ISSN 1752-2935 (online)

semiconductorTODAY

COMPOUNDS & ADVANCED SILICON

Vol. 5 • Issue 8 • October/November 2010 www.semiconductor-today.com

MOCVD automation and fab integration

Veeco plans Asia expansion • Umicore opens US Ge plant
News from EuMW & ECOC • Spire's record 42.3% PV efficiency

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Cover: Aixtron's 300mm MOCVD cluster tool with two process modules for III-V on silicon processes, which has provided experience for developing automation and fab integration for HB-LED production as substrate wafers expand and demands on manufacturing volume and yield increase. **p95**

editorial

Industry events highlight trends

The last month or so has seen several conferences and expos witness a plethora of product launches. In microelectronics, European Microwave Week (EuMW) in Paris, France saw the launch of new products for microwave and millimeter-wave application from the likes of RFIC makers RFMD and TriQuint, as well as M/A-COM Tech and M/A-COM Tech Asia (formerly Mimix Asia) — see 13–16. Also at both EuMW and the IEEE Compound Semiconductor IC Symposium (CSICS) in Monterey, CA, Agilent unveiled the 2011 version of its flagship Advanced Design System (ADS) electronic design automation (EDA) software, targeting multi-technology design inherent in RF system-in-package (SiP) components. Meanwhile, EDA software supplier AWR also demonstrated new capabilities at CSICS. Such tools should benefit RF design houses working with foundries such as Taiwan's AWSC and WIN Semiconductors, which are continuing to thrive (see page 19). But, in addition to integrated device manufacturer TriQuint also offering foundry services (for both GaAs and GaN technology), RFMD has announced that it is expanding its foundry services from GaN to also include GaAs, as well as MBE-related epi services (see pages 12–13), hence joining TriQuint in offering both GaAs and GaN foundry.

At the SCTE Cable-Tec Expo in New Orleans, RFMD, TriQuint and Anadigics also launched products focusing on cable TV and network technology such as fiber-to-the-home (FTTH), RF-over-glass (RFoG) and hybrid fiber coax (HFC) — see pages 20–21 — showing the increasing diversification of RFIC makers formerly focused heavily on handset power amplifiers.

Likewise, at the SCTE Cable-Tec Expo, RFMD launched GaN products targeted at HFC technology for CATV. Meanwhile, at CSICS, Fujitsu reported its development of a GaN HEMT power amplifier with record power output of 1.3W for W-band millimeter-wave wireless communications (page 24).

Showing the increasing burgeoning of market opportunities for compound semiconductors such as GaAs and GaN in applications like CATV, Japan's Renesas Electronics has announced that it aims to strengthen its compound semiconductor business, including launching GaN-based products for CATV by March while also focusing on GaAs FETs and optoelectronic devices (see page 26).

In optoelectronics, the ECOC event in Turin, Italy evidenced the increasingly rapid commercialization of 40–100Gb/s technology, with SEI for example unveiling the first 40km-reach 40 Gigabit Ethernet CFP transceiver just a year after launching the first 10km-reach 40GbE CFP (see pages 69–74).

The main growth driver however remains LEDs, in terms of both technology (see research-focused articles on pages 90–94 & 98–103) and manufacturing (see cover article by Aixtron on MOCVD automation and fab integration — page 95). Showing the corresponding increasing focus on Asia, Veeco has announced a $25m expansion, adding centers in Singapore, Korea, Taiwan and China to support LED growth. Such a move is justified by the latest example of Taiwanese LED maker Tyntek setting up a joint venture in China (page 50). This is part of a trend, reports Digitimes, with 60–70% of Taiwan LED industry investment going into China this year.

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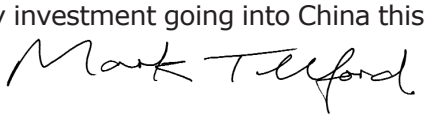

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***Semiconductor Today* covers the R&D and manufacturing of compound semiconductor and advanced silicon materials and devices** (e.g. GaAs, InP and SiGe wafers, chips and modules for microelectronic and optoelectronic devices such as RFICs, lasers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

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- news (funding, personnel, facilities, technology, applications and markets);
- 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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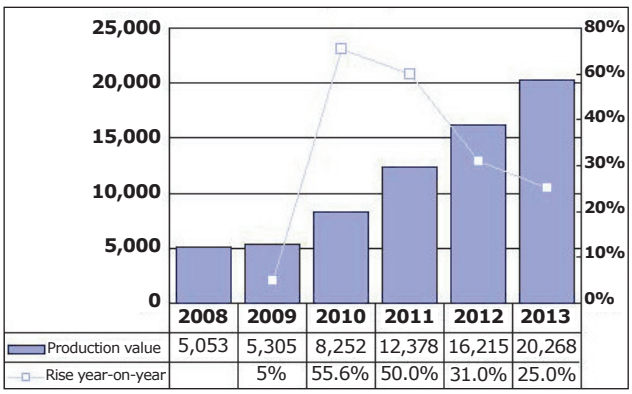
LED production to grow 25% annually to $20bn in 2013

Large-size backlights overtake portable applications in 2010

LED TV shipments in 2010 are projected to increase 10-fold from 2009 to 37.20 million units in 2010, driving LED production value up 55.6% to US$8.25bn, according to the Special Report 'LED: TV and lighting overview' from Digitimes Research (the research arm of Taiwan-based media outlet Digitimes).

By application, portable devices accounted for 36% of the high-brightness LED market in 2009. However, in 2010, due to the significant rise in LED TV demand, large-size LED backlight units (BLUs) will account for a 28% share, surpassing portable devices for the first time.

"Between 2011–2013, large-size LED BLUs will continue to represent the largest segment of the market, topping 41% in 2013," says the report's author, analyst Jessie Lin. "In addition to the rise of LED TV applications, LED lighting will begin to replace conventional lighting technology in the market. LED lighting will grab more than 10% of the market starting in 2012 and quickly move up to 16% in 2013."



	2008	2009	2010	2011	2012	2013
Production value	5,053	5,305	8,252	12,378	16,215	20,268
Rise year-on-year		5%	55.6%	50.0%	31.0%	25.0%

Global HB-LED production value (US$m) and growth, 2008–2013.

Driven by the rise in LED TV applications and the trend of LED lighting starting to replace conventional lighting, Digitimes Research forecasts that, from 2011 to 2013, global LED production value will rise by at least 25% each year and surpass US$20bn.

However, while LED lighting's luminous efficiency is currently comparable to that of fluorescent lamps, LED lamps remain unpopular mainly because of their high costs. High costs make it difficult to adopt LED lighting unless governments offer subsidies, or consumers realize that the total costs for LED lighting may not be higher if its power savings, longer service life, lower carbon emissions and other advantages are taken into consideration, concludes the report.

www.digitimes.com/Reports

Taiwan's LED industry to grow 18% in 2011

Government targets six-fold growth by 2015

Taiwan's LED industry revenue is likely to grow 18% next year from this year's estimated NT$86.4bn (US$2.7bn at US$1:NT$32) according to the government-backed Photonics Industry & Technology Development Association (PIDA), reports Taiwan Economic News.

According to the PIDA, Taiwan is currently the world's No.1 LED supplier by volume and No.2 by revenue. Of its 2010 revenue of NT$86.4bn, an estimated NT$54.4bn (US$1.7bn) will be generated by the packaging segment and NT$32bn (US$1bn) by the chip-making sector.

LED backlights for mobile phones remain the major revenue earner, accounting for 37% of the total, followed by 32% contributed by LED devices used in electronic equipment.

However, road sign, outdoor billboard and lighting applications will serve as the revenue growth engine. PIDA's statistics show that LED road signs and billboards comprised 20% of Taiwan's LED industry revenue in 2009, up from 2008's 5%, while lighting application comprised 7% of revenue in 2009, also up from 5% in 2008. The PIDA points out that this year LED TV and other consumer electronics applications will begin driving demands for LEDs.

In conjunction with a plan to build Taiwan into the world's center of LED lighting modules and light sources, the government has developed a plan to boost the island's LED industry revenue more than six-fold from 2010 to NT$540bn (US$16.8bn) in 2015, creating 54,000 jobs.

Industry executives says that the strength of Taiwan's LED industry lies in its complete processing chain manufacturing everything from epi-wafers and chips to packaging and modules. However, the industry's weakness lies in its 80% dependence on imported manufacturing equipment and materials, it is noted.

The executives add that cooperation with mainland China is crucial to Taiwan's LED industry in the light of the mainland's huge market for LED lighting projects. In addition, they urge the Taiwan government to offer lucrative incentives to users of LED lighting, in addition to coming up with industry standards for LED lighting.

http://news.cens.com/cens/html/en/news/news_inner_34026.html

Doubling of monthly sapphire wafer demand in 2010 sends 2-inch substrate price over $30s

Material shortage to be resolved by mid 2011, reckons Yole

Yole Développement's 'Sapphire Substrate Market 2010 – Q4 Update' fully updates the market research firm's 'Sapphire 2010 report' released at the beginning of the year, in response to the LED market's subsequent unprecedented growth driving monthly demand for finished sapphire substrates (for manufacturing blue and white GaN-based LEDs) to almost double, from 1 million two-inch equivalent (TIE) wafers in December 2009 to nearly 2 million in fourth-quarter 2010.

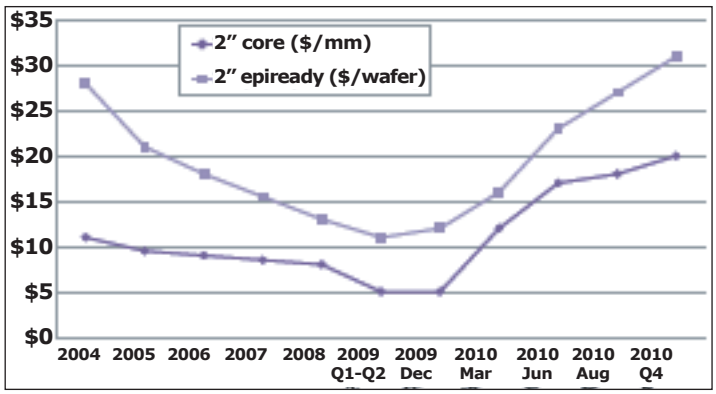
At the beginning of the year, most material makers were still cash strapped following the 2009 financial crisis and the strong price pressure experienced in the previous years, says Yole. As it typically takes 6–12 months to install and ramp up additional capacity, material supply was unable to follow demand. This triggered an acute shortage and a dramatic price rise. From being a commodity, sapphire became a strategic material that gave manufacturers the pricing power they've been lacking in recent years. The average selling price (ASP) for 2" wafers rose to $30 (above Yole's January forecast), and some users are now paying cash in advance to avoid idle production lines.

Yole cites several factors that are now reshaping the industry:

- South Korea's Sapphire Technologies Co Ltd now claims a capacity of 760,000 TIE per month, which is larger than Monocrystal Inc of Stavropol, Russia or Rubicon Technology Inc of Franklin Park, IL, USA. Historical market leaders Kyocera and Namiki of Japan seem slow to invest in further capacity. Access to capital is critical. Tera Xtal Technology Corp went public on the Taiwan Stock Exchange in September, and Monocrystal expect to raise about $250m on the Moscow Interbank Currency Exchange in October. Sapphire Technologies should follow suit, and the USA's Crystal Systems Inc was acquired by publically traded company GT Solar International Inc of Merrimack, NH, USA.
- Newcomers are lining up with aggressive and often unrealistic plans, reckons Yole, which now counts more than 40 firms active in the sapphire substrate business. Also, many more are in stealth mode, trying to secure funding and procure equipment. However, Yole believes that many are under-estimating the technical challenge of growing large and high-quality sapphire crystals.
- Rubicon and Monocrystal both announced plans for downstream integration and are increasing in-house wafer finishing capacities. This is enticing many finishing companies to develop in-house crystal growth or to secure alternative material sources through investment and partnerships with emerging material companies.

In addition, the sapphire crystal shortage is rippling through the raw materials supply chain and creating opportunities for crystal equipment manufacturers, says Yole.

For example, increased wafer demand is creating tensions on the raw materials market. The alumina specific density, form factors (pellets, microbeads or crackles) and high purity required for sapphire crystal growth is only available through a handful of companies. Raw material prices are therefore rising and some sapphire manufacturers are paying cash in advance to secure raw material capacity through 2011.



Price of 2" finished sapphire substrates (in dollars) for LED applications (Yole Développement, November 2010).

Meanwhile, crystal growth equipment makers are also benefitting from the urgent need for material capacity. More than 10 sapphire crystal growth equipment makers have been identified. Most of them, located in Ukraine and Russia, offer designs similar to the original 'Omega' machine developed in the USSR in the 1980s. Most offer turnkey solutions, allowing newcomers to quickly install and ramp up capacity. However, litigation has been reported between equipment makers and sapphire manufacturers, blaming each others for lower-than-expected yields or throughput. Equipment makers also face the risk of seeing their machine reverse-engineered, and orders dry up quickly as customers start manufacturing equipment themselves.

Yole says that the switch to larger-diameter sapphire also adds pressure to the material supply. More than 65% of the MOCVD reactors shipping in second-half 2010 are configured for 4" or larger wafers. In particular, Rubicon recently signed a $71m supply agreement with a Korean LED maker for 6" wafers. Yole therefore expects that in 2011, for the first time, 2" wafers will represent less than 50% of the total shipped sapphire substrate surface. This will create additional pressure on material supply as, for an equivalent surface, larger wafers are thicker than their 2" counterpart and command lower yields, notes Yole.

www.i-micronews.com

Emerging building-integrated PV market accelerates

After years of being confined to niche markets, the BIPV solar sector is poised for rapid expansion, according to GTM Research's latest report 'Building-Integrated Photovoltaics: An Emerging Market', which maps the global BIPV solar landscape from current and projected market opportunity to technology evolution, supplier portfolios and the sector's innate design challenges.

Impelled by maturing energy-efficiency codes, lucrative feed-in tariffs and supply-side product development, BIPV players are experiencing demand for a new array of BIPV solar components, including shingles, curtain walls and flexible panels for roofs and windows.

For the BIPV industry, which to date has been specialized, there is a pressing need for broader understanding of its scaling opportunity, the market research firm says. The technology's development (which has historically been spearheaded in European countries such as France and Germany where bankable feed-in tariffs have spurred initial BIPV build-out) is beginning to push globally, exemplified by the commissioning of the world's largest BIPV project (at 6.68MW) in China in July.

According to GTM Research, the installed capacity of PV on the whole is forecasted to reach more than 20GW globally by 2013 (equating to about US$60bn in revenue), and the cost of PV panels is projected to fall to US$1.20/W by that same date. This sustained boost for the overall PV industry will have an enormous spillover effect on the commercial opportunity for BIPV as engineering, construction and design companies avail themselves of PV's economic viability in the face of mounting energy-efficiency demands, says the firm.

The BIPV solar market's grasp is finally meeting its reach thanks to both significant cost reductions over the past two years and product development

"The BIPV solar market's grasp is finally meeting its reach thanks to both significant cost reductions over the past two years and product development that is enabling seamless integration of PV into the building envelope," comments Philip Drachman, a solar photovoltaics industry expert and the author of the report.

www.gtmresearch.com/report/building-integrated-photovoltaics-an-emerging-market

Thin-film PV substrate and encapsulation market to reach $1.3bn by 2015

While glass will continue to dominate substrate and encapsulation materials used for thin-film photovoltaics (TFPV), new materials including metal foils, plastics, ceramics and composites will grow rapidly in importance, according to the new report 'Encapsulation and Flexible Substrates for Thin-Film Photovoltaics' from industry analyst firm NanoMarkets.

The main driver for using these new materials will be the need to support flexible PV in order to reduce panel costs using roll-to-roll (R2R) processes and the rise of intrinsically flexible products, notably those used for building-integrated PV (BIPV).

In total, the TFPV substrate/encapsulation market is expected to reach $1.3bn by 2015, then $1.8bn by 2017. Also, while some of the most advanced encapsulation systems have proved difficult to develop and come with a high cost, NanoMarkets has identified several areas where these systems are beginning to make economic sense, most notably in the copper indium gallium (di)sulphide (CIGS) sector.

The report notes that, despite their decline in overall market share, glass makers can still expect opportunities to emerge. Thus new flexible glasses will be able to participate in the growing sector of the TFPV market that uses R2R processes. The report also suggests that glass will continue to dominate for the highest-performing 'utility-grade' TFPV panels for both encapsulation and substrate purposes.

The main driver for using these new materials will be the need to support flexible PV in order to reduce panel costs using roll-to-roll (R2R) processes

That said, NanoMarkets believes that the TFPV market is seeking new materials, such as low-cost thermally resistant plastics and lower-cost dyadic encapsulation systems that will serve as key enabling technologies for BIPV and mobile PV products. It claims that these new materials ultimately have opportunities that go well beyond the PV space, e.g. in flexible displays and flexible lighting.

The reports identifies the opportunities available for glassmakers, the plastics and metals industry and specialist encapsulation companies in the TFPV industry over the next eight years. Also covered are all the major inorganic TFPV markets, thin-film silicon, cadmium telluride (CdTe) and CIGS.

www.nanomarkets.net

ZnO electronics market to grow to $1.3bn by 2015

Zinc oxide LED sector to exceed $415m

Zinc oxide (ZnO) is emerging as an important electronics material, with sales of conductive coatings, electrode materials, and electronic devices using ZnO forecast to more than triple to $1.3bn by 2015 then grow to $2.3bn by 2017, according to the new market report 'Zinc Oxide Markets, 2010 and Beyond' from industry analyst firm NanoMarkets.

While some of the hoped-for developments in this part of the electronics market have not materialized, NanoMarkets has identified several areas where ZnO electronics can still expect to achieve growth in the coming years.

By 2015, the largest single segment of the zinc oxide electronics market will be ZnO light-emitting diodes (LEDs), exceeding $415m, notes the report. Despite the economic turndown, this sector is beginning to grow out of the pure R&D mode, fueled by the boom in energy-efficient lighting. ZnO offers several advantages in the solid-state lighting space, not the least of which is low cost compared with more traditional LED materials such as gallium nitride (GaN) and gallium arsenide (GaAs), comments NanoMarkets.

Meanwhile, ZnO is gradually proving itself to be a low-cost electrode material and conductive coating and an alternative to such high-price materials as indium tin oxide (ITO) and silver in display, lighting and photovoltaics applications. Sales of ZnO preparations used in such applications are expected to reach more than $220m by 2015, and they are also expected to become more effective as conventional ZnO is replaced by ZnO nanopowders and nanostructures.

The report also looks at the latest developments in some of the areas of electronics where ZnO has long-term potential, such as ZnO thin-film transistor (TFT) displays and ZnO-based power electronics.

www.nanomarkets.net

New military and sensing applications of mid-IR lasers to grow at 30% annually through 2014

New technologies such as QCLs to expand market opportunities

Advances in several new laser technologies are opening new opportunities in the part of the spectrum between telecom lasers and the nascent terahertz (mid-infrared) range, which is currently dominated by applications in materials processing and medical procedures but will be supplemented in the next few years by sizeable opportunities in new military and sensing applications, according to a new report 'Mid-Infrared Lasers 2010' from photonics market research firm Strategies Unlimited.

The new segments will grow 30% per year, compounded annually through 2014. However, the mid-IR range remains a complex and confusing segment, with competition from other laser and non-laser solutions, and with many companies ripe for acquisition.

The mid-infrared is best known for being a covert and eye-safe range, for the thermal vibrations of molecules (used in sensing and thermal imaging), and for the cheap photons of high-power CO_2 lasers, which currently dominate sales (from 10W lasers using sealed gas tubes to multi-kilowatt lasers using flowing gas blowers, for use in materials processing). Solid-state lasers are also established in medical applications.

Next to come are high-brightness sources for military applications: infrared countermeasures against heat-seeking missiles, illuminators for thermal imaging, mid-IR beacons etc. Such military applications are key to funding the new mid-infrared technologies while other applications get off the ground, says Strategies Unlimited. Another long-awaited segment is sensing for molecular detection, with many new opportunities in environmental monitoring, industrial process controls, security standoff detection of hazardous chemicals, and new breathalyzer instruments for medical diagnostics. Other sensor applications include mid-infrared range-finding and Doppler scatterometry.

However, mid-infrared laser suppliers face many unique challenges, reckons the market research firm. Mid-IR components are expensive because of requirements for exotic materials and coatings, cryogenic cooling, and low manufacturing volumes. Lasers have been bulky and the output power of compact laser solutions has been low. Also, the new technologies face challenges from other laser and non-laser technologies, such as Raman spectroscopy, near-infrared laser and LED sources, lamps, and non-optical approaches.

Now, new solutions in quantum cascade lasers and interband cascade lasers, gallium antimonide (GaSb) diode lasers and optically pumped semiconductor lasers (OPSLs), fiber lasers, solid-state lasers, and compact optical parametric oscillators (OPOs) promise to expand sales into new applications. Other innovations will also help the market, such as inexpensive quartz-enhanced photoacoustic spectroscopy (QEPAs), uncooled focal plane arrays (FPAs), and hollow-core optical fibers, reckons Strategies Unlimited.

www.strategies-u.com

Handset shipments to reach 1.43bn in 2011

Nokia to maintain market share above 35%

Global mobile handset shipments will grow by 19.2% from 1.2bn in 2009 to 1.43bn in 2011, according to the Q3/2010 'Global Handset Vendor Market Share and Forecast' database of IE Market Research Corp (IEMR). This includes annual growth of 8–10% over 2010–2011. "Although the global recession led to a significant slowdown in mobile handset shipments in 2009, we expect stronger growth over the next two years especially in key Asian and African markets," says Nizar Assanie, IEMR's VP (research).

"Intense competition continues between the largest handset vendors," adds Assanie. "We forecast that Nokia will maintain its global market share of above 35% over the next two years, with total handset shipments of 518.3 million in 2011 [36.3% market share]." IEMR's model also predicts that Samsung, the second largest handset supplier globally, will increase its market share from 19.9% currently to 20.5% in 2011, with shipments of 293 million.

Asia Pacific, Middle East and Africa will experience faster growth than other regional handset markets over the next two years. More than 40% of handset shipments are for the Asia Pacific (the largest regional market), and this should rise to 45% in June 2012. Emerging markets in Middle East and Africa will also see their shares of the global market rise over the next eight quarters.

In the Middle East and Africa, shipments are expected to rise to 167.8 million in 2011, with Nokia remaining dominant, shipping 28.4 million handsets (a market share of 63.6%). Shipments for second-biggest vendor Samsung should rise to 8.7 million (a market share of 19.4%).

In the Asia Pacific region, the top six vendors are Nokia (number-1 in both China and India), Samsung, ZTE, LG, Sony Ericsson and Huawei. IEMR forecasts handset shipments will rise to 617.8 million in 2011, including 222.6 million for Nokia (a market share of 36%). In South Korea the top three vendors are Samsung, LG and Pantech & Curitel, with Samsung's shipments expected to rise to 11.8 million. However, in Japan the top three vendors are Sharp, Fujitsu and Panasonic, with Sharp expected to maintain a market share of about 24%.

In Eastern Europe, unlike other regional markets, small suppliers have little market share, with Nokia, Samsung and LG, together with Sony Ericsson, continuing to take more than 95%. IEMR forecasts that handset shipments will rise to 123.2 million in 2011, including 66.4 million for Nokia (a market share of 54%) and 32.9 million for Samsung (a market share of 26.7%).

In Western Europe, the top six suppliers are Nokia, Samsung, Sony Ericsson, LG, and Apple, and Nokia and Samsung together continue to dominate. IEMR forecast that handset shipments will rise to 223.5 million in 2011, including 73.2 million for Nokia (a market share of 32.8%) and 59.6 million for Samsung (26.7%).

In the South and Central America market, the top six vendors are Nokia, LG, Samsung, Motorola, Sony Ericsson and Alcatel. Handset shipments will rise to 113.3 million in 2011, including 36.7 million for Nokia (32.4% market share). However, the market shares of LG and Samsung will increase over the next two years as they tie for second place in 2011, each shipping about 23 million handsets.

Compared with the overall global market (where Nokia is dominant), the market dynamics in North America (USA and Canada) are different: the top-6 handset suppliers are Samsung, LG, Research In Motion, Motorola, Apple and HTC. In 2011, handset shipments in North America will rise to 182.6 million, including 50.9 million for Samsung (a market share of 28%). Nokia, with its current 6% North American market share, has a long way to go before it can start displacing the market leaders there, comments IEMR.

www.iemarketresearch.com

Superphone shipments to grow from 15m to 100m by 2015

While handset sales are forecasted to grow to 1.3bn units in 2010, and smartphones should grow at 20% annually over the next six years, the new superphone sub-category will emerge as a high-growth market, with shipments growing 550% from 15 million to 100 million by 2015 according to a report from market research firm Strategy Analytics.

"We define a superphone as a high-end smartphone with a super-sized display above 4 inches and a superfast processor greater than 1GHz," says analyst Alex Spektor. "Major brands, such as Samsung, HTC, Android, Nvidia and Texas Instruments, are driving the high-growth superphone category in developed markets," he adds.

"Superphones are at the forefront of computerizing the handset market," says Strategy Analytics' director Neil Mawston. "Superphone models, such as the Samsung Galaxy S and HTC Evo 4G, are driving more PC-like features into the hands of mobile consumers," he adds. "Operators can launch advanced Internet services with superphones to lift their data revenues, while component makers can design cutting-edge products with higher profit margins such as dual-core application processors or 512MB RAM memory."

www.strategyanalytics.com

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RFMD adds its GaAs technology to foundry services

Newton Aycliffe fab eases access via European import/export controls

After 15 years of supplying GaAs-based products manufactured in its wafer fabrication plants, RF Micro Devices Inc of Greensboro, NC, USA has added its gallium arsenide technology to its foundry services portfolio and will begin providing a full suite of GaAs pseudomorphic high-electron-mobility transistor (pHEMT) technologies to customers of its Foundry Services business unit.

RFMD currently provides Foundry Services customers access to two of its gallium nitride process technologies from its wafer fab in Greensboro: GaN1 (targeted at high-power applications) and GaN2 (targeted at high-linearity applications). RFMD also offers an Integrated Passive Component (IPC) technology optimized to complement high-power applications. The firm's GaAs pHEMT technologies are complementary to its GaN technologies and other power semiconductor technologies for the design of multi-chip modules (MCMs).

Specifically, RFMD is now making available three distinct GaAs pHEMT technologies optimized for high power, low noise and RF switching products. The firm says that its 0.3μm pHEMT technology delivers high power and is optimized for X-band phased-array power amplifiers (PAs) and 8–16GHz wideband military electronic warfare jammers.

RFMD is now making available three distinct GaAs pHEMT technologies optimized for high power, low noise and RF switching

Its 0.25μm pHEMT technology delivers low noise, medium power and high linearity and is targeted at applications including low-noise front ends and transmitter MMICs. Its 0.6μm pHEMT technology provides low-noise and high-linearity switching of RF signals and is designed for applications including wireless front ends and transmit/receive modules.

All of the process technologies are manufactured in RFMD's fab in Newton Aycliffe, UK, providing Foundry Services customers access to European technology with the ease of European import/export controls, the firm notes.

