior VP, customer group for Soitec's Solar Energy business unit.

Soitec's equipment will be used to build a 3MW CPV plant in Hami, a city on the edge of the Taklamakan desert in Xinjiang province. Its CPV technology is suited to installations in ecologically sensitive desert areas since the land does not need to be graded and the indigenous plant life is not negatively impacted by shading. Concentrix also requires no water for cooling.

With module efficiency of up to 30% and low installation and maintenance costs, CPV is the most cost-efficient solution for high-volume generation in regions with high direct normal irradiance (DNI), says Soitec. China contains about 500,000 square miles of area with high DNI ratings as well as huge, growing demand for energy.

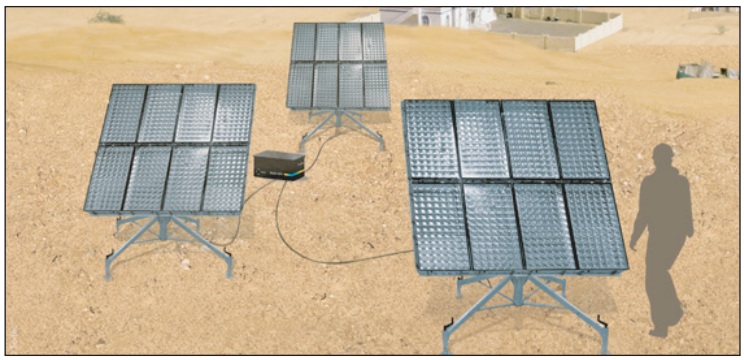
Soitec launches first portable CPV mini-tracker designed for remote applications

Soitec has expanded its family of concentrator photovoltaic (CPV) products with its Plug&Sun system, which is claimed to be the first stand-alone mini-tracker consisting of 3m^2 of highly efficiency modules.

The new system is designed for use in highly sunny regions with no power grid or unreliable grid connections. The mobile power-generating station's durability and tolerance to high temperatures make it suited to remote usage.

The stand-alone mini-tracker aims to supplement or replace existing electrification solutions, such as power generators or other forms of renewable energy. It delivers what is claimed to be superior energy efficiency, eliminates any reliance on fuel supplies, and needs very little maintenance.

With efficiency close to 30%, each Plug&Sun uses a two-axis tracker to generate up to 2.3kWp of electricity. Soitec says that it is compatible with the different electrical standards, allowing it to power common electrical devices simply and rapidly, 24 hours a day, seven days a week thanks to its batteries.



Artist's impression showing size of CPV mini-tracker.

Soitec reckons that the mini-tracker will be of specific interest to businesses and organizations looking for installations that are easy to transport and install. It suits bringing electricity to an isolated village, equiping a school, a dispensary or a hospital with electrical infrastructure, and helping to open up a region by setting up an RF antenna to power electronic devices.

"It takes just a few hours to set up three Plug&Sun mini-trackers, which can generate 12kW on a daily basis, the equivalent of the amount of electricity needed for a village," says president & CEO André-Jacques Auberton-Hervé. "It will ease access to electricity for the 20% of the worldwide population which lives without electricity today,"he adds.

Soitec has begun taking prototype orders for the Plug&Sun system. Shipments of production units are expected to begin in 2012.

www.soitec.com

Sunidarity initiative launched with donation of Plug&Sun CPV mini-tracker to three development aid organizations

Soitec of Bernin, France, which makes engineered substrates including silicon-on-insulator (SOI) wafers (as well as III-V epiwafers through its Picogiga International division), intends to provide remote locations in very sunny regions with a solution facilitating access to electricity due to its concentrator photovoltaic (CPV) technology. Soitec is launching the first edition of its Sunidarity program for development aid organizations in order to support their efforts to promote economic and human development in these remote regions.

Soitec will support selected projects by donating its new Plug&Sun CPV mini-tracker. Consisting of 3m^2 of high-efficiency modules with efficiency close to 30% and using a two-axis tracker to generate up to 2.3kWp of electricity, the Plug&Sun is claimed to be the first stand-alone mini-tracker, and can be used to generate electricity completely autonomously where it is needed most.

At present, 20% of the world's population does not have access to electricity, but the vast majority of the affected regions boast tremendous potential for solar energy, says Soitec. Greater use of solar energy can help to combat both climate change over the long term and energy poverty, but this drive is reliant on technological innovation and on collective development aid initiatives, it adds.

Soitec says that it will choose the three projects that stand out in terms of: their innovation (achieving a genuine advance in local development); the difficulty of the challenge they overcome; and their degree of integration within a global development project. All applications will be considered (education, information, communication, health, agriculture, etc).

Soitec reckons that its mini-tracker should be of particular interest to organizations looking for installations that can be transported and set up easily. Organizations can submit their applications by 15 April 2012 directly on Soitec's web-site.

As part of the Sunidarity initiative, Soitec is also setting up a partnership with global energy management specialist Schneider Electric to contribute to its energy and electrification of isolated areas access program.

www.soitec.com

South Africa's first CPV plant inaugurated as COP17 solar flagship legacy project

On 4 December President Dr Jacob G. Zuma officially inaugurated South Africa's first 500kW concentrator photovoltaic (CPV) power plant, which uses Concentrix CPV systems made by Soitec Solar GmbH in Freiburg, Germany (a subsidiary of Soitec of Bernin, France).

As the solar flagship legacy project for the 17th annual Conference of the Parties (COP17) to the United Nations Framework Convention on Climate Change (UNFCCC) in Durban, South Africa from 28 November to 9 December, the inauguration ceremony was attended by nearly 200 guests including the COP17 president and Minister of International Relations & Cooperation, the Minister of Environmental Affairs, the Minister of Energy, the Minister of Economic Development as well as French, German and British governmental officials and their respective ambassadors.

The solar plant in Hazelmere (next to Durban), installed by Soitec and developed in partnership with the Department of Environmental Affairs (DEA) and eThekwini Municipality, was constructed in just one month to showcase the country's commitment to lowering its carbon footprint through the deployment of renewable energy during COP17. Group Five (an integrated construction services, materials and infrastructure investment group operating in Africa) was the construction partner for the project.

South Africa's President Dr Jacob G. Zuma (left) opening the CPV plant, with Soitec's president & CEO André-Jacques Auberton-Hervé on the right.

"This is South Africa's first large-scale offering within the clean energy arena, but it is not the last," said Zuma in his keynote address. "We e are ready to forge and support those partnerships that will enable us to embark on the journey to a low-carbon economy, while stimulating economic development and creating jobs," he added.

"This project has already started contributing towards the Integrated Resource Plan 2010, which outlines 42% of renewable energy by 2030 and leaves a legacy for COP 17," said Minister of Energy Ms Dipuo Peters in her speech. "This is an exciting development for South Africa and will be the forerunner of a range of renewable energy projects currently being developed in the country. This CPV is connected to the electricity distribution supply grid of the city to augment the power supply to the ICCC where the UNFCCC COP 17 is being hosted to reduce the carbon footprint of the event," she added. "This clearly demonstrates the state of readiness in the municipal's energy planning and installation of this 500kW as a first phase. It is even more encouraging to see that the Municipality is a buyer of this clean electricity."

The 500kW solar plant consists of 32 two-axis tracking systems, delivering constant power output feeding into the area's power-supply grid. The Fresnel lens used in the modules focuses sunlight concentrated by a factor of 500 on the solar cells beneath, yielding what is claimed to be world-leading module efficiency of close to 30%.

www.soitec.com

Soitec selected as preferred bidder under South Africa's independent power producer program

Soitec has been selected by South Africa's Department of Energy as one of the preferred bidders under the country's independent power producer (IPP) program. Soitec's initial project under the program is to install a 50MW-peak CPV plant in Touwsrivier, Western Cape, next to the Aquila Private Game Reserve, where Soitec has already installed a solar pilot plant.

According to the Department of Energy, South Africa's goal is to generate 42% of all new electricity from renewable energy sources over the next 20 years. In the IPP program, the Department of Energy has received over 300 applications for grid connection.It says that it has applied very strict selection criteria in reviewing the applications and, in its first round of procurement decisions, approved the project proposal submitted by Soitec in partnership with Schneider Electric of South Africa.

Soitec developed the project from inception to its current status of preferred bidder, including conducting the environmental impact assessment and obtaining all the required permits. For the construction phase, it will supply CPV systems and expertise while Schneider Electric will provide engineering, procurement & construction (EPC) as well as operation and maintenance (O&M) based on its footprint in South Africa.

First Solar begins construction of Australia's first utility-scale solar farm

First Solar Inc of Tempe, AZ, USA, which manufactures thin-film photovoltaic modules based on cadmium telluride (CdTe), says that construction has started on the 10MW AC Greenough River Solar Farm, located 50km south of Geraldton, Western Australia. Once completed, it will be the first utility-scale PV project in Australia and will bring significant investment to the local community through a partnership with local contractor WBHO Civil (which has been awarded the Phase 1 construction contract for the project).

Construction is scheduled to last about nine months. Following civil engineering work, the project will progress to on-site construction of structural supports and the completion of above-ground electrical works. Installation of First Solar PV modules should start in March, with the solar farm expected to be fully operational by mid-2012.

Western Australian state-owned power utility Verve Energy and GE Energy Financial Services each own 50% of the Greenough River Solar Farm, with the WA Government providing A$20m (including A$10m from the WA Royalties for Regions program).

First Solar will supply the project with more than 150,000 modules and provide engineering, procurement and construction (EPC) services. Through the partnership with WBHO Civil, and in the sourcing of local products, the project is expected to generate millions of dollars for the City of Greater Geraldton's economy. Up to 150 people will be on site at any one time throughout the construction phase, with jobs lasting for up to nine months.

"First Solar aims to maximize local hiring and enable the project to make a meaningful and lasting contribution to regional communities," says Jack Curtis, VP, business development & sales for First Solar. "We are also building our in-country supply chain network by procuring as many materials as possible from local suppliers at all stages of the construction process," he adds.

"Increased localization is critical to the development of a sustainable large-scale solar industry in Australia," Curtis continues. "Developing a local capability to install utility-scale solar projects, together with stable government policy, will greatly improve the industry's long-term outlook."

WBHO Civil will play a pivotal role in providing site preparation services, underground electrical services and civil works. The firm's local expertise and network across Western Australian will ensure that the Greenough River Solar Farm is built to the highest possible standards, says First Solar.

www.firstsolar.com

First Solar to build, operate & maintain 66MW Alpine Solar Project for NRG Energy

Cadmium telluride (CdTe) thin-film photovoltaic module maker First Solar Inc of Tempe, AZ, USA, has agreed to provide engineering, procurement and construction (EPC) services for the 66MW (AC) Alpine solar project in Lancaster, CA of NRG Energy Inc of Princeton. NJ. The firm will also provide operations and maintenance (O&M) services. Construction is expected to start before the end of 2011 and be completed in third-quarter 2012, creating an estimated 250 jobs over the course of construction.

Electricity from the Alpine project in Los Angeles County will be sold under a 20-year power purchase agreement with Pacific Gas and Electric Company, helping California to meet its ambitious renewable energy goals.

The electricity generated by Alpine is enough to serve a yearly average of nearly 25,000 homes, and more than double that number at maximum capacity during peak hours of the day. The project is expected to offset about 1.5 million metric tons of greenhouse gases over 20 years (equivalent to taking more than 15,000 cars off the road annually).

Less than two years ago, NRG and First Solar began our productive collaboration for our first solar plant at Blythe, which at 21MW was the largest solar plant in California

"Less than two years ago, NRG and First Solar began our productive collaboration for our first solar plant at Blythe, which at 21MW was the largest solar plant in California at the time," says Tom Doyle, president of NRG's Solar and West Region. "Alpine is three times that size, so we've really come a long way together in a short amount of time," he adds. NRG subsidiary NRG Solar has more than 2000MW of PV and solar thermal projects under development or in construction across the southwestern USA.

"Our experience developing and building out our 2.7GW North American pipeline of utility-scale PV projects enables us to get our customers' projects rapidly completed and connected to the grid," comments Jim Lamon, First Solar's senior VP for EPC and O&M.

www.nrgsolarenergy.com.

First Solar cuts 2011 financial guidance further, to just 10% up on 2010

...but 35% revenue growth expected in 2012 as CdTe PV maker refocuses from subsidized to sustainable markets

First Solar Inc of Tempe, AZ, USA, which makes thin-film photovoltaic modules based on cadmium telluride as well as providing engineering, procurement and construction (EPC) services, has lowered its 2011 financial guidance, due mainly to continued delays of certain projects in its systems business (attributed to "weather and other factors").

After already reducing its guidance for 2011 net sales from $3.7–3.9bn (given in December 2010) to $3.7–3.8bn (in February) then $3.6–3.7bn (in August) and $3.0–3.3bn (at the end of October), First Solar has cut its forecast again, to $2.8–2.9bn. This represents growth of10% on 2010's $2.6bn (versus October's forecast of 23%).

Likewise, after being cut from guidance of $900–970m in May then $900–960m in August and $650–760m in October, operating income guidance has been cut further, to $575–600m. Correspondingly, after being cut from guidance of $9.25–9.75 to $9.00–9.50 then $6.50–7.50, guidance for earnings per diluted share (EPS) has been cut further to $5.75–6.00.

Not included in the latest guidance are expected charges related to initiatives to accelerate operating cost reductions and improve overall operating efficiency, most of which should be incurred in the current quarter. These charges include up to $0.75 per fully diluted share of impairment and associated charges related mainly to certain equipment, and a severance charge of up to $0.10 per fully diluted share for a workforce reduction of about 100 associates (less than 1.5% of First Solar's workforce).

For 2012, First Solar forecasts sales of $3.7–4.0bn, including $1.7bn from the systems business. This would be up 35% on the latest 2011 sales guidance. However, the firm expects drops in consolidated operating income to $425–450m and in diluted EPS to $3.75–4.25. Nevertheless, it expects to generate $0.9–1.1bn of operating cash flow, and plans capital investment of $375–425m in 2012.

"Our diverse business model and robust project pipeline will help First Solar generate a significant amount of cash in 2012 while improving operational efficiencies, but we are recalibrating our business to focus on building and serving sustainable markets rather than pursuing subsidized markets," says chairman & interim CEO Mike Ahearn. "By channeling our core strength in utility-scale PV systems to markets with immediate need for mass-scale renewable energy, our goal is to earn substantially all of our new revenues from sustainable markets by the end of 2014."

First Solar combines Utility Systems business group and Components business group into Global Business Development

First Solar is to consolidate its worldwide sales and project development activities under Jim Brown, performing the new role of president, Global Business Development. Brown joined First Solar in 2008 as VP, project finance, and was made president of the Utility Systems business in August. He previously worked in banking for 20 years, covering project and structured finance for the energy and industrial sectors.

The move combines First Solar's Utility Systems Business Group and Components Business Group under a unified global structure encompassing sales, project development, product management and the customer service and technical services groups. As a result, TK Kallenbach will leave First Solar on 1 January 2012. He joined the firm in December 2009 as executive VP of marketing and product management and was made president of the Components Business Group last February. Previously, he worked for Honeywell Aerospace for 30 years in senior business, technical and strategy leadership positions.

First Solar has also reorganized its finance and accounting groups to optimize efficiency. As a result, chief accounting officer James Zhu has elected to leave the firm to pursue other opportunities. He joined First Solar in 2007 as VP & corporate controller and has been chief accounting officer since 2009. Previously, he was VP & corporate controller at Salesforce.com. Chief financial officer Mark Widmar will add the chief accounting officer role to his responsibilities effective 1 February. He joined First Solar in April from Graftech International Ltd, where he was CFO. Prior to joining Graftech in 2006, he held senior posts in finance and controlling at NCR, Dell and Lucent. Widmar is a Certified Public Accountant (CPA). Zhu will stay with First Solar until 1 May to ensure a smooth transition.

"These changes support our broader effort to reposition First Solar to lead the industry through the current market turbulence, and to better serve our customers around the world with comprehensive solar energy solutions," says chairman & interim CEO Mike Ahearn.

MidAmerican acquiring 550MW Topaz Solar Farm

MidAmerican Energy Holdings of Des Moines, Iowa has entered into definitive agreements to acquire the Topaz Solar Farm from First Solar.

Incorporating CdTe PV modules made at First Solar's factories in Perrysburg, OH, and Mesa, AZ, the 550MW plant being built in San Luis Obispo County, CA will have to enough generating capacity to power 160,000 average California homes (displacing 377,000 metric tons of CO_2 per year). The more than $2bn Topaz solar farm is one of the two largest PV projects in the world (both being built by First Solar).

Pacific Gas and Electric Company will purchase the electricity under a 25-year power purchase agreement, helping California to meet its mandate to generate 33% of its power from renewable sources by 2020.

As well as constructing the plant, First Solar has agreed to operate and maintain the Topaz project for MidAmerican. Construction began in November and is expected to be complete by early 2015. The project will create about 400 construction jobs and 15 ongoing operations and maintenance jobs. According to an economic benefits study by The Brattle Group and California Polytechnic State University, the project is estimated to infuse $417m into the local economy (generated mostly during construction, with the remainder over the project's minimum 25-year operating period).

"MidAmerican is the No. 1 owner of wind-powered energy generation among US rate-regulated utilities. Adding solar energy to our generation portfolio is a strategic move to invest in yet another renewable energy source," says chairman, president & CEO Greg Abel. "This project also demonstrates that solar energy is a commercially viable technology without the support of governmental loan guarantees."

Previously, on 30 June, the US Department of Energy (DOE) offered a conditional commitment for a partial loan guarantee of $1.93bn for First Solar subsidiary Topaz Solar Farms LLC. However, on 22 September First Solar said Topaz would not meet the end-September deadline to receive the federal loan guarantee, and that it was in talks regarding the sale and financing of the project with potential buyers utilizing a different transaction structure not requiring a DOE loan guarantee. This followed a lawsuit against the project filed by North County Watch and Carrizo Commons. This was dismissed in early October after Topaz committed to the decommissioning and restoration of habitat at the site after 35 years of operation, placing a conservation easement on the land and providing an endowment for managing the land in perpetuity, and providing enhanced communication, collaboration, research and monitoring measures.

The closing of MidAmerican's acquisition of Topaz is contingent on the satisfaction of certain conditions in the sale agreement, including required actions with respect to the project's permits and electrical interconnection arrangements.

www.midamerican.com

First Solar's head of Government Affairs to also lead European sales

First Solar says that Christopher Burghardt will lead sales operations in Europe in addition to his current responsibilities leading Government Affairs in the region. He will report to Jim Brown, president of Global Business Development, and will continue to report to Maja Wessels, executive VP of public affairs, with respect to his Government Affairs responsibilities. Stephan Hansen, who has led First Solar's European sales organization for the past seven years, will leave First Solar on 1 May.

Both moves are part of a realignment of the European sales team amid the broader consolidation of worldwide sales and business development that has merged its Utility Systems Business Group and Components Business Group under a unified global structure.

"Christopher has a deep understanding of European markets that will be invaluable as we position our sales effort to develop sustainable, utility-scale energy opportunities," says Brown. "Stephan's helped found our European business and led it, with deep customer relationships, to more than $1bn in annual sales and 4GW of cumulative sales. Stephan will work with us to ensure a smooth transition," he adds.

Burghardt joined First Solar in September 2009 as VP of Government Affairs for EMEA. Previously, he was most recently VP for corporate affairs of Anheuser-Busch InBev for Western Europe and a VP for business development and marketing EMEA at Hill & Knowlton in the EMEA region. He is a dual German–Belgian national and earned an MBA from the Wharton School of Business at the University of Pennsylvania, a master's degree from the College of Europe, and a bachelor's from the University of Sussex and the Institut d'Etudes Politiques of Aix-en-Provence.

Hansen joined First Solar as managing director for the EMEA region in 2004. At the same time he was VP for sales, market strategy and customer service. Previously, he spent 5 years in the USA, first as general manager of an R&D venture, then starting his career in the photovoltaics industry as chief operating officer of Schott Applied Power, a distribution and engineering, procurement & construction provider and VP of sales & marketing for RWE Schott Solar. He earned his master's degree in mechanical engineering from the University of Stuttgart.

Q-Cells reports CIGS PV test module with record aperture-area efficiency of 17.4%

Solibro subsidiary raises its record from March's 14.7%

Q-Cells SE of Bitterfeld-Wolfen, Germany, which manufactures both silicon and thin-film copper indium gallium diselenide (CIGS) thin-film solar photovoltaic (PV) modules, says that a Q.SMART test of its subsidiary Solibro GmbH has raised its record for thin-film PV aperture-area module energy conversion efficiency to 17.4%, as verified independently by the Fraunhofer Institute for Solar Energy Systems (ISE) of Freiburg, Germany.

Despite measuring just 16cm^2, the module was fabricated using processes fully scalable to cost-effective mass production, says Q-Cells, since the co-evaporation CIGS process uses metal flux profiles, temperature profiles and process time similar to Solibro's current production technology.

The CIGS technology behind Q.SMART was developed in 1983 by the Ångström Solar Center at Uppsala University, Sweden, commercialized by the spin-off company Solibro in 2006, and acquired by Q-Cells in 2009. Q-Cells says that it has held the efficiency record for series-produced thin-film modules since 2009. This March, a Q.SMART module set the existing efficiency record for monolithically integrated CIGS thin-film modules in series production, with an independently confirmed aperture-area efficiency of 14.7%.