"RFMD is the world's largest manufacturer of III-V circuits for electronics, including both GaAs and GaN," comments Bob Van Buskirk, president of the firm's Multi-Market Products Group (MPG). "With our world-class GaAs technology, technology expertise, high-volume manufacturing, industry-leading cycle times and unprecedented levels of support, our foundry service enables a wide range of foundry customers to utilize advanced compound semiconductor technologies in an efficient and cost-effective business model," he claims.

www.rfmd.com

Samsung selects RFMD for GALAXY Tab's WiFi connectivity

RFMD says that Samsung has selected three highly integrated RFMD components to deliver WiFi connectivity in its recently introduced GALAXY Tab Android tablet.

Specifically, RFMD is supplying Samsung with the RF5521 front-end module (FEM) for the low-band 2.4GHz frequency, and the RF5515 low-noise amplifier (LNA) and RF5355 power amplifier (PA) for the high-band 5.0GHz frequency. Volume shipments have begun, and RFMD anticipates increasing WiFi shipments to Samsung — in mobile tablet devices as well as in smartphones — as single-band and dual-band design wins ramp into volume production.

With 3G connectivity, Wi-Fi and Bluetooth 3.0 as well as the Android OS 2.2, the Samsung GALAXY Tab is an always-on communication and entertainment tool. Its large battery (4000mAh) provides more than 7 hours of movie viewing time and, because it's powered by a Cortex A8 1.0GHz application processor, it's designed to deliver high performance.

The RF5521 FEM, RF5515 LNA and RF5355 PA are on a leading WiFi reference design and were selected primarily due to their combination of performance, integration and small footprint size. The RF5521 FEM combines an LNA with bypass and a single-pole three-throw (SP3T) switch. The RF5515 and RF5355 operate in tandem to provide a 5GHz RF front-end solution that is claimed to exceeds competitive performance and price levels while delivering extended range capability. Each component is targeted at high-performance mobile applications using WiFi and Bluetooth combination systems.

"We look forward to growing our WiFi business with Samsung across both smartphones and mobile tablet devices," says Bob Van Buskirk, president of RFMD's Multi-Market Products Group (MPG).

The mobile embedded WiFi market is growing at a rapid pace, and dual-band WiFi (2.5GHz/5GHz) is in the early stages of adoption in the expanding market for mobile internet devices (MIDs). RFMD offers a portfolio of low-band, high-band, and dual-band components, and expects its mobile WiFi product portfolio to contribute meaningfully to MPG's anticipated revenue growth.

RFMD expands Foundry Services to MBE-related epi products

After adding its gallium arsenide pHEMT technology to its foundry services portfolio, RF Micro Devices Inc of Greensboro, NC, USA has further expanded its foundry services to deliver multiple molecular beam epitaxial (MBE) platforms, epitaxial characterization and epitaxial development structures, including specialty and high-volume, arsenic- and phosphorus-based processes.

Offerings include working with customers to develop epitaxial structures and MBE growth conditions, delivery of epitaxial wafers grown to exact customer specifications, and developing epitaxial design of experiments (DOEs). RFMD adds that its MBE Foundry Services will leverage the firm's expertise in high-volume manufacturing and experience in developing several generations of epitaxial structures.

"We have the industry's fastest cycle times, and we expect to use that as a key performance discriminator in our MBE foundry service," says Bob Van Buskirk, president of RFMD's Multi-Market Products Group. "We have one of the world's largest MBE production facilities and two of the world's largest compound semiconductor wafer fabrication facilities in operation, which enable us to deliver a flexible set of MBE-related products and services while driving shorter time-to-market," he adds.

RFMD says that, depending on a customer's development requirements, its MBE Foundry Services team will help to design an epilayer structure and MBE process to optimize the performance of an existing epi-structure. The team can provide experience of growing and developing structures such as BiHEMTs, BiFETs, MOSFETs, VCSELs and metamorphic, along with a range of material offerings on GaAs substrates, including gallium arsenide, indium gallium arsenide (InGaAs), aluminum gallium arsenide (AlGaAs), indium gallium phosphide (InGaP) and aluminum indium phosphide (AlInP).

The launch of MBE Foundry Services marks another step in RFMD's diversification strategy. RFMD aims to leverage its existing foundry experience in supporting MBE-based customers. "We are committed to growing our foundry services and have the installed capacity to meet our internal needs and the needs of our external foundry customers," notes Van Buskirk.

"RFMD's introduction of GaN-based foundry services in 2009 has provided a flexible business platform to launch MBE services this year," says Chris Santana, director of MBE operations. "We now have all the aspects of a full-service, commercial turn-key foundry in place, including purchasing and IP agreements, work-flow procedures and web-based customer support processes, and we have tailored those commercial business processes and systems to our MBE-based service."

We have one of the world's largest MBE production facilities and two of the world's largest compound semiconductor wafer fabrication facilities... which enable us to deliver a flexible set of MBE-related products and services

RFMD's MBE Foundry Services can also offer ultra-high-vacuum (UHV) cleaning services. Wet cleaning capabilities include wet mechanical cleaning, wet bead blasting, acid wet chemical etch, base wet chemical etch, and other services on stainless steel, refractory metal and PBN ceramic parts.

www.rfmd.com

RFMD launches MMIC I/Q up-converter in SMT ceramic package

At the European Microwave Week (EuMW 2010) conference in Paris, France, RFMD added to its rapidly growing portfolio of components for microwave and millimeter-wave radio applications by introducing the RFUV5945A, a gallium arsenide MMIC I/Q up-converter housed in an SMT ceramic package and suited to end markets including point-to-point microwave radio, military radio, VSAT, and test & measurement.

RFMD says that the RFUV5945A accelerates radio design for engineers and reduces radio board space by integrating an I/Q mixer, an LO buffer amplifier, and an output driver amplifier, all within a compact 5mm x 5mm outline. Operating across a broad range of frequencies (from 10GHz to 16GHz), it enables increased efficiencies in inventory management by providing a single up-converter solution for 11GHz, 13GHz, and 15GHz microwave radios. Also, a DC–4GHz IF frequency range ensures that multiple radio modulation schemes can be supported, with lower power consumption helping to reduce environmental impact and facilitate 'greener' radios, RFMD claims.

"MPG is leveraging RFMD's deep expertise in RF design and our industry leadership in compound semiconductor technologies to aggressively target new customers in new markets, such as the high-value military radio and microwave point-to-point radio markets," says Bob Van Buskirk, president of RFMD's Multi-Market Products Group (MPG). "In fiscal 2011, MPG intends to launch more than one new product per day, expanding RFMD's product portfolio considerably and enhancing our opportunities for revenue growth, diversification and margin expansion," he adds.

IN BRIEF

M/A-COM Tech Asia launches 2.5–4GHz and 8.5–11GHz GaAs MMIC core chips

M/A-COM Tech Asia of Hsinchu, Taiwan has launched two GaAs MMIC core chips — operating at 2.5–4GHz and 8.5–11GHz — consisting of integrated transmit/receive switches, a low-noise amplifier, a 6-bit phase shifter, an attenuator and a driver amplifier.

The chips are suited to both military and weather phased-array radar applications and satellite communications systems.

The 8.5–11GHz XZ1002-BD features parallel data input and compensated on-chip gate bias. It delivers 21dB receive gain, 23.5dB transmit P1dB, and 28dBm receive OIP3. The transmit amplifier also has a typical small-signal gain of 19dB.

"Our highly integrated X-band core chip combines four functions in one device, making a two-chip phased-array radar T/R module a reality when matched with our XP1006 10W power amplifier," says senior director Peter J. Hales. "With these two devices, active X-band phased-array and T/R module manufacturers can add an accurate, fast and inexpensive solution to their arsenal."

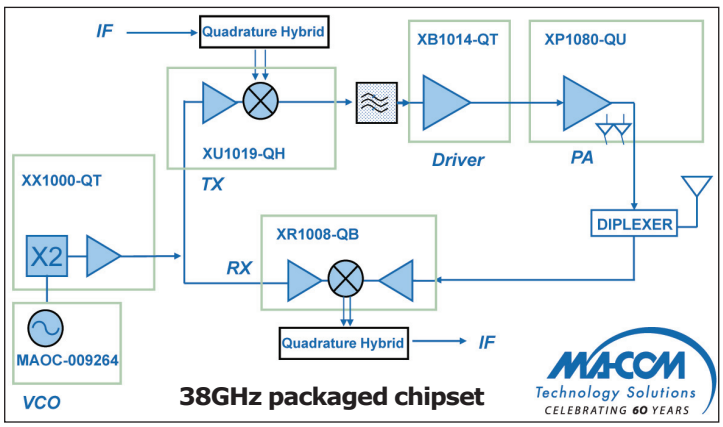
The 2.5–4GHz XZ1001-BD features compensated on-chip gate bias and delivers 33dB transmit/receive gain, 20dBm transmit/receive P1dB, and 2.5dB receive noise figure.

"Our highly integrated S-band core chip is comparable to our X-band core chip, the XZ1002-BD, only shifted down in frequency," says Hales.

The chips have surface passivation and backside via holes, as well as gold metallization to allow either a conductive epoxy or eutectic solder die attach process.

www.macomtechasia.com

M/A-COM launches 38GHz packaged chipset for point-to-point radio



38GHz packaged chipset

At the European Microwave Week (EuMW) exhibition in CNIT La Défense, Paris, France (28–30 September), M/A-COM Technology Solutions Inc of Lowell, MA, USA (which supplies semiconductors, components, and subassemblies for RF, microwave and millimeter-wave applications) introduced a 38GHz surface-mount technology (SMT) packaged GaAs MMIC chipset solution for the point-to-point (PtP) radio market.

The chipset includes an integrated up-converter and receiver, driver and power amplifiers, a voltage-controlled oscillator (VCO), and a multiplier.

The XB1014-QT driver amplifier and XP1080-QU power amplifier with integrated on-chip detector deliver what is claimed to be exceptional linearity performance. Integrated on a single SMT chip, the XR1008-QB receiver includes a low-noise amplifier (LNA) that provides optimum noise performance, an image reject mixer with high-linearity performance, an LO driver amplifier, and a frequency doubler for the LO input. The XU1019-QH up-converter includes a mixer, RF buffer, LO buffer, and an LO doubler.

The MAOC-009264 VCO achieves low phase noise performance and exhibits low performance variation over temperature. The XX1000-QT multiplier combines an active doubler with an output buffer amplifier to deliver constant power over a range of input powers.

"M/A-COM Tech's 38GHz chipset solution provides high-performance devices that combine to lower costs, reduce design time and improve time to market," claims David Richardson, market director, PtP products. "The recent merger of M/A-COM Tech and Mimix Broadband [in June], combined with M/A-COM Tech's new line of VCOs, enable us to provide enhanced chipset solutions for 38GHz as well as all the major PtP radio bands," adds product manager Jack Redus.

Engineering samples, sample boards and production devices for the devices are available.

www.macomtech.com

OMMIC launches 75–110GHz LNA

At European Microwave Week, OMMIC launched its CGY2190UH production 75–110GHz LNA.

The CGY2190UH is a four-stage ultra-low-noise amplifier operating in the band 75–110GHz with typically 23dB gain and a noise figure of 2.8dB at 90GHz. The MMIC is a low-power-consumption device, running from a 1V supply with 30mA of current.

The MMIC is designed for use in active and passive millimeter-wave imaging systems operating in the W-band, but is also suited to short-haul high-capacity links in band E.

The CGY2190UH is fabricated using OMMIC's proprietary 0.07μm MHEMT D007IH process technology, combining InP-like performance with the production maturity of GaAs substrates.

www.ommic.com

Agilent unveils ADS 2011 EDA software for multi-technology design

Agilent Technologies Inc of Santa Clara, CA, USA has begun unveiling the next release of Advanced Design System (ADS), the flagship electronic design automation software for RF, microwave and signal integrity applications from Agilent EEsof EDA (which supplies EDA software for microwave, RF, high-frequency, high-speed digital, RF system, electronic system-level, circuit, 3D electromagnetic, physical design and device-modeling applications).

ADS has pioneered technologies such as X-parameters and 3D EM simulators, used by companies in the wireless communication and networking and aerospace/defense industries. For WiMAX, LTE, multi-gigabit per second data links, radar and satellite applications, ADS provides full standards-based design and verification with wireless libraries and circuit-system-EM co-simulation in an integrated platform.

Agilent says that ADS 2011 now delivers what are claimed to be breakthrough capabilities for multi-technology design inherent in existing RF system-in-package (SiP) components.

Existing customers and partners, including foundries and component vendors, were invited to join the ADS 2011 Early Access Program from October, and to discuss ADS 2011 with experts from Agilent EEsof either at the European Microwave Week (EuMW 2010) at CNIT La Dèfense, Paris, France (26 September–1 October) or at the IEEE Compound Semiconductor IC Symposium (CSICS 2010) in Monterey, CA, USA (5–6 October).

"A few years back, we began sharing our RF module and multi-technology design challenges with Agilent," says Hongxiao Shao, design automation manager at Skyworks Solutions Inc of Woburn, MA, USA, which manufactures linear products, power amplifiers, front-end modules and radio solutions for handset and infrastructure equipment. "Since that time, we've worked closely to shape a solution," he adds.

"With ADS 2011, we're addressing the most challenging design complexity and integration needs of leading-edge commercial wireless and aerospace/defense companies," says Mark Pierpoint, VP & general manager at Agilent. "Customers will find that this release, almost two years in the making, enables them to design multi-technology RF system-in-package modules and perform complex EM simulations — all with greater ease and greater speed," he adds.

This release enables customers to design multi-technology RF system-in-package modules and perform complex EM simulations

New capabilities in ADS 2011 include:

- true multi-technology RF design, which enables co-design with multiple technologies (board, laminate, package, module, and IC);
- a use-model that makes EM simulation (via Momentum and FEM) easy for engineers;
- EM technologies for improved speed, accuracy and convergence;
- load-pull capabilities for faster, better matching-circuit design from measured data;
- layout improvements that make physical design in ADS easier; and
- dozens of additional capabilities and improvements for all ADS users.

Agilent is debuting ADS 2011 on the Web and at live events around the world (e.g. Agilent EEsof EDA users-group meetings, design forums and seminars) in November and December. ADS 2011 is expected to ship in early 2011.

www.agilent.com/find/eesof

IN BRIEF

AWR Connected for CapeSym SYMMIC to streamline thermal analysis of MMICs

At the IEEE Compound Semiconductor IC Symposium (CSICS) in Monterey, CA, USA (4–5 October), high-frequency electronic design automation (EDA) software tool provider AWR Corp of El Segundo, CA, USA and engineering services company CapeSym Inc (which provides electronic materials processing, process optimization, and thermal management solutions) jointly demonstrated AWR Connected for CapeSym SYMMIC.

The new AWR Connected product allows high-power RF designers to perform thermal analysis on monolithic microwave integrated circuits (MMICs) that are first designed within the AWR Microwave Office (MWO) design environment. AWR says that the combination of its MWO high-frequency design platform and CapeSym's easy-to-use SYMMIC templates produce what is claimed to be unparalleled electrical/thermal design-stage analysis of high-power RF components.

- At CSICS, Steve Brown of RF component maker and foundry services provider TriQuint Semiconductor Inc of Hillsboro, OR, USA was joined by AWR's solution architect Jim Carroll (an active member of the IEEE CSICS steering committee) in moderating the panel session 'Changing MMIC EDA Design Flows & Tools: Lessons Learned and Future Directions', in which AWR executive VP of sales & marketing & co-founder Ted Miracco also participated as a panel member.

www.awrcorp.com/mwo
www.capesym.com/thermal_software.html

TriQuint showcases integrated base-station modules enabling migration to smaller remote radio heads

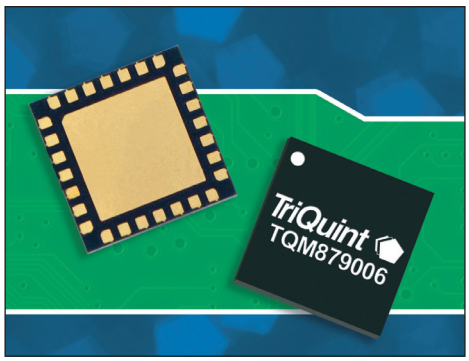
At the 40th annual European Microwave Week (EuMW 2010) in Paris, France (28–30 September), RF component maker and foundry services provider TriQuint Semiconductor of Hillsboro, OR, USA showcased its portfolio of integrated RF products for base transceiver station (BTS) radios, including launching its newest, fully integrated base station module, the TQM879006.

TriQuint says that its products reduce the size and complexity of RF circuitry by integrating multiple functions into modules, enabling migration to smaller, more 'green' remote radio head (RRH) base stations (a plan network operators are deploying to expand networks for 3G/4G smartphones and other mobile devices).

The firm says that its new base-station modules offer four levels of RF integration to reduce board space, lower bill of materials, and improve efficiency. Level 1 solutions include high-gain products that can replace one or more discrete components with a single module. At the highest level of integration, TriQuint's new Level 4 modules (such as the TQM879006) replace multiple discrete products with one module that incorporates two amplifiers, a digital step attenuator and all input/output matching circuitry.

"Global mobile networks are transitioning to base stations that use remote radio head designs," says TriQuint vice president Brian P. Balut. "TriQuint's newest products simplify RF connectivity in these systems... devices enable manufacturers to focus on competitive system performance instead of dedicating valuable resources toward RF component matching issues," he adds.

China's Huawei Networks touts the benefits of remote radio head designs in both trial and operational systems. In work with international mobile operator Vodaphone, it notes in the article 'Network Deployment; it's all in the mind' that the cost savings from increased efficiency in the links between the base station and the rest of the network are very significant. Remote radio head innovations are central to moving all key radio components closer to the antenna while reducing the size of radio housings; these advances reduce power consumption, both directly and through lower overall thermal mitigation requirements.



TriQuint's new TQM879006 module.

Integration levels

The levels of integration in TriQuint's pre-driver and driver integrated products are categorized as follows:

- Level 1 — Devices that offer higher gain than discrete components and integrated matching, eliminating one or more components in base-station amplifier line-ups for size and overall cost savings (e.g. TQP3M9008, TQP3M9009);
- Level 2 — Devices that integrate multiple functions in a package such as a multi-stage amplifier or mixer and an LO buffer amplifier for reduced system size (e.g. TQP8M9013, ML483, ML485);
- Level 3 — Devices that combine two complete amplifier stages and interstage matching. These products eliminate the need for matching circuits between amplifiers while reducing costs and circuit size (e.g. AH212, AH323);
- Level 4 — Full integration at 50Ω input/output impedance, with multiple functions incorporated into a package, such as two amplifiers, a digital step attenuator, all bias chokes as well as bypass and blocking capacitors that yields a simpler, more compact solution for lower overall costs (e.g. TQM879006).

TriQuint says that base-station customers including Samsung Electronics have benefitted from the space-saving and cost-reduction benefits of integrated components. "These devices [the AH212 and AH420] have enabled us to develop high-power amplifiers for new LTE base-station systems," says Samsung Electronics' RF Core Lab senior engineer Jong-Hyun Lee.

"Our experience with TriQuint's products including the AH212, AH225 and the ML485 has been very good," says Chul Lee, Access R&D senior engineer for Korean base-station repeater manufacturer SK-Telesys about using TriQuint components in the firm's WCDMA and CDMA systems. "These devices enabled us to develop new repeater systems," he adds. "Engineering and product support from TriQuint have been important for us in meeting customer deadlines and requirements."

TriQuint says that its products are used by major OEM base-station radio manufacturers across Europe, Asia and North America in WCDMA, CDMA, MC-GSM and LTE networks. The firm offers integrated pre-driver and driver RFIC base-station solutions designed to improve efficiency, reduce the PCB area dedicated to RF, and reduce RRH bill of materials. Its base-station portfolio includes gain blocks, switches, mixers, low-noise and driver amplifiers, converters, SAW filters and integrated modules.

www.triquint.com

TriQuint's auto-qualified 77GHz chipset powers Delphi radar system for motion-sensing applications

RF front-end component maker and foundry services provider TriQuint Semiconductor Inc of Hillsboro, OR, USA says that it is now offering its 77GHz GaAs chipset portfolio for motion detection and adaptive cruise control (ACC) applications.

The products are currently being used by Delphi Automotive in its multimode electronically scanning radar (ESR), which enables adaptive cruise control in multiple vehicles. The 77GHz chipset devices appeared first in 2010 model-year automobiles.

TriQuint's 77GHz portfolio includes eight products (TS-16949 factory certified) that can be used in a variety of design configurations for motion-sensing automotive and non-vehicular applications:

- TGA4705-FC flip-chip low-noise amplifier with 23dB small-signal gain and a 5dB noise figure at 77GHz (typical) for receive (Rx) chain architectures.
- TGA4706-FC flip-chip medium-power amplifier with 14dBm saturated output power with 15dB small-signal gain at 77GHz (typical).
- TGS4305-FC 60–90GHz SP3T switch, offering typical switching speed of <5ns and, when flipped, providing a nominal 2.3dB insertion loss, 13dB through state return loss, and 20dB isolation.
- TGS4306-FC 70–90GHz SP4T switch, offering a typical switching speed of <5ns and, when flipped, providing a nominal 3dB insertion loss, 8dB return loss in the through state, and 20dB isolation.
- TGV2204-FC flip-chip voltage-controlled oscillator (VCO) for frequency stability in transmit (Tx) chains, typically providing 7dBm output power at 19GHz with <–105dBc/Hz phase noise at 1MHz offset (with an integrated divide-by-8 prescaler easing PLL design).
- TGC4702-FC down-converting IQ mixer with 12dB conversion loss from 75–82GHz to an IF frequency band of DC–100MHz (typical).

A component in TriQuint's 77GHz GaAs chipset (inset) for motion-sensing and adaptive cruise control applications, as used by Delphi Automotive.

- TGC4703-FC flip-chip frequency doubler combining an input/output buffer amplifier and a frequency doubler, providing 14dBm saturated output power with 8dB conversion gain (typical).
- TGC4704-FC flip-chip combined medium-power amplifier and frequency doubler, providing 14dBm saturated output power with 5dB conversion gain (typical).

In developing its system for Delphi, TriQuint combined time-tested, rugged GaAs designs used in defense applications with cost-conscious systems scaled for high-reliability consumer products. The firm also developed processes to further enhance performance and reliability, including its proprietary CuFlip 'flip-chip' technology, which replaces wire-bonded devices with direct mounts to circuit boards. CuFlip enhances reliability and ruggedness while simplifying overall assembly.

"We were looking for a chipset supplier with a track record of developing high-performance products that would help us succeed in the commercial marketplace," says Mark Lynn, Delphi Automotive's chief engineer, Active Safety.

"TriQuint's experience with GaAs modules and their ongoing support has helped us to provide our customers game-changing driver-assist technology," he adds.

A multimode ESR with proven solid-state technology is the heart of adaptive cruise control systems like the one developed by Delphi. "Its class-leading performance, packaging and durability have helped enable a driver-assistance application that not only enhances safety and convenience, but is affordable to more buyers," says TriQuint VP Brian P. Balut.

"The microwave devices that Delphi has used in its ESR modules are now available for other motion-sensing applications that require market-tested, automotive-qualified performance," adds Balut. "The products are also cost-competitive for many different motion-based applications and concepts such as security systems."

TriQuint representatives attended the Society of Automobile Engineers' SAE Convergence 2010 exhibition in Detroit, MI, USA (19–20 October) to discuss the new 77GHz products.

www.sae.org/events/convergence
www.triquint.com

Anadigics launches highly efficient and linear PA for WiMAX CPE and small-cell infrastructure

Responding to demand from service providers to expand the footprint of high-performance wireless broadband, Anadigics Inc of Warren, NJ, USA has made available engineering samples of the AWB7221 power amplifier (PA) for use in WiMAX customer premises equipment (CPE) and small-cell infrastructure solutions, claiming that it is the most power-efficient PA available for WiMAX CPEs, as well as enabling cost-efficient femtocells for 3G and 4G networks.

Manufactured using InGaP HBT MMIC technology, the AWB7221's high linear transmit power (up to +28dBm of linear WiMAX power with exceptionally low EVM) enables CPEs with a powerful uplink that supports wide, high-data-rate network coverage. What is claimed to be excellent power-added efficiency (17.5% at rated output power) reduces the overall power consumption of a CPE or femtocell, leading to a reduction in system cooling requirements and less costly designs. Anadigics says that the AWB7221 enhances network performance in key global WiMAX markets such as North America, Japan and Korea, and also supports new LTE or TD-LTE networks in the 2.3–2.7GHz frequency bands. The AWB7221 also incorporates RF matching networks optimized for output power, efficiency and linearity in a 50Ω system.

Anadigics' AWB7221.

"A growing consumer appetite for enhanced wireless broadband applications is creating more demand for customer premises and small-cell infrastructure equipment that delivers faster data speeds over greater distances," says Joe Cozzarelli, senior director, Broadband RF product line. "Our AWB7221 PA provides a practical and effective way for service providers to answer this demand, and to continue to roll out 4G to a broader market," he adds.

WiMAX CPEs provide an alternative to DSL and cable modems, and also play a key role in the transition to 4G, by offering consumers high-speed wireless connectivity for their homes, shops or businesses. According to industry organization WiMAX Forum, nearly 600 WiMAX (fixed and mobile) networks have been deployed in 149 countries, with network coverage forecasted to be available to 800 million potential subscribers worldwide by the end of this year.

As WiMAX and other 4G networks continue to deploy worldwide, and 3G service providers seek to enhance their network coverage, the demands for small-cell base stations such as femtocells and picocells will grow tremendously, says Anadigics. Industry analyst In-Stat asserts that that small-cell base stations are "vital to 4G deployment", forecasting that femtocell revenue will rise at an 83% compounded annual growth rate (CAGR) over the next four years, and that the number of carrier-installed metropolitan picocells will increase at a 378% CAGR over the same period.

www.anadigics.com

Skyworks launches switch matrices for DBS and CATV

Skyworks Solutions Inc of Woburn, MA, USA, which makes linear products, power amplifiers, front-end modules and radio solutions for handset and infrastructure equipment, has launched several new CMOS switch matrix devices for the direct broadcast satellite (DBS) and cable TV markets. "These markets are expected to achieve double-digit growth every year through 2015," says David Stasey, VP of analog components.

Since DBS services allows households to receive TV programming directly from a satellite transponder via a low-noise block converter (LNB), across the satellite receiver industry low-noise block switches are increasingly enabling a single dish to view multiple satellites and allow hundreds of channels to be viewed per household. Skyworks' switch matrix solutions connect four of the satellite signals to two indoor set-top boxes selectable by the viewer's channel choice. Existing Skyworks' customers include BSkyB, DIRECTV, EchoStar and their design partners, along with a variety of emerging Chinese LNB OEMs and ODMs.

The new devices eliminate the need for external components by integrating critical functionality directly on the CMOS die, providing cost savings and reduced PCB space requirements, the firm claims.

The SKY13327-365LF and the SKY13369-365LF are 0.25–2.15GHz 4mm x 2mm switch matrices that combine a digital decoder with the RF switching network, tone/voltage detect and digital satellite equipment control rejection (DiSEqC) functionality. The compact 20-pin QFN-packaged switches enable any of the four inputs to connect to either of the two outputs. Switch states can be selected using tone and voltage signals together with vertical–horizontal mirror control inputs.