The Q.SMART CIGS PV technology harnesses a 'light-soaking effect' (claimed to be unique in the thin-film sector) that can boost output by an average of 2.5% above nominal power in standard field test conditions. Also, their capacity to produce high yields even when light is poor or the climate is hot makes the modules suitable for a diverse range of applications, from roof-mounted systems for residential customers to commercial roof-mounted systems and large ground-mounted utility-scale installations, claims Q-Cells. At the end of 2010, total production capacity in Thalheim, Germany had reached 135MWp.

"The current record [of 17.4%] verifies the feasibility of the efficiency roadmap of the Q.SMART module, targeting an average aperture efficiency out of series production of up to 16.7 % in 2016," says Solibro's chief technology officer Lars Stolt.

www.q-cells.com

Avancis' second plant begins operation, boosting production capacity six-fold

Commercial market launch of new product planned for Q1/2012

Avancis GmbH of Torgau, Germany, which since autumn 2009 has been a subsidiary of Saint-Gobain of Courbevoie, France (which designs, makes and distributes building materials and electronic materials), has begun production of its copper indium selenide (CIS) thin-film PV modules at its second plant. The new factory has an annual capacity of 100MWp per year (expanding Avancis' total production capacity six-fold, from 20MWp to 120MWp).

Construction began in June 2010 and was completed on schedule within just 18 months. At peak production on an area of 25,000m^2, the firm can now produce more than 800,000 modules annually – enough to supply a town of 15,000 inhabitants with electricity for a year. With more than 200 new jobs created, Avancis' staffing will double from 250 to almost 500.

"Developed and built by our own factory planning team and equipped with the most modern equipment by established German equipment manufactures, we will produce the next generation of CIS solar modules," says CEO Hartmut Fischer.

The multiplication of production capacity also means an expansion of the module portfolio. As part of this, Avancis is bringing together its existing and new product lines under the PowerMax brand. The established product line that (which has used this name until now) will be renamed PowerMax STRONG as of 1 January; the module design and functions of the product line will remain unchanged. The new product line (whiuch will be produced in the new plant) will be launched on the market in spring 2012 under the name PowerMax SMART.

The new product line (including all necessary quality certificates) should be commercially available by the end of first-quarter 2012. "By then we will also have concluded the start-up phase of the new facility as well as the certification of the new product line," says Fischer.

To mark the commercial market launch of PowerMax SMART, Avancis is planning an event in Torgau in spring 2012, to be attended by investors, politicians and customers. Until then, the new product line (currently in the certification phase) will be available upon request.

Avancis is also in the process of building a third plant (with an annual capacity of 100MWp) in South Korea as part of the Hyundai-Avancis joint venture, which was formed in October 2010 between Saint-Gobain and Hyundai Heavy Industries Co Ltd (HHI).

www.Avancis.de

Stion raises $130m in Korean-led funding round; partners with tool maker AVACO

CIGSSe PV firm to continue US expansion and form Korean manufacturing subsidiary

Stion Corp of San Jose, CA, USA, which makes nanostructure-based CIGSSe (copper indium gallium sulphur-diselenide) thin-film photovoltaic panels, has raised $130m in an equity investment round led by AVACO of Daegu, Korea (which makes vacuum-based thin-film coating equipment for flat-panel display manufacturing) and Korean private equity funds, joined by existing investors Khosla Ventures, Taiwan Semiconductor (through VentureTech Alliance), Lightspeed Venture Partners, Braemar Energy Ventures, and General Catalyst Partners.

Founded in 2006 as Nstructures, Stion raised $15m in June 2007 in a Series B financing round led by Lightspeed Venture Partners and joined by General Catalyst Partners along with previous investors Khosla Ventures and Braemar Energy Ventures. In June 2010, these added $20m to $50m invested by the world's largest semiconductor foundry Taiwan Semiconductor (TSMC) — via its affiliate VentureTech Alliance — in a $70m Series D round of fundraising to help scale production (boosting the total raised since 2006 to $114.6m). Stion also formed a strategic partnership with TSMC covering technology licensing, supply, and joint development.

Starting with a 10MW-capacity product line in San Jose, Stion makes modules using what is claimed to be a simple, low-cost monolithically integrated circuit design. With a convenient 65cm x 165cm form factor, the glass–glass CIGSSe PV panels are designed for use in major market segments including commercial/government, residential, utility and off-grid. Stion received its UL 1703 and IEC 61646 product certifications in January.

In September, Stion opened its first mass-production facility in Hattiesburg, MS, USA and produced what was claimed to be the most efficient monolithic thin-film circuit at production scale, verified at 14.1% efficiency by the US National Renewable Energy Laboratory (NREL).

With the new funding, Stion is continuing the planned expansion of its US manufacturing facility (the first phase of which includes a production line with an annual capacity of 100MW, entailing more than $100m of investment and 200 direct jobs in 2011 and 2012). In addition, the firm will make an initial investment of $35m to establish the subsidiary Stion Korea in order to build a thin-film PV module factory, targeted at serving the Asian and European markets.

"This investment and partnership represents an exceptional opportunity for Stion," says president & CEO Chet Farris. "Solar has always been a global business and this investment enables Stion to address market demand in Asia and beyond," he adds. "We have added world-class investors as well as a strategic partner with deep technical expertise."

The transaction includes a strategic partnership with AVACO, which is expanding into flexible display and thin-film PV technology. The two parties will collaborate to develop next-generation thin-film production equipment, focusing on lowering costs, improving tool productivity, and increasing module efficiency. "The strategic partnership between AVACO and Stion will accelerate each company's technology roadmap, thus enabling much faster growth for both parties," comments AVACO's chairman Jae-Gon Wee.

www.stion.com

IN BRIEF

ISET ships initial non-vacuum CIGS PV modules to customers

International Solar Electric Technology Inc (ISET) of Chatsworth, northwest of central Los Angeles, CA, USA, which makes printed thin-film copper indium gallium diselenide (CIGS) solar panels, has shipped full-sized modules from its pilot production facility to initial customers in South Korea. Initial products were designed and assembled to meet the specifications of distributed power markets as ISET targets growth in an underserved industry segment.

CIGS PV modules will supply off-grid electricity for LED lighting applications in agricultural, industrial, and transportation markets. ISET has raised just under $18m to develop a pilot facility in Southern California capable of manufacturing CIGS modules from bare glass to final module assembly.

ISET claims to be the first PV firm to ship monolithically integrated CIGS products based on a printed ink process. CEO & president Dr Vijay K. Kapur identifies this milestone as "the product of thinking globally and competitively", pointing out that "global competition has pushed prices to a level which we had anticipated from the start… I am extremely proud that we have begun to export American-made PV products based on ISET's manufacturing platform which can be truly cost competitive."

The firm's first shipments closely follow recent announcements of efficiency and yield milestones in preparation for expansion to volume manufacturing. In August, ISET announced the achievement of 11.3%-efficient prototype CIGS modules.

www.isetinc.com

Soltecture makes first 100W modules; receives ISO 9001 certification

Soltecture GmbH of Berlin, Germany, a manufacturer of CIGSe 'CIS' thin-film photovoltaic (PV) solar modules and a provider of system solutions for solar construction, has produced the first 100W solar modules from its production line in Berlin Adelsdorf, equating to an efficiency of 13.4% for the firm's Linion module.

"With our development work, we are on the best track to reaching the next milestone we have set for ourselves: 14% efficiency," says CEO & founder Nikolaus Meyer, adding that the firm will reach that by mid-2012.

Soltecture says that CIGSe thin-film modules offer enormous potential compared to competing technologies, as CIGSe-based thin film modules are the only ones to date that have reached 20% efficiency in laboratory conditions.

"We will, of course, continue to increase the efficiency of our modules," says Meyer. "Our research department continues to work full speed on optimization of the manufacturing process. The concrete projects needed to reach a 16% goal have already been tackled and drafted."

Soltecture also announced that it has received ISO 9001 certification. With this, the certification company DQS confirms Soltecture's highest innovation-driven production and service standards.

"We are very pleased with this official recognition of our quality management," says chief sales officer Henrik Kruepper. "We will use the guidelines of the certification to continuously improve our products and solutions and to streamline business processes throughout the entire company. In this way, we will remain adaptive and able to offer the highest degree of service to our clients."

www.soltecture.com

European Frost & Sullivan Award

Based on its recent analysis of the photovoltaic market, Frost & Sullivan has recognized Soltecture with the European Frost & Sullivan Award for Entrepreneurial Company of the Year.

The award is presented to the firm that has demonstrated excellence in growth strategy and innovation, has achieved innovation with its products and technologies, has shown proven leadership in offering customer value, and whose speed of response to market needs has been commendable.

"In an intensely competitive market, Soltecture GmbH has transformed its business from a mere module manufacturer to a complete system solutions provider, going beyond its core competency," notes Frost & Sullivan research analyst Neelam Patil.

www.frost.com

MiaSolé appoints former First Solar and Intel executives as CEO and president

MiaSolé of Santa Clara, CA, USA, which was founded in 2001 to make copper indium gallium diselenide (CIGS) thin-film photovoltaic panels, has appointed two executives to lead the firm into its next phase of growth. John Carrington assumes the role of CEO, and Bob Baker continues as president. Dr Joseph Laia is stepping down as CEO in order to pursue other interests.

Carrington was previously executive VP of global marketing & business development at cadmium telluride (CdTe) thin-film PV panel maker First Solar, where he directed global sales, marketing and product management initiatives, and supported its targeted expansions in Europe, Middle East, Asia and the USA. Prior to that, he spent 16 years at General Electric in a variety of global leadership roles, including four years in Japan running the Asian marketing and business development team.

Baker is a 32-year Intel veteran with experience across technology development, manufacturing, business and management. While at Intel, he managed the Technology and Manufacturing Group and also grew its NAND and SSD business to a profitable $1bn+.

"MiaSolé is entering into an important time in its evolution," says Martin Lagod, managing director and co-founder of Firelake Capital Management, on behalf of MiaSolé's board of directors. "Both John and Bob bring a wealth of experience and the right combination of skills," he adds.

MiaSolé says that the latest addition to its management team is part of the strategy to scale its capacity and continue building a sustainable and scalable business through innovation and manufacturing improvements.

In October, the firm announced that its latest module energy conversion efficiency of 13% had entered volume production, and that it was on track to meet its cost per watt goals. Under Laia's leadership, MiaSolé doubled its module efficiency, enabling its CIGS panels to approach crystalline silicon (c-Si) PV performance, it is claimed.

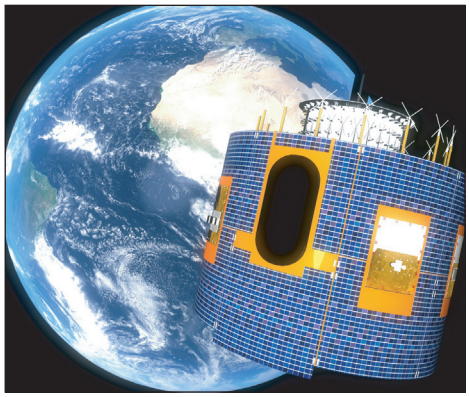
Also, early in November, the firm announced the production of its 50 millionth cell. MiaSolé says that this underscores the viability of its distinctive manufacturing process,

Sofradir wins third space mission contract of year

Sofradir of Châtenay-Malabry, near Paris, France, which makes cooled infrared (IR) detectors based on mercury cadmium telluride (MCT/HgCdTe) for military, space and commercial applications, has been awarded a contract worth tens of millions of euros to manufacture IR detectors for the engineering and flight model phases for the next generation of European meteorological satellites (MTG, the Meteosat third-generation project). A total of six satellites will be launched under the MTG program.

"This is Sofradir's third major space contract win this year [after the MUSIS/CSO military imaging system and the Sentinel-5-Precursor satellite mission] and the largest contract win in Sofradir's history," says chairman & CEO Philippe Bensussan. "This is a significant achievement on top of the record 26 flight model infrared detectors we delivered for space missions in 2010," he adds. "We've seen our satellite business triple in the last five years, as earth observation spacecraft use more infrared imaging and multi-spectral equipment that increasingly require visible and IR products."

Within the scope of the five-year MTG contract headed by the European Space Agency (ESA), Sofradir will deliver custom designed IR detectors to satellite and space equipment manufacturer Thales Alenia Space France (TAS-F). The detectors will be integrated in two payloads: the Flexible Combined Imager (FCI) to take IR images of clouds and the InfraRed Sounder (IRS) to analyze the chemical composition of the atmosphere versus altitude. They will operate wavelengths that extend from short-wave infrared (SWIR) to very long-wave infrared (VLWIR) in order to better identify and measure various types of clouds and chemical elements.



Artist's impression of a Meteosat second-generation satellite.

In total, Sofradir will develop six different types of detectors, and deliver up to 22 flight models for the MTG program. "It shows we are able to handle big space contracts (several tens of millions of euros)," says Bensussan.

The ESA contract represents the culmination of several years of work that Sofradir has carried out on the MTG program, and enables the firm to progress to the final phase. Sofradir's first involvement began in 2007, when it participated in the feasibility study in collaboration with CEA/LETI. It then advanced to the preliminary phase, where it developed MCT-based IR detectors for testing.

Sofradir claims that one of the significant characteristics that sets its MCT IR technology apart from competing technologies is its applicability to all wavelengths, from the visible to very long-wave IR (above 15μm). This enables the firm to use a single production line to manufacture IR detectors at different wavelengths, allowing more efficient supply of detectors for both high-volume production and customized designs.

www.sofradir.com
www.eumetsat.int

Sofradir awarded IR detector contract for MUSIS/CSO Earth observation military satellites

Sofradir of Châtenay-Malabry, near Paris, France, which makes cooled infrared (IR) detectors based on mercury cadmium telluride (MCT/HgCdTe) for military, space and industrial applications, has been awarded a multi-million Euro contract to supply IR detectors for the engineering and flight model phases for the MUSIS/CSO next-generation Earth observation military satellites, which will replace the current Helios 2 observational system.

Within the framework of the four-year MUSIS/CSO contract, Sofradir will deliver to satellite and space equipment manufacturer Thalès Alenia Space France (TAS-F) high-resolution custom-designed IR focal plane arrays for the optical imaging cameras.

"After our successful involvement in the satellites Helios IIA and IIB, launched in 2004 and 2009 respectively, Sofradir is proud to be part of the MUSIS/CSO project and have the continued confidence of the French MoD and TAS," says chairman & CEO Philippe Bensussan.

CSO (Optical Space Component) is the French government's contribution to the future MUSIS (MUltinational Spacebased Imaging System), which will include optical and radar space components. Aerospace firm Astrium is the prime contractor for the CSO satellite development contract. The French space agency CNES awarded the contract to Astrium in 2010. CNES was delegated by the French procurement agency DGA to manage the project.

Sofradir first became involved in MUSIS/CSO in 2005, when it carried out a feasibility study and preliminary development of the IR detectors. The firm will complete delivery of all the MCT-based detectors by 2015.

ZnO microwires improve performance of GaN LEDs through piezo-phototronic effect

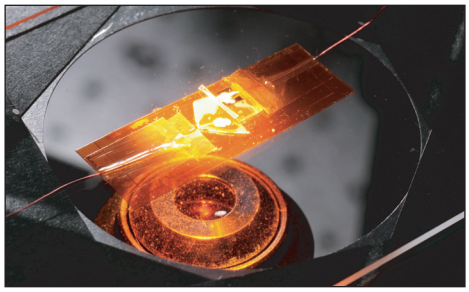
Researchers at the Georgia Institute of Technology have used zinc oxide (ZnO) microwires to significantly improve the efficiency at which gallium nitride (GaN) LEDs convert electricity to ultraviolet light. The devices are believed to be the first LEDs whose performance has been enhanced by creating an electrical charge in a piezoelectric material using the piezo-phototronic effect.

The research was sponsored by the Defense Advanced Research Projects Agency (DARPA) and the US Department of Energy (DOE). In addition to Wang, the research team mainly included Qing Yang, a visiting scientist from the Department of Optical Engineering at Zhejiang University in China.

By applying mechanical strain to the microwires, the researchers created a piezoelectric potential in the wires, and that potential was used to tune the charge transport and enhance carrier injection in the LEDs. This control of an optoelectronic device with piezoelectric potential (piezo-phototronics) represents an example of how materials that have both piezoelectric and semiconducting properties can be controlled mechanically.

"By utilizing this effect, we can enhance the external efficiency of these devices by a factor of more than four times, up to 8%," says Zhong Lin Wang, Regents professor in Georgia Tech's School of Materials Science and Engineering. "From a practical standpoint, this new effect could have many impacts for electro-optical processes — including improvements in the energy efficiency of lighting devices," he adds.

Because of the polarization of ions in crystals of piezoelectric materials such as ZnO, mechanically compressing or otherwise straining structures made from the materials creates a piezoelectric potential. In GaN LEDs, the researchers used the local piezoelectric potential to tune the charge transport at the p-n junction.



LED with performance enhanced through piezo-phototronic effect.

The effect was to increase the rate at which electrons and holes recombined to generate photons, enhancing the external efficiency of the device through improved light emission and higher injection current. "The effect of the piezo potential on the transport behavior of charge carriers is significant due to its modification of the band structure at the junction," Wang explains.

The ZnO wires form the n part of a p-n junction, and the GaN thin film the p part. Free carriers were trapped at this interface region in a channel created by the piezoelectric charge formed by compressing the wires.

Traditional LED designs use structures such as quantum wells to trap electrons and holes, which must remain close together long enough to recombine. The longer that electrons and holes can be retained in close to each other, the higher the LED's efficiency will ultimately be.

The Georgia Tech devices increased their emission intensity by a factor of 17 and boosted injection current by a factor of four when compressive strain of 0.093% was applied to the ZnO wire. That improved conversion efficiency by up to a factor of 4.25.

The LEDs emitted at ultraviolet wavelengths (about 390nm), but Wang believes the wavelengths can be extended into the visible region of the spectrum for a variety of optoelectronic devices. "These devices are important for today's focus on green and renewable energy technology," he comments.

In the experimental devices, a single ZnO micro/nanowire LED was fabricated by manipulating a wire on a trenched substrate. A magnesium-doped GaN film was grown epitaxially on a sapphire substrate by MOCVD and was used to form a p-n junction with the ZnO wire.

A sapphire substrate was used as the cathode, placed side-by-side with the GaN substrate with a well-controlled gap. The wire was placed across the gap in close contact with the GaN. Transparent polystyrene tape was used to cover the nanowire. A force was then applied to the tape by an alumina rod connected to a piezo nanopositioning stage, creating the strain in the wire.

The researchers then studied the change in light emission produced by varying the amount of strain in 20 different devices. Half of the devices showed enhanced efficiency, while the others — fabricated with the opposite orientation of the microwires — showed a decrease. This difference was due to the reversal in the sign of the piezopotential because of the switch of the microwire orientation from +c to −c.

High-efficiency UV emitters are needed for applications in chemical, biological, aerospace, military and medical technologies. Although the internal quantum efficiencies (IQEs) of these LEDs can be up to 80%, the external efficiency for a conventional single p-n junction thin-film LED is currently only about 3%.

Beyond LEDs, Wang believes the approach pioneered in this study can be applied to other optical devices controlled by electric fields. "This opens up a new field of using the piezoelectric effect to tune optoelectronic devices," he says. "Improving the efficiency of LED lighting could ultimately be very important, bringing about significant energy savings because so much of the world's energy is used for lighting."

www.gatech.edu

MRS Medal for Georgia Tech ZnO nanostructure researcher Zhong Lin Wang

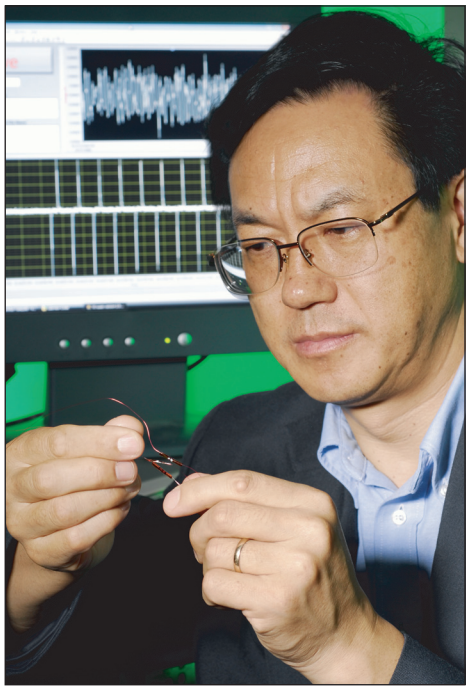
At the 2011 MRS Fall Meeting in Boston, MA, USA (28 November – 2 December), one of the two MRS Medals was awarded to Zhong Lin Wang, a Regent's professor at the Georgia Institute of Technology in Atlanta, GA, USA. The medal's commendation notes his "seminal contributions in the discovery, controlled synthesis, and fundamental understanding of zinc oxide nanowires and nanobelts, and the design and fabrication of novel, nanowire-based nanosensors, piezotronic devices and nanogenerators for energy harvesting."

Wang joined Georgia Tech in 1995, after earning his Ph.D. at Arizona State University and working for Oak Ridge National Laboratory and the National Institute of Standards and Technology (NIST). His first interest was electron microscopy.

He got his first major international attention from research on carbon nanotubes. Collaboration with Georgia Tech physicist Walt de Heer — now known for his work with epitaxial graphene — produced a 1996 paper on nanotube properties that included a microscope image of a carbon particle on the end of a nanotube. Analyzing the nanotube's vibration allowed the researchers to determine the approximate mass of the particle, and their device become known as a 'nanobalance'.