"These newest additions to our CMOS switch family are just several solutions within Skyworks' broad portfolio designed to drive greater network reliability, capacity and efficiency while also reducing size and complexity," says Stasey.

www.skyworksinc.com

Taiwan GaAs foundries AWSC & WIN continue record sales in September

Taiwan-based gallium arsenide foundries Advanced Wireless Semiconductor Company (AWSC) and WIN Semiconductor Corp saw their sales reach new records in September, as demand for end-products such as smartphones remains strong, reports Taiwanese publication Digitimes.

AWSC reported revenue of NT$185m (US$6m), its seventh consecutive record month (up slightly from August's NT$183m). Revenues for third-quarter 2010 grew 17.2% from Q2 to NT$543m, beating expectations of 10–15% growth. AWSC is a contract partner for Skyworks, whose power amplifiers (PAs) have penetrated the supply chain of Apple's iPhones as well as several of HTC's smartphones.

WIN Semiconductors reported revenue of NT$670m in September, its sixth consecutive record month (up slightly from August's NT$667m). Revenue for January–September was NT$5.27bn, up 63% year-on-year, according to data available from the Taiwan Stock Exchange (TSE).

For third-quarter 2010, WIN Semiconductors has posted pre-tax profit of NT$864m (US$28m), more than doubling from second-quarter 2010. The firm credited the strong results to non-operational income in addition to the rising sales from its core business.

WIN has ramped up its monthly 6-inch GaAs wafer capacity from 10,000–12,000 in May to 12,000–14,000, helping to increase its gross margin to 30% in Q3. In late June, shareholders approved a plan to issue 100 million new shares to raise funds for ramping up manufacturing capacity, while also soliciting equity investments from its upstream and downstream production partners, reported Digitimes at the time.

Despite seasonal factors, WIN Semiconductors and AWSC are expected to see fourth-quarter revenues decline only slightly quarter-on-quarter (from 0–5%), due to strong demand from the smartphone sector, according to estimates from industry sources.

www.digitimes.com/news/a20101014PD212.html

Taiwanese GaAs foundry WIN promotes Yu-Chi Wang to CEO

Taiwanese GaAs foundry WIN Semiconductors has promoted Dr Yu-Chi Wang to the position of chief executive officer (effective from 1 November). Wang will also be acting general manager (in charge of daily operations) of the MMIC business unit.

YC has been general manager of the MMIC business unit since 2007, driving revenue growth and new process development to meet the firm's business plan in the GaAs foundry service business segment. Previously, he was director (2003) and associate VP of the Technology Development Division (2004).

Wang joined WIN as section manager of HBT Product Development Department in 1999. Prior to that, he worked at Lucent Technologies' Bell Laboratories in Murray Hill, NJ, USA, where he was a member of the technical staff, involved in compound semiconductor device design and process development for wireless and fiber-optic ICs.

Wang received a bachelor degree in physics from the National Central University, Chung-Li, Taiwan in 1989 and a PhD in materials science and engineering from Rutgers University, New Brunswick, NJ in 1998.

www.winfoundry.com

TriQuint enters co-marketing agreement with VIPER RF

VIPER RF Ltd of Sunderland, UK has entered into a co-marketing agreement with RF front-end component maker and foundry services provider TriQuint Semiconductor Inc of Hillsboro, OR, USA in which it will offer design support and specialized RF expertise to help customers develop chips using TriQuint's process technologies and design tools.

VIPER RF is a privately funded microwave and RF IC design and development consultancy and product-based firm founded in 2008 that addresses markets including defence & security, communications and wireless applications, covering frequencies in the range DC–100GHz.

TriQuint's foundry offers a range of process technologies including GaAs FETs (pHEMT and MESFET), InGaP HBT, BiHEMT and GaN, on 3-inch, 100mm and 150mm wafers. Customers include OEMs, fabless semiconductor and wireless startups. VIPER RF says it joins an established network of design resources worldwide that each has the experience and tools to assist TriQuint's customers in realizing their RF and microwave IC design goals.

"Third-party design expertise, such as that provided by VIPER RF, is invaluable to customers with limited design resources, and this type of co-marketing agreement provides tangible benefits to the entire RF ecosystem," comments Mike Peters, TriQuint's director of marketing for Commercial Foundry. "VIPER RF's experience in GaAs MMIC and RFIC design, as well as its market focus, is a very good match to the application areas we address," he adds.

"TriQuint is one of the world's leading providers of GaAs and GaN foundry technologies," comments VIPER RF's CEO Jim Mayock. "We look forward to a long and mutually rewarding relationship helping customers to use TriQuint's foundry services profitably."

www.viper-rf.com
www.triquint.com

IN BRIEF

Low-noise, high-gain line amplifier for FTTH/RFoG

TriQuint Semiconductor has launched a new TriAccess amplifier, the TAT6254B, with lower equivalent input noise (EIN) of 3pA/rtHz and gain of 38dB.

The improved performance is targeted at networks with QAM-dominated content and those that can benefit from an extended optical link budget, including single system amplifier/receiver applications where noise optimization is most critical such as fiber-to-the-home (FTTH)/RF-over-glass (RFoG) systems.

"Our FTTH/GPON/RFoG amplifiers are ultra-low-noise, and our latest product release sets a new standard for low EIN—a critical parameter for improving optical link budgets," says Brian Bauer, TriQuint's CATV product marketing manager.

www.triquint.com

RFMD expands broadband portfolio for hybrid fiber coax networks

At the SCTE Cable-Tec Expo in New Orleans (20–22 October), RF Micro Devices Inc is announcing the expansion of its broadband product portfolio, targeting hybrid fiber coax (HFC) transmission network hardware, cable head-end, cable hub equipment, and multi-dwelling unit/multiple tenant unit (MDU/MTU) equipment.

RFMD says that the new products enhance cable operators' network performance and enable increased bandwidth to support rapidly growing digital-centric services, such as HDTV, 3D HDTV and 'mid-split' DOCSIS networking.

The use of mid-split architectures can expand the amount of usable upstream or return-path bandwidth by more than 160MHz. For example, a mid-split capable HFC network can provide cable subscribers with Internet upload data rates that are five times faster than typical North American DOCSIS capable cable HFC networks. This enables multiple service operators (MSOs) to scale the data services on their existing cable transmission infrastructure, while delivering an enhanced Internet user experience and expanded digital services (e.g. HDTV streaming, HDTV downloads at ten times real-time data rates) to cable subscribers.

RFMD's new HFC RF components include a broad selection of amplifiers and wide-bandwidth passive components. The amplifiers include linear amplifiers, low-noise amplifiers and return-path amplifiers. The passive components include couplers, two-way splitters and transformers.

RFMD says that, as it extends its product and technology range in broadband components, leading cable network equipment OEMs are increasingly selecting its HFC RF components for their performance, reduced power consumption and enhanced user experience.

www.rfmd.com

High-bandwidth RF amplifier for FTTH and RFoG

Responding to increasing demand for wider-bandwidth data pipes for fiber-to-the-home (FTTH) and RF-over-glass (RFoG) systems, Anadigics has upgraded its ACA2604 RF amplifier to support operation from 50MHz up to 1GHz.

The ACA2604 now enables cable MSOs and telco service providers to increase data rates as well as the number of channels available to consumers. This functionality is essential, says Anadigics, as sales continue to grow for high-definition TVs, video-on-demand (VOD), and other OTT services which require significant amounts of bandwidth.

The ACA2604 is designed for use in fiber-to-coax equipment, such as optical network units for FTTH and RFoG systems incorporating RF overlay, and fiber-to-the-building (FTTB) optical receivers for multi-dwelling units. Driven by the forward-path photodiode in fiber-optic RF receivers, the amplifier forms the optical-to-electrical interface and boosts overall output to the in-home coax wiring.

Anadigics' 1GHz ACA2604 amplifier.

"Delivering 1GHz performance from the ACA2604 is a significant milestone in our efforts to ensure that broadband service providers have the components necessary to provide the highest-performance networks," says Joe Cozzarelli, senior director, Broadband RF product line. "As the industry continues to evolve and equipment performance requirements increase, we'll continue to push the limits of innovation to keep our customers ahead on the broadband demand curve."

Operating from a single +5V supply and offered in an RoHS-compliant 5mm x 5mm x 1mm surface-mount package (pin compatible with Anadigics' ACA2601 RF amplifier), the ACA2604 offers low equivalent input noise (EIN) of 4.5pA/rtHz and features 22dB gain adjust.

www.anadigics.com

Anadigics' upstream-path RF amplifier enables higher data rates to more CATV subscribers via DOCSIS 3.0

At the SCTE Cable-Tec Expo 2010 in New Orleans (20–22 October), broadband wireless and wireline communications component maker Anadigics Inc of Warren, NJ, USA launched its latest upstream-path RF amplifier, which is offered in a 20-pin, 4mm x 4mm x 1mm MLPQ (QFN) package and optimized for use in DOCSIS-compliant cable modems, CATV set-top boxes (STBs), residential gateways and Embedded-Multimedia Terminal Adapter (E-MTA) applications.

Designed to support a new high-power operation mode specified in the recently amended DOCSIS 3.0 telecoms standard, the ARA2021 provides the fastest broadband upstream pipe to subscribers located further from the CATV head-end. Anadigics says that the device's performance enables more subscribers on the network to take advantage of the fastest possible data transmission rates, while supporting 'green' energy initiatives by reducing power consumption by up to 97% in standby mode (via a low-power transmit disable mode that consumes just 35mW).

Managed by non-profit R&D industry consortium CableLabs, the DOCSIS standard was created to help cable operators transition their businesses from solely delivering TV programming to becoming full-service providers of video, voice and data services. DOCSIS 3.0 is the current version of the standard, which includes features such as channel bonding techniques that provide cable operators with a flexible way to boost end-user data speeds to as much as 160Mbps downstream and 120Mbps upstream.

ARA2021 upstream-path RF amplifier.

"Based on the broadband consumers' growing appetite for bandwidth-intensive applications such as remote hard-drive backup, sharing of large data files, and HD video uploads, industry analysts foresee steady growth in the coming years for DOCSIS 3.0-compliant products," says Joe Cozzarelli, Anadigics' senior director, Broadband RF product line. "We've developed the ARA2021 amplifier to meet the demanding requirements of CATV networks that can deliver the highest data rates and extended reach."

Operating at frequencies of 5–85MHz, the ARA2021 is a highly linear, programmable gain amplifier that integrates a digitally controlled, multiple-stage precision step attenuator (with up to 49dB of attenuation in 1dB increments) — with RF voltage gain of 35dB (at minimum attenuation) — and provides what is claimed to be extremely low harmonics and superior distortion performance at high output power levels (linear up to +67dBmV, single channel). This performance enables the amplifier to overcome long loop attenuation created by directional couplers, taps, attenuators, and other input losses, ensuring a high-quality signal at the head end.

Engineering evaluation samples of the ARA2021 are available for qualified opportunities.

www.anadigics.com

TriQuint launches CATV amplifier for ONU, EoC

At the SCTE Cable-Tec Expo 2010 in New Orleans (20–22 October), RF component maker and foundry services provider TriQuint Semiconductor Inc of Hillsboro, OR, USA is launching the TAT7457 device, a highly flexible, single-ended cable television (CATV) amplifier operating at frequencies from DC to 2000MHz such as RF-over-glass (RFoG) and emerging subscriber/premises applications, including optical network units (ONU), Ethernet over Coax (EoC) distribution and a variety of existing and emerging home amplifier designs.

The TAT7457 is suited to cost-sensitive CATV applications, since it provides 19dB gain (typical) yet, when an off-chip external feedback resistor is added, it can also provide variable gain adjustment, trading off the typical current of 120mA (at 5V), suiting home network amplification requirements.

Also, it offers higher gain, superior distortion and better return loss compared to incumbent 16dB amplifiers, TriQuint claims. The balance of low distortion and noise figure (<2dB to 1000MHz) provides a solution for a wide range of broadband amplifiers used in CATV applications such as optical receivers and low-noise front ends. An internal bias circuit mitigates the effect of temperature and process variation.

"Our newest device, TAT7457, offers the flexibility that engineers haven't found in other home network products at a very cost-competitive price point," reckons CATV/FTTH product marketing manager Brian Bauer. Pricing is below $0.45 each in quantities over 100,000 units.

www.triquint.com

IN BRIEF

TELEFUNKEN offers Si and SiGe epitaxial deposition services

Specialty analog & mixed-signal chip maker TELEFUNKEN Semiconductors GmbH of Heilbronn, Germany has announced the availability of in-line silicon and silicon-germanium (SiGe) epitaxial deposition service for customers (both commercial and non-commercial) worldwide to address increasing epitaxial layer market demand for high-speed amplifier and power driver applications.

"We are ready to provide high-quality silicon and silicon-germanium epitaxial service to support our 150mm wafer customers," says chief technology officer Dr Volker Dudek. "Epitaxy is a key enabling technology for today's high performance devices," he adds.

Certified according ISO 9001:2008 and ISO 14001:2009 since December 2009, TELEFUNKEN Semiconductors' fabrication facility has both single-wafer reactors and batch-wafer reactors tools to meet various in-line epitaxial requirements. The service offers Si epitaxial and ultra-thin SiGe:Si composite layers on buried doped regions. The firm also provides metrology services. The range of epitaxial layer thickness can vary from below 20nm up to 9μm, with resistivity from 0.005Ωcm to 15Ωcm.

TELEFUNKEN Semiconductors argues that, by outsourcing the epitaxial growth process, customers can benefit from the elimination of expensive equipment investment and significant operation and maintenance costs.

www.telefunkensemi.com/foundry-business.html

SEMATECH gate-stack symposium identifies post-22nm strategies

At the 7th Annual International Symposium on Advanced Gate Stack Technology (ISAGST) held at the Rensselaer Banquet & Conference Facility, Troy, NY, USA (29 September – 1 October), which was hosted by semiconductor industry research consortium SEMATECH of Albany, NY, more than 100 international researchers from industry and academia shared discoveries and outlined strategies for implementing advanced logic and memory process technologies for the sub-16nm node and beyond, focusing on new gate stacks.

The technologies covered were high-k/metal gate stacks for silicon (Si), silicon-germanium (SiGe), III-V high-performance MOSFETs, metal/high-k/metal stacks for resistance change memory, flash memory, and phase-change memory.

Key observations included:

- Progress is being made on germanium and III-V alternative channel material devices, although there was general acknowledgement that this area will require more effort and more resources to demonstrate manufacturable solutions;
- Various presenters addressed the functional stack challenges for logic and memory centered on high-k metal gate for both silicon and silicon germanium as well as concerns over III-V high-performance MOSFETs;
- The consensus was that, although there are many hurdles still to overcome, vertical stacking seems the most promising pathway for continued scaling; and
- To offset the slowdown in scaling and to achieve uniformity and address reliability, newer more innovative materials and switching mechanisms of non-volatile memories need to be investigated further.

Other findings disclosed at the symposium included:

- Keynote presenters from Intel's Technology and Manufacturing Group as well as Macronix provided a comprehensive overview of transistor scaling options beyond the 15nm node and the challenges of non-volatile memories, including floating gate for planar and non-planar devices;
- High-k/metal gate process issues were discussed by SONY, Toshiba, IBM and GLOBALFOUNDRIES, highlighting issues with stack scaling;
- Andrew Kummel of the University of California, San Diego (UCSD) discussed density-functional theory (DFT) simulations suggesting practical pathways to improve the quality of high-k oxides on both Ge and III-V interfaces;
- In the area of emerging memory development, resistance change memory is considered to be one of the most promising candidates for the next generation of memory — various materials, selector devices and architectures were showcased, and cross-bar architectures were discussed for future memory;
- The impressive progress on spin transfer torque (STTRAM) was discussed by Grandis Inc, Everspin Technologies Inc and the University of Virginia; and
- Several presentations explored new or alternative materials and architectures beyond CMOS devices for 2020, including electron spin devices, graphene, and nanowire transistors. Professor Kang Wang of University of California at Los Angeles (UCLA) reported that efficient spin injection into Ge has been realized using magnesium oxide (MgO) and is being optimized for spin transfer torque.

ISAGST is part of the SEMATECH Knowledge Series, a set of public, single-focused industry meetings designed to increase global knowledge in key areas of semiconductor R&D.

www.sematech.org

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Fujitsu develops record 1.3W power output W-band gallium nitride HEMT power amplifier

Transmission range extended by six-fold over GaAs transceivers

At the 2010 IEEE Compound Semiconductor IC Symposium (CSICS) in Monterey, CA, USA (3–6 October), Japan's Fujitsu Laboratories Ltd is presenting its development of a power amplifier using gallium nitride (GaN) high-electron-mobility transistors (HEMTs) that has achieved record power output of 1.3W for wireless communications in the millimeter-wave W-band (75–110GHz), for which widespread usage is expected in the future (e.g. for applications including high-speed wireless communications, automotive radar, and image sensors). The new amplifier can offer output equivalent to about 16 times that of existing amplifiers using gallium arsenide, enabling W-band transmission ranges to be extended by about six times.

Fujitsu says that the new GaN HEMT-based power amplifier will make high-capacity wireless communications possible in regions in which it is unfeasible to lay optical fiber cables, in addition to ensuring high-quality communications in rain and under other conditions where the millimeter-wave signal is known to attenuate.

Part of the research was conducted under contract as part of the 'Research and Development Project for Expansion of Radio Spectrum Resources' of Japan's Ministry of Internal Affairs and Communications.

To accommodate the demands for greater bandwidth resulting from increases in Internet communications and expansions in mobile phone networks, optic fiber cables are being laid in nations throughout the world to create a high-capacity trunk-line system. Fujitsu says that this is problematic in areas with challenging topography, sparking interest in high-bandwidth wireless trunk lines capable of data transmission capacities up to 10Gbps — on a par with fiber-optic cabling — as a way to bridge what Fujitsu calls the 'digital divide' for wireless communications (Figure 1).

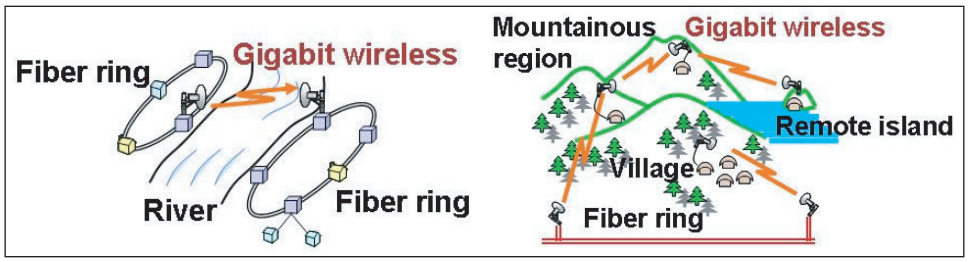

Figure 1: Usage scenarios for millimeter-wave W-band wireless communications.

The millimeter-wave W-band is an effective band for wireless communications at speeds of up to 10Gbps, as it is readily available (see wireless transceiver employing millimeter-wave W-band in Figure 2). The power amplifier inside a transmitter is the key component for amplifying the millimeter-wave signal to the intensity required for transmission.

Up until now, Fujitsu and Fujitsu Laboratories have produced 350mW of power using power amplifiers based on GaN HEMTs. However, the W-band experiences significant signal attenuation due to factors such as atmospheric absorption and rain, and there has been demand for high-output power amplifiers that can transmit a stable signal across distances ranging from a few kilometers to several tens of kilometers.

Fujitsu says that, to develop a high-output W-band power amplifier, the following issues had to be addressed:

- Transistor operating speed (operating frequency) is determined by the speed at which electrons pass directly beneath the gate electrodes. To operate at high frequency (e.g. the millimeter-wave band) the length of the gate electrodes must be decreased. On the other hand, an effective method of achieving high power output is applying a high voltage to the transistor. But, when the GaN HEMT gate length is reduced and the transistor is operated at a high voltage, electrons increase speed dramatically, and hence some of them can leak from the current pathway (electron channel layer), reaching the passivation layer, where they accumulate (Figure 3). There is hence a reduction in electrons contributing to high-frequency operation (a loss in high-frequency current), making it difficult to increase power output.
- Power distribution within a power amplifier is performed by dividing the input signal among multiple parallel transistors in the power

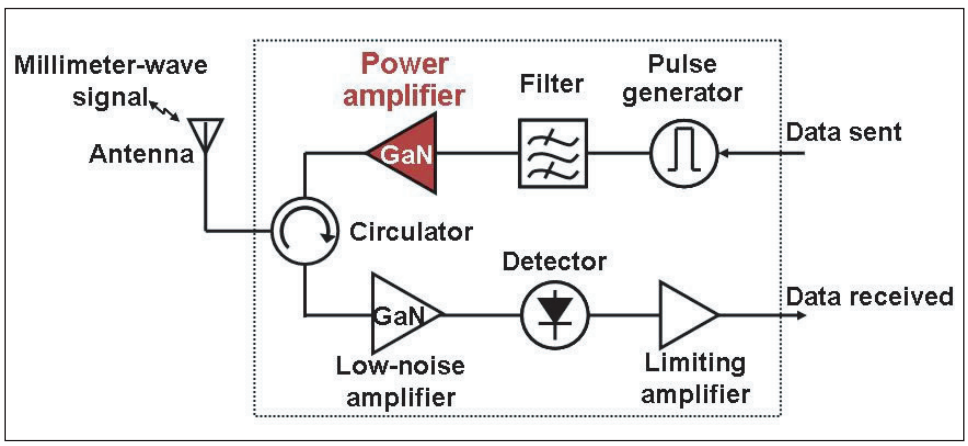

Figure 2: Millimeter-wave W-band transceiver (example of impulse radio).

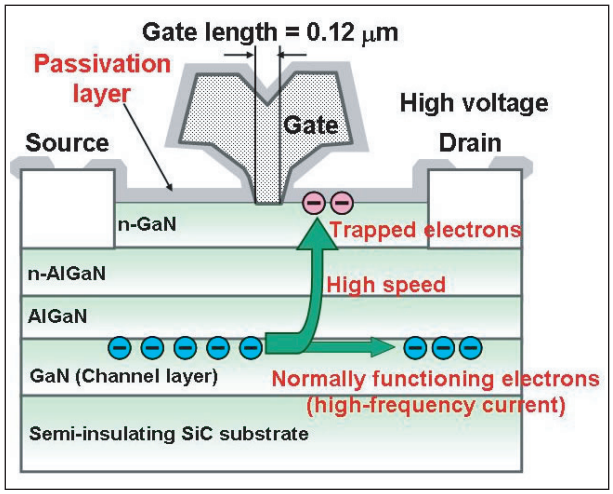

Figure 3: Cross section of millimeter-wave GaN HEMT transistor.

splitter circuit. After the signal is amplified by each transistor, it is combined again using the combiner circuit, enabling high power output (Figure 4). But at frequencies above 70GHz, due to the interference of high-frequency complex signal distribution, the signal undergoes attenuation in the power splitter and combiner circuits. It was hence necessary to construct a power splitting and combination model for use in the millimeter-wave band, and to develop a design that takes the complex signal distribution into consideration while enabling the desired output to be achieved.

To resolve these issues, Fujitsu therefore developed the following technologies:

● **Optimizing the GaN HEMT passivation layer.** After analyzing why electrons escaped from the electron channel layer and accumulated in the passivation layer, Fujitsu traced the issue to the existence of defects in the crystallization of the silicon nitride (SiN) used as part of the passivation layer. By enhancing the layer's SiN composition and crystalline structure, Fujitsu fabricated a passivation layer with minimal crystalline defects, making it difficult for electrons to accumulate. The new technology able to amplify high-frequency current to more than two times the power of existing technology.

● **Building a power division and combination model via electromagnetic analysis.** By performing electromagnetic analysis on the complex signal distribution of the high-frequency signal, based on the physical properties of the power splitter and combiner circuits, Fujitsu designed a highly precise circuit that reduces signal attenuation in the two circuits. Fujitsu was hence able to increase design precision by about 15%.

The above technologies were used to develop a power amplifier for millimeter-wave W-band wireless equipment that achieved a maximum output of 1.3W which, among GaN HEMT power amplifiers, represents the highest output in this frequency band using a single integrated circuit, it is claimed.

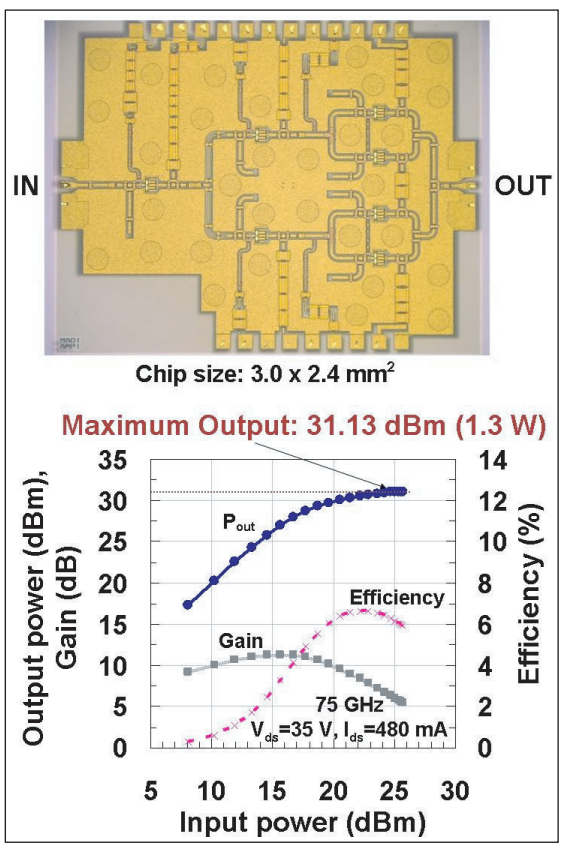

Figure 5: New GaN HEMT amplifier and its characteristics.

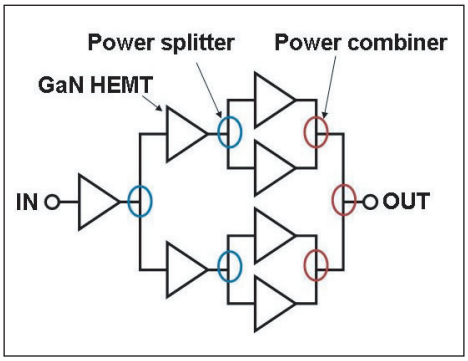

Figure 4: Structure of millimeter-wave W-band amplifier.

The new technology also achieves transmission output equivalent to 16 times that of existing amplifiers using GaAs. Employed in combination with the GaN HEMT receiver amplifier developed by Fujitsu last year, it is expected that transmission ranges can be extended by about six times compared to GaAs-based transceivers. The firm says that this should enable millimeter-wave wireless communications equipment to be deployed in a wider range of fields, while ensuring high-quality communications in which ample signal output can be obtained even when there is signal attenuation due to rain and other factors.

Fujitsu and Fujitsu Laboratories plan to work to further improve the performance and expand the frequency spectrum of the GaN HEMT power amplifier, while employing the technology in a wide range of applications, including millimeter-wave-enabled trunk lines and ultra-high-speed wireless network access.

http://jp.fujitsu.com/labs/en

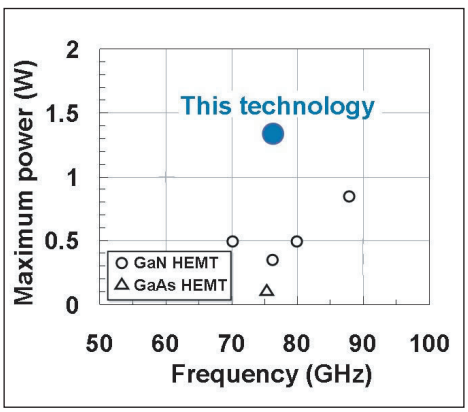

Figure 6: Comparison with other millimeter-wave W-band amplifiers.

Renesas Electronics strengthens compound semiconductor business

Renesas aims to grow market share in photocouplers and RF switch ICs, and launch GaN products for CATV amplifiers

Renesas Electronics Corp of Tokyo, Japan, which supplies semiconductors including microcontrollers, system-on-chip (SoC) solutions, and analog and power devices, has announced new objectives to strengthen its compound semiconductor business, which includes optoelectronic devices based on gallium arsenide as well as microwave devices. This follows the formation of the firm just in April through the integration of NEC Electronics Corp and Renesas Technology Corp.

Renesas Electronics aims to:

1. *Attain number-1 market shares in photocouplers and optical storage devices (e.g. visible laser diodes) and extend its leading market shares in RF switch ICs and GaAs low-noise field-effect transistors (FETs).*

In photocouplers, Renesas Electronics plans to accelerate its development of high-temperature-operation, low-power and small-sized packages to address rising demand from 'green' markets such as hybrid and electric vehicles, LED lighting systems and electric meters. It intends to further expand sales by combining its photocouplers with its IGBTs (insulated-gate bipolar transistors, suitable for high-voltage and high-current output) and microcontrollers (MCUs), as one-kit solutions. In particular, the firm will strengthen overseas marketing by doubling headcount in that role. In addition, in anticipation of a rapid rise in demand, Renesas Electronics plans to double its production capacity over that of fiscal Q4/2009.

For RF switch ICs that enable transmit–receive switching and 3G GSM-mode switching and antenna switching on electronic devices with an RF function such as mobile phones and notebook PCs, Renesas Electronics aims to launch new low-loss transistors. Also, to be flexible to customers' demands, the company will offer its RF switch ICs either in an ultra-small package or as bare die. Renesas Electronics also aims to expand its RF switch IC business through collaboration with chipset vendors in the USA, Europe and Taiwan to provide reference designs for system manufacturers.

2. *Launch new gallium nitride (GaN)-based semiconductor products by March 2011.*

Unlike firms that use 3–4-inch silicon carbide (SiC) substrates, Renesas Electronics fabricates GaN devices on silicon wafers, enabling the use of larger (6-inch) wafers and hence lower-cost production. The firm plans to launch GaN-based products first for the cable television (CATV) amplifier market. Sample shipments of its first GaN-based product, a module for CATV incorporating multiple GaN FETs, condensers and other devices, is scheduled to begin by March 2011. Renesas Electronics also plans to launch other microwave and millimeter-wave devices.

Renesas Electronics expects the compound semiconductor market to increase at an average annual growth rate of 8% from 2010 to 2012, and intends to expand its compound semiconductor business by 11% (exceeding the market growth rate). The firm also plans to grow its compound semiconductor sales in fiscal year 2012 by 1.2 times.

www.renesas.com

AWR releases PDK for Cree GaN HEMT MMIC foundry

High-frequency electronic design automation (EDA) software tool provider AWR of El Segundo, CA, USA has released a new process design kit (PDK) supporting the high-power gallium nitride (GaN) high-electron-mobility transistor (HEMT) monolithic microwave integrated circuit (MMIC) foundry process of Cree Inc of Durham, NC.

The new Cree/AWR PDK enables MMIC designers to model Cree's GaN HEMT MMIC process within AWR's Microwave Office software environment and enable the design of MMICs that offer more power bandwidth, higher efficiency, and a smaller footprint than can be achieved using conventional technologies such as GaAs.

The Cree GaN HEMT MMIC process features high power density (4–6W/mm) transistors, slot vias, and high reliability (up to 225ºC operating channel temperatures), as well as scalable transistors. In addition, the Cree/AWR PDK leverages AWR's Intelligent Net (iNet) automated interconnect construction technology to automatically radius and fillet corners when connecting different parts together, ensuring design-rule-check (DRC)-compliant layouts and eliminating the need for manual editing. The PDK is also setup for ready electromagnetic (EM) extraction through AWR's EXTRACT technology, which can save designers' time by not having to manually edit schematics for EM results.

http://web.awrcorp.com

RFMD launches GaN hybrid power doubler amplifier module for CATV at SCTE Cable-Tec Expo

At the SCTE Cable-Tec Expo in New Orleans (20–22 October), RF Micro Devices Inc of Greensboro, NC, USA is announcing availability of the RFPD2650, a gallium nitride-based hybrid power doubler amplifier that delivers low distortion performance with the flexibility to optimize for supply current or energy consumption. The module is designed specifically for CATV infrastructure applications including hybrid fiber coaxial (HFC) optical nodes.

Power doublers are used in HFC networks to extend the range of signal transmission from the head-end to the consumer. To minimize the cost of delivering the signal to the edge of their networks, multi-system operators (MSOs) prefer to use as few amplifiers as possible. MSOs are also increasingly seeking to minimize the operational expenses associated with the HFC network, most notably power consumption and reliability. The RFPD2650 power doubler addresses both of these concerns, as does RFMD's entire line-up of GaN-based amplifiers.

The RFPD2650 supplies a minimum gain of 21dB over the entire 45–1003MHz frequency range. RFMD says that it can deliver up to 20% power or energy savings with no performance penalty in HFC networks, or it can be configured to provide 3dB higher distortion level performance with the same power consumption. With this blend of attributes, RFMD claims that the RFPD2650 enables MSO system designers to select either industry-leading or energy saving (green) performance, while maintaining the ease-of-use infrastructure that OEMs have come to expect from industry-standard SOT115J-packaged amplifier modules.

The RFPD2650 leverages GaN HEMT and GaAs pHEMT technology to provide what is claimed to be the industry's best distortion performance, enabling longer-range transmission. Maximum current is 450mA, and current consumption can be reduced to less than 370mA for applications requiring reduced distortion performance. Programmed to match the distortion level of competitive devices, the RFPD2650 delivers 2W of power consumption savings.

The RFPD2650 is available in sample or production quantities, priced at $26.50 in quantities of 5000.

High-efficiency 140W GaN RF transistor enters volume production

RF Micro Devices has qualified and production released the RF3934, a 140W highly efficient GaN RF unmatched power transistor (UPT) with what is claimed to be superior performance versus competing GaAs and silicon power technologies. The RF3934 is currently available for sampling and mass production.

The firm says that its unmatched power transistors support 'green' architectures that reduce energy consumption, improving thermal management and network efficiency for network operators.

The RF3934 operates over a broad frequency range (DC to 3GHz) in a single amplifier design. The high peak efficiency of more than 65% minimizes thermal management demand and improves overall power consumption requirements for end customers.

Also, ease of design implementation and integration is enhanced through the incorporation of simple, optimized matching networks external to the package, providing wideband gain and power performance advantages in a single amplifier. The RF3934 is packaged in a hermetic, flanged ceramic two-leaded package that leverages RFMD's heat sink and power dissipation technologies to deliver what it claimed to be excellent thermal stability and conductivity.

"The release of the RF3934 is an important milestone because it is the highest-output power device in our UPT family," says Jeff Shealy, VP & general manager of RFMD's Defense and Power business unit. "Furthermore, it is a key building block for our upcoming matched power transistor family, scheduled to be released later this fiscal year," he adds.

"Our GaN products offer the added benefit of being produced in the same high-volume manufacturing environment as our RFMD cellular products, which translates into industry-leading manufacturing cycle times," claims Bob Van Buskirk, president of RFMD's Multi-Market Products Group. "We further leverage our internal, high-power packaging facility, with military and government security clearances, to enable flexible assembly & test strategies and short learning cycles to support important aerospace and defense programs," he adds.

The RF3934 is designed in RFMD's 48V high-power-density GaN process — featuring a unique combination of high RF power density and efficiency, low capacitance and high thermal conductivity. Such features enable the development of compact and efficient high power amplifiers (HPAs) for a broad range of applications, including public mobile radio (PMR), 3G/4G wireless infrastructure, ISM (industrial scientific & medical), military and civilian radar and CATV transmission networks.

www.rfmd.com

IN BRIEF

Kopin wins SBIR Phase II award to optimize AlInN HEMTs for X-band

Kopin Corp of Taunton, MA, USA, which makes III-V heterojunction bipolar transistor (HBT) epiwafers and CyberDisplay LCDs, has won a $750,000 two-year Phase II Small Business Innovative Research (SBIR) award through the Missile Defense Agency (MDA) to develop aluminum indium nitride-based high-electron-mobility transistors (AlInN HEMTs). The award aims to leverage the firm's capability in Group III-nitrides to enhance the performance and manufacturability of AlInN materials.

"This SBIR program by MDA validates the potential of the AlInN material system for high-performance electronic devices," says president & CEO Dr John C.C. Fan. "Our long-term objective is to commercialize AlInN-based electronic materials, which parallels our highly successful GaAs HBT wafer business. It is part of Kopin's strategy to leverage our expertise in III-V materials and nanoengineering to offer technology-differentiated solutions to our customers," he adds.

"The AlInN material system has shown great promise to extend the power and frequency capability of GaN-based HEMTs, but it is a challenging material to produce," comments VP of technology Dr Wayne Johnson. "During the Phase I effort, we demonstrated encouraging results in AlInN/GaN heterostructures, including record-low sheet resistance. The goals of Phase II will involve optimization of the AlInN HEMT structures and fabrication of HEMT devices for X-band electronic applications in collaboration with leading-edge GaN foundries."

www.kopin.com

Accel-RF agrees CRADA with AFRL for reliability test-method improvement

Accel-RF Corp of San Diego, CA, USA has signed a Cooperative Research & Development Agreement (CRADA) with the Aerospace Components and Subsystems Division of the Sensors Directorate of the Air Force Research Laboratory (AFRL/RYD) relating to compound semiconductor reliability measurement expansion.

The agreement enables technology transfer between Accel-RF and AFRL for device and component reliability test-method improvement on a broad range of technologies including wide-bandgap semiconductors.

"AFRL continues to be a strong advocate for increased quantity and environmentally meaningful test data. This agreement allows a collaborative interaction between our technical staff and AFRL personnel to push forward development of state-of-the-art reliability and performance-degradation testing of semiconductor technologies used in advanced system applications," says Accel-RF's president Roland Shaw. "Reliability testing of state-of-the art technologies is difficult enough, but reliability testing of a significant sample size of discrete devices or MMICs at dc through V-band and at controlled channel-temperatures for thousands of hours, compounds the problem exponentially," he adds.

"Sharing our mutual expertise and resources will accelerate the collection of device data and improve the technology diversity of the test samples," continues Shaw. "The primary goal is to increase confidence levels of long-term reliability on a wide range of semiconductor technology as quickly as possible."

Fixture for compound semiconductor devices

Accel-RF has a new 'Smart Fixture' product line for performance characterization of compound semiconductor devices.

The USB-controlled fixture, complete with custom matching circuits or proprietary wide-bandwidth bias-tees, includes an embedded heater and integrated analog/digital control board for temperature setting and DC/RF pulsing setup. A clamping system allows electrical, mechanical and RF contact of the device-under-test without 'hard mounting' of the package and leads. The configuration can be used with different thermal imaging systems, including micro-Raman spectroscopy, for channel-temperature measurement under active bias, temperature and RF stimulation.

The smart fixture allows users to manage the stimulus to their RF device on a bench-top setting to control the base-plate or channel-temperature, DC bias and RF signal to specific test conditions. "This opens an avenue to quickly characterize device performance on numerous levels," says president Roland Shaw. "These performance metrics can be for intrinsic reliability studies, performance degradation studies, or for parameter variation analysis," he adds. "This off-the-shelf solution provides a standard fixture with the capability to adapt to as many as 11 different package types and allowing our customer to get on with the task of testing the device without the issue of developing a new fixture for each application."

With the same footprint as the RF fixture in the Accel-RF Reliability Test System, the smart fixture can be used by technology developers, RF engineers and reliability engineers to characterize their devices in a thermally controlled, RF-friendly environment. It also uses Accel-RF's Lifetest Software for the graphical user interface and data analysis and presentation capability.

www.accelrf.com

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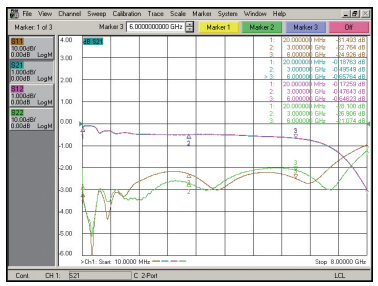
TBT-H06M20-F TBT-H06M20-F **25W / 20MHz～6GHz**

SPECIFICATION

Series		TBT			
Model		TBT-H06M20-F			
Impedance		50Ω			
Frequency Range		20MHz～6GHz			
		20～50MHz	50MHz～2GHz	2～3GHz	3～6GHz
VSWR (Return loss)		1.4 max.	1.22 max.	1.28 max.	1.4 max.
Insertion Loss		0.5dB typ.			0.7dB typ.
		0.8dB max.			1.0dB max.
Connector	RF	SMA (Female)			
	DC	Feedthru			
RF Power		25W max.			
Bias Current		3A max.			
Bias Voltage		50V max.			
Dimensions *		50 x 38 x 18 ㎜			
Weight		70g			
Temparature		0℃～ +40℃			

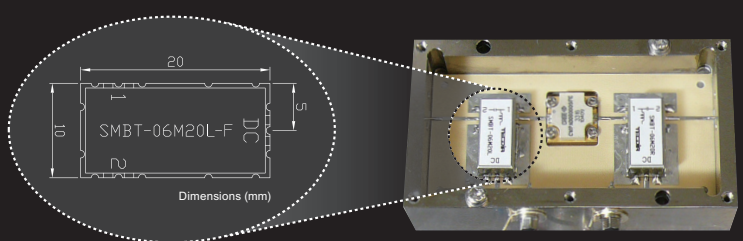
* Excluding Connectors

Typical VSWR & Insertion Loss



Surface Mount Design

20MHz～6GHz Typical Installation

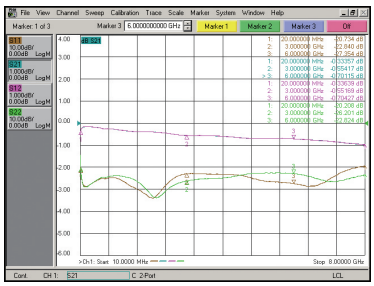


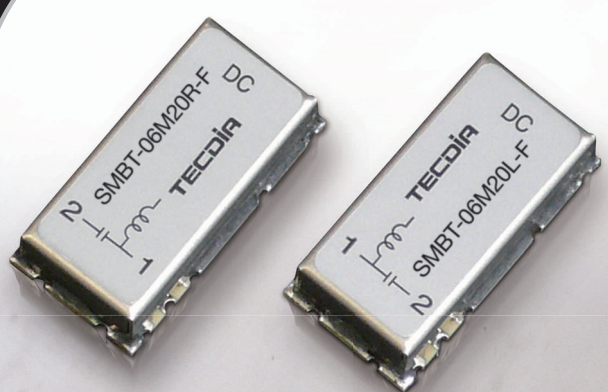
SPECIFICATION

Series	SMBT			
Model	SMBT-06M20□*-F			
Impedance	50Ω			
Frequency Range	20MHz～6GHz			
	20～50MHz	50MHz～2GHz	2～3GHz	3～6GHz
VSWR (Return loss)	1.5 max.	1.22 max.	1.28 max.	1.4 max.
Insertion Loss	0.8dB max.			1.0dB max.
RF Power	5W max.			
Bias Current	2A max.			
Bias Voltage	50V max.			
Dimensions	20 x 10 x 5 ㎜			
Weight	2g			
Temparature	-40℃～ +90℃			

*□=L or R for connection orientation

Typical VSWR & Insertion Loss





Ready-made Bias Network for GaN FET

* Left/Right Connection Available

Power Integrations invests $30m in SemiSouth

Partnership to speed development of power devices for solar, wind & hybrid/electric auto industries

Power Integrations Inc of San Jose, CA, USA, which supplies high-voltage integrated circuits for compact, energy-efficient AC–DC and DC–DC power conversion in electronic products, has made a strategic investment in SemiSouth Laboratories Inc of Starkville, MS, USA.

Founded in 2000 as a spin-out from Mississippi State University, SemiSouth is a privately held firm that designs and manufactures high-voltage silicon carbide (SiC) semiconductor power devices and electronics for high-efficiency, harsh-environment power management and conversion in applications ranging from 3kW to 100kW (with products in development to serve applications up to 1MW). With a 10,000ft^2 cleanroom and more than 70 staff at its Starkville headquarters, products include 1200V and 1700V transistors as well as high-voltage diodes and power modules.

Power Integrations' EcoSmart energy-efficiency technology cuts standby energy consumption. Since 1998, the firm has sold nearly 4bn of its EcoSmart chips (used in electronic products including computers, appliances, mobile-phone chargers, consumer electronics and LED lights), saving an estimated $4.4bn of standby power and millions of tons of CO_2 emissions.

Power Integrations' commitment of $30m (which includes an equity investment in SemiSouth, a technology license and other financial commitments) should help to drive the continued expansion of SemiSouth's SiC fabrication facility. The firms will also collaborate to drive adoption of SemiSouth's SiC technology, aiming to speed the development of efficient power conversion devices for applications including solar and wind inverters as well as hybrid/electric vehicles.

The new relationship was announced at SemiSouth's Starkville base in the Thad Cochran Technology, Research and Economic Development Park at Mississippi State University in the presence of public officials including Mississippi Governor Haley Barbour, US Representative Gregg Harper, and Mississippi State University president Dr Mark Keenum.

"SemiSouth has made impressive breakthroughs in the development of silicon carbide technology, attaining exceptionally high levels of efficiency and establishing SiC as an enabler of clean technologies such as solar energy and hybrid/electric vehicles," says Power Integrations' president & CEO Balu Balakrishnan. "With a mutual focus on energy-efficient high-voltage semiconductor technology, Power Integrations and SemiSouth are natural strategic partners," he reckons. "We are particularly enthusiastic about investing in Mississippi's emerging high-tech sector, where strong support from government and the academic community has created an environment highly conducive to innovation and private-sector investment," Balakrishnan notes.

"Today's announcement is a testament to SemiSouth's success and to Mississippi's growing stature as a center for technology and innovation," asserts Barbour. "As a leader in automotive manufacturing, Mississippi understands the strategic importance of advanced power electronics, which are becoming a critical part of the supply chain as the industry migrates to hybrid/electric vehicles. Home-grown innovations like SemiSouth's SiC technology represent a tremendous economic opportunity for our state," he adds.

"In response to unprecedented global demand for our products in energy-sensitive markets such as solar inverters, server power supplies, wind inverters, and electric vehicle development, we needed to find the right investor willing to share our vision of expansion," says SemiSouth's president & CEO Kenney Roberts. "We welcome Power Integrations' investment in SemiSouth's future, to allow us to quickly expand and serve our customers on a much broader scale."

www.powerint.com
www.semisouth.com

Dow Corning producing micropipe-free 76mm 4H-SiC

Dow Corning Compound Semiconductor Solutions (DCCSS) of Midland, MI, USA says that it has developed technology to grow 76mm-diameter 4H-SiC (silicon carbide) crystals that are free of micropipe defects. Crystals made from the new zero-micropipe technology are now made routinely and supply the DCCSS 76mm 4H-SiC wafer and epitaxy manufacturing line.

Since micropipe defects are highly focused on killer defects in SiC devices, a supply of SiC substrates free of micropipes establishes the potential to manufacture SiC devices with higher yields than what has been possible with available SiC substrates in the past, says the firm.

"Dow Corning will continue to invest in the advancement of our SiC technology to support our customers' efforts in achieving their goals," says commercial manager Fred Buether. "We're using our technology experience to develop advanced application solutions for the power electronics market that result in innovative, energy-efficient products that are cost effective," he adds.

www.dowcorning.com/content/compsemi

GeneSiC wins $2.5m grant to develop multi-kV thyristors

The US Advanced Research Projects Agency – Energy (ARPA-E) has entered into a cooperative agreement with a team led by GeneSiC Semiconductor Inc of Dulles, VA, USA to develop ultra-high-voltage silicon carbide (SiC) thyristor-based devices, which are expected to be key enablers for integrating large-scale wind and solar power plants into the next-generation smart grid.

Located near Washington DC, GeneSiC develops SiC-based devices for high-voltage, high-frequency SiC devices for power grid, pulsed power and directed energy weapons as well as high-temperature SiC power devices for aircraft actuators and oil exploration. Development projects include high-temperature rectifiers, SuperJunction Transistors (SJT) and a variety of thyristor-based devices. GeneSiC has had prime/sub-contracts from US Government agencies including the Department of Energy, Navy, Army, DARPA, and Department of Homeland Security.

"This highly competitive award to GeneSiC will allow us to extend our technical leadership position in multi-kV SiC technology, as well as our commitment to grid-scale alternative energy solutions with solid-state solutions," believes president Dr Ranbir Singh. "Multi-kV SiC thyristors we're developing are the key enabling technology towards the realization of Flexible AC Transmission Systems (FACTS) elements and High Voltage DC (HVDC) architectures envisaged towards an integrated, efficient, smart grid," he adds. "GeneSiC's SiC-based thyristors offer 10 times higher voltage, 100 times faster switching frequencies and higher-temperature operation in FACTS and HVDC power processing solutions as compared to conventional silicon-based thyristors."

In April, GeneSiC responded to the Agile Delivery of Electrical Power Technology (ADEPT) solicitation from ARPA-E that sought to invest in materials for fundamental advances in high-voltage switches that has the potential to leapfrog existing power converter performance while offering reductions in cost. The firm's proposal 'Silicon Carbide Anode Switched Thyristor for medium voltage power conversion' was selected to provide a lightweight, solid-state, medium-voltage energy conversion for high-power applications such as solid-state electrical substations and wind turbine generators. Deploying these advanced power semiconductor technologies could provide a reduction in electricity consumption of as much as 25–30% through increased efficiencies in delivery of electrical power, says GeneSiC.

Ultra-high-voltage (>10kV) SiC device technology will play a revolutionary role in the next-generation utility grid, believes GeneSiC. Thyristor-based SiC devices offer the highest on-state performance for >5kV devices, and are widely applicable to medium-voltage power conversion circuits such as fault-current limiters, AC–DC converters, static VAR compensators and series compensators, adds the firm. SiC-based thyristors also offer the best chance of early adoption due to their similarities to conventional power grid elements. Other promising applications and advantages for the devices include:

- power-management and power-conditioning systems for medium-voltage DC conversion sought under Future Naval Capability (FNC) of US Navy, electro-magnetic launch systems, high-energy weapon systems and medical imaging (the 10–100x higher operating frequency capability allows unprecedented improvements in size, weight, volume and, ultimately, cost of such systems, says GeneSiC); and
- a variety of energy storage, high-temperature and high-energy physics applications (energy storage and power grid applications are receiving increasing attention as the world focuses on more efficient and cost-effective energy-management solutions).

www.genesicsemi.com

High-linearity power amplfiers for 4.4–5.1GHz band

IXYS Corp subsidiary MicroWave Technology Inc (MwT) of Fremont, CA, USA, which makes GaAs-based devices, MMICs and amplifier modules for microwave and wireless communications, has launched a family of three GaAs- and GaN-based high-linearity microwave/RF power amplifiers.

The WPS-445133-02 has 2W output at 1dB gain compression point and 26dBm linear output power (burst power) at 2.5% EVM under the 64 QAM 802.11 digital signal modulation scheme. The multi-stage power amplifier has 33dB of gain.

The WPS-444924-02 produces 4W output power at 1dB gain compression point and 29dBm linear output power at 2% EVM with 10dB gain.

As a GaN-based high-power amplifier that requires 28V on the drain bias, the MGA-444940-02 achieves 10W output at 2dB gain compression point and 33dBm linear power at 2.5% EVM with 12dB gain. The power-added efficiency at 2W linear power level is as high as 20%.

The power amplifiers suit emerging applications in the 4.4–5.1GHz frequency band, including telemetry, dedicated high-data-rate wireless network, point-to-point wireless communications, and military wireless communications.

All three are fully matched for both input and output terminals for easy cascade and are packaged in RoHS-compliant MwT-02 surface-mount package. Mean time before failure is over 100 years at 85ºC ambient.

www.mwtinc.com

Belgium's Umicore opens US germanium wafer plant, bolstering 6-inch diameter capability

Only Ge wafer maker with high-volume production on two continents

Materials technology firm Umicore of Brussels, Belgium has officially opened its new germanium (Ge) wafer production facility at its site in Quapaw, OK, USA, which is on the same campus as the firm's germanium optics and high-purity chemicals operation for the US market.

The Grand Opening was held in the presence of almost 100 guests including CEO Marc Grynberg and Oklahoma State's Secretary of Commerce Natalie Shirley. Umicore says that it has invested several tens of millions of dollars in the 40,000 square-foot facility.

Two years after the ground-breaking in October 2008, the completion of installation work and testing at the new facility makes Umicore the only Ge wafer manufacturer with high-volume production facilities on two continents (North America and Europe). The firm says that this enables it to respond flexibly to demand for Ge wafers in a growing market.

Umicore's CEO Marc Grynberg and Oklahoma's Secretary of Commerce Natalie Shirley at the Grand Opening of the Quapaw wafer plant.

The production operation is modeled on Umicore's Olen facility in Belgium, which has supplied millions of substrates for space and terrestrial photovoltaic applications. The firm says that its new Quapaw plant embodies proven equipment and an advanced product tracking system.

"Global demand for Ge wafers is set to rise significantly in the years to come," says Carl Quaeyhaegens, general manager at Umicore's Substrates business line. "This is why we pursue an ambitious production expansion plan. With our production facilities in the United States and Belgium, we are now in an ideal position in terms of quantity and quality to meet rising demand," he adds. "In addition, Quapaw will enable us to strengthen our global lead in 6-inch Ge wafers."

www.substrates.umicore.com

Patent granted for NCSU's buffer-free GaN-on-silicon

Jay Narayan, the John C. Fan Distinguished Chair professor of Materials Science and Engineering at North Carolina State University (NCSU), and former NCSU Ph.D. student Thomas Rawdanowicz have just been granted a patent for technology that allows gallium nitride (GaN) sensors and devices to be integrated directly into silicon-based integrated circuits without any buffer layers for the first time, it is claimed (US Patent 20050124161 'Growth and integration of epitaxial gallium nitride films with silicon-based devices', originally filed in 2004). "This enables the development of high-power (high-voltage and high-current) devices that are critical for the development of energy distribution devices, such as smart grid technology and high-frequency military communications," says Narayan.

"This integration of GaN on the silicon platform without any buffer layers has enabled the creation of multi-functional smart sensors, high-electron-mobility transistors, high-power devices, and high-voltage switches for smart grids which impact our energy and environmental future," reckons Narayan.

Integrating GaN into silicon chips also makes a broader range of radio frequencies available, which will enable the development of advanced communication technologies. "These devices stand to meet the challenges of high-power, high-frequency and high bandwidth needs for advanced consumer applications and military satellite communications," Narayan says.