But, in search of a research area with more opportunity, Wang returned to his undergraduate roots in oxide materials, in particular zinc oxide. Georgia Tech says that Wang has since almost single-handedly launched a new field of research that takes advantage of the unique properties of ZnO nanostructures.

"Zinc oxide has a lot of advantages because of its semiconducting, piezoelectric, optical and other properties for sensors, transducers, energy applications and other uses," Wang notes. He began work on the material in 1999 and quickly produced significant results, including the development of 'nanobelts' (reported in the journal Science in 2001). Details of the structures and their synthesis attracted other researchers, and the paper has now been cited more than 3500 times.



In this 2008 photo, Georgia Tech's Zhong Lin Wang displays flexible charge pumps that are able to produce alternating current through the stretching and relaxing of ZnO wires.

The nanobelt paper was followed by years of work investigating the properties and synthesis of ZnO structures. Perhaps the most significant advance was the ability to grow aligned arrays of ZnO nanowires, leading directly to the development of nanogenerators, which harvest mechanical energy from the environment (taking advantage of the piezoelectric properties of ZnO nanowires to produce electrical current). Reported in April 2006 in the journal Science, nanogenerators drew international attention to Georgia Tech and rapidly led to a series of improvements that opened up new ways of powering nanometer-scale devices for building self-powered nanotechnology. Starting with output that could barely be measured in 2006, Wang's research team has steadily improved the devices until arrays of connected nanogenerators can now produce as much as 30V. The generators now produce enough power to operate conventional electronic components such as LED displays.

In the last few years, Wang has used the piezoelectric properties of the nanostructures to control charge transport in new forms of 'piezotronic' electronic devices (e.g. logic gates and memory), providing an alternative to traditional CMOS technology, as well as light-emitting diodes enhanced with an effect that he has termed 'piezo-phototronics' (to describe techniques for controlling electro-optical processes in devices). Multiple devices have been combined into self-powered sensing systems that not only detect harmful materials, but also alert authorities wirelessly. Wang has also built systems that combine different kinds of power harvesting, such as nanogenerators and photovoltaic cells, and developed a hybrid cell for the first time.

In his 16-year career at Georgia Tech, Wang has produced 28 patent applications, along with another dozen invention disclosures. He has formed a startup company to commercialize the technology, and published more than 20 articles in Science and Nature journals. Overall, he estimates his research team has produced more than 700 publications that have been cited 45,000 times (with an h index of 103).

Wang leads a large research group composed of post-doctoral fellows, graduate students and undergraduate students. From his laboratory have come seven graduates who now hold assistant professor positions at US institutions, plus more than 50 working at universities in China or Taiwan.

www.mrs.org/f11-awards
www.gatech.edu

AlN interlayer doubles conversion of nitride semiconductor solar cell

Japanese researchers improve leakage and material quality of nitride solar cells by using a super-thin aluminum nitride layer.

Japan's National Institute for Materials Science (NIMS) has used a super-thin layer of aluminum nitride (AlN) to double the conversion efficiency of nitride semiconductor photovoltaic solar cells [Liwen Sang et al, Appl. Phys. Lett., vol99, p161109, 2011].

The AlN is placed between the intrinsic/undoped indium gallium nitride (InGaN) active region and the p-contact layers. The researchers believe that the AlN acts both as an electron barrier for stopping leakage in forward and reverse bias, and as a block to growth of dislocations into the p-InGaN.

Table 1. Summary of photovoltaic performance of samples.

Photovoltaic property	Device A (without AlN IL)	Device B (with AlN IL)
J_{sc} (mA/cm^2)	0.77	1.25
V_{oc} (V)	1.31	1.50
R_{sh} (Ω-cm^2)	1.55x10^4	1.96x10^4
R_s (Ω-cm^2)	4.78x10^2	6.28x10^2
Fill factor (%)	55	56
Conversion efficiency (%)	0.55	1.05

The nitride materials were grown on sapphire substrates using metal-organic chemical vapor deposition (MOCVD). The GaN template-buffer region was grown in a standard two-step process. Next, a 150nm layer of n-$In_{0.15}Ga_{0.85}N$ was grown at a lowered temperature of 800°C, followed by an undoped 240nm-thick $In_{0.15}Ga_{0.85}N$ active region.

The p-type layers were grown in two different ways. Sample A consisted of 90nm of p-$In_{0.15}Ga_{0.85}N$ and 15nm of p-GaN. Sample B had an AlN interlayer (IL) before the same p-type layers (Figure 1 inset). The hole concentration for the p-InGaN was measured by Hall techniques as being 1.2x10^{18}/cm^3. The mobility was 2.6cm^2/V-s.

The standard solar-cell devices were not enhanced with current-spreading layers or anti-reflective coatings.

One effect of the AlN interlayer is to reduce dark current (Figure 1) by two orders of magnitude (a factor of 100). At a reverse bias of −3V, the current density is 9.76x10^{4}A/cm^2 without interlayer, but 4.72x10^{6}A/cm^2 with.

Other parameters, such as ideality and saturation current density, are also improved by including the interlayer. The ideality improvement from 6.0 (without IL) to 3.9 (with) is thought to result from better material quality across the p-n junction and reduced carrier tunneling.

Series resistance, estimated from the dark current–voltage curves, was slightly higher for the Al interlayer device (140Ω rather than 113Ω). This higher resistance may result from the presence of the interlayer itself.

The photovoltaic performance under 1.5 air mass (AM) simulated solar radiation showed increased performance (Table 1) such as a short-circuit current for sample B of 1.25mA/cm^2, compared with 0.77mA/cm^2 for sample A. The maximum power density for device B was 1.05mW/cm^2, corresponding to a conversion efficiency of 1.05%. The conversion efficiency for the device without AlN interlayer was almost halved, at 0.55%.

The reduced shunt resistance of sample B is seen as indicating a reduction in bulk defects across the p-n junction. The open-circuit voltage is also improved by insertion of the AlN interlayer.

In terms of spectral performance, the peak external quantum efficiency of 50% was found at 372nm for device A, and more than 80% at the same wavelength for device B. Since the 372nm wavelength falls in the ultraviolet, the low conversion efficiency is no surprise, since the bulk of solar radiation comes in at wavelengths longer than around 500nm. There are hopes that active layers with higher indium content will bridge this gap, but such material becomes increasingly difficult to grow with high quality.

The researchers believe that the reverse bias leakage in device A is due to trap-assisted effects. The traps

could arise from the greater density of structural defects across the p-n junction in this device structure. In device B, by contrast, the reverse leakage is restricted to thermionic field emission tunneling effects.

The researchers comment: "The different electrical transport mechanisms of these two devices imply that the structural defects are suppressed by the AlN layer in the p-InGaN layer."

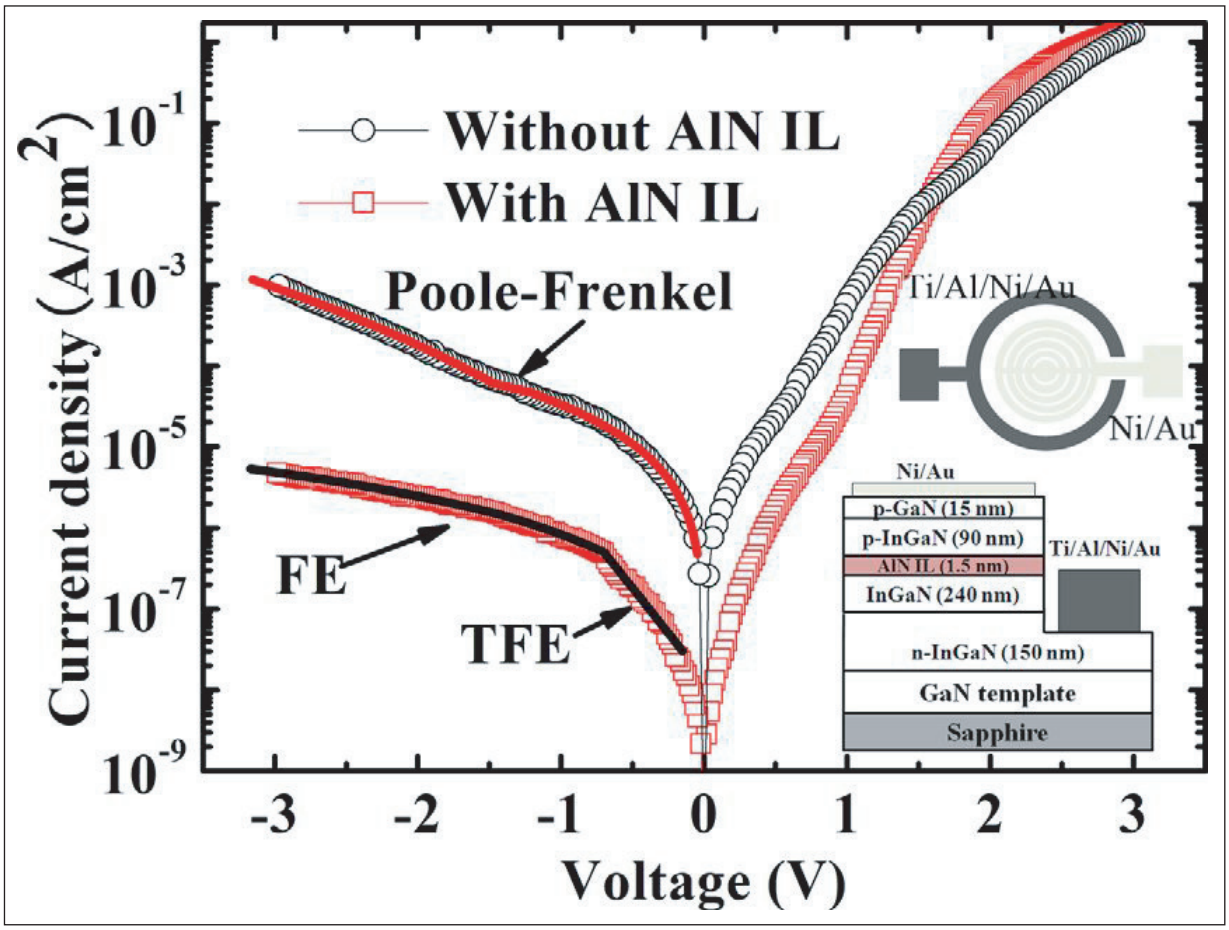


Figure 1. Schematic diagrams of fabricated GaN-based (a) LLED on sapphire substrate and (b) VLED on graphite substrate with mesa size of 1mm x 1mm.

The researchers used transmission electron micrography (TEM) and atomic force microscopy (AFM) to study the defects. They found that the AlN layer blocked some of the screw-type dislocations from reaching the p-InGaN material.

The AFM study confirmed this, showing a reduced surface density of the V-pits that are associated with screw-type dislocations. According to the AFM study, the root-mean-square surface roughness was 1.1nm in sample B, but 2.1nm in sample A. Further, the AFM images show that sample A had grown with a spiral growth mode, whereas sample B had realized step-flow growth that indicates better quality p-InGaN. ■

http://link.aip.org/link/doi/10.1063/1.3654155

Author: Mike Cooke

Graphite substrate exploration for vertical nitride LEDs

Light output power increased 23% over conventional lateral LEDs.

Korea's universities have used aluminum-alloyed graphite as a thermally conducting substrate to improve the light output power performance of nitride semiconductor LEDs by 23% [H K Lee et al, Semicond. Sci. Technol., vol26, p115011, 2011]. Korea Advanced Nano-Fab Center (KANC) supported the device fabrication.

Conventional nitride semiconductor LEDs grown on sapphire are forced to use a lateral conduction scheme since the substrate is insulating. LEDs, particularly with nitrides, perform better with vertical conduction where the current density is uniform. This can be achieved by separating the nitride semiconductor from the sapphire substrate on which the device layers are grown.

Generally, the layers have to be transferred to a new substrate before separation. It is advantageous to choose substrates that are thermally conducting, since junction temperature is also important in LED performance. The Kyung Hee/Dongguk are exploring the graphite-based option as a low-cost alternative to the use of much more expensive replacement of sapphire by gallium nitride (GaN) or silicon carbide (SiC).

The blue (~450nm) indium gallium nitride (InGaN) LED structures were grown on 430μm thick sapphire substrates using MOCVD. The undoped GaN buffer was 3.5μm, the n-GaN 4μm, and the p-GaN 0.21μm. The active region, sandwiched between the n- and p-GaN, consisted of five pairs of undoped InGaN/GaN layers, creating a multi-quantum well (MQW).

This material was then used to make both traditional lateral LEDs (LLEDs) and also vertical LEDs (VLEDs) through transfer/flipping onto 500μm-thick aluminum-alloyed graphite substrates (Figure 1). The aluminum alloy allows tuning of the thermal expansion coefficient. The final devices measured 1mm x 1mm.

The VLED process consisted of depositing p-contact and barrier metal layers on the p-GaN contact layer using e-beam evaporation. The barrier layer was needed to prevent tin (Sn) from the gold-tin/gold (AuSn/Au) graphite bond from diffusing into the LED.

The epitaxial layers were flipped and bonded to the graphite. The sapphire substrate layer was now removed using a 248nm krypton fluoride excimer laser lift-off process. The undoped GaN layer was etched away with an inductively coupled plasma. The n-GaN surface was roughened by immersion in potassium hydroxide solution for 15 minutes at 50°C to improve light extraction.

The LLEDs were processed in a conventional way with a 200nm indium tin oxide (ITO) current-spreading layer being deposited and annealed at 600°C for 1 minute, before mesa etching and metal contact deposition.

To enable temperature-dependent measurements (288–378K), the chips were indium-bonded to copper heat-sinks and wire-bonded to contact pads.

The light output powers for the LLED and VLED were 127.2mW and 156.4mW, respectively, at 350mA injection current and 298K temperature. The improved performance of the VLED is attributed to improved extraction from the surface roughening and the reflective metal layers at the base of the device. Such enhancements are difficult to implement in the LLED since the top layer of p-GaN is thin and there is a lack of reflectors to avoid light entering and being trapped in the sapphire substrate.

The far-field emission pattern was different for the two devices with the LLED having a wider beam due to light being emitted from all directions in the active layer. In the VLED, the bottom reflector is thought to increase extraction in the upward direction, giving a narrower, more directional beam.

Thermal measurements showed a gradual decrease in performance of the VLED at higher temperatures beyond 338K. Light output power in the range 288–338K was nearly constant at 156.4mW for an injection current of 350mA. This decreased to 149.4mW at 378K, a fall of 4.5%. The decrease became more significant at higher injection currents: at 700mA, the power values were 262.8mW and 236.6mW at 288K and 378K, respectively, a fall of 10%.

Temperature also affected turn-on and forward voltages. The turn-on voltage decreased with increasing temperature, being 2.65V at 288K and 2.39V at 378K. The forward voltages for a 350mA injection current were 3.84V at 288K and 3.47V at 378K.

Thermal degradation was more marked in the LLEDs on sapphire substrates, due to its lower thermal conductivity compared with the Al-graphite alloy. The decrease in light output power for the LLEDs in the range 288–378K is given as 12%. Fitting an exponential decrease to the fall in light emission intensity beyond 298K, the researchers derived characteristic temperatures (T_1) of 295K and 414K for the LLED and VLED, respectively. The higher characteristic temperature for the VLED is indicative of the weaker dependence of its performance on temperature.

The impact of using a vertical current injection structure was also seen in a higher external quantum efficiency (EQE) of 16.2% at 350mA, compared with 13.2% for the LLED. At 550mA, the VLED EQE fell 11.9%, compared with 14.6% for the LLED. Increasing the heat-sink temperature above 298K (~room temperature) decreases overall efficiency in these devices, but the degradation is slower for the VLED, compared with the LLED. For the temperature range 288–338K, the VLED maintained a roughly constant value with degradation only appearing beyond this. At 378K, the EQE for the VLED was 15.5% (–4.3%) for the VLED at 350mA injection.

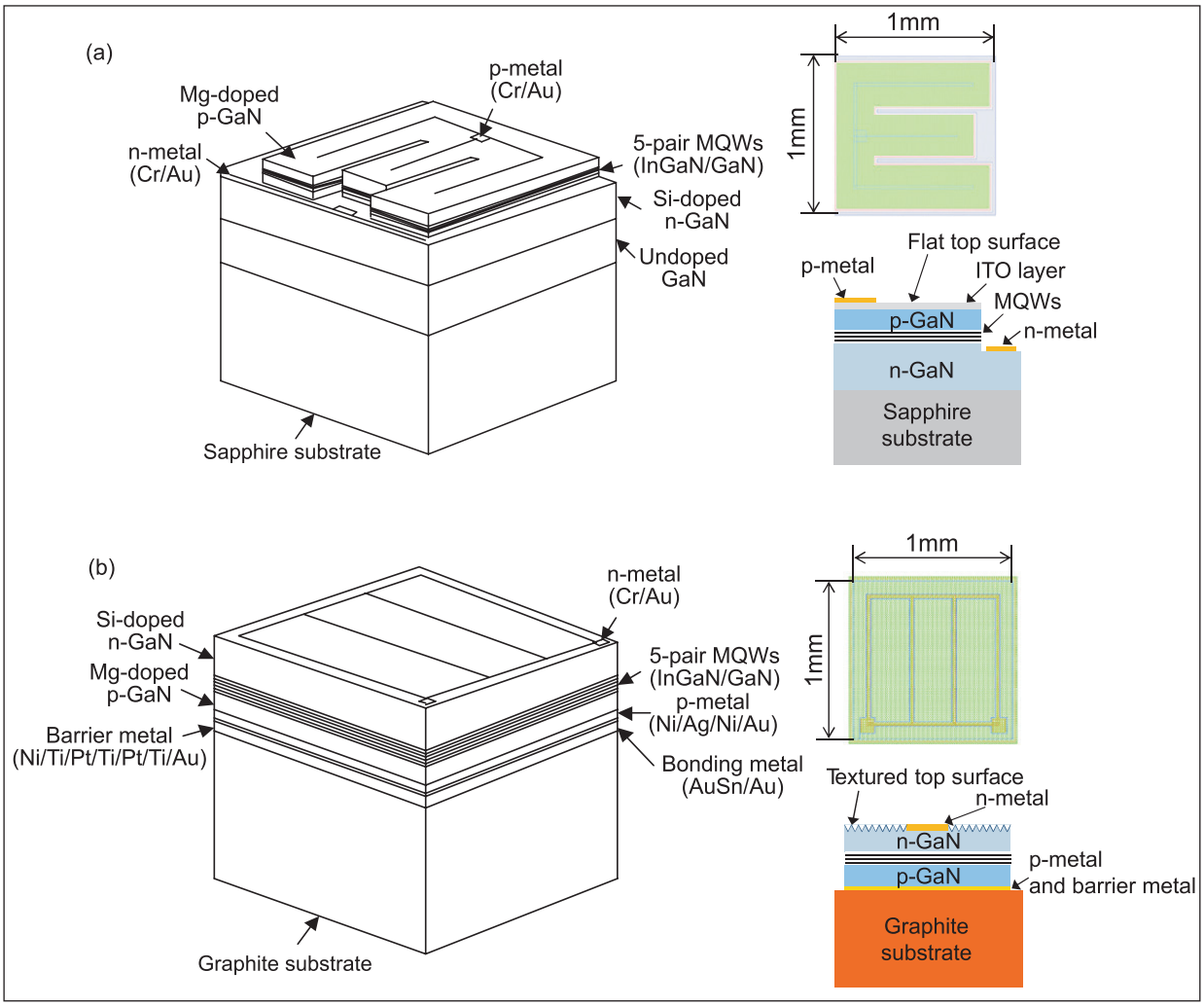


Figure 1. Schematic diagrams of fabricated GaN-based (a) LLED on sapphire substrate and (b) VLED on graphite substrate with mesa size of 1mm x 1mm.

A further effect of temperature increase is to narrow the energy gap, red-shifting the radiation to longer wavelengths. Between 298K and 378K, the peak wavelength of the LLED shifted from 449.3nm to 453.7nm (0.55nm/K), and the VLED from 449.5nm to 453.2nm (0.48nm/K). By contrast, there was a blue-shift in wavelengths as the current increased to 300mA, after which the wavelength remained constant in the VLED.

For the LLED, Joule heating in the devices due to the poor thermal conductivity of the sapphire substrate leads to red-shifting at currents beyond 300mA, because the real junction temperature is higher than that of the thermal stage that was used to control the temperature.

The initial blue-shift is ascribed to the quantum-confined Stark effect (QCSE), where the changing electric field in the MQWs for different injection currents shifts the energy bands differently and hence affects the emission wavelength. The polarization fields that arise in nitride semiconductors due to spontaneous and piezoelectric (strain-dependent) effects tend to increase QCSEs.

The junction temperatures of the various devices at different injection currents in continuous wave (CW) operation were estimated through the initial forward and the voltage after 30 minutes, when the device had reached thermal equilibrium. The dependence of the forward voltage on temperature was estimated from pulsed measurements at controlled temperatures where thermal equilibrium of the junction is not reached.

In a 298K environment, the junction of the LLED reached 300.6K at 60mA and 312.4K at 350mA (40.74K/A increase). The same experiment on the VLED gave 299.7K and 310.2K (35.68K/A), respectively. The results suggest a thermal resistance of 10.12K/W for the VLED, compared with 12.53K/W for the LLED. Previous work by Kyung Hee University and Korea Advanced Nano Fab Center achieved ~8K/W for a VLED on 100μm copper. Three of the researchers from the new work were involved in this earlier result.