"Direct integration of devices based on different types of semiconductors onto silicon chips is of considerable interest because it can enable different functionalities, such as lasers or higher-performance transistors," comments Dr Pradeep Fulay of the US National Science Foundation (NSF), which funded the research. "Narayan has used a special process that allows integration of semiconducting materials like GaN on the silicon so as to create hybrid-type computer chips. This research will likely lead to transistors with far superior power and performance sought for many commercial and military communication applications," he reckons.

The research was originally published in 'Epitaxial GaN on Si(111): Process control of SiNx interlayer formation' Applied Physics Letters 85(1), 133 (2004). The NSF is currently funding additional research by Narayan in this area. A US-based corporation is currently in the process of licensing the technology.

www.mse.ncsu.edu/nnnr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Strained Layer & Quantum Well
HBTs
pHEMTs
BiFET/BiHEMTs
Multi-junction CPV Cells

IQE acquires antimony-based substrate maker Galaxy

£20.8m stock placement to also expand capacity, repay debt, and strengthen balance sheet

Epiwafer foundry & substrate maker IQE plc of Cardiff, Wales, UK has acquired Galaxy Compound Semiconductors Inc of Spokane, WA, USA, a specialist maker of antimony-based substrates used in infrared (IR) technology, for between $5.5m and $14.15m in cash, based on a multiple of up to 5.5x Galaxy's 2010 earnings before interest, tax, depreciation and amortization (EBITDA). Galaxy's unaudited 2009 accounts showed EBITDA of $0.8m on revenue of $3m, as well as pre-tax profit of $0.7m and net assets of $1.6m at end-2009. IQE says that the acquisition will immediately enhance its earnings.

Also, on 5 October IQE placed 65 million new ordinary shares on the London Stock Exchange's AIM market at 32p each to raise £20.8m (gross) in order to: fund the acquisition, selectively expand IQE's existing manufacturing capacity, repay about £10m of debt, and strengthen its balance sheet to position the group for accelerating future growth.

Founded in 1999, Galaxy's key products are indium antimonide (InSb) and gallium antimonide (GaSb) substrates, for use in applications including thermal imaging cameras, forward-looking IR for navigation through darkness, IR homing missile guidance, detection of heat sources, magneto-resistance, biomedical imaging, and ultra-high-speed electronic circuits.

IQE says that the strategic acquisition complements its existing IR capabilities at its substrate manufacturing division Wafer Technology Ltd of Milton Keynes, UK, enables multi-site manufacturing, provides access to the large US market, and creates significant technology benefits. Consistent with its multi-site manufacturing strategy, IQE will be able to provide IR materials from independent manufacturing facilities at Spokane and Milton Keynes. Galaxy's management and key technical personnel are being retained.

The firm also reckons that Galaxy positions IQE as a leading provider in the rapidly growing market for antimony-based IR substrates, with diverse applications in advanced imaging for both commercial and military applications. The acquisition forms part of IQE's strategy to be a global supplier of advanced optoelectronic materials, as well as adding additional intellectual property.

"Galaxy provides IQE with new manufacturing capacity, new products and significant new clients [including major US defence contractors and commercial customers in IR imaging]," comments IQE's chief executive Dr Drew Nelson.

Since IR materials form a rapidly growing segment of the optoelectronics sector, IQE's directors believe that the acquisition of Galaxy will open up major opportunities in global imaging markets. IQE therefore intends to support Galaxy's expansion by providing $1m of capital expenditure in 2011.

www.galaxywafer.com
www.iqep.com

CSTG completes qualification of Hamilton wafer fab

Compound Semiconductor Technologies Global Ltd (CSTG) has completed qualification of its wafer fabrication plant in Hamilton Technology Park (near Glasgow), Scotland, UK.

CSTG was formed in 1999 by the universities of Strathclyde and Glasgow together with Scottish Enterprise, and is a 'pure play' foundry supplier specializing in the design, development and manufacture of discrete and integrated III-V optoelectronic wafers and chips with clients in the communications, defense, medical, energy and instrumentation markets.

The firm acquired the Hamilton plant in January from Intense Ltd, which makes single- and multi-mode monolithic laser array products and high-power laser diodes.

In addition to providing continuity of supply of all high-power laser products to Intense throughout the qualification period, transfer of all products from the former facility on the West of Scotland Science Park was completed at the end of September.

The Hamilton facility is now engaged in the manufacture of a range of GaAs and InP foundry products including high-power 650–1600nm lasers, 1310–1550nm single-mode lasers and gain elements, semiconductor optical amplifiers (SOAs), superluminescent LEDs (SLEDs), quantum cascade lasers (QCLs), InGaAs detectors and custom monolithic chip solutions.

"We set ourselves a very aggressive timetable of an exit from the former facility within six months, which included equipment transfer and staff consolidation," says CEO Neil Martin. "The Hamilton acquisition will fulfil its aim in allowing us to continue our expansion with both enhanced capacity and capability to service growth in all sectors of the compound semiconductor markets," he adds.

CSTG's engineering focus is now shifting to expanding the portfolio of foundry processes into materials technologies such as gallium nitride and antimonides, and device technologies such as QCLs, VCSELs (vertical-cavity surface-emitting lasers) and high-speed edge-emitting lasers.

www.compoundsemi.co.uk

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Wisconsin awards 5N Plus $500,000 for PV materials making & panel recycling plant

5N Plus Inc of Montreal, Canada, a provider of high-purity metals and compounds for electronic applications, says that its US subsidiary 5N Plus Corp of DeForest, WI has been awarded $500,000 in funding from the State Energy Program of Wisconsin to support equipment purchases directed at expanding its recycling activities and to create new jobs.

Representing an investment of more than $4m, the 60,500ft^2 facility will recycle solar modules and manufacture specialty compounds for thin-film PV applications, and will be operational in the coming weeks.

"This new facility is an important milestone for 5N Plus as it expands its footprint in the USA," says VP Nicholas Audet. "The DeForest plant enables us to recycle solar panels and to provide cradle-to-cradle solutions to the PV industry."

5N Plus was founded in 2000 after developing electronic materials within Canadian natural resource company Noranda Inc (one of the world's largest mining firms). It focuses on specialty high-purity metals such as tellurium, cadmium, selenium, germanium, indium and antimony. It 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 infra-red detectors for night-vision systems, gamma-ray detectors for nuclear imaging in medicine, and thin-film photovoltaic cells for solar panels. The firm is an integrated producer, with both primary and secondary refining capabilities (enabling it to control the entire manufacturing process), and also provides recycling services to treat production residues.

www.5nplus.com

5N Plus' revenue supplemented by non-solar products as Firebird ramps

Solar to be boosted by CdTe supply agreements

For its fiscal first-quarter 2011 (to end-August 2010), 5N Plus Inc of Montreal, Quebec, Canada has reported (in Canadian dollars) revenue of $18.8m, down 5% on $19.7m last quarter but up 16.9% on $16.1m a year ago.

Net earnings were $4m, down on last quarter's $4.4m but up on $3m a year ago. The firm says that its financial position remains solid, with cash and cash equivalents falling only slightly during the quarter from $68m to $64m. 5N Plus is now also part of the S&P/TSX Small Cap Index as of 17 September and the S&P/TSX Clean Technology Index as of 20 September.

The backlog of orders expected to translate into sales over the following 12 months has risen to $57.4m, from $52.7m last quarter.

"Demand for our solar-grade products remained strong throughout the quarter, although growth in overall sales revenues was driven primarily by our non-solar-grade products, including those of our Firebird subsidiary [acquired last December]," says president & CEO Jacques L'Écuyer. Firebird Technologies of Trail, British Columbia produces InSb wafers as well as antimony, indium and tin pure metals. "A further increase in the coming quarters for such non-solar products is expected, as our new Firebird facility is gradually brought up to speed," adds L'Écuyer.

"Further strengthening in the demand for our solar products is also expected following recent capacity expansion announcements made by our main customer, as well as by the supply agreements we recently entered into with other CdTe solar module manufacturers, including Abound Solar [in August]," continues L'Écuyer.

"We are also extending the range of services offered to our solar customers to include full module recycling services, which will be soon be carried out in our new facility in Madison, Wisconsin, in an effort to address all key customer requirements," he adds.

"Consistent with our growth strategy, we also elected during the quarter to provide financing to Sylarus [of Saint George, UT, USA], one of the very few germanium substrate suppliers for high-efficiency solar cells in both space and terrestrial applications," says L'Écuyer. "This is an area of the solar market that we were not addressing through our existing product offering. As a result we expect to further strengthen our germanium-related activities and leverage Firebird's line of products."

5N wins Deloitte Technology Fast 50 awards

5N Plus has been ranked among Canada's 'Deloitte Technology Fast 50' awards program. It also won the 'Deloitte Technology Green 15 Award' and the 'Leadership Award, emerging technologies category'.

The ranking of the 50 fastest-growing technology companies in Canada is based on revenue growth over five years. 5N's growth of 574% from 2005 to 2009 resulted in being ranked 36th. The Deloitte Technology Green 15 Award was created in 2007 to showcase 15 Canadian firms leading the way to create breakthroughs in 'green' technology. Deloitte Technology Fast 50 Leadership Award candidates are judged on ability to create a distinct competitive advantage in a high-growth market.

"This year we are celebrating 10 years of growth along with 40 quarters of profitability," said chief financial officer David Langlois.

www.fast50.ca

JX transferring InP epiwafer business to Optrans and forming InP joint venture

JX Nippon Mining & Metals focuses on its substrate manufacturing

Tokyo-based JX Nippon Mining & Metals Corp says that it is to transfer the indium phosphide epitaxial wafer segment of its compound semiconductor business to Optrans Corp of Kawasaki, Japan, which makes optoelectronic assemblies and components (including full-color LEDs and photodetectors), as it decides to focus on its compound semiconductor substrate manufacturing business (InP, CdTe and ZnTe) rather than epiwafers.

Founded in 1987 by president Katsuya Homma, in March 2009 Optrans acquired the operations and patented technology of the specialty microchip division of Nippon Telegraph and Telephone Advanced Technology (NTT-AT) which, supported by Japan's New Energy and Industrial Technology Development Organization (NEDO), had developed epitaxial crystal growth manufacturing technology as well as high-volume manufacturing of ultra-high-speed InP chips.

JX Nippon Mining & Metals says that it will also form an InP compound semiconductor business tie-up with Optrans and develop high-quality substrates by leveraging synergies with Optrans. JX will provide Optrans with InP compound semiconductor substrates, and benefit from Optrans' epitaxial technology, which particularly suits mass production.

JX anticipates that, through the business tie-up, it will be able to go beyond optical communications applications and promote the development of new applications of the substrates, including solar cells and sensors

JX Nippon Mining & Metals is said to hold a global market share of about 50% in InP substrates, which are mainly used in photodiodes and light-emitting diodes for optical communications.

JX anticipates that, through the business tie-up, it will be able to go beyond optical communications applications and promote the development of new applications of the substrates, including solar cells and sensors (where demand is expected to grow in the future).

www.optrans.com/index.htm
www.nmm.jx-group.co.jp/english

IN BRIEF

Silan Azure orders reactors for LED ramp

China's Hangzhou Silan Azure Co Ltd has ordered multiple Veeco TurboDisc K465i MOCVD systems for its HB-LED manufacturing ramp in Hangzhou.

"We started the cooperation with Veeco by selecting the K465i MOCVD systems because we heard very positive feedback from the industry on the excellent system design and good performance," says Silan Azure's president Zhongyong Jiang. "Given the increased demand for LEDs in such applications as general illumination, TV backlight and outdoor displays, we intend to ramp our production quickly," he adds.

"The China market will drive significant advancement of the LED industry," says Bill Miller Ph.D., executive VP, Compound Semiconductor and head of Veeco's MOCVD operations.

www.silanazure.com/en

Veeco plans $25m Asia expansion

Four new centers to support LED growth

At the 7th China International Forum for Solid State Lighting in Shenzhen (14–16 October), John R. Peeler, CEO of epitaxial deposition and process equipment maker Veeco Instruments Inc of Plainview, NY, USA, announced a significant expansion of the firm's Asia presence in order to better support the rapid growth of the LED industry and the needs of its customers.

"We see a tremendous opportunity to help our Asian customers to 'go faster' to advance brightness and decrease the cost of LEDs," says Peeler. "Veeco intends to provide an unprecedented level of technology development on latest-generation MOCVD systems, customer training, and world-class service and support."

The expansion plan includes:

- Shanghai, China — Shanghai Training Center (STC): customer support & training (target opening Q1/2011);
- Hsinchu, Taiwan — Taiwan Technology Center (TTC): applications center & demonstration lab (target opening Q1/2011);
- Korea Development Center (KDC): engineering & process development center, including tool demonstrations and customer training (target opening, second-half 2011);
- Singapore: expanded manufacturing center & supply chain hub;
- Japan: move to direct sales & service for MOCVD from prior sales representative (target effective date, January 2011).

"As our Asian customers continue to accelerate the pace of adoption of LEDs for consumer electronics and solid-state lighting, we believe this strategic investment of more than $25m will position Veeco as the region's top equipment supplier and ensure the mutual success of Veeco and our customers," adds Peeler. "Over time, we will also leverage these new sites to support our customers in solar and other clean-tech markets."

www.veeco.com

Riber's revenue bounces back by 11% in Q3/2010

Order book up 155% year-on-year, promising growth and profitability

Riber S.A. of Bezons, France, which manufactures molecular beam epitaxy (MBE) systems as well as evaporation sources and effusion cells, has reported revenue for third-quarter 2010 of €3.2m, down 11% on €3.6m a year ago but more than doubling from last quarter's low of €1.5m and bouncing back above Q1/2010's €2.9m.

Nevertheless, total revenue for Q1–Q3/2010 of €7.6m in still down 20% on €9.5m year-on-year. In particular, MBE system sales of €2.8m are down 46% from €5.2m (although a €2.5m production system has been produced but will only be delivered in December for contractual reasons). Revenue from evaporation sources and effusion cells of €0.6m are down 61% on €1.7m (although the delivery schedule is concentrated over last-quarter 2010). However, services and accessories business is on track for strong growth, with revenue rising 60% from €2.6m to €4.2m.

At the end of September, Riber's order book was up 155% on just €7.5m a year ago to €19.1m. This has been generated by 10 MBE systems — two production systems and eight research systems (including three to be delivered in 2011) — giving system orders up 158% from just €4.8m a year ago to €12.4m. This also includes major effusion cell orders for the strongly growing OLED (organic LED) and copper indium gallium (di)selenide (CIGS) thin-film photovoltaic panels sectors, leading to cell and source orders rising 4.7-fold from €0.7m to €4m. Services and accessories orders are up 35% from €2m to €2.7m.

Riber concludes that its strong growth in orders backs up its business model, based on:

- capitalizing on the installed base and growing sales of epitaxy equipment, spare parts and accessories, as well as corresponding services;
- launching a range of high-value-added equipment and services for high-growth application fields (thin-film solar panels, OLED lighting and flat-screen displays etc).

In view of the delivery schedule for the end of the year, Riber expects revenue of more than €19m for full-year 2010, paving the way for further improvement in profitability.

www.riber.com

Alferov-Riber MBE Academy center of excellence to be established at Russia's St Petersburg Academic University

On 30 September, the Nobel Prize winning physicist Zhores Alferov, rector of the St Petersburg Academy University in Russia, visited the plant of Riber S.A. of Bezons, France, which manufactures molecular beam epitaxy (MBE) systems as well as evaporation sources and effusion cells, where he participated in an agreement between St Petersburg Academic University – Nanotechnology Research and Education Center RAS (Russian Academy of Sciences) and Riber concerning the creation and management of the 'Alferov-Riber MBE Academy' Center of Excellence.

Zhores Ivanovich Alferov has been working on semiconductor heterostructures since 1962. His contributions to semiconductor heterostructure physics and technology, including investigations of injection properties, the development of lasers, solar cells, LEDs and epitaxy processes, have contributed significantly to the creation of modern heterostructure physics and electronics, leading to receiving the 2000 Nobel Prize in Physics for developing semiconductor heterostructures used in high-speed electronics and optoelectronics.

With a view to further promoting basic research in semiconductor physics and the effective use of Riber's MBE systems, the Russian Academy of Sciences and Riber have agreed to jointly create a Center of Excellence on the premises of the Academic University in St Petersburg, Russia.

The Russian Academy of Sciences and Riber have agreed to jointly create a Center of Excellence on the premises of the Academic University in St Petersburg, Russia

Combining the Academic University's scientific and pedagogical capabilities and Riber's expertise in MBE system design and use, the two parties aim to:

- design and implement a graduate course for Academic University students, aiming to teach the use of MBE technology for research and manufacturing of new nanotechnology devices; and
- design and implement a basic training course aimed at technicians and engineers worldwide who will operate MBE systems.

The creation of the new Center of Excellence follows the Rusnanoprize awarded to Riber by the Russian Nanotechnology Society in 2009.

http://edu.ioffe.ru/index1_en.html
www.riber.com

IN BRIEF

FOREPI purchases its first G5 system

In Q2/2010 Formosa Epitaxy Inc (FOREPI) of Lung-Tan, Taoyuan, Taiwan ordered a 56x2"-wafer Aixtron AIX G5 HT MOCVD reactor, to be shipped in Q4/2010 and used for the production of GaN-based ultra-high-brightness LEDs (joining FOREPI's existing multiple Aixtron high-throughput Planetary Reactor systems).

For over ten years, FOREPI has focused on pure-play manufacture of high-power InGaN LED wafers and chips and has been a long-time user of Aixtron systems for HB-LED manufacturing. It has set its sights on meeting the needs of high-end applications such as LCD TV backlighting.

"This is our company's first AIX G5 HT system, allowing us to smoothly transfer our process recipes to a new reactor," says FOREPI's president Dr Fen-Ren Chien. "Once this is proven, we can look forward to the purchase of more systems for production."

FOREPI says that it chose the Aixtron system due to the performance of its existing systems like the G4 and CRIUS. "Hence we have a strong interest in acquiring Aixtron's recently launched products — such as the G5 and the CRIUS II," says Chien. "Following successful recipe transfer, FOREPI will exercise all the advantages that we can get from the G5 system, having already demonstrated high-quality GaN deposition at very high growth rates and high pressure above 600mbar, resulting in superior GaN/InGaN uniformities," adds Chien.

Special features of the G5 include a new high-growth-rate injector, a graphite ceiling, and the EqiSat, which enables identical surface temperatures on all satellites/wafers, improving process yield, says Aixtron.

www.forepi.com.tw

Russia's Optogan first in Europe to order Aixtron CRIUS II for GaN HB-LED production

Deposition equipment maker Aixtron AG of Aachen-Herzogenrath, Germany received an order for two CRIUS II deposition systems for delivery in fourth-quarter 2010 to CJSC Optogan of St Petersburg, Russia. The new reactors will be commissioned by the Aixtron Europe support team in CJSC Optogan's dedicated facilities and used for gallium nitride high-brightness LED production.

"Our main consideration for reactor selection was the scalability of the Close Coupled Showerhead process technology," says Dr Maxim Odnoblyudov, general manager & CEO of Optogan Group. "We were impressed with the data from Aixtron on the CRIUS family of MOCVD systems. It reassured us that moving up to the CRIUS II will be straightforward," he adds. "This system will be a very important part of our plan to add more capacity for the new high-performance, cost-competitive products demanded by our customers."

"It is the first CRIUS II order from a European customer," says Dr Frank Schulte, VP Aixtron Europe. "It is particularly satisfying that it is the Optogan Group, one of the main players on the emerging and fast-growing Russian market," he adds. "Optogan has been using our MOCVD reactors for several years."

Founded in Finland in 2004 by a team of Russian scientists from Ioffe Institute in St Petersburg, Optogan is a vertically integrated manufacturer of HB-LEDs for global markets including solid-state lighting. In July 2009, Optogan began operations in Russia. This May, it acquired the industrial facility and infrastructure of Elcoteq in St Petersburg, where new LED production lines are being set up. It plans to launch its first manufacturing line this fall, with a monthly production capacity of 30 million LEDs.

Our main consideration for reactor selection was the scalability of the Close Coupled Showerhead process

www.optogan.com

Tongfang selects Aixtron MOCVD systems to boost capacity for blue HB-LEDs

Aixtron AG of Aachen-Herzogenrath, Germany says that, in first-quarter 2010, it received a new order from China's Tsinghua Tongfang for two AIX 2800G4 HT 42x2"-wafer configuration MOCVD systems which, after delivery in third-quarter 2010, will be used for production of gallium nitride (GaN)-based ultra-high-brightness (UHB) blue LED. The local Aixtron support team will be responsible for the installation and commissioning of the new reactors at Tongfang's production plant.

"Our company is seeking to carry out a major production capacity increase for our high-brightness blue gallium nitride LED devices," says professor Liu Gang, general manager of Tongfang Opto. "The Aixtron AIX 2800G4 HT system is a perfect match for these requirements," he comments. "Through our close relationship with Aixtron we have built up great confidence not only in the quality and performance of their equipment but also in their support and service."

http://en.thtf.com.cn
www.aixtron.com

MicroLink orders Aixtron 2800G4-R MOCVD system for solar cell and HBT production

Deposition equipment maker Aixtron of Aachen-Herzogenrath, Germany has received an order from MicroLink Devices Inc of Niles, IL, USA for an AIX 2800G4-R MOCVD reactor in 8x6"-wafer configuration, for delivery in second-quarter 2011 for the production of GaAs-based multi-junction solar cells and HBTs. The new reactor will be commissioned by the local Aixtron support team working with MicroLink Devices' engineers in their fab.

MicroLink was founded in 2000 by president Dr Noren Pan, specializing in growing custom-designed epitaxial structures for HBTs and power amplifiers. Over the last six years, the firm has been a prime federal contractor on projects to develop solar cells, detectors, lasers, and high-speed transistors.

The purchase is partly funded by a $5m grant from the Illinois Department of Commerce and Economic Opportunity (DCEO), as part of its role in the Renewable Energy Production Program of the American Recovery and Reinvestment Act.

"We have had a good relationship with Aixtron for many years, and this order is a centrepiece in our expansion program to satisfy the mandate of the DCEO grant. The G4-R will give us the opportunity to significantly expand production of solar cells that will be fabricated using our proprietary epitaxial lift-off (ELO) process," says Pan.

www.mldevices.com
www.aixtron.com

LayTec ranked among Germany's 50 fastest-growing technology firms for second consecutive year

At the Deloitte's Technology Fast 50 award ceremony in Berlin, Germany on 20 October, LayTec GmbH, which provides in-situ optical metrology systems for thin-film processes, was awarded for the second consecutive year as one of the 50 fastest-growing technology firms in Germany.

The nomination is based on total growth in sales within the last 5 years. Between 2005 and 2009 LayTec increased its turnover by 241%, and as a result it is also one of the 500 fastest-growing technology firms in Europe in 2010.

LayTec's president & founder Dr Thomas Zettler regards the nomination as recognition of successful technology transfer from research to industry, "Among other factors, LayTec's continuous growth has been possible thanks to its position at the interface between research and industry," he says. "Our R&D department closely collaborates with research institutions in Germany and abroad, and our efficient company structure makes it possible to launch the latest product developments on the global market within a very short period of time," Zettler says.

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. Since 2009, its integrated metrology solutions have also been applied to solar cell production as well as other large-area deposition processes.

www.laytec.de
www.deloitte.com/view/de_DE/de

LayTec presents latest Pyro 400 results at IWN

At the International Workshop on Nitrides (IWN 2010) in Tampa, FL, USA (20–24 September), Dr Kolja Haberland of LayTec GmbH of Berlin, Germany (which provides in-situ optical metrology systems for thin-film processes) presented the latest results obtained by its new in-situ tool Pyro 400 on an Aixtron AIX MOCVD Planetary Reactor in combination with its EpiCurve TT sensor. Figure 1 shows the effects of reactor pressure changes on temperature during the LED growth process.

During standard gallium nitride growth conditions and standard pressure (2), the pocket temperature and wafer temperature in the wafer center are in good agreement. When changing process conditions — lower reactor pressure and increased process temperature (3) — the wafer temperature (red) drops 20K below the pocket temperature (orange), undetected by conventional pyrometry. The cause is less effective heat transfer by the carrier gas from the pocket to the wafer. Understanding and controlling this effect is crucial for temperature management during device growth and can only be measured with the Pyro 400, says LayTec.

Figure 2 demonstrates that the temperature distribution across the wafer differs at different growth steps and depends on the specific growth conditions:

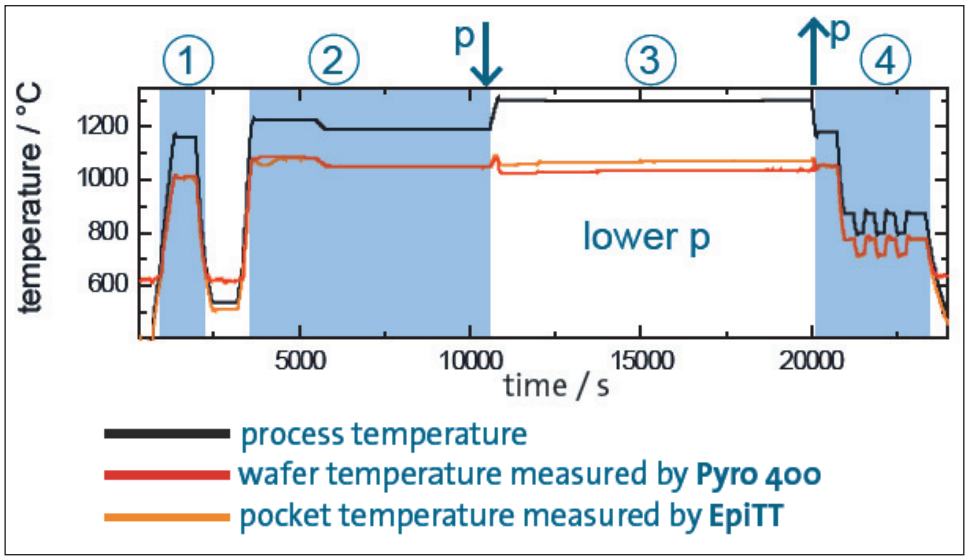


Fig. 1: Temperature changes during LED growth caused by changes of reactor pressure (p).

1. Before growth: Pyro 400 shows the flat temperature profile of the pocket under the bare sapphire.
2. GaN buffer growth: the center of the wafer is hotter than the edges due to concave wafer bow.
3. Superlattice growth: cool center due to lower reactor pressure and changed heat transport from pocket to wafer.
4. Multi quantum well growth (MQW): flat temperature profile due to the flat wafer.

LayTec says that the UV-sensing Pyro 400 measures the temperature directly on the GaN surface, revealing temperature changes at the growth surface that are not visible with a conventional pyrometer.

● LayTec invites all its customers in Korea to a technical training session in the Ramada Hotel Suwon, Korea on 23 November, where LayTec engineers, customers and Korean partners will report on the monitoring of LED processes using the firm's in-situ systems.