The researchers conclude that "the graphite substrate can be considered as a promising candidate for high-brightness LEDs by the wafer bonding process." ■

http://iopscience.iop.org/0268-1242/26/11/115011

Author: Mike Cooke

Grading barriers for improved hole transport

Taiwan researchers produce nitride LEDs with only 6% drop between peak value and 200A/cm²

Researchers based in Taiwan have used graded quantum barriers (GQBs) to reduce droop effects in nitride LEDs [C. H. Wang et al, Appl. Phys. Lett., vol99, p171106, 2011]. The drop in efficiency at 200A/cm^2 from the peak values were 34% for a conventional LED, but only 6% for a device with GQB. The researchers were associated variously with National Chiao-Tung University (NCTU) and LED chip maker Epistar Co Ltd. These institutions reported earlier this year on graded electron-blocking layers [www.semiconductor-today.com/news_items/2011/JAN/NCTU_130111.htm].

Leading explanations for droop effects in nitride semiconductor devices include Auger recombination, electron overflow, hole transport barriers, and polarization fields. Auger recombination is a reduction in radiative recombination in favor of many-body interactions that can occur at higher carrier densities without light emission.

Electron overflow occurs where the electrons do not recombine with holes in the active region and reach the p-contact layers where they recombine non-radiatively.

Hole transport problems arise because these quasi-particles are heavier and less mobile than 'electrons' in most semiconductors, including nitrides.

Polarization effects arise from the more ionic nature of the III-nitrogen bond compared with group IV (e.g. silicon) semiconductors.

The GQB structures of the NCTU/Epistar work were designed to improve hole distribution through the active region. A number of other research groups have found that multi-quantum well (MQW) structures tend to emit light only from the last well before the p-contact region. This defeats the purpose of the MQW, which is to increase the volume of active material, hopefully increasing light output, while allowing the growth of strained indium gallium nitride (InGaN) wells that have a critical thickness of the order of nanometers before the quality degrades significantly.

Simulations were used to design the GQB so that the barrier to hole transport is reduced. The NCTU/Epistar structures were grown on c-plane sapphire using metal-organic chemical vapor deposition (MOCVD). The template layers consisted of nucleation layer of

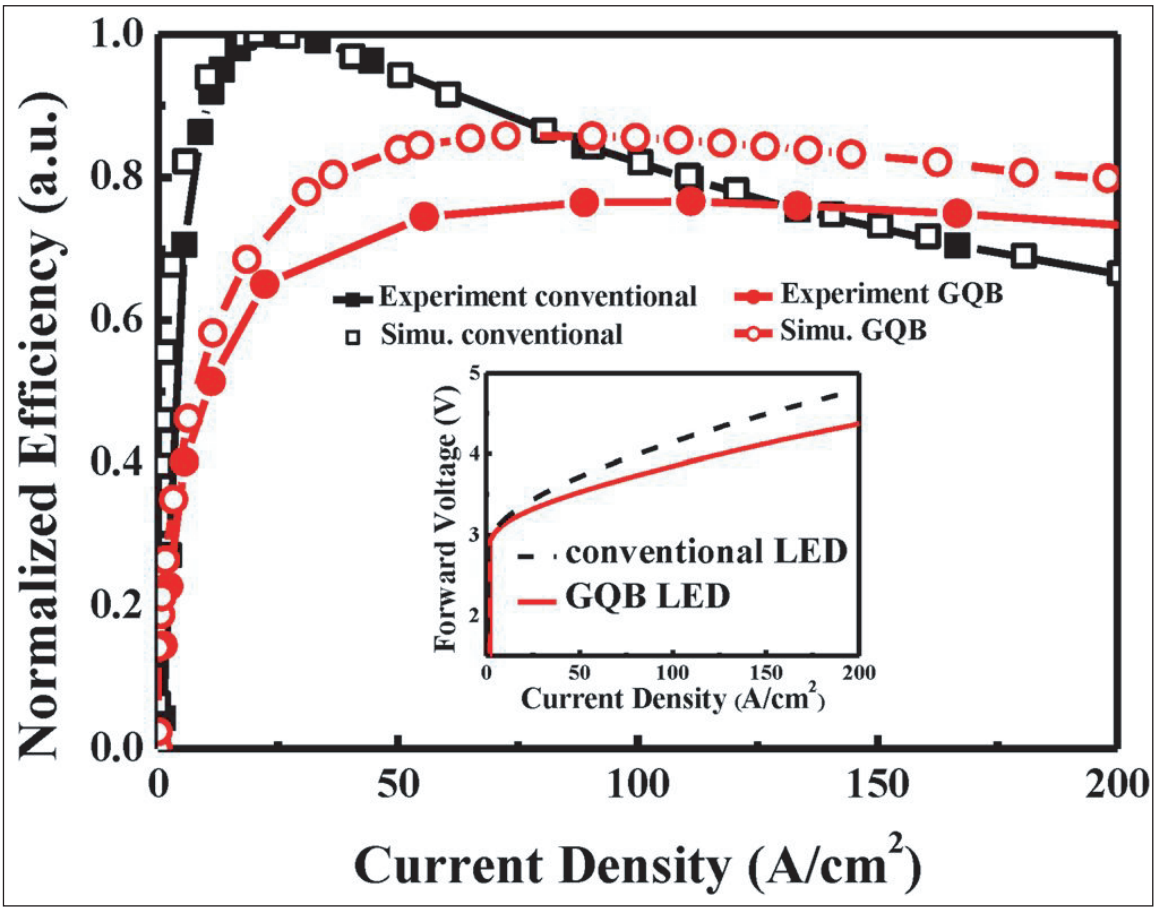


Figure 1. Experiment and simulation normalized efficiency for conventional and GQB LEDs. Inset: current–voltage (I–V) characteristics of conventional and GQB LEDs.

GaN grown at low temperature, followed by 4μm of n-GaN. On top of this, ten pairs of InGaN/GaN were used as a pre-strain layer. The active region consisted of six pairs of InGaN/GaN forming multi-quantum wells. The p-contact consisted of a 20nm 15%-Al p-AlGaN electron-blocking layer and 200nm of p-GaN.

The graded quantum barrier device had InGaN barriers, rather than pure GaN, which had graded In content from 5% to 0% along the c-direction, designed to counteract the effect of polarization electric fields. The grading was achieved through ramping the In/Ga ratio, to avoid changes in the growth rate that would result from temperature variation (another technique used for composition grading).

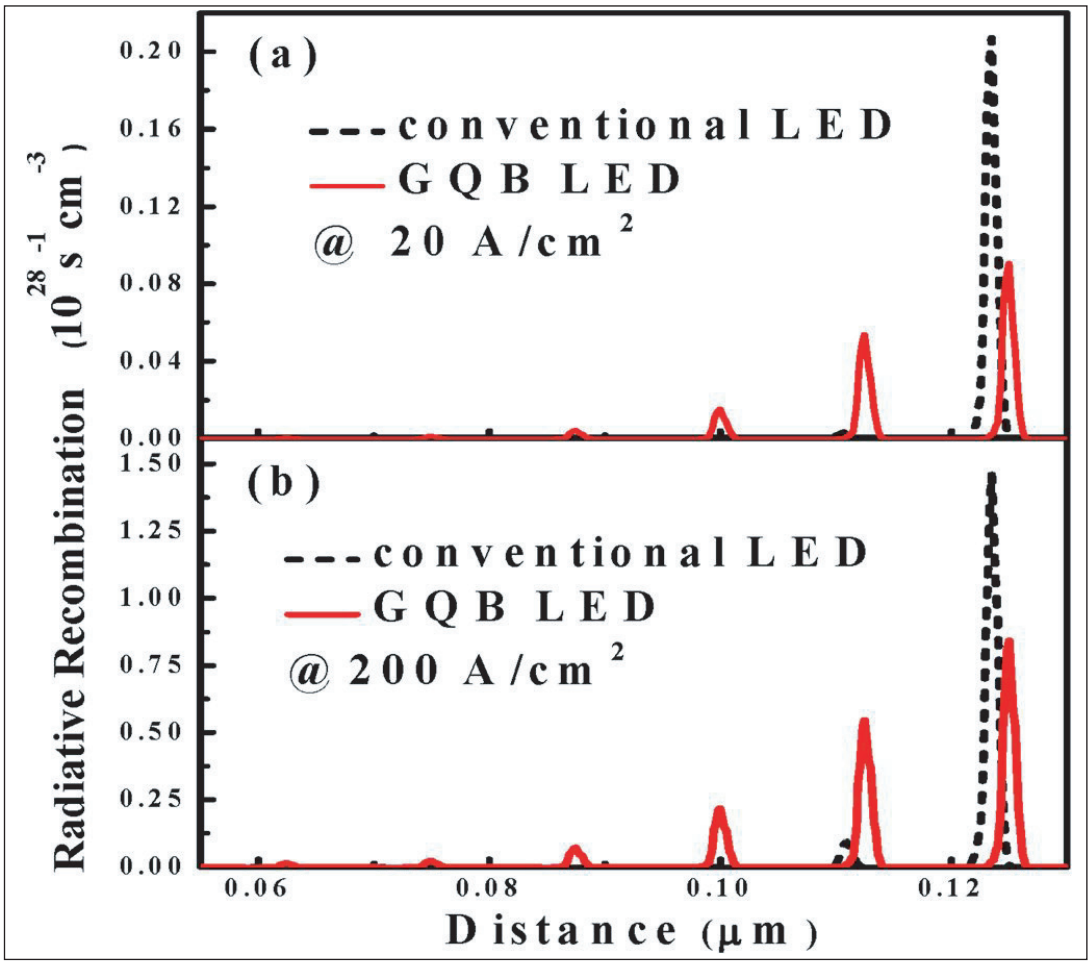


Figure 2. Calculated radiative recombination rates of conventional and GQB LEDs at current densities of (a) 20A/cm² and (b) 200A/cm².

The fabricated LED chips had indium tin oxide (ITO) transparent conducting layers on the p-electrode and nickel-gold metal contacts. The typical chip sizes were 300μm x 300μm. At 22A/cm² injection current density, the emission wavelength was ~450nm (blue).

The efficiencies (Figure 1) of the two devices compared well in terms of droop behavior with simulated values. The lower efficiency of the GQB device compared with the simulation is attributed to non-optimized epitaxial parameters for the graded composition barriers.

The series resistance was reduced in the GQB device at 6.5Ω, compared with the conventional device value of 8.2Ω. The reduction is reflected in the forward voltages at 22A/cm² of 3.4V in the conventional LED and 3.27V in the GQB device.

Although the droop effect is reduced, the actual efficiency for the GQB LED at 20A/cm² is only 70% that of the conventional device. Although at higher currents the GQB device does exceed that of the conventional device in efficiency, 20A/cm² is a typical operating current for nitride LEDs (partly because of the droop problem). Such reduced efficiency is also seen in other droop reduction techniques.

To reduce droop behavior without deteriorating the total recombination, one should pay more attention to the spatial distribution between holes and electrons

Simulations suggest that the efficiency problem for the GQB device is creating a suitable overlap between the electron and hole distributions to maximize radiative recombination (Figure 2). The model shows a congregation of electrons and holes in the last well before the p-type layers for the conventional device, particularly at low currents. The GQB LED has higher hole concentration in the fifth rather than sixth well, but higher electron concentration in the sixth well (as for the conventional device), at 20A/cm². The mismatch reduces efficiency.

At 200A/cm², simulations give noticeable peaks for the individual electron and hole concentrations in all the wells for the GQB device (higher at the p-end), but only in the fifth and sixth wells for the conventional LED model.

The researchers conclude: "These results indicate that to reduce droop behavior without deteriorating the total recombination, one should pay more attention to the spatial distribution between holes and electrons". ■

http://apl.aip.org/resource/1/applab/v99/i17/p171106_s1

Author: Mike Cooke

Non-polar laser diode power comparable to c-plane devices

UCSB and Mitsubishi Chemical produce m-plane laser diode with 1.6W light output power but no catastrophic optical mirror damage.

University of California Santa Barbara and Japan's Mitsubishi Chemical Corp have developed aluminum gallium nitride (AlGaN) cladding-free (ACF) m-plane nitride semiconductor laser diodes (LDs) with output powers comparable to state-of-the-art single-stripe emitter c-plane devices [R. M. Farrell et al, Appl. Phys. Lett., vol99, p171113, 2011].

There is much interest in non-polar or semi-polar nitride crystal orientations that can eliminate or alter/reduce the large polarization electric fields that arise in c-plane materials and gallium nitride (GaN) and indium gallium nitride (InGaN) that form the active visible light-emitting layers in nitride semiconductor devices. Altering these fields could allow better performance to be realized.

Cladding layers in laser diodes are used to confine the electromagnetic field, creating the conditions needed for stimulated emission. AlGaN is often used for this, but has a large lattice mismatch with the underlying InGaN/GaN structures and is therefore difficult to grow with sufficient quality (e.g. without cracking, and with low defect density, etc).

UCSB has been working on AlGaN-cladding-free technology since 2007. Its technique involves using separate-confinement heterostructures of InGaN or GaN and thicker InGaN quantum well regions.

Reducing the Al-content of cladding layers has allowed higher maximum output powers and reduced catastrophic optical mirror damage (COMD) to be realized in such devices. The COMD effect occurs because of high field densities at the mirror facets of the laser cavity. The AlGaN-cladding-free device expands the optical field distribution of the transverse mode. Also, such devices are more resistant to sudden failure or gradual degradation, offering the prospect of higher reliability and higher-power operation.

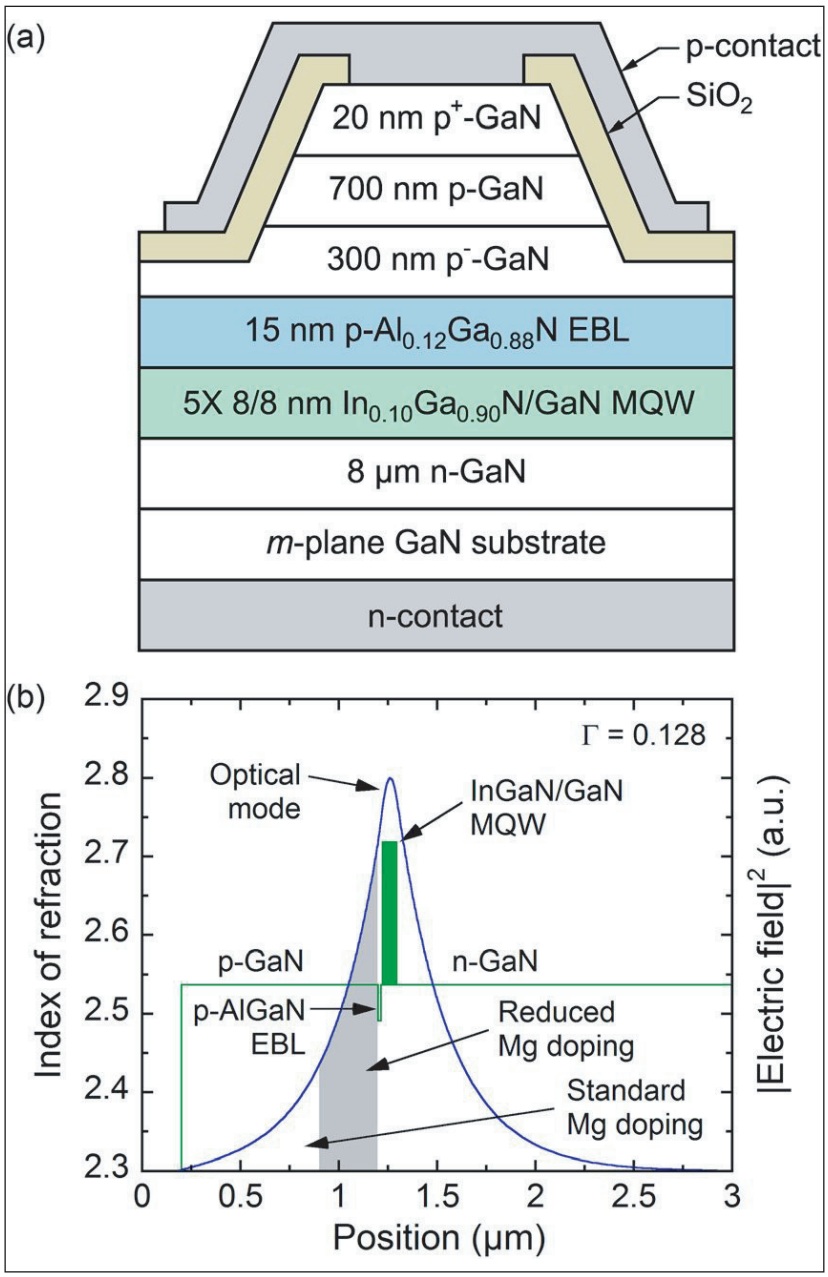


Figure 1. (a) Cross-sectional schematic of the device structure. (b) Calculated 1-D transverse mode profile.

The epitaxial structures (Figure 1a) were grown using metal-organic chemical vapor deposition (MOCVD) on a nominally on-axis free-standing m-plane GaN substrate manufactured by Mitsubishi Chemical.

The active region consisted of a five-period multi-quantum well (MQW) structure of InGaN with GaN barriers. The InGaN wells were 8nm thick, which is much thicker than the usual 2–3nm. Although the 15nm electron-blocking layer (EBL) contained

p-AlGaN, the subsequent cladding layers did not. Simulations (Figure 1b) suggest that the UCSB structure should have a transverse confinement factor in the active region (√act) of 0.128 at a lasing wavelength of 410nm (violet).

The researchers designed the non-uniform doping of the p-GaN layers to decrease total absorption losses in the device by reducing phonon-assisted absorption by acceptor-bound holes. First-principles calculations have predicted that such losses should make the single largest contribution to modal loss in InGaN/GaN LDs and should scale with the density of the magnesium-doping that is used to give p-type conduction in nitride semiconductors. The transverse confinement in the low-doped p-GaN layer is given as 0.282.

Ridge LDs were produced using a self-aligned dry etch and insulator lift-off process. The 900nm-deep ridges were aligned with the c-direction of the nitride crystal. Dry etching was used to make the mirror facets. The p-contact was palladium/gold and the n-contact aluminum/gold.

The resulting devices with 600μm-long, 10μm-wide ridges were subjected to pulsed currents with 2μsec pulse width and 1kHz repetition (Figure 2). Laser threshold currents were 244.9mA (4.08kA/cm^2) before and 279.9mA (4.66kA/cm^2) after facet coating. The threshold voltage of 7.7V for these devices is relatively high compared with state-of-the-art c-plane LDs. The researchers expect improvement with device optimization.

Although the facet coating increases the threshold current, it also increases the slope efficiency from 0.99W/A to 1.29W/A. The peak light output power also increased from 1.3W to 1.6W. The peak optical output power density at the front facet is estimated at 51.2MW/cm^2 for the coated device. These levels are comparable to those that cause COMD in high-power c-plane InGaN/GaN LDs (40–70MW/cm^2). Further, the level is higher than COMD levels reported for GaAs-based LDs under single-pulse excitation conditions (~30MW/cm^2).

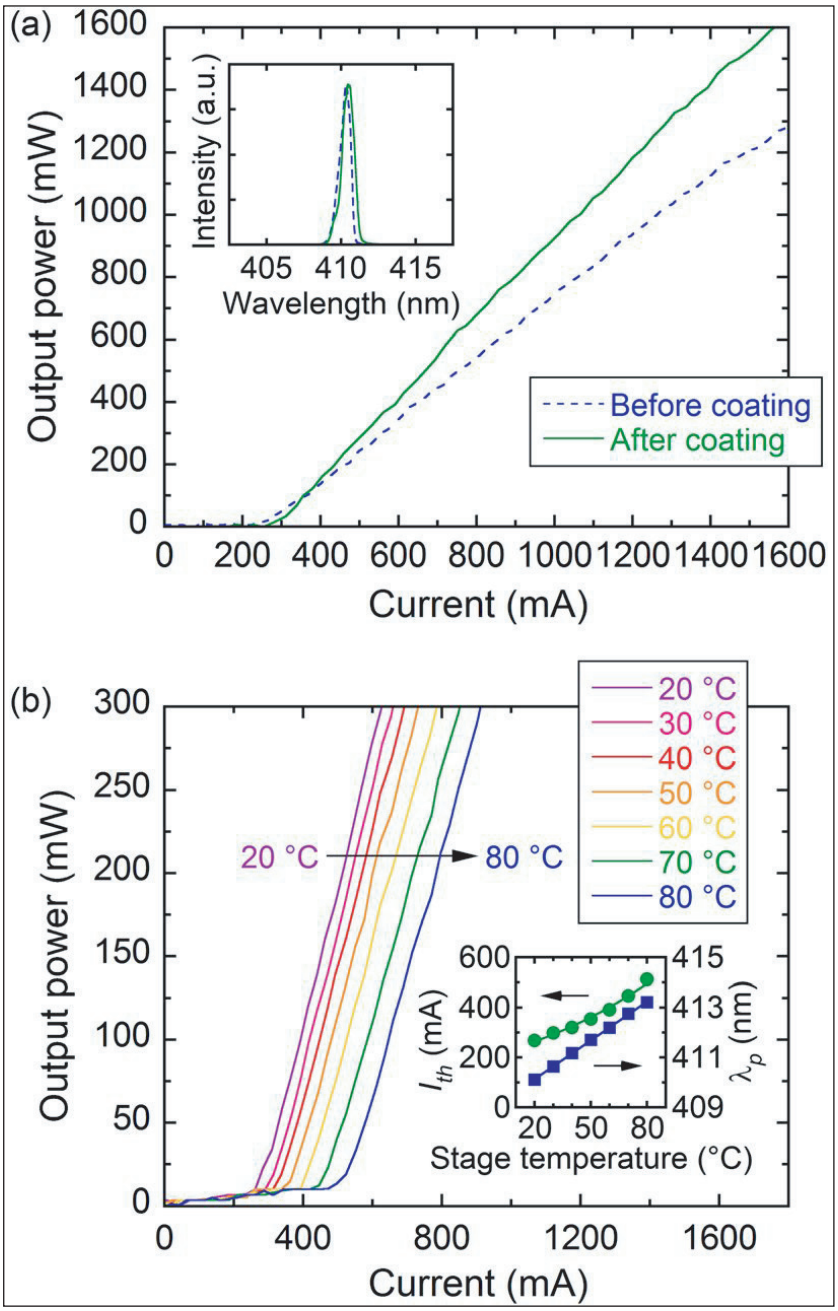


Figure 2. (a) Light output power vs current (L–I) characteristics collected before and after facet coating for a 600μm-long by 10μm-wide ridge waveguide LD. Inset: lasing spectra collected before and after facet coating. (b) L–I characteristics collected at varying stage temperatures. Inset: dependence of threshold current and lasing wavelength on stage temperature.

However, the new LDs were not limited by either thermal roll-over or COMD. The restriction came from the power supply used to drive the LD that was limited to currents less than 1.6A.

The spectra for at 600mA (before coating) and 700mA (after) show little shift in peak wavelength (Figure 2a inset). Thermal measurements (Figure 2b) of the threshold current resulted in a characteristic temperature of 95K, "comparable to the values reported for early c-plane LDs, but will need improvement for commercial applications," according to the researchers. Similarly, the peak wavelength shift of 0.052nm/K was similar to early c-plane devices.

The UCSB/Mitsubishi work was supported by the Solid State Lighting and Energy Center (SSLEC) at UCSB and the US Defense Advanced Research Projects Agency (DARPA) VIGIL program. ■

http://link.aip.org/link/doi/10.1063/1.3656970

The author Mike Cooke is a freelance technology journalist who has worked in the semiconductor and advanced technology sectors since 1997.

Two steps to high breakdown voltage in GaN diodes

Researchers in Japan have achieved the best values ever reported for GaN p-n diodes on free-standing gallium nitride substrates.

Researchers at Hosei University and Hitachi Cable Ltd have increased the breakdown voltage (V_B) for gallium nitride (GaN) semiconductor p-n junction diodes to more than 1100V and reduced the leakage current to the nanoampere range [Yoshitomo Hatakeyama et al, IEEE Electron Device Letters, published online 13 October 2011]. This performance was achieved with a new two-step process for creating the p-electrode (anode) with a field plate that avoids plasma damage of the p-nitride semiconductor surface.

The on-resistance (R_{on}) was also reduced to 0.4mΩ-cm^2 for a 50μm diameter device, allowing a very high value for Baliga's figure of merit (V_B^2/R_{on}) of 3.0GW/cm^2. "These are the best values ever reported among those achieved by GaN p-n junction diodes on free-standing GaN substrates," the researchers comment.

Field-plate structures are used in high-voltage components to create more uniform electric fields in semiconductor materials, reducing the field concentrating effects of sharp corners, for example, to avoid going beyond the critical electric field for the material. Gallium nitride has a large value for the critical breakdown field of ~2–3MV/cm at 300K. This is similar to the value for silicon carbide (SiC) (2.2MV/cm), but far exceeds that of silicon (0.3MV/cm). Gallium nitride also benefits from a higher electron mobility than SiC.

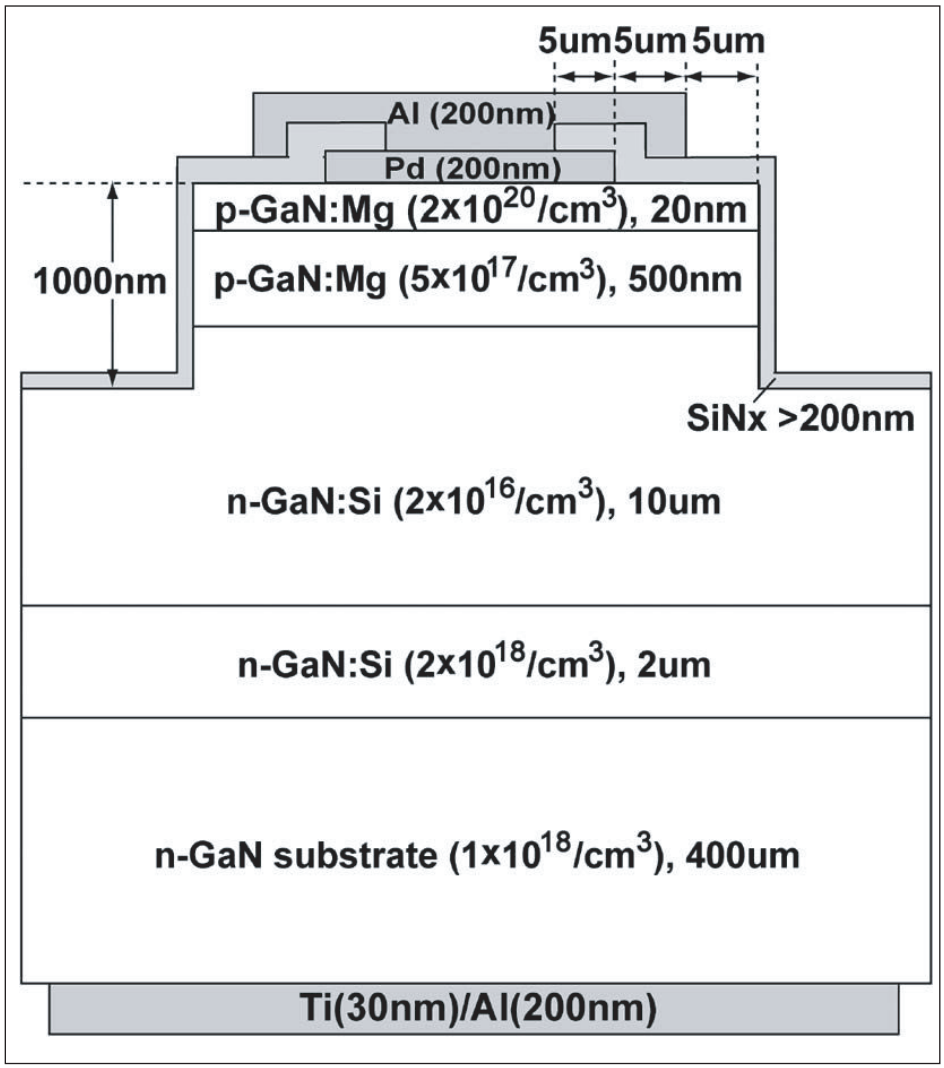


Figure 1. Schematic cross section of the GaN p-n junction diode with silicon nitride (SiNx) passivation and aluminum (Al) field-plate (FP) structure.

The Hosei/Hitachi devices were grown on free-standing GaN substrates to reduce defect densities that also impact breakdown performance and leakage. The diode nitride semiconductor growth was through metal-organic chemical vapor deposition (MOCVD) on these substrates. Low threading dislocation densities of ~10^6/cm^2 were achieved by using substrates that were fabricated using the void-assisted separation method.

The gallium and nitrogen precursors were trimethylgallium (TMG) and ammonia (NH_3), respectively. The silicon (n-type) and magnesium (p-type) doping were achieved through silane (SiH_4) and bicyclopentadienylmagnesium (Cp2Mg), respectively. After the growth of the epitaxial GaN layers (Figure 1), a thermal anneal was performed at 700°C to activate the Mg acceptors.

The researchers produced three sorts of device: devices with field plate and silicon nitride passivation (Figure 1), devices without field plate or passivation,

and, devices with passivation but without field plate.

In making the field plates, the researchers were keen to avoid the damage that can result from plasma etching by using a two-step process.

First, the mesa structure was created using inductively coupled plasma etching. Circular palladium (Pd) electrodes formed an ohmic contact with the top p-GaN layer.

A 200nm silicon nitride film was then sputtered onto the whole chip. This avoided damage to the interface between the Pd and p-GaN. Contact holes were made in a wet-etch process (less damaging than dry plasma etch). The aluminum (Al) field plates were then deposited.

The titanium-aluminum (Ti/Al) electrode was then placed on the rear n-GaN surface. The metal structures (Pd, Al, Ti/Al) were created using electron-beam deposition.

Diodes with 50μm, 180μm and 780μm diameter were produced. These diodes had similar performance according to type. The devices with silicon nitride passivation and field plates continued to operate in reverse bias up to −1100V with leakage around 10^9A (1nA). Removing the field plates, but keeping the silicon nitride passivation, caused breakdown to occur at less than 650V; removing both factors reduced the breakdown further to less than 450V.

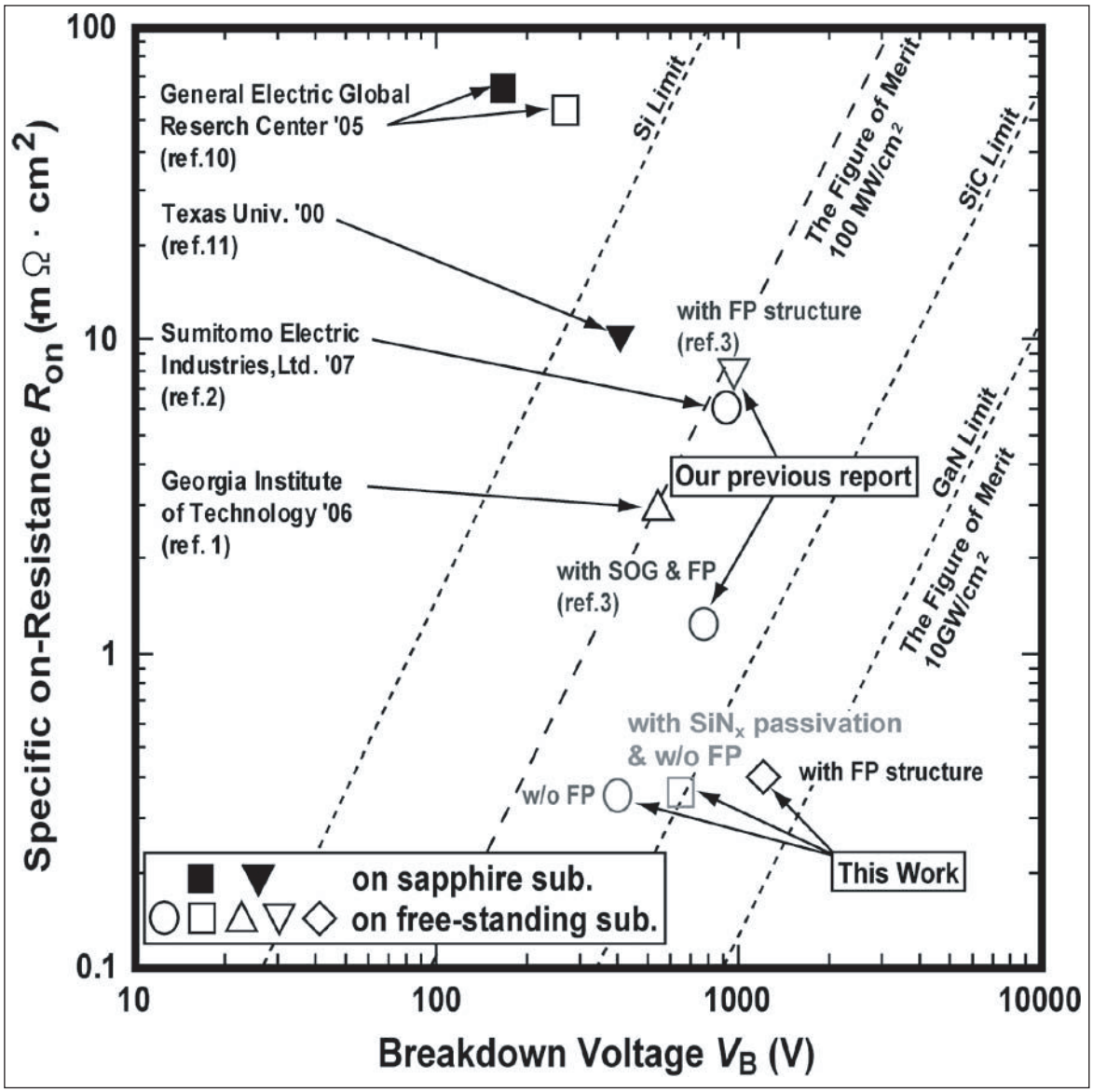


Figure 2. Relations between the specific ON-resistance and breakdown voltage for the fabricated GaN p-n and p-i-n junction diodes in this work and previously reported work. The dotted lines represent the theoretical Baliga figure of merit V_B^2/R_{on} for various values and material limits based on dielectric constant, electron mobility, and critical breakdown electric field, respectively ($\varepsilon x \mu x E_c^3$).

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The on-resistance was reduced from a value of 1.2Ω-cm^2 for a 50μm diameter device with field plate previously reported by the same researchers to 0.4Ω-cm^2 in the new work. The breakdown voltage of the previous device was 798V. The researchers compared their new values of on-resistance and breakdown voltage with those of other devices (Figure 2). ■

http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=6042353

Author: Mike Cooke

Increasing power density for InAlN/GaN HEMTs on sapphire

Record microwave power of 2.9W/mm at a frequency of 18GHz has been reported for devices grown on sapphire substrates.

Researchers in France and Germany have developed high-electron-mobility transistors (HEMTs) with indium aluminum nitride (InAlN) barrier on sapphire substrates that give an output power density at 18GHz of 2.9W/mm [F. Lecourt et al, IEEE Electron Device Letters, published online 10 October 2011].

This output power density value is the best reported microwave power for 225nm T-gate InAlN/AlN/GaN HEMTs on sapphire substrates, made using metal-organic chemical vapor deposition (MOCVD). The research involved Lille University's Institut d'Electronique, Microélectronique et Nanotechnologie (IEMN, UMR-CNRS 8520), RWTH Aachen University, and MOCVD system maker Aixtron.

The research is aimed at devices for microwave power amplification for transmission and low-noise amplification for reception. This can be achieved in wide-bandgap nitride semiconductors without added limiter components to protect the receiver in transmit/receive systems.

Until recently, nitride semiconductor HEMTs have used gallium nitride (GaN) buffers with aluminum gallium nitride (AlGaN) barriers to produce a two-dimensional electron gas (2DEG) channel near the interface between the materials.

It has been found in the past couple of years that newly developed high-quality indium aluminum nitride (InAlN) barriers can produce even better 2DEGs with higher carrier concentrations, and hence lower on-resistance. This allows thinner barrier layers to be used, bringing the gate closer to the channel and hence creating better control of current flow.

In AlGaN/GaN devices, the gate is often brought nearer to the channel with recessing through a plasma etch process. Plasma etch processes tend to damage nitride semiconductor HEMT structures, reducing reliability. Another disadvantage of adding etch recessing is more complicated processing and thus higher production costs.

Another direction that the research into InAlN/GaN HEMTs has taken is to replace expensive silicon carbide (SiC) substrates with silicon or sapphire, where power densities at 10GHz of 2.5W/mm and 1.5W/mm have been achieved, respectively. On SiC, such devices have achieved power densities at the same frequency of 10.3W/mm.

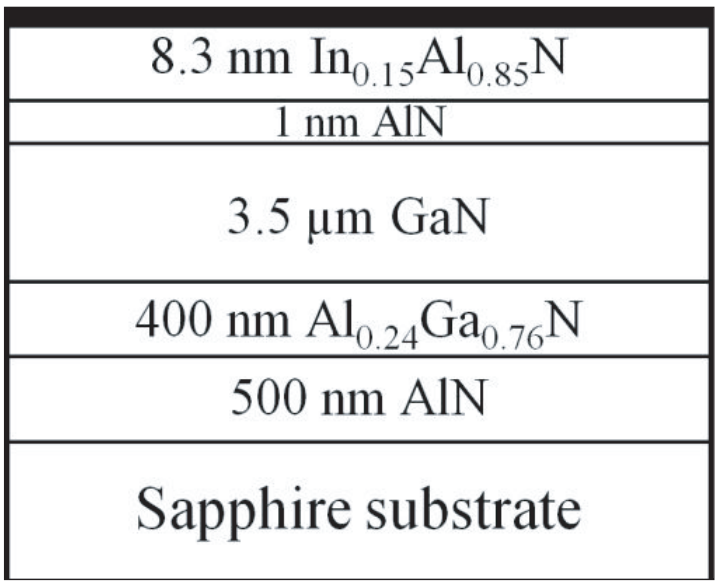

Figure 1. Schematic cross section of $In_{0.15}Al_{0.85}N$/AlN/GaN heterostructure on sapphire substrate.

The new IEMN/RWTH/Aixtron HEMT InAlN/AlN/GaN heterostructure was grown using MOCVD on c-plane sapphire (Figure 1). This resulted in Hall mobility of ~1800cm^2/V-s, sheet carrier density ~1.9x10^{13}/cm^2 and sheet resistance of 190Ω. "The very high electron mobility obtained on this epi-material indicates a very low interface roughness scattering at the hetero-interface and so a high crystal quality," the researchers comment.

The HEMTs were formed by first creating ohmic source/drain contacts of titanium-aluminum-nickel-gold that were annealed at 825°C for 30s in nitrogen. The devices were isolated with a helium ion implant. Measurements on two isolated ohmic contacts separated by 10μm gave a leakage at 200V for this isolation process of 10nA/mm. Transmission line model (TLM) structures gave an average contact resistance of ~0.6Ω-mm.

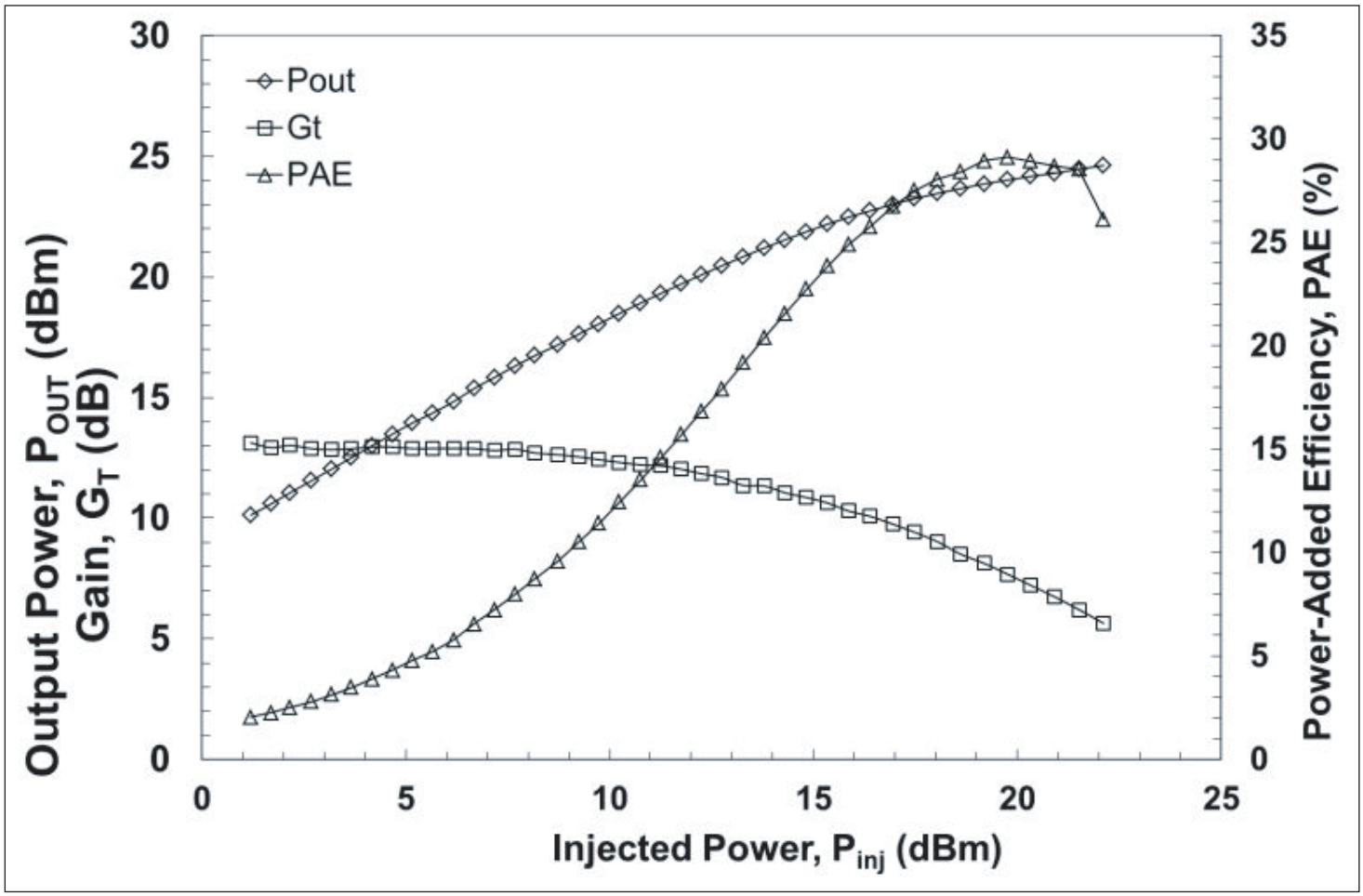

Figure 2. Output power, PAE and power gain versus injected power for InAlN/AlN/GaN HEMT at drain bias of 15V and gate bias of –3V.