LayTec invites all its customers in Korea to a technical training session in the Ramada Hotel Suwon, Korea on 23 November

www.laytec.de

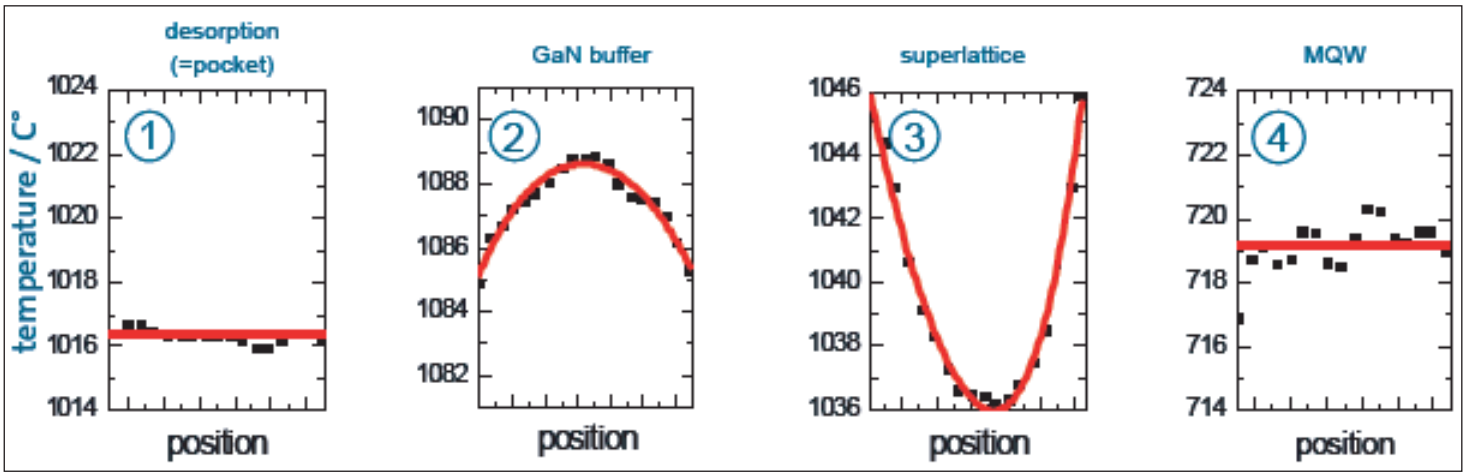


Fig. 2: Pyro 400 linescan measurements: temperature distribution across the wafer during different growth steps as shown in Fig. 1.

OIPT launches next-generation HB-LED batch wafer plasma etch and deposition production tools

New platform offers batch sizes from 61 x 2" to 7 x 6" wafers

UK-based equipment maker Oxford Instruments Plasma Technology (OIPT) has launched the PlasmaPro NGP1000 HB-LED range of plasma etch and deposition tools, which offer what is claimed to be unparalleled throughput with batch sizes from 61 x 2" wafers up to 7 x 6" wafers, coupled with high-quality device performance and yield for high-brightness light-emitting diode manufacturing.

The range has been designed to enhance throughput, maximize uptime and reduce cost of ownership through reliable hardware and ease of service. In particular, the NGP1000 platform has been optimized for batch production, with a vacuum load-lock as standard. Open load and 4-sided cluster options are available.

"High-brightness LEDs are now an integral part of our lives, providing lighting solutions for a growing number of applications, from back-lit televisions to general lighting," comments sales director Mark Vosloo. "The industry justifiably demands high throughput, device quality and lower cost of ownership, and the NGP1000 offers all these solutions," he claims. OIPT has supplied high-volume batch plasma tools in the production market for over 15 years, with a wide installed base of HB-LED production systems, he adds.

OIPT's new NGP1000 system

The PlasmaPro NGP1000 PECVD system is designed for the deposition of SiO_2 and SiN_x layers, and incorporates a large-area electrode and optimized showerhead design, allowing up to 61 x 2", 15 x 4" or 7 x 6" wafers in a single load. The PlasmaPro NGP1000 etch system, designed for GaN, AlGaInP and sapphire etch, offers batch sizes up to 55 x 2", 13 x 4" or 5 x 6", yielding what is claimed to be market-leading volumes of wafers per month.

What is said to be excellent uniformity over large areas is provided by the new 60MHz Viper plasma source, which achieves comparable plasma densities to ICP (inductively coupled plasma) sources, maintaining the benefits of high etch rates and low damage.

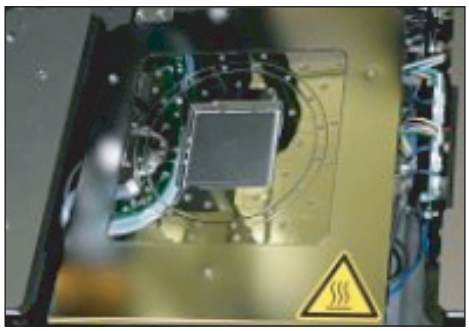
www.oxford-instruments.com

SET launches semi-open non-contact localized confinement chamber for oxide removal in device bonding

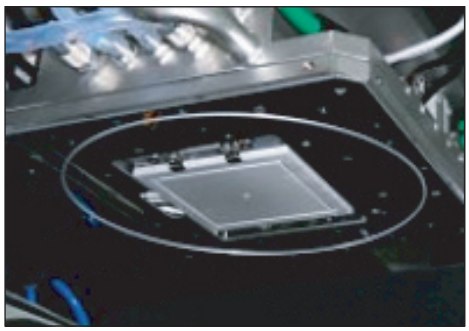
Replisaurus Technologies subsidiary SET (Smart Equipment Technology) of Saint-Jeoire, France (which supplies die-to-die, die-to-wafer bonding and nanoimprint lithography solutions) has unveiled a patented system that enables thorough removal of oxides before or during the bonding sequence.

Addressing the challenges of oxidation of metal surfaces in device bonding, the system encompasses a substrate chuck and a bond head with a non-contact localized confinement chamber that operates safely with reducing gases such as forming gas or formic acid vapor. It can be implemented on any new bonder models FC150 and FC300.

To preserve the standard abilities of SET's bonding tools and especially the low-contact-force measurement applied to the components, the 'Semi-Open' Confinement Chamber has no hardware sealing. A non-contact virtual seal of the micro-chamber enables gas confinement for either chip-to-chip or chip-to-wafer bonding under a controlled atmosphere; it ensures gas collection and prevents oxygen intrusion while preserving the alignment of the device with respect to its substrate. Consequently, the system ensures what is claimed to be excellent wetting and a higher quality of solder joints at reduced bonding forces and temperatures as well as higher yield, as no cleaning step is required.



The FC300's 50mm bottom chuck.

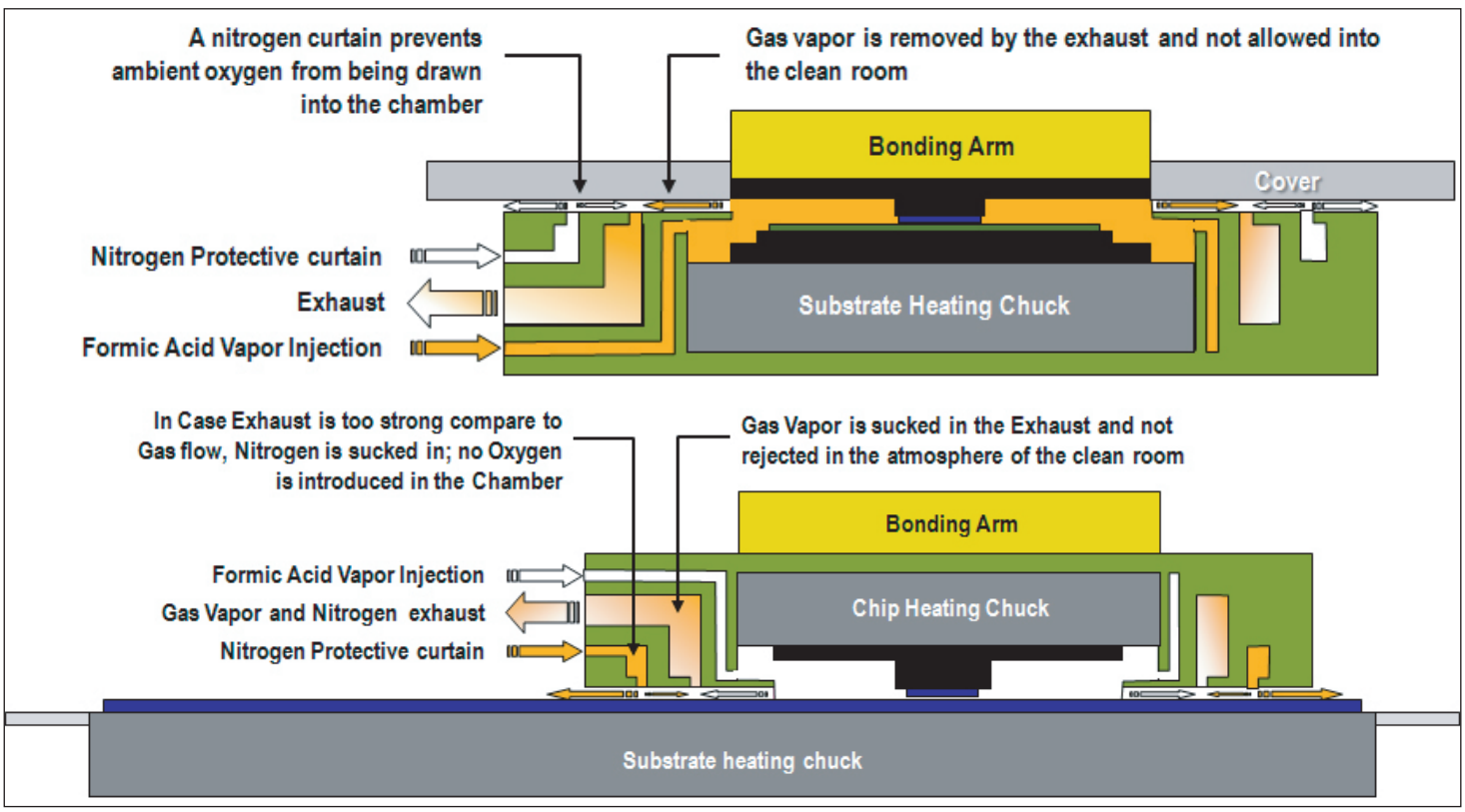


The FC300's 50mm bond head.

The technology provides a solution to overcome the bonding challenges of demanding applications using AuSn and indium, such as optoelectronics assembly (laser bars, VCSELs)

SET says that the technology provides a solution to overcome the bonding challenges of demanding applications using AuSn and indium, such as optoelectronics assembly (laser bars, VCSELs) and imaging sensors (IR-FPAs).

www.set-sas.fr



The chip-to-chip (top) and chip-to-wafer (bottom) configurations of SET's Semi-Open Confinement Chamber.

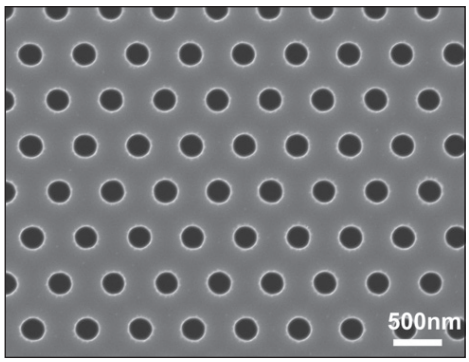
Eulitha unveils litho technology for photonics patterning

'Photonics Enabler' targets enhanced light extraction

Nanolithography firm Eulitha AG, a spin-off of the Paul Scherrer Institute in Villigen, Switzerland, has unveiled its proprietary PHABLE (Photonics Enabler) mask-based ultraviolet (UV) photolithography technology for the low-cost, high-throughput fabrication of photonic nanostructures.

The firm says that this solves an ongoing problem in the fabrication of high-resolution photonic structures, since standard lithography equipment either lacks the required resolution or its cost is prohibitively high. The patented technology enables the formation of periodic nanostructures over large areas for applications such as LEDs, solar cells and flat-screen displays.

Eulitha says that, unlike currently available technologies, the PHABLE system forms an image that has practically unlimited depth of focus. Non-flat substrates, such as LED wafers, can hence be patterned uniformly and reproducibly. It also allows combinations of different patterns such as linear diffraction gratings and arrays of holes on hexagonal or square grids to be printed using a single exposure onto a chip or a wafer. The resolution of the printed features can be as small as one quarter of the illumination wavelength. The required masks can be produced inexpensively using standard chromium-on-quartz mask-writing technology. The technology is being presented at the 23rd International Microprocesses and Nanotechnology Conference (MNC 2010) in Fukuoka, Japan (9–12 November).



Photonic crystal pattern with 500nm pitch and 250nm hole diameter.

One of the major applications of the new technology involves photonic crystals, which are required to enhance the light extraction efficiency of LEDs. Unlike the nanoimprint method commonly employed for this purpose, it avoids contact between the mask and the wafer and does not require consumable soft-stamps, avoiding an expensive two-step process. Other applications are expected to also benefit from the development, including nanowire-based LEDs and photovoltaic devices, heteroepitaxy on patterned silicon substrates, and epitaxial lateral overgrowth (ELO) in blue-ray lasers. Wire-grid polarizers, as needed for both LCD displays and projectors, can also be produced.

PHABLE's compatibility with conventional masks and UV exposure processing can smooth adoption by the industry, reckons Eulitha. Standard photoresists with suitable resolution and etch properties are available from multiple vendors, so manufacturers of HB-LEDs and other devices can rely on the usual, well-established sources for obtaining the required consumable materials, ensuring a low-cost manufacturing process for photonic nanostructures.

Eulitha is now offering samples and wafer batch processing services to companies and researchers developing nanostructure-based products who are interested in taking advantage of the technology. It is also offering laboratory lithography tools for 2–4" wafers that are suitable for product development. High-volume production tools with throughput in excess of 100 wafer-per-hour will be made available to manufacturers in the near future.

www.eulitha.com

Nextreme appoints chief executive officer

Nextreme Thermal Solutions of Durham, NC, USA, which designs and manufactures microscale thin-film thermal and power management products, says that John Goehrke has joined the firm as CEO.

Goehrke has over 25 years of sales, marketing, and general management experience, most recently as CEO of siXis Inc, pioneers of silicon circuit board (SiCB) technology, and chief operating officer of Luna Innovations, where he was part of the executive management team that completed an initial public offering in June 2006. Previously, he was CEO of Luna Technologies, a VC-funded start-up, which led to profitability and a successful exit in the form of an acquisition. Before joining Luna, Goehrke was general manager of Acterna's Access Division, based in Germantown, MD, USA, and the Fiber Optics Division based in St Etienne, France.

Goehrke began his career in sales & marketing for VC-funded start-up American Photonics, which was sold to Siecor Fiberlan. He earned a Bachelor of Science degree in Electrical Engineering from the University of Connecticut and an MBA from the University of Pittsburgh.

"John's track record in high-tech marketing, sales, and operations makes him well suited to lead the company," says Rich Harris, Nextreme's chairman and managing general partner at Redshift Ventures.

www.nextreme.com

IN BRIEF

KAUST orders multiple EVG tools

EV Group of St Florian, Austria has shipped an EVG520IS semi-automated wafer bonding system and two EVG6200 automated alignment tools to King Abdullah University of Science and Technology (KAUST) in Saudi Arabia (opened in September 2009, and EVG's first customer headquartered in the Middle East).

Graduate-level students will use the equipment for R&D including projects outsourced to KAUST from technology firms in the region. One EVG6200 will be used for bond alignment and nanoimprint lithography (NIL) and the other for lithography mask alignment.

"We were impressed with the EVG systems' performance and ability to multi-task, which will be of great value in working on the variety of research projects that the university is undertaking," says Dr Xixiang Zhang, manager of KAUST's Nanofabrication, Imaging & Characterization Core Lab. "EV Group has proven its ability to provide us with excellent onsite process and application support so that our local needs can be met quickly and efficiently."

"Working with KAUST is an important milestone for EVG, as technology activity in this region of the world continues to expand," says EVG's executive technology director Paul Lindner. "Working with this prestigious institution marks a further step in our partnering with leading universities and research firms around the world."

In the past year, EVG has received orders to support R&D and university-related projects from the University of Texas at Arlington, the University of Michigan's Lurie Nanofabrication Facility, the Institute of Microelectronics in Singapore, Europe's IMEC, and the RFID/USN Center in Korea.

www.EVGroup.com

EV Group launches three-chamber wafer bonding system

At SEMICON Europa 2010 in Dresden, Germany (19–21 October), wafer bonding and lithography equipment maker EV Group (EVG) of St Florian, Austria introduced the latest addition to its EVG500 Series of permanent wafer bonding systems. The new three-chamber EVG520L3 system builds on the series' proven strengths in temperature control, piston force uniformity and modularity, with the next major implementation of the bond chamber concept addressing the need for high-vacuum, CMOS-compatible bonding processes while delivering significantly higher throughput, cost of ownership (CoO) and yields, says the firm.

"We developed the EVG520L3 over several years as part of a global innovation effort driven by customers' feedback on their next-generation bonding requirements," says executive technology director Paul Lindner. "The system's highly stable design has minimal moving parts inside the chamber, while the bonding module is fully compatible with our EVG540 single-chamber and Gemini integrated wafer bonding systems," he adds. "Moreover, the bond chucks are compatible with our Gemini and EVG600 Series aligners. Together, these capabilities allow us to help our customers achieve both faster time to market and lower overall cost of ownership for their wafer bonding processes."

Industry exploration of new technologies for MEMS devices and advanced packaging/3D interconnect applications is driving increased demand for flexible, reliable, processing equipment. Wafer stacking and bonding systems must be able to accommodate a variety of materials and material properties, offer faster heating and cooling, and enable parallel processing capabilities to ensure overall quality and uniformity. The EVG520L3 was developed with these requirements in mind.

EV Group's new EVG520L3 system, which has a three-chamber design enabling processing of up to three substrate stacks simultaneously.

According to EVG, a significant hurdle to higher throughput is long pumping times for achieving high vacuum. The EVG520L3 hence features a new three-chamber design, which enables processing of up to three substrate stacks simultaneously. This concept uses pre- and post-bond process chambers, which separates the baking and pumping, high-vacuum bonding and post-bond cooling. The new layout speeds up the bond process (by up to 3x for high-vacuum and 5.5x for ultra-high-vacuum).

Other enhancements include:

- A heater design that supports 45ºC/minute heating and up to 100ºC/minute cooling ramps with silent wafer cooling, for improved temperature uniformity in EVG's proven heater design.
- Rapid vacuum build-up to enable high-vacuum applications, such as bolometers.
- Option to support up to 100kN contact force—enabling metallic bonds on the larger substrates used for MEMS and 3D IC applications.
- Unparalleled force accuracy and uniformity for highest yield.

www.EVGroup.com

EVG installs wafer cleaning system at University of Tokyo

Particle-free surface targets void-free wafer bonding of III-Vs on Si

Wafer bonding and lithography equipment maker EV Group (EVG) of St Florian, Austria has received an order for its EVG301 megasonic wafer cleaning system for compound semiconductor research at the University of Tokyo.

Installed at the university's Takagi & Takenaka Laboratory, the new tool is focused on preparing a particle-free wafer surface for bonding III-V materials such as gallium arsenide, indium phosphide and indium gallium arsenide (GaAs, InP and InGaAs) to silicon wafers. The system augments the laboratory's research focused on developing semiconductor transistors incorporating compound semiconductor materials for large-scale integrated (LSI) devices to overcome limitations introduced with scaling beyond the 22nm node using traditional silicon.

"The miniaturization of semiconductor devices is reaching its physical limitations, and traditional scaling in line with Moore's law is not sufficient to address future demands for higher-performing LSI devices," notes Takagi & Takenaka Lab researcher Dr Masafumi Yokoyama. "We have been evaluating new materials, such as III-V compounds, with silicon in an effort to create new research breakthroughs that will address device performance demands in the post-scaling era. In support of our efforts, we adopted EV Group's megasonic wafer cleaner, the EVG301, to help us achieve superior quality wafer bonds that are void-free," he adds.

To continue to meet consumer demands for lower-power-consuming, higher-performing and higher-functioning chips, the semiconductor industry is evaluating the benefits of incorporating new materials with silicon, beyond pure silicon-based wafers, says EVG. This shift is paving the way for future market growth of compound semiconductors, as well as more efficient manufacturing technologies to achieve maximum end-device performance. For example, MOCVD heteroepitaxial growth can result in inconsistent wafer formation, compromising the integrity of the wafer surface and ultimately impacting end-device performance. EVG believes that wafer bonding is a promising solution to overcoming this problem. Essential to wafer bonding integrity is the need for a particle-free bonding surface. Wafer cleaning is hence critical to ensuring that the wafer surface is free of voids created by particles that can negatively impact the quality of the wafer bond and the overall wafer uniformity.

"The Takagi & Takenaka Laboratory is invested in a vital research area, given the limitations the semiconductor industry faces with traditional scaling using silicon alone," comments Yuichi Otsuka, representative director of EV Group Japan K.K. "We have always been a significant supporter of R&D work, which EV Group was founded upon, and continue to provide enabling technologies to advance innovation."

Fraunhofer ENAS orders EVG's UV-NIL/hot embossing systems

EVG has received its first order from the Fraunhofer Research Institution for Electronic Nano Systems (ENAS) in Chemnitz, Germany.

Fraunhofer ENAS purchased an EVG6200NT automated mask aligner and an EVG540 automated wafer bonder, and will employ the flexible, multi-process systems for mask lithography, ultraviolet nanoimprint lithography (UV-NIL), bond alignment, bonding and hot embossing (HE), says the firm. The systems, which will enable Fraunhofer ENAS to process product wafers up to 200mm in diameter, will be delivered in November.

"NIL and hot embossing are key processes for extending our advanced R&D efforts," says Fraunhofer ENAS' director professor Thomas Gessner. "The EVG systems allow us to implement these technologies far better than competitive tools. We can now perform full-area nanoimprints, as well as optically aligned UV-NIL and HE, on larger wafers, further expanding our ability to support a broad spectrum of processes."

EVG's recently announced soft molecular scale UV-NIL (SMS-NIL) technology patterns ultra-high-resolution features down to 12.5nm on EVG's proven UV-NIL systems. The technology uses soft polymeric working stamps to avoid damaging costly master stamps. SMS-NIL is already used in industrial environments for CMOS image sensors, micro-lens molding and other optical applications.

"This order from a leading research partner such as Fraunhofer ENAS underscores the value of our ongoing efforts to develop and implement new, leading-edge technologies that compliment and extend the applications for our systems," said Markus Wimplinger, EVG's corporate technology development and IP director. "Not only will our tools' flexibility allow Fraunhofer ENAS to perform multiple lithography, alignment and bonding processes on just two systems, but through close cooperation between both companies, processes such as EVG's unique SMS-NIL technology, as well as hot embossing processes, will be implemented and further advanced."

www.EVGroup.com.

glo raises $25m, establishes Silicon Valley engineering center, and hires CEO

Sweden's Lund University spin-off commercializing first nanowire LEDs for general illumination

Nanowire semiconductor LED developer glo AB of Ideon Science Park, Lund, Sweden has closed an SEK170m ($25m) fundraising round, led by new investor Wellington Partners and joined by existing investors Provider Venture Partners of Stockholm, Hafslund Venture, Agder Energi Venture, Teknoinvest of Oslo, and VantagePoint Venture Partners of San Bruno, CA, together with LU Innovation and LUAB (the investment arm of Sweden's Lund University) as major owners, plus glo's founders and employees.

"Wellington Partners, headquartered in London/Munich, has been one of the most successful pan-European venture capital firms and has invested in more than 100 companies throughout Europe since its founding in 1991," says glo's executive chairman G. Russell Mortenson.

glo was founded in September 2005 as a technology spin-out from the Nanometer Structure Consortium (nmC) at Lund University. The firm focuses on commercializing LEDs for general illumination using the proprietary heterostructured semiconductor nanowire technology research of the team of Solid State Physics professor Lars Samuelson, head of nmC and glo's chief scientific officer. Specifically, glo develops nanowire-based LEDs (nLEDs) emitting at brightness levels suitable for general illumination applications and with performance equal to or better than current state-of-the-art planar chips, yet simultaneously at much lower manufacturing cost at the die level, it is claimed, by using readily available, low-cost and large-area silicon substrates with mass-production friendly technologies. glo controls a portfolio of patents and patent applications covering relevant innovations in nanowire epitaxial growth and process technologies made by the Lund team and by glo itself. The firm says that it maintains a close working relationship with nmC and has access under contract to relevant labs and intellectual property developed there.

To supplement its current efforts in Sweden and Denmark (GLO ApS at DTU Danchip in Lyngby, where it began pilot production in May), glo has now also established a California-based engineering center in Sunnyvale.

In addition, Fariba Danesh has been appointed as CEO of both glo AB and new US subsidiary GLO-USA Inc. Danesh was most recently senior VP & general manager of Avago Technologies, with responsibilities including LEDs and laser devices. She was also previously executive VP of Maxtor Corp, chief operating officer of Finisar Corp, CEO of Genoa Corp, and VP of Seagate Technology.

To supplement its efforts in Sweden and Denmark, glo has now also established a California-based engineering center

"Her deep experience in III-V semiconductors and high-volume global production and business environments will be very helpful to GLO in its next stage of development," reckons Mortenson. "Dr Bo Pedersen will initially continue with GLO as deputy managing director supervising the company's newly expanded activities in Europe, while Ms Danesh will be responsible for overall company supervision and strategy globally as well as direct supervision over the newly established Silicon Valley (US) efforts."

Danesh will help to lead GLO in its final steps towards mass production of what is claimed to the world's first nanowire-based semiconductor LED device in a commercial phase. "The wafer and device engineering capabilities at the new company facilities in Sunnyvale, along with the strong research team and foundation in Lund, will help accelerate initial productization of this ground-breaking technology," she says.

glo has developed technologies to fabricate perfect one-dimensional crystalline semiconductor structures (nanowires), and complex structures composed of nanowire-trees, with direct control of morphology and chemical composition, including atomically sharp heterostructures. Such nanowires hold great promise as LEDs because: (1) they are produced to a large extent with self-assembly techniques, providing complex structures with relatively simple processing; (2) the limited radial extent of the nanowires allows heteroepitaxial combination of materials with virtually no regard to lattice matching or thermal expansion issues, avoiding the strains and defects in conventional planar LEDs that plague both efficiency and manufacturing yields; (3) the vertical form factor of the nanowire itself promotes efficient light extraction, and (4) nLEDs can be grown directly on large-area (6" or even bigger) silicon wafers with mass-manufacturing techniques already in common use, avoiding the high cost of small (2–4") expensive wafers (such as sapphire, SiC and GaN) uniformly used by the LED industry.

glo says that these advantages allow simple growth of complex networks of optically active heterostructured materials with monolithically integrated electronic devices on inexpensive mono- and polycrystalline silicon substrates.

www.glo.se

Fox licenses IP to Kyma and TDI

After proving its technologies in the areas of silicon carbide (SiC), aluminum nitride (AlN), gallium nitride (GaN), and aluminum gallium nitride (AlGaN), as well as the hydride vapor phase epitaxy (HVPE) method of making both blue and ultraviolet (UV) light-emitting diodes, The Fox Group of Warrenton VA, USA has begun licensing its intellectual property rights to other companies, starting with deals with two separate firms.

Founded in 1999, The Fox Group is a privately held US corporation that has a portfolio of proprietary intellectual property (IP) relating to the growth of compound semiconductor crystals and crystal layers (both patents and know-how owned by Fox Group, plus patents rights and know-how licensed exclusively to Fox Group).