A 'soft' surface clean was performed using argon ion beam etching. A T-shape Schottky gate was formed of nickel-gold. The gate length/footprint was 225nm. A 240nm silicon nitride layer was used as passivation. The 2μm x 50μm wide gate was placed centrally in the space between the source and drain contacts, which were separated by 1.75μm.

The maximum drain current density at zero gate bias (V_{GS}) was 1.22A/mm. Pinch-off occurred at –3.9V when the drain bias (V_{DS}) was 6V. The maximum extrinsic peak transconductance reached 460mS/mm at V_{GS} of –2.6V and V_{DS} of 4V. The intrinsic maximum transconductance value of 692mS/mm under these bias conditions is derived from a source access resistance estimated at 7.2Ω, subtracting the effect of contact and sheet resistance.

The reverse gate leakage at –20V is 378μA/mm, which is considered to be a good value for an InAlN Schottky contact. Using a thermionic model, the Schottky barrier height is estimated to be 1.11eV. Off-state breakdown at pinch-off occurred at a voltage of 35V.

The radio frequency (RF) characteristics were obtained at drain and gate biases of 4V and –2.6V, respectively. The extrinsic current gain cutoff frequency (f_T) was 52GHz and the maximum power gain cutoff frequency (f_{MAX}) was 110GHz.

Power measurements were carried out at 18GHz in class AB operation. The output impedance was adjusted to give maximum power density at each bias point. The maximum output power density of 2.4W/mm was achieved at a drain bias of 10V and a gate bias of –3V. Power-added efficiency (PAE) was 34% with 6dB compression level (a measure of non-linearity). At the higher drain bias of 15V (Figure 2) the power density was up to 2.9W/mm, but the power-added efficiency reduced to 26% with 6.5dB compression and linear power gain of 13.1dB.

The researchers propose that further surface pre-treatment and passivation optimization will lead to trap mitigation and increased device performance. Also, they believe that these devices could eventually beat the performance of more mature AlGaN/GaN HEMT technology, mainly through improving the ohmic performance of the source/drain contacts. ■

http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=6036145

The author Mike Cooke is a freelance technology journalist who has worked in the semiconductor and advanced technology sectors since 1997.

First enhancement-mode AlInN/GaN MOS-HFET using SiON insulation

Nitek and USC produce normally-off devices with positive 1.8V threshold and 0.7A/mm drain current.

Nitek Inc and University of South Carolina (USC) have reported the first enhancement-mode (normally-off) aluminum indium nitride on gallium nitride (AlInN/GaN) metal-oxide-semiconductor heterostructure field-effect transistors (MOS-HFETs) using silicon oxynitride (SiON) as the gate insulator [Daniel Morgan et al, Appl. Phys. Express, vol4, p114101, 2011].

A 1.5μm gate-length device with 8μm source–drain spacing demonstrated a positive threshold voltage of about 1.8V and a maximum dc output current density of 0.7A/mm. Three-terminal off-state (0V gate potential) breakdown occurred at 345V.

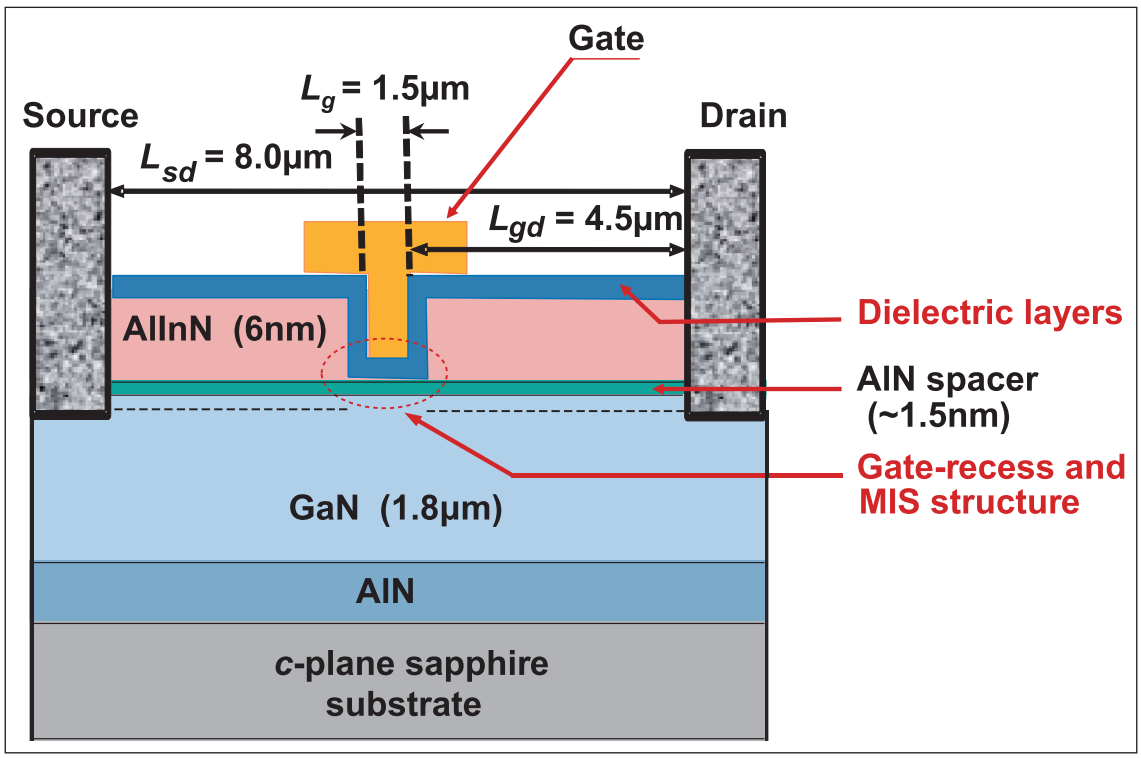

Figure 1. Schematic cross-section of the AlInN/AlN/GaN MOS-HEMT with a recessed-gate geometry and SiON gate dielectric. The gate–drain distance is 4.5μm and the total channel length is 8μm.

"The results of this study clearly show the potential of normally-off AlInN-GaN MOS-HFETs as next-generation devices for the realization of power electronics systems," the researchers say.

Normal nitride semiconductor HFETs use a Schottky metal-semiconductor contact. These devices have a negative threshold voltage and are therefore normally 'on' with zero gate potential (depletion-mode operation). For many applications, normally-off/enhancement-mode operation is desired to reduce power consumption and for failure protection.

Special processing and structuring can achieve normally-off behavior, but usually some performance factor is adversely affected, such as on-resistance, off-state breakdown voltage, threshold voltage or on-state drain current.

Metal-insulator-semiconductor aluminum gallium nitride/gallium nitride (AlGaN/GaN) devices have shown some promise, with Fujitsu achieving output currents of 800mA/mm, with a threshold of +3V and breakdown at 320V.

Recently high-quality AlInN has been developed and used instead of AlGaN as the barrier layer to provide higher charge density in the channel near the GaN interface. This higher charge is induced by spontaneous polarization fields in the nitride material. Higher charge densities give the potential of higher conductance, and hence lower resistance current flow.

Another advantage of high-quality AlInN is that the proportions of Al and In can be balanced to give layers

that are lattice matched to GaN, unlike AlGaN that is always strained in tension. This balance is achieved at about 17% In (83% Al). Lattice matching improves material quality by avoiding strain-generated defects.

The Nitek/USC devices (Figure 1) were grown on sapphire substrates using metal-organic chemical vapor deposition (MOCVD). The deposition began with a 300nm lattice-matched aluminum nitride (AlN) layer. The AlInN/AlN/GaN layer structure resulted in an epitaxial material with room-temperature sheet carrier density of $2.1 \times 10^{13}/cm^2$, mobility of $1338 cm^2/V\text{-}s$, and sheet resistance of 204Ω/square.

The MOS-HFETs were created on isolated mesas. The ohmic source–drain contact resistance for the non-optimized titanium-based metal stack was 0.7Ω-mm.

Silicon nitride (SiN) passivation was deposited using plasma-enhanced CVD. The gate region was first defined by etching a 1.8μm 'long' (i.e. in the plane of Figure 1) trench in the SiN that was 100μm 'wide' (perpendicular to plane). This etch process revealed the AlInN surface. The trench was continued down to the AlN with a controlled, low-power boron trichloride-based reactive ion etch.

The gate recess was coated with ~30nm of silicon oxynitride (SiON) using a 'digital oxide deposition' (DOD) that consisted of alternate pulses of oxygen and nitrogen precursor in a plasma-enhanced CVD process. The DOD allows for smooth layers to be created with precise thickness control. The process was previously reported by USC for use with AlGaN/GaN HFETs in 2006.

The 1.5μm nickel/gold gate metal was then deposited asymmetrically between the source and drain contact regions with a source–gate distance of about 2μm. No passivation was added after the gate was defined.

The maximum saturation current density of 0.5A/mm for the devices was reached at a gate voltage of 4V. At 6V gate potential, the drain current was 0.7A/mm.

The MOS-HFET devices operated in normally-off/enhancement mode with a threshold voltage of +1.5–2.0V. By contrast, a comparison device with conventional Schottky gate HFET had a negative threshold (–2.3V) giving normally-on/depletion behavior. The 4V shift in threshold is attributed to barrier layer thinning and insertion of a relatively thick dielectric layer between gate and channel.

The results of this study clearly show the potential of normally-off AlInN-GaN MOS-HFETs as next-generation devices for the realization of power electronics systems, the researchers say

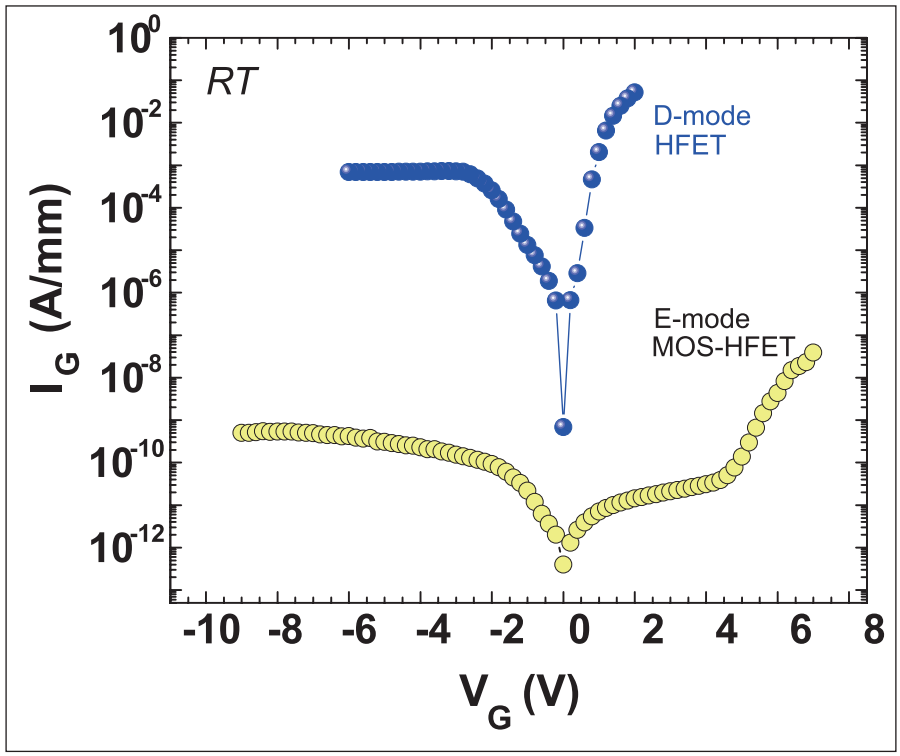

Figure 2. Gate-leakage current I_G as a function of V_G for insulating-gate E-mode MOS-HFET and conventional D-mode HFET.

The MOS-HFETs generally had a drain current leakage of 1mA/mm with 0V gate 'off-state', although for some devices the value was as high at 33mA/mm. The 0V-gate current was attributed to leakage through the GaN buffer.

The peak extrinsic transconductance of the MOS-HFET was 272mS/mm, compared with 200mS/mm for the traditional HFET. The researchers note that the transconductance is higher in the MOS-HEMT despite the 30nm-thick dielectric between the gate and channel.

The impact of dielectric insulation on gate leakage currents is several orders of magnitude (Figure 2). Without dielectric, the conventional Schottky HFET has an appreciable increase in gate current above +2V, while the MOS-HFET can continue to operate beyond +5V with significantly less than 1μA/mm leakage. At +6V, the leakage is only 4.3nA/mm. Under reverse bias, the device had less than 550pA/mm leakage.

The three-terminal breakdown characteristics were also investigated, where the both types of device were found to sustain 345V drain bias. The researchers believe that this value can be increased by dealing with buffer leakage effects and improving surface passivation. The devices were not immersed in 3M's Fluorinert insulating cooling fluid, which is sometimes used in such measurements.

The work at Nitek Inc was supported by the US Missile Defense Agency. ■

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Author: Mike Cooke

Increasing performance with III-V transistors on silicon

Researchers in Japan use new source/drain technology to boost extremely-thin-body-on-insulator channels.

A first demonstration of a new metal source/drain technology for extremely thin body (ETB) indium gallium arsenide (InGaAs) transistor channels on insulator (OI) with silicon substrates has been reported by University of Tokyo, National Institute of Advanced Industrial Science and Technology and Sumitomo Chemical Co Ltd [SangHyeon Kim et al, Appl. Phys. Express, vol4, p114201, 2011].

ETB-OI devices with channel mobilities as high as 1700cm^2/V-s were produced, despite the channel being only 10nm thick. Although the mobility was much reduced in 5nm-thick channel devices, other parameters improved, such as the on/off current ratio increasing to 10^5 and the subthreshold swing being reduced to 120mV/dec.

These achievements were due to the use of a new self-aligned source–drain technology involving nickel-indium gallium arsenide alloys reported by the same research collaboration earlier this year [see www.semiconductor-today.com/news_items/2011/FEB/NAIST_040211.htm or Semiconductor Today, p104, February 2011]. The technology avoids the damage of traditional ion implant doping and allows the use of light doping of the channel. High doping and ion damage increase resistance, reducing transistor performance.

The researchers produced the new devices (Figure 1) using direct wafer bonding (DWB) techniques. The p-type layers of $In_{0.53}Ga_{0.47}As$ (5nm) or $In_{0.7}Ga_{0.3}As$ (10nm) were grown on 2-inch indium phosphide (100) substrates using metal-organic chemical vapor deposition (MOCVD). The acceptor concentration was ~10^{16}/cm^2.

The InP substrate had sacrificial layers of $In_{0.53}Ga_{0.47}As$ and InP before the channel, for use in a subsequent series of wet etch processes involving hydrochloric acid and a mix of phosphoric acid and hydrogen peroxide. The wet etches were performed after bonding to the silicon substrate (n˘, (100)). Wet etch was chosen so that the ETB $In_{0.7}Ga_{0.3}As$ or $In_{0.53}Ga_{0.47}As$ channel layer was smooth and uniform with a root mean square surface roughness ~0.55nm.

The bonding was achieved by first passivating with ammonium sulfide ($(NH_4)_2S$) solution and applying aluminum oxide (Al_2O_3) insulator with atomic layer deposition (ALD) at 200°C on the InGaAs and Si surfaces. The bond was carried out in air after a 330°C pre-bond anneal.

The gate dielectric consisted of 10nm of Al_2O_3 deposited by ALD. The gate electrode metal was tantalum (Ta). The source/drain electrodes were produced with Ni-InGaAs alloy: first, nickel was deposited on the S/D regions and annealed at 250°C for a minute to

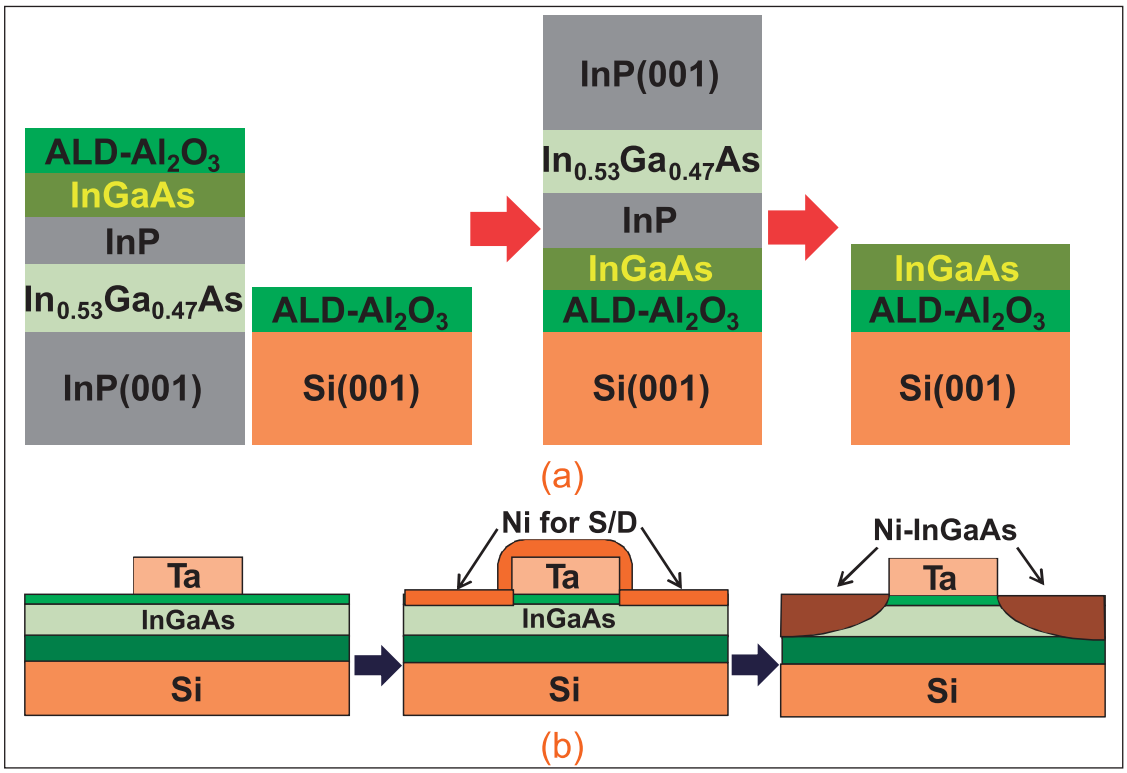

Figure 1. Fabrication of (a) III–V-OI on Si substrate by DWB and (b) InGaAs-OI MOSFETs with metal S/D structure using Ni–InGaAs alloy.

make the alloy with InGaAs; then, unreacted nickel was removed using hydrochloric acid for three minutes. Finally, aluminum electrode pads were deposited and the devices were isolated by etching a 10μm gap.

$In_{0.7}Ga_{0.3}As$ 10nm-thick channel devices with 5μm gate length and 150μm width had transfer characteristics that are described as 'good' by the researchers, although the subthreshold swing of 347mV/dec is "quite high".

In fact, one would want to see a much lower value for this parameter: a number of groups have achieved 120mV/dec and better with III-V devices, and one would even then want to get closer to the 60mV/dec theoretical limit for planar devices. Traditional silicon CMOS can reach below 100mV/dec.

The researchers explain their high swing value as arising possibly from a large off-leakage current due to the InGaAs layer remaining between the active region of the MOSFET and the isolation mesa edge.

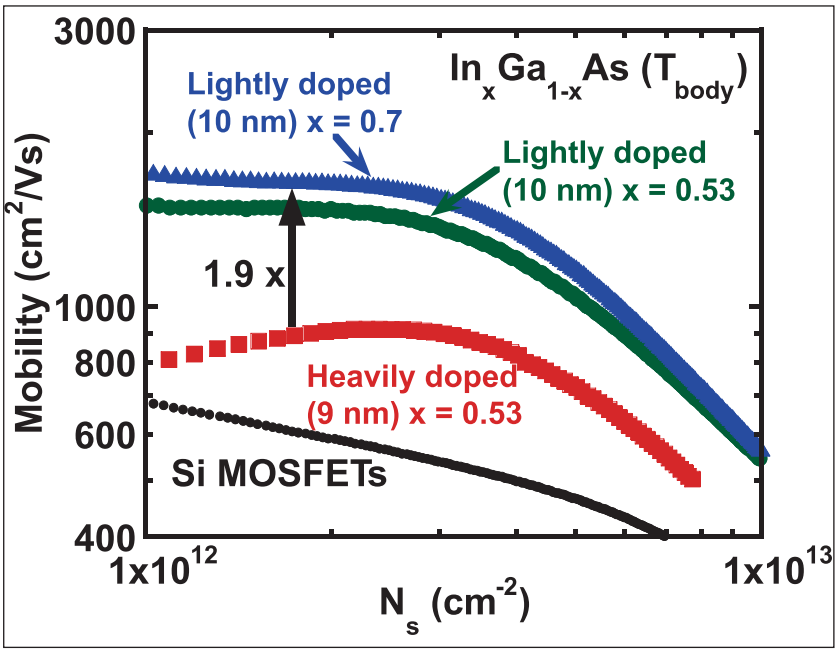

Figure 2. Mobility of heavily doped ($N_D \sim 10^{19}/cm^3$) 9nm-thick $In_{0.53}Ga_{0.47}As$-OI channel and lightly doped ($N_A \sim 10^{16}/cm^3$) 10nm-thick $In_xGa_{1x}As$-OI MOSFETs (x ~ 0.53 and 0.7).

The drain current saturation and pinch-off characteristics are good (i.e. flat). There is a shift in threshold between a drain bias of 50mV and 1V, indicating the effect of drain induced barrier lowering, due to either large source/drain parasitic resistance and/or the large off-state leakage current.

The parasitic S/D resistance of 38.2kΩ-μm also gives a low on-current, with an on-resistance of 45kΩ-μm ((1V)/(22μA/μm)). This high resistance is attributed to the thinness of Ni-InGaAs alloy layers and the long distance from the channel to electrode pad metal contacts.

New devices with lightly doped $In_{0.7}Ga_{0.3}As$ and $In_{0.53}Ga_{0.47}As$ 10nm channels were compared with previous heavily doped 9nm $In_{0.53}Ga_{0.47}As$ channel devices. The previous devices were produced by the same collaboration and reported last year.

Lead researcher SangHyeon Kim comments: "Our previous work used an n-type channel because there was a difficulty in the formation of S/D (ion implantation etc) with the ETB-OI structure. Therefore, we then fabricated InGaAs-OI with highly n-type doped channel (fabricated using in-situ doping during epitaxial growth). Its operation was similar to that of depletion type MOSFETs (junctionless transistor). However, this type of device has a lot of dopant in the channel, causing reduced mobility.

"In our new work, we have introduced (could introduce) a lightly doped p-type channel using the novel S/D formation method (metal S/D). This new device is an inversion-type MOSFET that operates in a similar way to silicon CMOS transistors. Despite the different depletion- and inversion-modes of operation, both devices use electrons as channel carrier in the on-state."

The reduction in doping from an donor concentration (N_D) of $10^{19}/cm^3$ to an acceptor concentration (NA) of $10^{16}/cm^3$ gave an enhancement in mobility of up to 1.9x with an inversion carrier density $10^{12}/cm^2$ (Figure 2). This improvement is attributed to reduced carrier scattering from ionized acceptors.

For the $In_{0.7}Ga_{0.3}As$ device, mobility was $1700cm^2/V\text{-}s$ at this inversion carrier density. All the InGaAs devices had higher mobility than Si-based devices over the inversion carrier density range 10^{12}–$10^{13}/cm^2$.

The researchers also produced devices with 5nm-thick $In_{0.7}Ga_{0.3}As$ channels. At drain bias 1V, the on-off current ratio was 10^5 and the subthreshold swing was reduced to 120mV/dec. The off current was as small as 5pA/μm.

The 5 orders of magnitude improvement in off current is ascribed to the likely increase in effective band gap due to stronger quantization and/or effective reduction in possible leakage passing through the InGaAs layer that remains between the active region of the MOSFET and the isolation mesa edge due to such a low body thickness.

Unfortunately, the on-current is also reduced with the thinner channel. This is attributed to mobility degradation and increased series resistance. The series resistance of the 5nm channel was 442.6kΩ-μm, compared with the 38.2kΩ-μm of the 10nm channel. The mobility was also reduced to less than $100cm^2/V\text{-}s$ for the range 10^{12}–$10^{13}/cm^2$ of inversion carrier density.

The researchers point to recent reports on the effects of surface roughness and dielectric deposition on device performance. Roughness reduction and process optimization can therefore be expected to deliver better performance in the future. ■

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Author: Mike Cooke

GaN-on-Si: best solution for efficient energy management

Belgium-based IMEC spin-off EpiGaN sees huge opportunities for GaN-on-silicon power-up. Mike Cooke talked to CEO Marianne Germain.

Nitride semiconductors have been at the center of new light-emitting applications for some 20 years. In recent years, a new application has been coming to the fore — heterostructure field-effect transistors (HFETs), also known as high-electron mobility transistors (HEMTs), which can handle high power density and high frequency at the same time. A further potential advantage is the ability to run at higher temperature, reducing or eliminating the need for special cooling apparatus. Also, such devices should have reduced switching and conduction losses.

Such capabilities have been developed for high-frequency power amplification, as used in mobile network transmissions from base-station connections to the telecom network. Another recent potential application is power-switching/management applications such as solar power inverters (i.e. DC-to-AC conversion), compact and switched-mode power supplies, smart electric power distribution grids that can handle fluctuating renewable resources, switching between internal combustion and electric power in hybrid electric vehicles, and electric motor control drivers. These devices need a range of different voltage ratings, such as 30–600V for IT and consumer power management and 600–1200V for automotive and industrial power-switching applications.

Whether these options will be taken up depends in large part on competing with low-cost silicon devices. EpiGaN believes that the new challenges presented by the need for efficient energy management in power electronics cannot be fulfilled by silicon-only devices and that GaN grown on silicon offers the best solution. Although the GaN-on-Si process uses (111) silicon, rather than the (100) silicon of mainstream CMOS, additional opportunities could come from the integration of silicon and nitride semiconductor components.

While LED opportunities will come, according to EpiGaN's CEO Marianne Germain, the present focus is on the huge opportunities in power electronics. In the LED sector, there are already a lot of players, and much research and development is still needed to put these devices on silicon. By contrast, GaN power electronics is a new opportunity that can be used today.

EpiGaN was spun-out of IMEC last year with a founding executive team — Germain, Joff Derluyn (CTO), and Stefan Degroote (COO) — that has more than 10 years in IMEC researching GaN epi solutions for device applications. This work culminated in demonstrations of pioneering and industry-leading GaN-on-Si wafer size and quality, as reported in several research papers and patents in the field. The €4m capital for the venture came from Capricorn Cleantech Fund, Robert Bosch Venture Capital, and LRM.

A particular advantage of growing nitride semiconductors on silicon wafers is the possibility of fab and equipment reuse — as the mainstream transfers to larger diameters (300mm, and in the future 450mm), older 6" (150mm) and 8" (200mm) facilities become available for other work. But even the smaller silicon substrates usually exceed the diameter of alternative GaN substrates.

EpiGaN can supply 4" and 6" wafers now, still in sampling quantities. But, moving to a new production facility in Q1 2012, EpiGaN expects to progress into volume capability next year and deliver its first 8" substrates, also next year.

The company claims state-of-the-art epilayer quality on standard wafers and low leakage, high breakdown voltage for thinner wafers. Although the surface roughness is specified to be less than 5%, in reality it is always less than 3% (Figure 1). Other features of EpiGaN's product include low RF losses and low-dispersion buffer layers. Products can be designed to handle kV potentials and up to 100GHz frequencies. Nitride layers on silicon carbide substrates are also on offer.

Germain believes that the most important route to process development and optimization is through look-

ing at device results and not just material characterization: dynamic characteristics of these devices intended to operate in switching mode is the key feature. EpiGaN offers such customer support and development of substrates. After all, device performance is the final aim of the work.

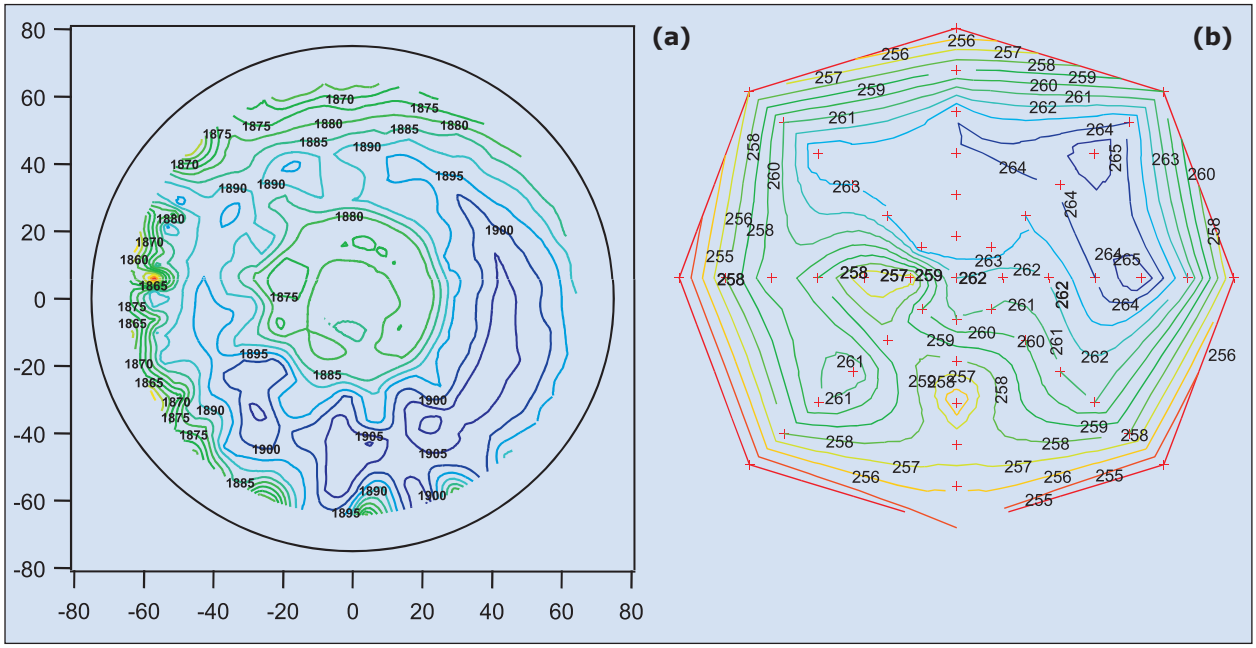

Figure 1. Thickness uniformity mappings for (a) GaN HFET and (b) AlGaN/GaN HEMT epitaxial layers on 150mm (111)Si. The variation in thickness was 0.6% for (a) and 1.3% for (b).

In-situ surface passivation

In the work at IMEC, after having solved the impact of traps in the buffer on device operation, it was found that surface traps were also degrading performance, so in-situ silicon nitride passivation was developed (Figure 2). This 'in situ grown' layer of silicon nitride (SiN) is one of the technologies that EpiGaN licenses from IMEC. The in-situ SiN layer is grown as part of the nitride metal-organic chemical vapor deposition (MOCVD) epitaxy process, rather than separately. The deposition of SiN is usually carried out with plasma-enhanced CVD (PECVD), rather than MOCVD. EpiGaN's in-situ SiN further enhances the robustness of the devices and plays a key role for enhancing device reliability.

In December 2009, IMEC reported on the use of the in-situ SiN technology for making enhancement-mode devices at the International Electron Devices Meeting (IEDM) [Derluyn et al, IEDM 2009, session 7.4; reported Semiconductor Today, p71, March 2010]. In the 2009 research, the SiN layer was used to neutralize a thin AlGaN top barrier surface charge so that it no longer contributed to the depletion of the two-dimensional electron gas (2DEG) conducting layer. This enabled the creation of enhancement-mode (normally-off) GaN double-heterostructure field-effect transistors (DHFETs) on 4-inch (~100mm) silicon substrates.

The importance of enhancement-mode devices is that the current is 'normally-off' and needs a gate potential to flow. Although circuits can be designed to use depletion-mode normally-on devices, normally-off behavior is preferred for power devices that usually need to have fail-safe operation.

Enhanced breakdown

With enhancement or depletion mode devices, the breakdown voltage is primarily determined by the quality and design of the wafer epitaxy. EpiGaN has demonstrated up to kV-capable material. Leakage current at 600V is below 500nA/mm. The breakdown behavior for enhancement-mode devices is consistent with that obtained with depletion-mode DHFETs. This breakdown is explained as being due firstly to breakdown in the top part of the device structure for small gate–drain gaps, but for larger gate–drain distances as being due to vertical conduction down to the silicon substrate. Extended gate–drain distances are used to reduce electric fields in high-voltage devices.

Since that work, EpiGaN has supplied material to different customers and R&D institutes, including

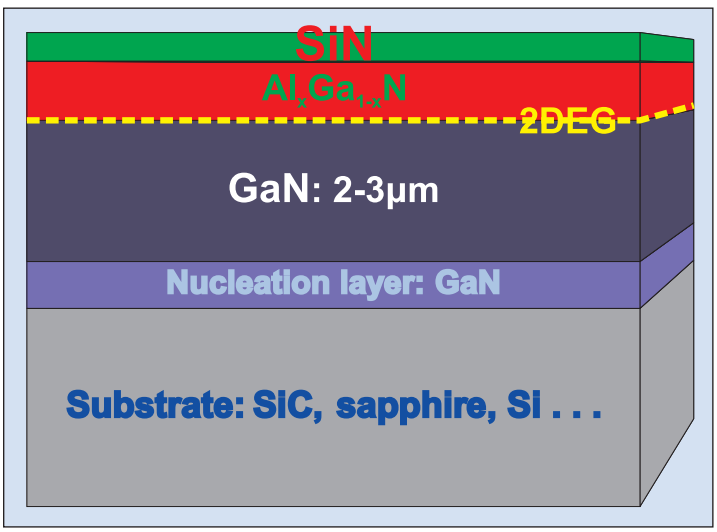

Figure 2. Schematic of in-situ growth of SiN passivation on AlGaN/GaN HEMT epitaxial structure.

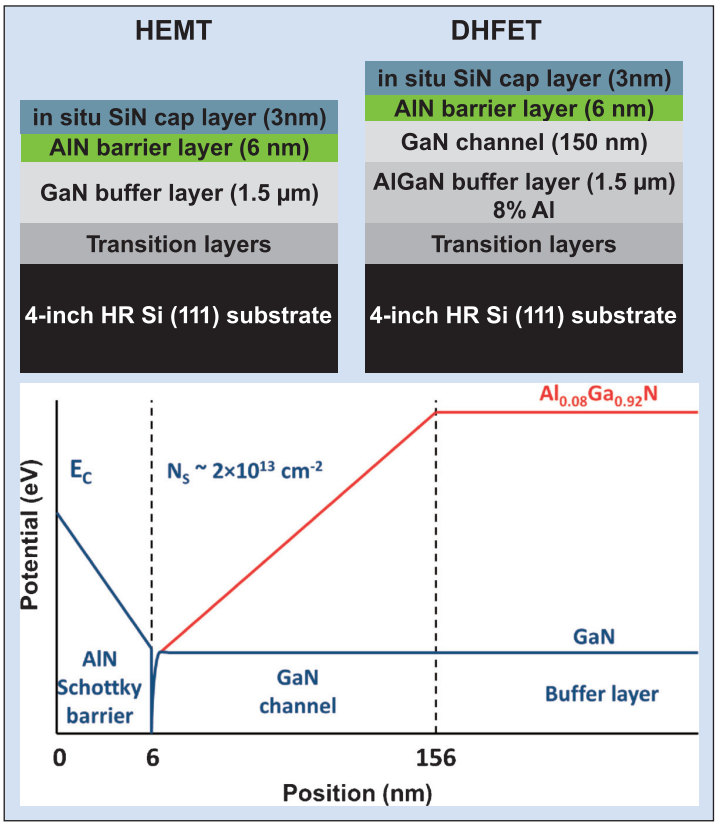

Figure 3. Cross section of fabricated AlN/GaN-on-Si HEMTs (top left) and DHFETs (top right) and schematic of conduction-band diagram of the HEMT and DHFET.

France's Institute of Electronic, Microelectronic and Nanotechnology (IEMN) where the researchers used AlN as the barrier material instead of AlGaN [Farid Medjdoub et al, Appl. Phys. Express, vol4, p064106, 2011; reported Semiconductor Today, p110, June/July 2011]. This allowed the creation of a higher-carrier-density two-dimensional electron gas (2DEG) channel near the barrier–buffer interface, giving drain currents of more than 2A/mm and a record transconductance of 600mS/mm. Farid Medjdoub, the lead author of this work at IEMN, previously worked with the EpiGaN management team at IMEC and is among the authors listed in the IEDM 2009 paper referred to above.

More recently, IEMN has produced devices with back-barriers (Figure 3) to improve RF performance, using material supplied by EpiGaN [Farid Medjdoub et al, Appl. Phys. Express, vol4, p124101, 2011]. The back-barrier overcomes a previous limitation of the drain potential to less than 20V by improving confinement in the channel and thus cutting off a leakage path through the buffer layer. These new IEMN devices achieve a current density of almost 2A/mm together with high-voltage operation at potentials of more than 50V. The gate–drain distance in these devices is 1µm.

"The gate length scaling down to sub-100 nm in the AlN/GaN-on-Si DHFET should undoubtedly open the way for cost-effective millimeter-wave high-power/high-linearity device applications," says IEMN.

Another recent research announcement that includes EpiGaN is the new European Union HiPoSwitch project, targeting more compact and more powerful energy converters for information and communication technology and solar inverters. The leader of this work is the Ferdinand-Braun-Institut, with industrial support from EpiGaN, Aixtron, Artesyn and Infineon. The Slovak Academy of Sciences (Slovenskej akadémii vied), Vienna University of Technology (Technische Universität Wien) and University of Padua (Università degli Studi di Padova) are also involved on the academic side. ■

Mike Cooke is a freelance technology journalist who has worked in semiconductor and advanced technology sectors since 1997.

Other developments in GaN-on-silicon

A number of other firms are looking to produce nitride-on-silicon substrates, for sale or in-house devices.

Kyma in the USA is expanding its nitride-on-silicon substrate product line with diameters up to 150mm (AlN/Si). Demonstrations have been made for 200mm and 300mm diameters. Kyma uses patented plasma vapor deposition of nanocolumns (PVDNC) and hydride vapor phase epitaxy (HVPE) processes to produce AlN and GaN layers, respectively. GaN-on-Si diameters up to 100mm are available now. The GaN-on-Si is available in semi-insulating form, as is needed for high-frequency FETs. The AlN/Si could be used as an alternative to sapphire for LED production.

Another US company producing GaN-on-Si substrates is Translucent. The company uses a layer of rare earth oxide to bridge the gap in lattice properties between silicon and GaN, targeting products for LED and FET manufacturing. The company also has products available at 100mm and is due to have 150mm and 200mm wafers available next year.

Azzurro in Germany has been offering 150mm GaN-on-Si substrates since 2005 for LEDs and power electronics. The company has plans to offer 200mm GaN-on-Si for LEDs in the near future. It has a new production facility in Dresden due to come online.

Companies producing and developing GaN-on-Si substrates and devices include Nitronex, International Rectifier, startup company EPC, NEC in Japan, and Brigdgelux for LEDs. University of California Santa Barbara spin-off Transphorm (which develops GaN devices for power conversion) has ordered in Aixtron GaN-on-Si tools. LG Electronics in Korea is looking to GaN-on-Si for power electronic devices, aimed at home appliances and electric vehicles.


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200 Voyageur Drive, Montreal,
Quebec H9R 6A8, Canada
Tel: +1 925 980 5645
Fax: +1 514 630 0227
www.thefoxgroupinc.com

Freiberger Compound Materials
Am Junger Loewe Schacht 5,
Freiberg, 09599, Germany
Tel: +49 3731 280 0
Fax: +49 3731 280 106
www.fcm-germany.com

Kyma Technologies Inc
8829 Midway West Road,
Raleigh, NC,
USA
Tel: +1 919 789 8880
Fax: +1 919 789 8881
www.kymatech.com

Nikko Materials
125 North Price Road,
Chandler, AZ,
USA
Tel: +1 480 732 9857
Fax: +1 480 899 0779
www.nikkomaterials.com

SiCrystal AG
Guenther-Scharowsky-Str. 1
D-91058 Erlangen,
Germany
Tel: +49 (0) 9131 / 73 33 97
Fax: +49 (0) 9131 / 73 22 37
www.sicrystal.de

sp3 Diamond Technologies
2220 Martin Avenue,
Santa Clara, CA 95050,
USA
Tel: +1 877 773 9940
Fax: +1 408 492 0633
www.sp3inc.com

Sumitomo Electric Semiconductor Materials Inc
7230 NW Evergreen Parkway,
Hillsboro, OR 97124, USA
Tel: +1 503 693 3100 x207
Fax: +1 503 693 8275
www.sesmi.com

TECDIA Inc
(see section 16 for full contact details)

III/V-Reclaim
Wald 10,
84568 Pleiskirchen,
Germany
Tel: +49 8728 911 093
Fax: +49 8728 911 156
www.35reclaim.de
III/V-Reclaim offers reclaim (recycling) of GaAs and InP wafers, removing all kinds of layers and structures from customers' wafers. All formats and sizes can be handled. The firm offers single-side and double-side-polishing and ready-to-use surface treatment.

Umicore Electro-Optic Materials
Watertorenstraat 33,
B-2250 Olen, Belgium
Tel: +32-14 24 53 67
Fax: +32-14 24 58 00
www.substrates.umicore.com

Wafer Technology Ltd
34 Maryland Road, Tongwell,
Milton Keynes, Bucks, MK15 8HJ,
UK
Tel: +44 (0)1908 210444
Fax: +44 (0)1908 210443
www.wafertech.co.uk
Wafer Technology Ltd is a UK-based producer of III-V materials and epitaxy-ready substrates offering the widest product range in the business.

Wafer World Inc
1100 Technology Place, Suite 104,
West Palm Beach, FL 33407, USA
Tel: +1-561-842-4441
Fax: +1-561-842-2677
E-mail: sales@waferworld.com
www.waferworld.com
World's leading supplier of small-diameter (25.4–150.0mm) silicon, germanium, GaAs & InP reclaim, cleanroom packaging and 50 other materials!