Kyma Technologies Inc of Raleigh, NC, USA, which provides crystalline GaN and AlN materials and related products and services, says that it has acquired certain assets and IP rights from Fox.

The assets and IP rights acquired pertain to nitride semiconductor HVPE and light-emitting semiconductor materials and devices. Kyma and Fox had been in discussions over such a possible deal for the past two years.

Kyma expects the acquired resources to accelerate its advances in materials and processes, in both contract R&D and product development. "This deal adds significantly to our ability to improve certain products and to develop new products which will become important for several electronic and opto-electronic device applications," believes Kyma's president & CEO Dr Keith Evans.

"Fox engineers were able to produce certain (Al,Ga)N structures and certain p- and n-doped layers that are of immediate interest to both our current HVPE products and our new product development plans," adds chief technology officer & VP of business development Dr Edward Preble.

"Fox Group is very pleased that our key equipment, patent rights, and know-how have been acquired by Kyma," says Fox Group's president & CEO Barney O'Meara. "Kyma has solid expertise and deep experience in HVPE processes, and these added assets should have a multiplier effect, to help accelerate Kyma to the next level," he adds.

TDI of Silver Spring, MD, USA, a subsidiary of UK-based Oxford Instruments that develops HVPE processes and techniques for the production of compound semiconductors such as GaN, AlN, AlGaN, InN and InGaN, has also entered into an IP licensing agreement with Fox Group.

The deal is for Oxford Instruments-TDI to acquire certain IP allowing it to offer hardware and processes for the production of light-emitting devices and p-doped layers, in addition to the hardware and process that Oxford Instruments-TDI already offers for growing III-nitride materials.

"This agreement allows for an expansion of the existing processes and materials structures we can offer, especially to our R&D customers, in the field of light-emitting structures," says Frazer Anderson, Oxford Instruments-TDI's business development director. "Using TDI's HVPE technology, Oxford Instruments can produce templates for applications such as high-brightness LEDs, laser diodes, HEMTs, and the acquisition of this IP will help us to extend our offering," he adds.

"They have long been one of the leading companies in HVPE processes and materials, with expertise all the way from fundamental science to implemented processes and products," comments O'Meara about TDI. "We look forward to Fox Group's IP helping TDI become a major contributor to evolving greentech-cleantech solutions in solid-state lighting and efficient power conditioning."

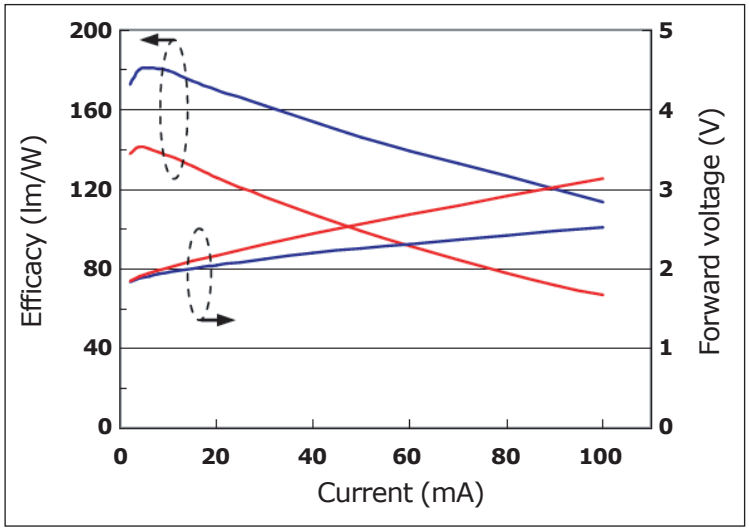
www.thefoxgroupinc.com
www.kymatech.com
www.oxford-instruments.com

Epistar raises AlGaInP LED efficiency record for 0.35mm² chip at 20mA by 26% from 133 to 168lm/W

Taiwan's largest LED chipmaker Epistar Corp of Hsin-chu Science-based Industrial Park has announced the development of a new generation of its Aquarius-series AlGaInP LEDs that emits at an efficacy boosted by 26% from the previous record of 133lm/W (from Epistar's AX14 LED, announced in March) to 168lm/W.

Applying novel light-extraction technology from Epistar Lab, the new LED's Lambertian transmission raises efficacy to 168lm/W at a dominant wavelength of 610nm when driven by a current of 20mA (or 180lm/w at 6mA) from a 0.35mm x 0.35mm chip. The horizontal chip structure was designed to satisfy chip-on-board packages for lighting applications that require multiple chips in series on non-conductive substrates.

Epistar reckons that the new LED's performance promises to make the small chips a preferred choice for outdoor displays and red–green–blue (RGB) backlight unit (BLU) applications. It also adds that the development allows warm-white LED solutions with higher efficacy and better color rendering index (CRI) to be provided via color mixing than can be achieved through conventional conversion of blue LEDs with phosphors.



New Aquarius-series chips have higher efficacy and lower forward voltage than AX14.

So far, the new generation of Aquarius-series AlGaInP LED has been demonstrated primarily in Epistar Lab, but plans are in motion to transfer the technology to Epistar's production line. Moreover, Epistar Lab is developing higher-efficacy AlGaInP LEDs that should facilitate lighting solutions with both high-CRI and high-efficacy warm-white light for lighting applications as well as high performance in RGB BLUs.

www.epistar.com.tw

Tyntek to set up China LED-making JV in Fuzhou

60–70% of Taiwan LED makers' investment going into China in 2010

Taiwan-based LED chipmaker Tyntek has announced plans to invest 153m yuan (US$4.94m) to set up a LED-making joint venture with the Fuzhou regional government in China, reports Taiwan's Digitimes. Total investment will be 353m yuan.

First-phase development will focus on LED epitaxial wafer and chip production, with plans to install 30 MOCVD reactors and to start production in December 2012. The second phase will install LED packaging equipment, with the aim of gaining market share in the backlighting and general lighting markets in China. Tyntek notes that capacity may expand to 100 MOCVD reactors in three and a half years time, depending on the market situation.

Investments by Taiwan LED firms in China totaled about US$240m in 2009 and have risen to US$1.17bn so far in 2010 (up to the end of August) including almost US$1.1bn for upstream LED epiwafer and chip production, according to industry statistics.

By the end of 2009 about half of Taiwan-based LED firms' investment had shifted to China. Taiwan's LED industry value is expected to increase to US$2.7bn in 2010, with as much as 60–70% of the investment going into China

Taiwan's LED industry value in 2009 was about US$2.17bn, accounting for 25% of the global LED industry. By the end of 2009 about half of Taiwan-based LED firms' investment had shifted to China. Taiwan's LED industry value is expected to increase to US$2.7bn in 2010, with as much as 60–70% of the investment going into China.

The main reason for Taiwan-based LED players investing in China is the Chinese government's subsidy of 10m yuan per MOCVD reactor installed (about half of the cost) amid significant market demand, notes the report.

www.tyntek.com.tw
www.digitimes.com/news/a20101012PD224.html

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www.evatecnet.com

Osram launches OSLON Black Series of LEDs, with metal lead frame for thermal stability

Osram Opto Semiconductors GmbH of Regensburg, Germany has added the OSLON Black Series to its OSLON family of LEDs. The first member of the new series has a metal lead frame, a compact package and a tried and tested lens design, and can be used wherever there are large fluctuations in temperature and a large amount of light is needed from a small area, such as in signal lights, interior lighting for refrigerators, and lighting for trains and planes.

The black molded package of the high-power LED ensures high stability, says Osram Opto. Not only does the thermal coefficient of expansion of the molding material precisely match the coefficient of expansion of the boards, but an ESD protective diode is concealed in the molding. Due to the high output efficiency in the black package there is no need for additional reflectors. The materials have been chosen so that even large fluctuations in temperature do not have an adverse effect on reliability or on the life of the LED (about 50,000 hours). Another benefit of the OSLON Black Series is its low thermal resistance of 6.5K/W, which again is due mainly to the metal lead frame.

OSLON Black Series combines thermal stability with high performance and reliability in a compact black package, suitable for trains, planes and automobiles and even refrigerators.

Like other OSLON LEDs, the Black Series has a lens with a 90° beam angle and produces a typical brightness of 115lm at an operating current of 350mA and a color temperature of 6500K. By increasing the operating current to 1A, it achieves a brightness of 250lm. The LED uses a 1mm^2 chip and is available in all colors including warm white. As is usual with Osram, the OSLON Black Series solder pad is compatible with the other LEDs in the product family.

Osram is showcasing the OSLON Black Series at electronica in Munich, Germany (9–12 November).

www.osram-os.com/electronica2010

Osram Opto and Iwasaki provide street lights to Tokyo's Chuo-ward

As one of its programs to ensure further security and environment in society, street-light maker Iwasaki Electric Co Ltd has provided Tokyo's Chuo-ward (home to its new headquarters since August) with 50 LEDioc STREET 40VA units.

The project has been conducted jointly with Osram Opto, whose Golden DRAGON Plus LEDs (which have a life-time of 60,000 hours) provide the lamps' light source.

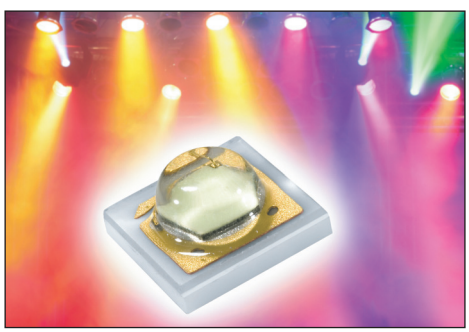
Of the 50 LED streetlight, 18 units have been installed in Ginza and 32 units in Nihonbashi-Bakurocho. They replace 80–100W mercury lamps, cutting energy consumption by about 75% as well as lowering electricity costs while maintaining similar brightness.

www.eye.co.jp

OSLON SSL 80 range of 1W LEDs gains color

Osram Opto Semiconductors says that its OSLON SSL 80 1W LED is now available not only in white tones but also in a range of colors — deep blue, true green, amber, red and hyper red — each offering high performance due to using the firm's latest chip technology. Typical brightness is 480mW (deep blue) and 92lm (true green) at an operating current of 350mA and 70lm (amber), 55lm (red) and 320mW (hyper red) at an operating current of 400mA.

Like their white counterparts, the LEDs are very small (3mm x 3mm) and have a narrow beam angle of 80°, which provides efficient injection into external optics, e.g. for spotlight applications. The same low thermal resistance of 7K/W makes thermal management easier.



Osram's OSLON SSL 80 LED.

The LEDs suit applications where colored light, color mixing and color effects are needed. Their small dimensions offer luminaire designers great flexibility, and their high efficiency suits applications that require high luminous intensities. The 80° beam angle and compact form factor allow close clustering if required and hence strong concentrated light and color mixing with close spacing. Even very low-profile lighting solutions are hence possible. Concentration of the light in clusters can be put to use for example in architectural lighting to provide high-intensity effects.

New LED with maximum efficiency and reduced CRI for urban lighting

Osram Opto Semiconductors GmbH of Regensburg, Germany is offering a new version of its Golden DRAGON Plus LED tailored for outdoor applications that can allow urban spaces such as roads, car parks, underground car parks and public parks to be illuminated more effectively and energy-efficiently by light with a neutral-white colour appearance (with color temperatures of 4000K, 4500K and 5000K available).

Specifically, the new Golden DRAGON Plus combines maximum efficiency with reduced color rendering properties, i.e. typically efficiency of 90lm/W at 4000K and a color rendering index (CRI) of 70 (supplementing the established Golden DRAGON Plus, which has a CRI of 82 and typical efficiency of 75lm/W).

Osram Opto says that, with the new Golden DRAGON Plus LED, efficiency can hence be increased by more than 15%. Its color appearance is very similar to that of conventional lighting technologies such as high-pressure discharge (HID) lamps, so the light is perceived as comparable, the firm claims.

The new high-efficiency Golden DRAGON Plus LED for outdoor use.

The new LED also has a very long service life in excess of 50,000 hours (depending on operating conditions) and contains no materials harmful to the environment.

The radiation characteristics and footprint are compatible with previous Golden DRAGON Plus LEDs, enabling the user to switch to the required version easily at any time, without having to redesign the optical system, Osram Opto says.

www.osram-os.com

LED light website gains online Tools section

Osram Opto Semiconductors is supplying new tools, downloads, and technical information for solution providers and engineers via the new online Tools section of its LED light website,.

"The new tools section of the Osram Opto Semiconductors LED light site is designed to be a leading resource for engineers in the LED light industry, with free information and tools to help deliver LED lighting solutions using Osram Opto Semiconductors components," says Brian Terao, director of SSL (Solid-State Lighting).

The tools section features a section of LED lighting resources open to the public, including video slidecasts of recent reference designs, LED product highlights, and SSL technical guides.

Registration for the tools section is free, giving users access to helpful resources for lighting industry engineers. Among these tools are the downloadable printed circuit board design files (Gerbers) along with a viewer if needed, including links to purchase the associated components; an Optic Selector Tool that helps users identify the best lens and optics solutions from several Osram partners; and Technical Papers and Reference Designs (which will be updated regularly with the latest LED and SSL industry innovations from Osram Opto).

The tools section will be updated continuously with new LED light resources, features and information.

http://ledlight.osram-os.com/led-ssl-tools

New CEO starts at Osram Opto

Osram Opto Semiconductors says that LED expert and executive Aldo Kamper has succeeded Dr Rüdiger Müller who, after heading the optoelectronic semiconductor business for 22 years at Osram and formerly at Siemens, is reaching retirement.

"Müller has been one of the driving forces worldwide in the development of LED technology," says Martin Goetzeler, CEO of parent firm Osram. "With Aldo Kamper, we have been able to win a successor from our own ranks — someone who will advance Osram Opto Semiconductors and make his own mark."

Müller (right) with Kamper.

Kamper started his career at Osram in 1994 after completing his business administration studies. Between 1999 and 2006, he held executive positions at Osram Opto Semiconductors in the fields of automotive and visible LEDs. Since 2006, he has been executive VP & general manager, Specialty Lighting at Osram Sylvania in the USA. With his technical and business-administration expertise, he has the credentials to further extend the firm's role globally in close coordination with its customers, it is believed.

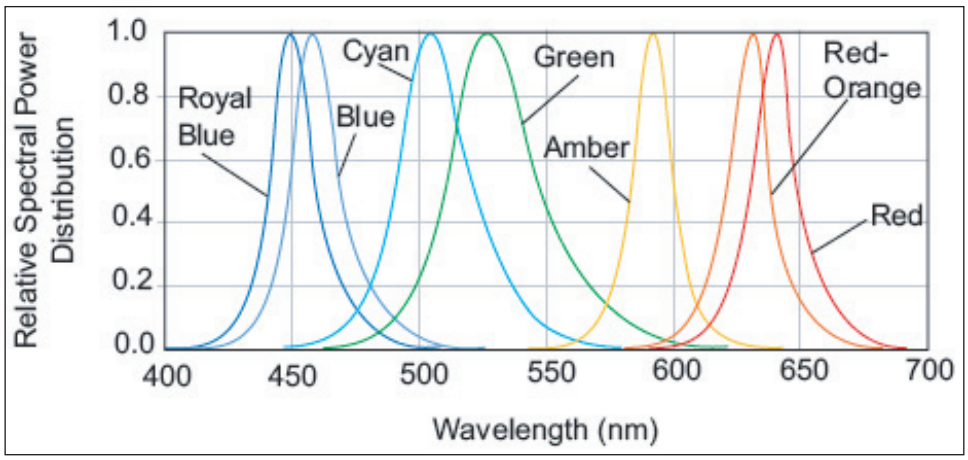
Müller headed the optoelectronic semiconductor business at Siemens from 1988 and, in 1999, was founding CEO of Osram Opto Semiconductors, in which Siemens' LED and infrared business was pooled with Osram's lighting competence. Besides strong growth and continuous expansion of production in Regensburg and Penang, Malaysia, Müller is closely linked with advances in optoelectronics. Innovations such as thin-film technology, direct blue or green semiconductor laser diodes, the first organic LED (OLED) product and the first surface-mount (SMT) LED emerged under his leadership.

www.osram-os.com

LUXEON Rebel color LED output and efficacy boosted

Philips Lumileds of San Jose, CA, USA says that it has increased the light output specifications and top performance bins for virtually every color of its LUXEON Rebel LED manufactured. In addition, significantly lower forward voltage for red and red-orange emitters results in very high-efficacy LEDs, which is critical as lighting engineers strive to reduce luminaire energy consumption says the firm.

"Demand for colored power LEDs continues to grow," says Frank Harder, VP marketing LUXEON Product Lines. "Across the globe, applications for city beautification, architectural lighting, entertainment, traffic, and signaling, are increasingly in demand," he adds. "Our position as a manufacturer of all colors allows us to support our customers with a portfolio that's efficient, delivers high light output, is extremely reliable, and is cost effective in lumens per Watt and lumens per dollar for a wide variety of solutions."



Relative intensity distribution versus wavelength for the various colors of LUXEON Rebel LEDs at test current thermal pad temperature of 25ºC.

Lumileds' AlInGaP-based red and red-orange LUXEON Rebel LEDs now generate 40% more light and are 50% more efficient. The firm also claims that its blue LEDs have the best hot/cold factor, delivering superior in-application results and better lumens per Watt. Royal blue, which is often used in remote phosphor applications and is the base for white LEDs, typically delivers output of 875mW at a drive current of 700mA.

In addition to the standard color portfolio, Lumileds also offers its unique InGaN-based LUXEON Rebel PC Amber LED, which is claimed to have 4–5 times more light output than conventional AlInGaP LEDs and better thermal and color stability performance.

www.philipslumileds.com

LUXEON LEDs used by AOP's modular street lights in Chinese city

A street in the Chinese city of Dongguan Songshan Lake recently installed 144 modularized LED street lights from Taiwan's Alliance Optotek Corporation (AOP), marking the first project using AOP's new ARTEMIS street light series, which incorporate LUXEON Rebel LEDs made by Philips Lumileds of San Jose, CA, USA. The lamps are available in two- to five-module configurations for environments ranging from 3m-high park roadway lighting to 10m-high main road illumination. Components can be customized to meet lighting requirements in the USA and Europe as well as mainland China.

AOP's modular strategy shortened development time and simplifies production and assembly, lowering product cost. LED specialist Future Lighting Solutions of Montreal, Quebec, Canada (a division of Future Electronics) says that its engineering support further reduced the development effort and time-to-market by supplying AOP with optimized LED count, current, forward voltage and heat management information, calculated using proprietary Future software tools.

In addition to the 144-unit installation in Dongguan Songshan Lake, AOP says that it now has ARTEMIS customers for street lighting, wall wash and architectural lighting projects. The variety reflects the ability of the core 24-LED ARTEMIS module to adapt to different applications by changing the lens used, the firm notes.

AOP is relying on Future's inventory management services to ensure that it has a reliable supply of LUXEON Rebel LEDs to fulfill these and other orders.

"Energy-saving initiatives like those in China are driving the adoption of LED street lighting in particular," says Clint Yu, director of AOP's Sales & Marketing Division. "Municipalities also reap the benefits of fewer bulb replacements and associated labor costs related to long LED life," he adds. "With our modular design and Future's engineering and supply chain assistance, our ARTEMIS series offers pricing, performance, customization and time-to-market advantages for customers around the globe," he claims.

"The modular approach of AOP's ARTEMIS products will be inevitably imitated by other LED lighting developers," believes Winter Chan, regional sales VP for Future Lighting Solutions.

www.futurelightingsolutions.com
www.philipslumileds.com

Lumileds adds 4000K CCT Rebel white LED and raises top flux bin for cool- and neutral-white by 20%

Philips Lumileds of San Jose, CA, USA has added a new 4000K CCT (correlated color temperature) ANSI-binned LED to its LUXEON Rebel product portfolio and raised the top flux bin for its cool- and neutral-white LUXEON Rebel by 20%.

The new LED delivers improved color rendering and tight binning to simplify luminaire designers' engineering efforts. In addition, flux bin increases for neutral-white (3500–4500K) and cool-white (4500–10,000K) LUXEON Rebel LEDs to a minimum 120 lumen flux bin at a drive current of 350mA demonstrates continued flux and efficacy improvements that are part of the firm's technology development path. Coupled with the recent introduction of the LUXEON Rebel ES, Lumileds says that its LEDs provide high-performance options for a wide variety of applications.

"As the market for solid-state lighting solutions takes hold, feedback from lighting engineers, designers, and end-users is playing a critical role in the development of the LUXEON LED portfolio," says Frank Harder, VP marketing LUXEON Product Lines. "The new 4000K CCT part addresses specific needs in the office lighting segment, where light output, efficacy and quality of light must meet certain levels," he adds. "Our light output increases, coupled with superior performance at application conditions, means that our LUXEON Rebel LEDs will outperform virtually any similar product available,."

www.philipslumileds.com

Australia's Crompton Lighting launches LUXEON-based LED downlight

Crompton Lighting Pty Ltd (one of Australia's largest and best-known lighting brands and a division of the Gerard Lighting Group) has launched XL LED Downlights, based on Lumileds' LUXEON Rebel LEDs.

LED specialist Future Lighting Solutions of Montreal, Canada (a division of Future Electronics) supplied LED selection assistance, engineering support that included recommending driver topologies enabling dimming of the LED light assembly, and supply chain management to ensure component availability.

The LUXEON Rebel LEDs enable the downlights to generate more than 530lm of output with a colour temperature of 3000K (comparable to a standard 50W MR16 halogen lamp). The fixtures consume 70% less energy and provide a much longer 50,000-hour life than 50W MR16 halogen counterparts.

Gerard Lighting Group's patent-pending design withstands higher temperatures to accommodate the hot Australian weather while also auto-dimming the light output at ambient temperatures over 45°C to avoid overheating.

The XL LED Downlights can be used for new installations or as a retrofit for standard MR16 halogen fixtures. They are registered under the Lighting Council of Australia's Solid State Lighting Luminaire Quality Scheme for quality assurance, and support Australian efforts to cut greenhouse gas emissions by phasing out incandescent lamps.

"These downlights are the first of a planned series of LED offerings that will become a cornerstone of our product line here and in the broader international marketplace," says Jason Gerard, Gerard Lighting's group general manager, Intelligent Lighting Products.

www.cromptonlighting.com
www.FutureLightingSolutions.com

Lighting for Tomorrow 2010 winners announced

At the American Lighting Association (ALA) Annual Conference in Las Vegas on 20–22 September, winners of the 8th annual Lighting for Tomorrow competition were announced. Organized by the ALA, the Consortium for Energy Efficiency (CEE), and the US Department of Energy, the solid-state lighting (SSL) competition aims to increase market acceptance and awareness of energy-efficient lighting by recognizing the best-designed products on the residential market.

This year the competition was expanded beyond SSL fixtures to include LED replacement lamps plus lighting control devices compatible with energy-efficient technologies such as LEDs and fluorescents. Fifty firms submitted a total of 107 SSL products, which were evaluated by a panel of nine judges on criteria such as color appearance, color rendering, application efficiency and aesthetics. Winning entries included:

SSL fixtures:

- Kichler Lighting, Design Pro LED Broad Roof LED Path Spread Light;
- Kichler Lighting, Design Pro LED Modular and Disc System;
- Edge Lighting, Scope LED Pendant;
- Edge Lighting, Scope LED Monorail/Track Light;
- Albeo Technologies Inc, Agito — Intelligent Task Light (honorable mention);
- Blackstone International Ltd, Sunter Architect LED Desk Lamp (honorable mention); and
- Cree LED Lighting, CR6 Downlight (honorable mention).

LED replacement lamps:

- Philips Lighting, EnduraLED A19 Lamp.

Lighting controls:

- Leviton Manufacturing Co Inc, Decora CFL Slide Dimmer;
- Lutron Electronics Co Inc, Radio Powr Savr Occupancy/Vacancy Sensor with Maestro Wireless Switch; and
- Legrand/Pass Seymour, RT1 7-Button Timer.

www.lightingfortomorrow.com

Cree's quarterly revenue rises 1.5% to record $268m

LED lighting adoption drives growth, offsetting drop in chip sales

For its fiscal first-quarter 2011 (ended 26 September), Cree Inc of Durham, NC, USA (which makes LED chips, lamps and lighting fixtures as well as GaN and SiC power-switching and RF/wireless microelectronic devices and SiC substrates) has reported record revenue of $268.4m, up 1.5% on last quarter's record of $264.6m and up 59% on $169.1m a year ago.

"Revenue grew in lighting, LED components and power products," says chairman & CEO Chuck Swoboda, as Cree continues to invest in its factories to support the increased adoption of LED lighting, driven by the USA and Asia. "Although total revenue was on the low end of our target range of $270–280m due to a decline in LED chips [down nearly 20% quarter-to-quarter for consumer display backlighting applications, particularly due to a supply/demand correction in Europe], LED lighting adoption continues to gain momentum and the growth drivers for the company remain on track."

On a non-GAAP basis, gross margin was 49%, up on 44.1% a year ago though down slightly on 49.9% last quarter. However, operating margin has continued to rise from 20.9% a year ago and 29.6% last quarter to 31.3%. Non-GAAP net income has risen from $27.4m a year ago and $60.1m last quarter to $66.3m, above the expected $62–65m.

Free cash flow (i.e. cash flow from operations of $88.5m minus capital expenditure of $61.6m) was $26.9m. This is down on last quarter's $54.2m and $40.8m a year ago.

However, this is due largely to CapEx tripling from just $20.4m a year ago and rising more than 50% from $40.8m last quarter. Cree's authorized capital expenditure for fiscal 2011 is about $300m (up from $168m in fiscal 2010), as the firm aims to:

- support targeted growth in LED lighting applications (by more than doubling XLamp LED capacity by the end of fiscal 2011);
- support initial capacity to develop and qualify LED products based on 150mm (6-inch) substrates; and
- position the factory to support additional growth in fiscal 2012.

During the quarter, Cree announced plans to build a new 150mm LED wafer fabrication plant at its facility in Research Triangle Park, NC.

The free cash flow of $26.9m, together with accounts receivable (net) rising $5.5m during the quarter (to $123m), meant that cash and investments grew $32.4m to $1,098.8m.

For its fiscal second-quarter 2011 (to 26 December 2010), Cree expects non-GAAP net income of $61–65m on revenue of $270–280m (up about 2.4% on fiscal Q1).

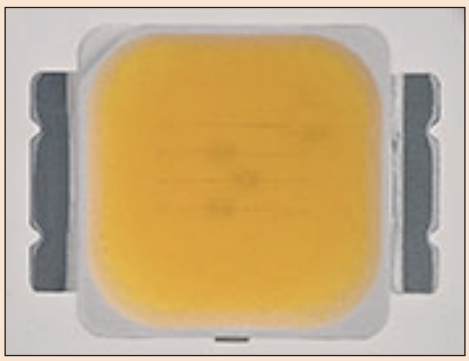
Although total revenue was on the low end of our target range of $270–280m due to a decline in LED chips, LED lighting adoption continues to gain momentum and the growth drivers for the company remain on track

Cree extends lighting-class LEDs to high voltage for more efficient LED light bulbs

Cree has extended its lighting-class LEDs to high voltage with commercial availability of the new XLamp MX-6S and MX-3S LEDs.