4 Epiwafer foundry

Spire Semiconductor LLC
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Hudson, NH 03051, USA
Tel: +1 603 595 8900
Fax: +1 603 595 0975
www.spirecorp.com

Cambridge Chemical Company Ltd
Unit 5 Chesterton Mills,
French's Road, Cambridge CB4 3NP,
UK
Tel: +44 (0)1223 352244
Fax: +44 (0)1223 352444
www.camchem.co.uk

The Fox Group Inc
(see section 3 for full contact details)

Intelligent Epitaxy Technology Inc
1250 E Collins Blvd, Richardson,
TX 75081-2401, USA
Tel: +1 972 234 0068
Fax: +1 972 234 0069
www.intelliepi.com

IQE
Cypress Drive,
St Mellons, Cardiff
CF3 0EG,
UK
Tel: +44 29 2083 9400
Fax: +44 29 2083 9401
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IQE is a leading global supplier of advanced epiwafers, with products covering a diverse range of applications within the wireless, optoelectronic, photovoltaic and electronic markets.

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France
Tel: +33 1 45 10 67 31
Fax: +33 1 45 10 69 53
www.ommic.fr

Picogiga International S.A.S.
Place Marcel Rebuffat, Parc de Villejust, 91971 Courtabouef,
France
Tel: +33 (0)1 69 31 61 30
Fax: +33 (0)1 69 31 61 79
www.picogiga.com

SemiSouth Laboratories Inc
201 Research Boulevard,
Starkville, MS 39759,
USA
Tel: +1 662 324 7607
Fax: +1 662 324 7997
www.semisouth.com

5 Deposition materials

Akzo Nobel High Purity Metalorganics
525 West Van Buren Street,
Chicago, IL 60607,
USA
Tel: +1 312 544 7371
Fax: +1 312 544 7188
www.akzonobel-hpmo.com

Cambridge Chemical Company Ltd
Unit 5 Chesterton Mills,
French's Road,
Cambridge CB4 3NP,
UK
Tel: +44 (0)1223 352244
Fax: +44 (0)1223 352444
www.camchem.co.uk

Dow Electronic Materials
60 Willow Street,
North Andover, MA 01845,
USA
Tel: +1 978 557 1700
Fax: +1 978 557 1701
www.metalorganics.com

Matheson Tri-Gas
6775 Central Avenue
Newark, CA 94560,
USA
Tel: +1 510 793 2559
Fax: +1 510 790 6241
www.mathesontrigas.com

Mining & Chemical Products Ltd
(see section 1 for full contact details)

Power + Energy Inc
(see section 10 for full contact details)

Praxair Electronics
542 Route 303,
Orangeburg,
NY 10962,
USA
Tel: +1 845 398 8242
Fax: +1 845 398 8304
www.praxair.com/electronics

SAFC Hitech
Power Road,
Bromborough,
Wirral,
Merseyside CH62 3QF,
UK
Tel: +44 151 334 2774
Fax: +44 151 334 6422
www.safchitech.com

Williams Advanced Materials
2978 Main Street,
Buffalo,
NY 14214,
USA
Tel: +1 716 837 1000
Fax: +1 716 833 2926
www.williams-adv.com

6 Deposition equipment

AIXTRON SE
Kaiserstrasse 98,
52134 Herzogenrath,
Germany
Tel: +49 241 89 09 0
Fax: +49 241 89 09 40
www.aixtron.com

AIXTRON is a leading provider of deposition equipment to the semiconductor industry. AIXTRON's technology solutions (MOCVD, ALD, AVD®, CVD, OVPD) are used by a diverse range of customers worldwide to build advanced components for electronic and optoelectronic applications based on compound, silicon, or organic semiconductors. Several system configurations of AIXTRON, Epigress, Genus or Thomas Swan are available.

Oxford Instruments Plasma Technology
North End, Yatton,
Bristol, Avon BS49 4AP,
UK
Tel: +44 1934 837 000
Fax: +44 1934 837 001
www.oxford-instruments.co.uk

We provide flexible tools and processes for precise materials deposition, etching and controlled nanostructure growth. Core technologies include plasma and ion-beam deposition and etch and ALD.

Plasma-Therm LLC
10050 16th Street North,
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USA
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Fax: +1 727 577 7035
www.plasmatherm.com

Plasma-Therm, LLC is an established leading provider of advanced plasma processing equipment for the semiconductor industry and related specialty markets.

Riber
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Tel: +33 (0) 1 39 96 65 00
Fax: +33 (0) 1 39 47 45 62
www.riber.com

Riber is a leading supplier of MBE products and related services for the compound semiconductor industry.

SVT Associates Inc
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Eden Prairie,
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Fax: +1 952 934 2737
www.svta.com

Temescal, a part of Ferrotec
4569-C Las Positas Rd,
Livermore,
CA 94551,
USA
Tel: +1 925 245 5817
Fax: +1 925 449-4096
www.temescal.net

Temescal, the expert in metallization systems for the processing of compound semiconductor-based substrates, provides the finest evaporation systems available. Multi-layer coatings of materials such as Ti, Pt, Au, Pd, Ag, NiCr, Al, Cr, Cu, Mo, Nb, SiO_2, with high uniformity are guaranteed. Today the world's most sophisticated handsets, optical, wireless and telecom systems rely on millions of devices that are made using Temescal deposition systems and components.

Veeco Instruments Inc
100 Sunnyside Blvd.,
Woodbury, NY 11797,
USA
Tel: +1 516 677 0200
Fax: +1 516 714 1231
www.veeco.com

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Veeco is a world-leading supplier of compound semiconductor equipment, and the only company offering both MOCVD and MBE solutions. With complementary AFM technology and the industry's most advanced Process Integration Center, Veeco tools help grow and measure nanoscale devices in worldwide LED/wireless, data storage, semiconductor and scientific research markets—offering important choices, delivering ideal solutions.

7 Wafer processing materials

Air Products and Chemicals Inc
7201 Hamilton Blvd.,
Allentown, PA 18195,
USA
Tel: +1 610 481 4911
www.airproducts.com/compound

MicroChem Corp
1254 Chestnut St. Newton,
MA 02464, USA
Tel: +1 617 965 5511
Fax: +1 617 965 5818
www.microchem.com

Power + Energy Inc
(see section 10 for full contact details)

Praxair Electronics
(see section 5 for full contact details)

8 Wafer processing equipment

EV Group
DI Erich Thallner Strasse 1,
St. Florian/Inn, 4782,
Austria
Tel: +43 7712 5311 0
Fax: +43 7712 5311 4600
www.EVGroup.com
Technology and market leader for wafer processing equipment.
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Scotland, UK
Tel: +44 (0) 1389 875 444
Fax: +44 (0) 1389 879 042
www.logitech.uk.com
Logitech Ltd is a leading designer and manufacturer of high-precision cutting, lapping, polishing and CMP equipment enabling high-specification surface finishes to be prepared with precise geometric accuracy.

Oxford Instruments Plasma Technology
(see section 6 for full contact details)

Plasma-Therm LLC
(see section 6 for full contact details)

Power + Energy Inc
(see section 10 for full contact details)

SAMCO International Inc
532 Weddell Drive,
Sunnyvale,
CA, USA
Tel: +1 408 734 0459
Fax: +1 408 734 0961
www.samcointl.com

SPP Process Technology Systems Ltd
Imperial Park,
Newport NP10 8UJ,
Wales, UK
Tel: +44 (0)1633 652400
Fax: +44 (0)1633 652405
www.spp-pts.com

TECDIA Inc
(see section 16 for full contact details)

Veeco Instruments Inc
(see section 6 for full contact details)

9 Materials & metals

Goodfellow Cambridge Ltd
Ermine Business Park,
Huntingdon,
Cambridgeshire PE29 6WR,
UK
Tel: +44 (0) 1480 424800
Fax: +44 (0) 1480 424900
www.goodfellow.com

Goodfellow
Goodfellow supplies small quantities of metals and materials for research, development, prototyping and specialised manufacturing operations.

TECDIA Inc
(see section 16 for full contact details)

10 Gas and liquid handling equipment

Air Products and Chemicals Inc
(see section 7 for full contact details)

Cambridge Fluid Systems
12 Trafalgar Way, Bar Hill,
Cambridge CB3 8SQ, UK
Tel: +44 (0)1954 786800
Fax: +44 (0)1954 786818
www.cambridge-fluid.com

CS CLEAN SYSTEMS AG
Fraunhoferstrasse 4,
Ismaning, 85737, Germany
Tel: +49 89 96 24 00 0
Fax: +49 89 96 24 00 122
www.cscleansystems.com

Power + Energy Inc
106 Railroad Drive,
Ivyland, PA 18974,
USA
Tel: +1 215 942-4600
Fax: +1 215 942-9300
www.powerandenergy.com

SAES Pure Gas Inc
4175 Santa Fe Road,
San Luis Obispo, CA 93401,
USA
Tel: +1 805 541 9299
Fax: +1 805 541 9399
www.saesgetters.com

11 Process monitoring and control

k-Space Associates Inc
2182 Bishop Circle East, Dexter,
MI 48130, USA
Tel: +1 734 426 7977
Fax: +1 734 426 7955

www.k-space.com
k-Space Associates Inc specializes in in-situ, real-time thin-film process monitoring tools for MBE, MOCVD, PVD, and thermal evaporation. Applications and materials include the research and production line monitoring of compound semiconductor-based electronic, optoelectronic, and photovoltaic devices.

KLA-Tencor
One Technology Dr,
1-2221I, Milpitas,
CA 95035,
USA
Tel: +1 408 875 3000
Fax: +1 408 875 4144
www.kla-tencor.com

LayTec AG
Seesener Str. 10–13,
10709 Berlin,
Germany
Tel: +49 30 39 800 80 0
Fax: +49 30 3180 8237
www.laytec.de
LayTec develops and manufactures optical in-situ and in-line metrology systems for thin-film processes with particular focus on compound semiconductor and photovoltaic applications. Its know-how is based on optical techniques: reflectometry, emissivity corrected pyrometry, curvature measurements and reflectance anisotropy spectroscopy.

Optical Reference Systems Ltd
OpTIC Technium,
St Asaph Business Park,
St Asaph, LL17 0JD,
UK
Tel: +44 (0)1745 535 188
Fax: +44 (0)1745 535 186
www.ors-ltd.com

WEP (Ingenieurbüro Wolff für Elektronik- und Programmentwicklungen)
Bregstrasse 90, D-78120
Furtwangen im Schwarzwald,
Germany
Tel: +49 7723 9197 0
Fax: +49 7723 9197 22
www.wepcontrol.com

12 Inspection equipment

Bruker AXS GmbH
Oestliche Rheinbrueckenstrasse 49,
Karlsruhe, 76187, Germany
Tel: +49 (0)721 595 2888
Fax: +49 (0)721 595 4587
www.bruker-axs.de

13 Characterization equipment

J.A. Woollam Co. Inc.
645 M Street Suite 102,
Lincoln, NE 68508,
USA
Tel: +1 402 477 7501
Fax: +1 402 477 8214
www.jawoollam.com

Lake Shore Cryotronics Inc
575 McCorkle Boulevard,
Westerville, OH 43082,
USA
Tel: +1 614 891 2244
Fax: +1 614 818 1600
www.lakeshore.com

14 Chip test equipment

Keithley Instruments Inc
28775 Aurora Road,
Cleveland, OH 44139,
USA
Tel: +1 440.248.0400
Fax: +1 440.248.6168
www.keithley.com

SUSS MicroTec Test Systems
228 Suss Drive,
Waterbury Center, VT 05677,
USA
Tel: +1 800 685 7877
Fax: +1 802 244 7853
www.suss.com

15 Assembly/packaging materials

ePAK International Inc
4926 Spicewood Springs Road,
Austin, TX 78759, USA
Tel: +1 512 231 8083
Fax: +1 512 231 8183
www.epak.com

Gel-Pak
31398 Huntwood Avenue,
Hayward,
CA 94544,
USA
Tel: +1 510 576 2220
Fax: +1 510 576 2282
www.gelpak.com

Wafer World Inc
(see section 3 for full contact details)

Williams Advanced Materials
2978 Main Street,
Buffalo, NY 14214,
USA
Tel: +1 716 837 1000
Fax: +1 716 833 2926
www.williams-adv.com

16 Assembly/packaging equipment

Ismeca Europe Semiconductor SA
Helvetie 283,
La Chaux-de-Fonds, 2301,
Switzerland
Tel: +41 329257111
Fax: +41 329257115
www.ismeca.com

Kulicke & Soffa Industries
1005 Virginia Drive,
Fort Washington,
PA 19034,
USA
Tel: +1 215 784 6000
Fax: +1 215 784 6001
www.kns.com

Palomar Technologies Inc
2728 Loker Avenue West,
Carlsbad,
CA 92010,
USA
Tel: +1 760 931 3600
Fax: +1 760 931 5191
www.PalomarTechnologies.com

TECDIA Inc
2700 Augustine Drive, Suite 110,
Santa Clara,
CA 95054,
USA
Tel: +1 408 748 0100
Fax: +1 408 748 0111
www.tecdia.com

Tecdia is a manufacturer of single-layer chip capacitors, chip resistors, DC boards, bias-Ts, diamond scribing tools and dispensing nozzles.

17 Assembly/packaging foundry

Quik-Pak
10987 Via Frontera,
San Diego, CA 92127,
USA
Tel: +1 858 674 4676
Fax: +1 8586 74 4681
www.quikicpak.com

18 Chip foundry

Compound Semiconductor Technologies Ltd
Block 7, Kelvin Campus,
West of Scotland, Glasgow,
Scotland G20 0TH,
UK
Tel: +44 141 579 3000
Fax: +44 141 579 3040
www.compoundsemi.co.uk

United Monolithic Semiconductors
Route departementale 128,
BP46, Orsay, 91401,
France
Tel: +33 1 69 33 04 72
Fax: +33 169 33 02 92
www.ums-gaas.com

19 Facility equipment

MEI, LLC
3474 18th Avenue SE,
Albany, OR 97322-7014,
USA
Tel: +1 541 917 3626
Fax: +1 541 917 3623
www.marlerenterprises.net

20 Facility consumables

W.L. Gore & Associates
401 Airport Rd,
Elkton, MD 21921-4236,
USA
Tel: +1 410 392 4440
Fax: +1 410 506 8749
www.gore.com

21 Computer hardware & software

Ansoft Corp
4 Station Square, Suite 200,
Pittsburgh, PA 15219,
USA
Tel: +1 412 261 3200
Fax: +1 412 471 9427
www.ansoft.com

Crosslight Software Inc
121-3989 Henning Dr.,
Burnaby, BC, V5C 6P8,
Canada
Tel: +1 604 320 1704
Fax: +1 604 320 1734
www.crosslight.com

Semiconductor Technology Research Inc
10404 Patterson Ave., Suite 108,
Richmond, VA 23238,
USA
Tel: +1 804 740 8314
Fax: +1 804 740 3814
www.semitech.us

22 Used equipment

Class One Equipment Inc
5302 Snapfinger Woods Drive,
Decatur, GA 30035,
USA
Tel: +1 770 808 8708
Fax: +1 770 808 8308
www.ClassOneEquipment.com

Brumley South Inc
422 North Broad Street,
Mooresville,
NC 28115,
USA
Tel: +1 704 664 9251
Fax: +1 704 664 9246
www.brumleysouth.com
As an ISO 9001 registered global leader in the remanufacturing of wafer inspection systems, Brumley South Inc specializes in designing, installing and supporting upgrades for ADE, Nanometrics, Dryden and KLA-Tencor Surfscan tools, polysterene latex sphere calibration standards, particle deposition systems, and semiconductor parts and service.

23 Services

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High Holborn,
London WC1V 6EG,
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Tel: +44 (0)20 7405 8411
Fax: +44 (0)20 7405 9772
www.henrybutcher.com

M+W Zander Holding AG
Lotterbergstrasse 30,
Stuttgart,
Germany
Tel: +49 711 8804 1141
Fax: +49 711 8804 1950
www.mw-zander.com

TECDIA Inc
(see section 16 for full contact details)

24 Consulting

Fishbone Consulting SARL
8 Rue de la Grange aux Moines,
78460 Choisel,
France
Tel: + 33 (0)1 30 47 29 03
E-mail: jean-luc.ledys@neuf.fr

25 Resources

SEMI Global Headquarters
3081 Zanker Road,
San Jose, CA 95134, USA
Tel: +1 408 943 6900
Fax: +1 408 428 9600
www.semi.org

Yole Développement
45 rue Sainte Geneviève,
69006 Lyon,
France
Tel: +33 472 83 01 86
www.yole.fr

event calendar

If you would like your event listed in *Semiconductor Today*'s Event Calendar, then please e-mail all details to the Editor at mark@semiconductor-today.com

21–26 January 2012
SPIE Photonics West 2012
Moscone Center San Francisco, CA, USA
E-mail: customerservice@spie.org
http://spie.org/photonics-west.xml

31 January – 2 February 2012
Transformations in Lighting: 2012 DOE Solid-State Lighting R&D Workshop
Hyatt Regency Atlanta, GA, USA
E-mail: solidstate@courtesyassoc.com
www1.eere.energy.gov/buildings/ssl/atlanta2012.html

7–9 February 2012
Strategies in Light 2012 Conference & Expo
Santa Clara Covention Center, CA, USA
E-mail: LubaH@pennwell.com
www.strategiesinlight.com

7–9 February 2012
LED/SEMICON Korea 2012
COEX, Seoul, Korea
E-mail: semiconkorea@semi.org
www.led-korea.org/en eshim@semi.org

12–16 February 2012
SPIE Advanced Lithography 2012
San Jose, CA, USA
E-mail: customerservice@spie.org
http://spie.org/advanced-lithography.xml

4–8 March 2012
Optical Fiber Communication Conference and Exhibition/National Fiber Optic Engineers Conference (OFC/NFOEC 2012)
Los Angeles Convention Center, CA, USA
E-mail: info@ofcconference.org
www.ofcnfoec.org

18–19 March 2012
China Semiconductor Technology International Conference (CSTIC 2012)
Kerry Hotel Pudong, Shanghai, China
E-mail: cstic@semi.org.cn
http://semiconchina.semi.org/cstic

20–22 March 2012
SEMICON China 2012
Shanghai New International Expo Centre (SNIEC), China
E-mail: semichina@semi.org
www.semiconchina.org

20–22 March 2012
LASER World of PHOTONICS CHINA
Shanghai New International Expo Centre (SNIEC), China
E-mail: laser@mmi-shanghai.com
www.world-of-photonics.net/en/laser-china/start

21–23 March 2012
7th Asia Solar Photovoltaic Industry Exhibition
Shanghai Expo Theme Pavilion, China

advertisers' index

E-mail: info@aiexpo.com.cn
www.asiasolar.cc/en

25-30 March 2012
8th conference on Porous Semiconductors - Science and Technology (PSST-2012)
Hotel Monte Malaga, Spain
Abstract deadline: 25 December 2011
E-mail: info@the-psst.com
www.the-psst.com

2–4 April 2012
Semiconductor and Integrated Opto-Electronics Conference (SIOE'12)
Cardiff University, Wales, UK
E-mail:K.A.Shore@bangor.ac.uk
www.astro.cardiff.ac.uk/research/pm/events/?page=sioe

9–13 April 2012
2012 MRS Spring Meeting
San Francisco, CA, USA
E-mail: info@mrs.org
www.mrs.org/spring2012

15–19 April 2012
IEEE International Reliability Physics Symposium (IRPS-2012)
Hyatt Regency Orange County, Anahelm, CA, USA
E-mail: yuan.chen@nasa.gov
www.irps.org

15–20 April 2012
Light+Building 2012
Frankfurt am Main, Germany
http://light-building.messefrankfurt.com

16–18 April 2012
12th European Advanced Process Control and Manufacturing Conference (APCM 2012)
MINATEC, Grenoble - France
E-mail: weber@apcm-europe.eu
www.apcm-europe.eu

16–18 April 2012
CPV-8 International Conference on Concentrating Photovoltaic Systems
Toledo, Spain
E-mail: iinfo@cpv-8.org
www.cpv-8.org/cms

16–20 April 2012
SPIE Photonics Europe 2012
The Square Conference Center, Brussels, Belgium
E-mail: customerservice@spie.org
http://spie.org/photonics-europe.xml

18–20 April 2012
16th European Conference on Integrated Optics (ECIO 2012)
Hotel Melia Sitges, Barcelona, Spain
E-mail: ecio2012@icfo.es
www.ecio2012.com

19–20 April 2012
4th Photovoltaics Thin-Film Week, including: 4th Thin-Film Industry Forum (TIF 2012)
Berlin, Germany
E-mail: info@solarpraxis.de
www.solarpraxis.de/en/conferences

23–26 April 2012
2012 CS MANTECH: International Conference on Compound Semiconductor Manufacturing Technology
The Boston Park Plaza Hotel, Boston, MA, USA
E-mail: csmantech@csmantech.org
www.csmantech.org

23–27 April 2012
SPIE Defense, Security, and Sensing 2012
Baltimore, MD, USA
E-mail: customerservice@spie.org
http://spie.org/defense-security.xml

28 April – 3 May 2012
2012 SVC TechCon: 55th Society of Vacuum Coaters Annual Technical Conference
Santa Clara Convention Center, CA, USA
E-mail: svcinfo@svc.org
www.svc.org/ConferencesExhibits/Future-Meetings.cfm

6–11 May 2012
221st Electrochemical Society (ECS) Meeting
Seattle, Washington
E-mail: meetings@electrochem.org
www.electrochem.org/meetings/biannual/fut_mtgs.htm

14–18 May 2012
E-MRS 2012 Spring Meeting
Congress Center, Strasbourg, France
Abstract deadline: 12 January 2012
E-mail: emrs@emrs-strasbourg.com
www.emrs-strasbourg.com

15–16 May 2012
SEMICON Russia 2012
ExpoCenter Moscow, Russia
E-mail: semimoscow@semi.org
www.semiconrussia.org


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