With the same footprint and high performance as the XLamp MX-6 and MX-3 LEDs, the MX-6S and MX-3S offer new high-voltage configurations designed for space-constrained LED lamps and bulbs. For these applications, high-voltage LEDs can be used to achieve smaller, more efficient power supplies and thermal systems.

The MX-6S delivers luminous flux of up to 139 lumens at 60mA/20V in 6000K and 114 lumens in 3000K correlated color temperatures (CCTs). The MX-3S provides up to 122 lumens at 115mA/10.7V in 6000K and 100 lumens in 3000K. Cree says that the MX series LEDs deliver lighting-class performance for high-voltage LEDs, including high reliability, high efficacy and what is claimed to be industry-leading color consistency.



Cree's MX-3 LED, which has the same footprint and performance as the new high-voltage MX-3S LED.

"These new XLamp LED products can enable LED lamp manufacturers to create more efficient and cost-effective designs in applications such as A-19-bulbs or GU10 lamps," says Paul Thieken, Cree's director of marketing, LED components.

www.cree.com

LED City's US members join forces with DOE consortium

Municipal Solid-State Lighting Consortium to assume functions of Cree LED City Program

US participants in the Cree LED City Program are to join forces with the Municipal Solid-State Street Lighting Consortium, which is sponsored by the US Department of Energy (DOE).

The LED City Program is an international community of government and industry parties initiated by LED chip, lamp and lighting fixture maker Cree Inc of Durham, NC, USA in 2007 to evaluate, deploy and promote LED lighting across municipal infrastructure (with the aim of saving energy, protecting the environment, reducing maintenance costs, and providing better light quality for improved visibility and safety). The objective is to accelerate the implementation of LED lighting by encouraging users to share experiences and data. The program has since helped cities across the world move to solid-state lighting, and member cities are regularly reporting energy savings of 50–80% and maintenance cost avoidance in the hundreds of thousands of dollars, over the life of the fixtures, says Cree.

The Municipal Solid-State Street Lighting Consortium is a voluntary group of representatives from interested municipalities, utilities and lighting professionals. Its goal is to build a catalog of field experience and data that will accelerate the learning curve for buying and implementing high-quality LED lighting, as well as serving as an objective resource to evaluate new products on the market. Formed earlier this year, the consortium has nearly 400 members in 48 states, five Canadian provinces, and four other countries, all seeking to share technical information and experiences related to LED street and area lighting demonstrations.

The Municipal Solid-State Street Lighting Consortium will now provide ongoing national organizational structure and guidance to LED City members and new members in the process of evaluating solid-state street-lighting technologies meant for public streets and other public areas. The consortium also aims to provide a forum like the LED City Council Meetings, where buyers and implementers can get information, discuss best practices, and share lessons learned.

The Municipal Solid-State Street Lighting Consortium will now provide ongoing national organizational structure and guidance to LED City members

"Cree's innovative LED City Program has provided a valuable forum for municipalities to learn and share in the earliest stages of LED street lighting," says Jim Brodrick, DOE's Solid-State Lighting Program Manager. "We are pleased to have the leadership and rich base of experience these cities bring to the consortium. Their knowledge and interest in continuing to mentor other municipalities will speed many up the learning curve as they evaluate new street-lighting options for their communities," he reckons.

"DOE's Municipal Solid-State Lighting Consortium represents a significant next step in the continued adoption of LED lighting in cities across the country," comments Greg Merritt, Cree's VP corporate marketing. "The DOE's consortium is well positioned to build on and enhance the growing momentum of the Cree LED City program, guiding cities along the path to LED lighting," he adds.

www.ledcity.org
www.ssl.energy.gov/consortium.html

Japan distributor to expand Avago's household appliance and automotive sales

In September, Avago Technologies signed an agreement with Japanese distributor Tomen Electronics Corp.

Avago is providing electronics firms in Japan with a range of products including optocouplers, LEDs, fiber optics, encoders and high-frequency semiconductors. The deal is intended to help Avago expand sales channels in the household appliance and automotive markets. Through selling products to more than 1000 companies, Tomen has a network in both of these markets.

"Tomen Electronics has a strong presence in the growing household appliance and automotive markets, and I expect their added sales support to accelerate our business expansion," says Itaru Yoneyama, Avago's VP of Japan Field Operations.

"Automotive and household appliance applications present demanding operational environments, and Tomen Electronics is committed to providing our customers with high-quality products that meet their needs," says Tomen's president Hiroyuki Isono.

www.tomen-ele.co.jp

Bridgelux introduces first 5-year warranty for LED arrays and modules

LED lighting and chip maker Bridgelux Inc of Livermore, CA, USA has boosted its standard 1-year and 3-year warranties by introducing 5-year warranty protection on all of its integrated LED arrays and light sources sold worldwide.

The 5-year warranty covers not only the Bridgelux LED Array product families (offering what is claimed to be the industry's widest performance range of 240–4500 operational lumens) but also the Helieon sustainable light module (co-developed, marketed and sold by Bridgelux and Molex).

"It addresses our customers' needs, supports the entire industry by accelerating market penetration, and helps deliver LED technology's energy savings and environmental benefits more quickly to the end customer," says CEO Bill Watkins.

"The lighting market is demanding 3–5 year warranties on solid-state lighting products," says VP of marketing Jason Posselt. "The 5-year warranty protection on light sources provided by Bridgelux will make it easier for our customers, lamp and luminaire manufacturers, to meet market requirements for their products. Further, it also allows our partners to minimize the cost and time they spend on warranty-related issues while improving their ability to win new business opportunities," he adds.

"With LED technology evolving at a pace faster than typical lighting design cycles, we are faced with a challenge to ensure that we bring high-quality products to market while still using leading-edge technology," says Chuck Campagna, CEO of lighting manufacturer Amerlux LLC of Fairfield, NJ, USA. "The 5-year warranty provided by Bridgelux allows us to confidently deliver one of the industry's most advanced solid-state lighting solutions at a pace that addresses both Amerlux business requirements and lighting industry demands."

We are faced with a challenge to ensure that we bring high-quality products to market while still using leading-edge technology

www.bridgelux.com

Bridgelux selects ESI's AccuScribe wafer scriber

Electro Scientific Industries Inc (ESI) of Portland, OR, USA, which provides laser-based manufacturing solutions for the microtechnology industry, says that Bridgelux Inc of Livermore, CA has selected its AccuScribe 2150P fully automated wafer scriber (which is optimized for laser scribing of sapphire-based LEDs) as the LED lighting and chip maker ramps up its new design and manufacturing center.

"Bridgelux is a vertically integrated manufacturer of LED light sources for the lighting industry. Our technology development, LED design innovations and manufacturing process advancements are focused on providing our customers with high-quality, high-performance solid-state lighting products," says Bridgelux's VP of manufacturing Mike Peanasky. "The precision, quality and customizable features in ESI's AccuScribe 2150P wafer scriber will play a central role in driving optimization of our manufacturing processes," he adds.

The 2150P is a cost-effective, automated laser system that enables consistent and uniform die-scribed LEDs at a controlled depth, resulting in better die singulation yield, claims ESI.

Bridgelux integrates its LED chips into LED Array light sources that provide what is claimed to be the industry's widest performance ranges, from 240 to 4500 operational lumens, displacing incandescent, halogen, CFL (compact fluorescent lamp) and HID (high-intensity discharge) light sources in a variety of applications. The firm says that its broad product portfolio provides wide-ranging options for the development of replacement lamps and luminaires for a market that is rapidly transitioning to energy-efficient lighting.

www.esi.com

Optogan appoints general manager of global sales & marketing

LED maker Optogan Group is boosting its sales activities by appointing Markus Zeiler as general manager of global sales & marketing. With a decade of experience in LED sales, marketing and engineering at a global level, Zeiler will oversee the expansion of Optogan to worldwide operations.

Founded in Helsinki, Finland in 2004 by Russian entrepreneurs and scientists from Ioffe Institute in St Petersburg, Optogan is a vertically integrated manufacturer of high-brightness LEDs. In addition to Optogan Group having locations in Helsinki and St Petersburg, since 2005 Optogan GmbH in Germany has been developing chip technologies in Dortmund, and is currently ramping up its new production facility in Landshut.

Zeiler previously worked at Osram for more than 10 years, most recently heading the marketing team for the LED consumer product business (e.g. LCD TV and mobile phone components). His knowledge and background will support activities to take advantage of the booming demand for LEDs in LCD backlighting. At the same time, Zeiler will prepare the launch of LED lamp and luminaire sales on a global level, in order to build on the success that Optogan is currently experiencing in Russia.

After earning degrees in Physics (specializing in semiconductors and crystallography) at Germany's University of Regensburg and Reading University in the UK, Zeiler started his career at Osram Opto Semiconductors GmbH in 2000. His work has led him through engineering, project management, marketing and sales activities for LEDs and sensors, with applications ranging from consumer, automotive and industrial to lighting. From his engineering background he is the holder of more than a dozen LED design and application patents. Between 2005 and 2008, Zeiler made contributions in business development for new LED applications in the Asian region, working with several large consumer firms. From 2008 onwards Zeiler spent two years in Japan establishing a key sales account for a top international consumer electronics brand. This year those operations were extended to a global level within his marketing function at the headquarters in Germany.

Optogan's general manager of global sales & marketing Markus Zeiler.

"We are happy that he can bring his business leadership, sales know-how and marketing expertise to Optogan," comments CEO Maxim Odnoblyudov. "Leading chip technology combined with competitive pricing, speed and a very highly motivated workforce are the key reasons why I joined Optogan," says Zeiler.

Zeiler will prepare the launch of LED lamp and luminaire sales on a global level

LEDs in lighting applications have seen tremendous growth over the last few years, comments Optogan. The greatest potential is currently LED backlighting for LCDs. The second wave of business growth will go hand in hand with the continuous rise in energy-saving lighting applications for indoor and outdoor use. "The addition of such top professionals to our team will enable us to achieve our ambitious plans on the global market," says executive VP Alexey Kovsh. "Our LEDs will soon be part of LCD TVs, street lighting and indoor luminaries all over the world," adds Zeiler.

www.optogan.com

IN BRIEF

OPTEK reaches franchise agreement for TTI to distribute opto components

Providing design engineers with a worldwide source for optoelectronic components, OPTEK Technology of Carrollton, TX, USA (a division of TT electronics plc of Weybridge, UK) has partnered with TTI Inc of Fort Worth, TX (a specialty global distributor of passive, interconnect and discrete components to industrial and consumer electronic manufacturers) via a new franchise agreement.

TTI now stocks and distributes OPTEK's range of optoelectronic components, including visible LEDs and assemblies, infrared sensors and switches, magnetic sensors, encoders and a range of high-reliability optoelectronic discretes and hybrid assemblies.

"The addition of TTI will enhance OPTEK's distribution network, both in North America as well as globally," says TT electronics OPTEK Technology's president Bob Taber. "TTI has a proven reputation for effectively reaching new customers while maintaining excellent quality of service for current customers," he adds.

"Adding OPTEK's products to our growing portfolio of optoelectronics and discrete semiconductor devices definitely will help us grow market presence in this area," believes Jeff Ray, TTI's VP of product marketing. TTI has been a long-standing distribution partner for TT electronics' components businesses.

www.optekinc.com
www.ttiinc.com

IN BRIEF

Luminus appoints CFO as it expands to new solid-state lighting applications

Luminus Devices has appointed Walter A. Shephard as chief financial officer, responsible for worldwide finance, administrative, legal and IT operations. He will also focus on driving employee productivity and reducing operational costs.

Shephard has a track record of diversified financial leadership with both public and private firms, says president & CEO Keith T.S. Ward.

Prior to Luminus, Shephard was chief financial officer at Zygo Corp, where he focused on improving its business model, operational efficiencies and cost containment programs. Previously, he was VP & CFO at GenRad Inc, responsible for developing and delivering corporate financial targets and overseeing a corporate expense budget of $70m.

Shephard has a Masters of Business Administration from Babson College and a Bachelor of Science in Finance from Boston College.

"Luminus has been executing on its sound business plan in 2010, is now expanding its brands globally in new solid-state products and applications," comments Shephard. "Today, more solid-state applications from entertainment, architectural, manufacturing, ultra-violet and display lighting are using the PhlatLight brand to expand their product and application portfolios," he continues. "Luminus is expanding the company and PhlatLight LEDs in new markets where traditional light sources are being phased out with long-lasting, energy-efficient solid-state LEDs," Ward adds.

www.luminus.com

DOE grant for Luminus to develop driver electronics for high-power LEDs

Luminus Devices Inc of Billerica, MA, USA, which makes large-chip PhlatLight (photonic lattice) LEDs for illumination applications, says it has been awarded a grant from the US Department of Energy's (DOE) Office of Science to develop low-cost, high-efficiency drive electronics to enhance its big-chip LED technology for use in next-generation, solid-state light sources and fixtures in commercial and industrial buildings as well as residential applications.

The grant is one of seven Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) grants awarded by the DOE in September targeting advances in solid-state lighting (SSL) technology.

Luminus was awarded the Phase 1 grant under the SBIR Program. The primary aim is to bring big-chip solid-state lighting solutions to world markets more rapidly and at lower costs with energy-efficient electronics.

"Luminus develops the world's brightest single-element, solid-state light sources," claims president & CEO Keith T. S. Ward. The DOE grant should help to expand the global reach of PhlatLight LEDs into untapped environments, he reckons. "In 2012, many traditional light sources will begin to be phased out as part of the Energy Independence & Security Act of 2007, and will be replaced with next-generation, long-lasting, energy-efficient solid-state light sources," he adds. "The DOE award is further validation of Luminus' LED solutions that bring value and new designs to the North American lighting market."

Designed to provide an ultra-bright, reliable light source, Luminus LEDs are used in lighting applications by many of the world's largest electronics and lighting companies. The firm's solutions are enabling new general illumination applications in lighting markets such as architectural, entertainment, retail, residential, roadways, industrial high-bay lighting, digital displays and signage and UV for industrial processing.

PhlatLight LEDs light up Crowded House

Luminus Devices' CBT-90 white PhlatLight LEDs are being used in Martin Professional's new MAC 350 Entour lighting fixtures, which are lighting the stage for rock band Crowded House on it's world tour.

Said to be the entertainment lighting industry's first LED alternative to traditional high-intensity discharge (HID)-based profile fixtures, the MAC 350 Entour exceeds traditional 300W fixtures in brightness and is equipped with seven CBT-90 white PhlatLight LEDs. Total light output is 8000lm, while lifespan is more than 25,000 hours (compared with traditional HID lamp profile lights that have a life span of only 3000 hours, necessitating frequent replacement, as well as being costly to replace and containing mercury).

"The MAC 350 Entour is a powerful and bright lighting fixture with the industry's only big-chip LED architecture," says Martin's product manager Peter Skytte. "Combine that with its energy-efficiency and the industry has an affordable and long-lasting alternative to HID-based fixtures still in wide use in touring and entertainment environments," he adds.

www.martin.com

Sony launches first 400mW blue–violet laser for Blu-ray

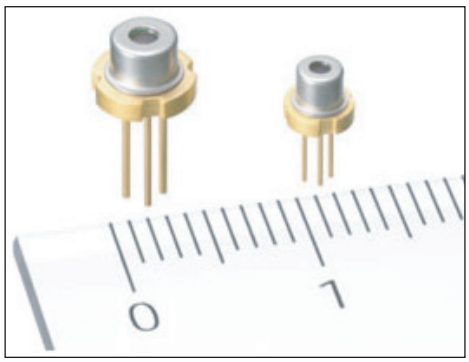
Catastrophic optical damage threshold raised from 300mW-class laser

Sony Corp has launched the SLD3237VF blue–violet laser diode, manufactured by subsidiary Sony Shiroishi Semiconductor Inc of Miyagi-Prefecture, Japan, which targets use for recording and playing Blu-ray discs, and supports BDXL, a new standard for large-capacity Blu-ray discs, reports Nikkei Electronics.

According to Sony, the SLD3237VF is the first blue–violet laser diode with a pulsed output power of 400mW or higher, allowing the use of a wider variety of optical components such as lenses and prisms and hence freer design of hardware.

Sony says that, to realize the high output, innovative technologies are necessary to prevent the end face of a laser resonator being melted by the heat from the laser — i.e. catastrophic optical damage (COD) — and to enhance the quality of the gallium nitride (GaN) crystal, in order to ensure high reliability.

The firm has therefore developed an end-face coating material and a film-forming method, raising the optical output threshold for causing COD compared with that of the firm's 300mW-class laser diode.



New 400mW-output laser SLD3237VF (left) and 350mW-output laser SLD3237VFR (right).

The firm has developed an end-face coating material and a film-forming method, raising the optical output threshold for causing COD

Moreover, to improve crystal quality, Sony has developed new metal-organic chemical vapor deposition (MOCVD) crystal growth equipment optimized for producing GaN materials. The firm says that the equipment can grow on multiple substrates simultaneously as well as being able to deal with a future increase in demand for Blu-ray disc lasers.

Furthermore, Sony has developed a process and processing equipment that, it claims, boosts production efficiency in wafer processing.

The SLD3237VF is mounted in a standard package with a diameter of 5.6mm, and its operating temperature range is 0–85°C.

Sony has also launched the SLD3237VFR, which has a pulsed output of 350mW. Mounted in a 3.8mm-diameter package, its operating temperature range is 0–90°C.

Both lasers have a sample price of ¥1000 (about US$11.9).

www.sony.co.jp

Quantum dot laser wins Japan's Green IT Award

As part of the Green IT Awards 2010 granted by Japan's Green IT Promotion Council, Tokyo-based QD Laser Inc, Fujitsu Ltd and the University of Tokyo have received the Ministry of Trade, Economy and Industry Minister Award in the category of 'Savings in IT-related Energy Consumption' for their quantum dot semiconductor laser technology. The award recognizes quantum dot laser technology as making a significant contribution to the energy efficiency of IT equipment.

The Green IT Award was founded to "honor contributions to the development, expansion and application of IT equipment, services and solutions that reduce society's energy consumption, with the aim of increasing the prevalence of green IT and bringing about a society that both preserves the environment and achieves economic growth".

The advantages of QD lasers over other types of semiconductor lasers include lower power consumption, better temperature stability, and higher temperature tolerance. The lasers will make it possible to conserve energy as energy usage increases with the expansion of the Internet and improvements in the capabilities of ICT equipment.

The technology was proposed in 1982 by professor Yasuhiko Arakawa, director of the Institute for Nano Quantum Information Electronics at the University of Tokyo, and was subsequently developed through an industrial–academic collaboration between Fujitsu and the University of Tokyo. QD Laser Inc was founded in 2006 with funding from Fujitsu and Mitsui Ventures to commercialize the technology, and the firm has begun the world's first mass production of QD lasers for use in optical communications.

The Green IT Award recognized the advanced capabilities of the device technology, as well as its wide range of potential medium- to long-term applications. It also praised the creative thinking that led researchers to bring about innovation by leveraging the principles underlying the device, as well as the achievements resulting from the innovation and the 15-year-long industrial–academic collaboration.

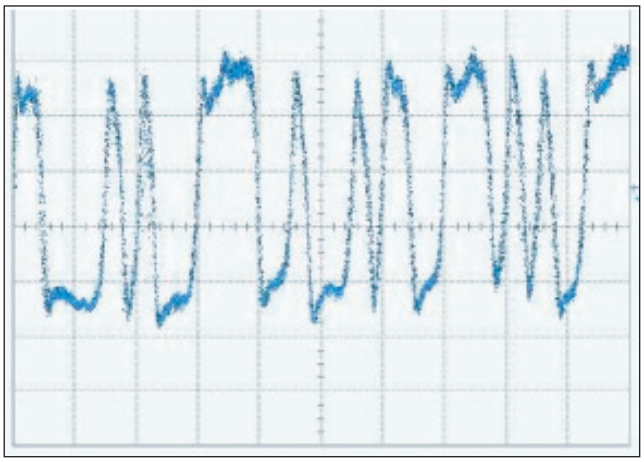
www.fujitsu.com
www.qdlaser.com
www.qdot.iis.u-tokyo.ac.jp

VI Systems unveils low-power 45G short-reach receiver

At the European Forum for Research and Innovation on Information and Communication Technology (ICT 2010) in Brussels, Belgium (26–29 September), VI Systems GmbH of Berlin, Germany (a fabless spin-off of the Technical University of Berlin and the A. F. Ioffe Physico-Technical Institute in St Petersburg, Russia that provides laser and photo-detector chips and modules for optical datacoms, industrial and consumer applications) presented its new R40-850TB optical receiver package.

The device integrates the firm's multimode-fiber-compatible photodetector chip, a transimpedance amplifier (TIA) integrated circuit and matching components within a high-frequency ceramic microassembly, enabling extremely low power consumption for data rates of up to 45Gb/s.

Integration is designed to dramatically improve the quality of signal transmission. Using the firm's V40-850M multimode-fiber-coupled vertical-cavity surface-emitting laser (VCSEL) module as the transmitting device, the signal-to-noise (S/N) ratio measured at the receiver at –3dBm optical power using non-return-to-zero pseudo-random bit sequence (PRBS 27-1) encoding at 40Gb/s exceeded S/N = 6.5, demonstrating a major advance in low-cost, low-power-consumption 40Gb/s optical transmission, the firm claims.



Non-return-to-zero (NRZ) pseudo-random bit sequence (PRBS 27–1) at 40Gb/s.

VI Systems says that the advantages of its optical subassemblies are in their ultra-low power consumption, with the driver and TIA ICs each consuming less than 130–150mW at 40Gb/s, improving the energy efficiency of data centers.

Targeted applications include short-reach (0.5m–10km) and very-short-reach systems as well chip-to-chip optical interconnects used in high-performance computing. Future serial standards for electrical interfaces operating at data rates higher than the present rates of up to 14Gb/s are currently being developed within the Infiniband EDR (26Gb/s per lane, 2011), Common Electrical Interface (CEI-25/28G), Fiber Channel FC32G and IEEE 40/100G Ethernet standards.

The work has been supported in part by the project 'Vertical Integrated Systems for Information Transfer' (VISIT), funded within the Seventh Framework Programme (FP7) of the European Union (EU). The members of the VISIT consortium are Intel (Ireland), IQE (UK), VI Systems (Germany), Chalmers University of Technology (Sweden), The University of Cambridge (UK), University College Cork (Ireland), The Technical University of Berlin (Germany) and the Ioffe Physical Technical Institute (Russia).

VI Systems gives update on 25/40G VCSEL technology at ECOC

At the European Conference on Optical Communication (ECOC) in Turin, Italy (24–27 September), VI Systems presented an update on its 25 and 40Gb/s VCSEL device technology and packaging results.

Chief technology officer Dr James Lott presented the performance characteristics of high-speed VCSELs operating with extreme temperature stability throughout the linear output power versus current region, demonstrating that high-speed VCSELs are ready for product insertion in short-range optical communication systems.

VI Systems developed the VCSEL products at a wavelength of 850nm along with a range of very fast integrated circuits based on silicon-germanium (SiGe) BiCMOS (bipolar complementary metal-oxide-semiconductor) technology. The firm uses a patent-pending micro-assembly platform for integrating the opto-electrical components and for alignment to a standard high-performance multi-mode glass-based fiber. The low-cost design enables mass deployment of such optical interconnects for high-bandwidth data communications, says the firm.

The work on such ultra-high-speed optoelectronic and electrical components is expected to lead to new standards in optical communication systems in the next 2 years.

Targeted applications include short-reach and very-short-reach optical receivers, transmitters and transceiver modules used in optical communication networks as well as chip-to-chip optical interconnects used in high-performance computing. Future serial standards for data rates of more than 14Gb/s are currently developed or on the roadmap within the Common Electrical Standard (CEI-25/28Gb/s), Fiber Channel 16Gb/s and 32Gb/s, and IEEE Ethernet 40/100Gb/s, Infiniband EDR (26Gb/s per lane), Intel Light Peak up to 100Gb/s as well as in a number of customer-specific applications.

www.v-i-systems.com

Infinera reports its sixth consecutive quarter of revenue growth, up 17% to record $130.1m in Q3

Second consecutive quarter of profitability generates $10 in cash

For third-quarter 2009, Infinera Corp of Sunnyvale, CA, USA, a vertically integrated manufacturer of digital optical network systems incorporating its indium phosphide-based photonic integrated circuits (PICs), revenue of $130.1m, up 17% on $111.4m last quarter and up 56% on $83.4m a year ago (representing the sixth consecutive quarter of improving revenue).

On a non-GAAP basis (excluding restructuring and other related costs and non-cash stock-based compensation), gross margin has risen from 38% a year ago and 44% last quarter to 51% (the fifth quarter of improving gross margin).

"We achieved new records for quarterly revenue, gross margin and tributary adapter module (TAM) shipments [more than 3000 units]," says president & CEO Tom Fallon. "The stronger revenue, higher profit margins and ongoing operating expense control resulted in significant income leverage, with a non-GAAP operating income contribution of $18.5m," he adds.

"This operating income contribution, combined with our achievement of 51% gross margin, validates our long-term business model and demonstrates the leverage that is achievable," says Fallon.

Non-GAAP net income was $18.7m, compared to $3m last quarter and a net loss of $3.1m a year ago. Positive cash from operations was $10m.

"Our continued solid financial performance stems from our customers' confidence in Infinera's unique and differentiated PIC-based networks and our expanded product portfolio that provides the end-to-end solutions that they are demanding," believes Fallon.

Continued solid financial performance stems from our customers' confidence in Infinera's unique and differentiated PIC-based networks and our expanded product portfolio that provides the end-to-end solutions that they are demanding

The company also noted the following developments, both during third-quarter 2010 and since:

- the addition of two new invoiced customers (bringing the customer roster to 77);
- the addition of six new ATN metro customers (bringing total ATN customers to 15);
- the launch of new hardware and software products for the DTN and ATN platforms enabling a new end-to-end 'Digital OTN' solution;
- two technical demonstrations, including PIC-based 100Gb/s coherent transmission and reception over a 1348km route on an XO Communications nationwide network on a production Infinera line system, and 100 Gigabit Ethernet services over Colt's existing London to Frankfurt Infinera network.

www.infinera.com

Midcontinent deploys Infinera network for Upper Midwest

Midcontinent Communications has deployed an Infinera Digital Optical Network for its cable television, high-speed Internet and telecom customers in its Upper Midwest service area.

Midcontinent is one of the USA's largest independent cable companies, with more than 250,000 customers in North Dakota, South Dakota, and Minnesota. It operates the largest and most resilient network in the region, a 4600 fiber-mile network delivering services to urban and rural areas within the three states.

The firm has been experiencing rapid growth in traffic on its network due to a growing offering of high-definition TV channels, accelerating demand for Internet bandwidth, the move to IP technology for carrying TV services between head-ends, and a growing enterprise business. Midcontinent deployed the Infinera DTN digital ROADM (reconfigurable optical add-drop multiplexer) after examining a range of alternatives for bringing additional capacity to its optical network. With the new network, Infinera says that Midcontinent can turn up services, including Gigabit Ethernet, 10Gb/s and other services, quickly and easily. With Infinera's Bandwidth Virtualization capability, optical capacity can be deployed between any points on the network to carry a wide range of services, as and when needed.

"With our Internet traffic growing at 80% year-on-year and enterprise customers requesting services up to 10Gb/s, we could not afford to take months to add capacity," says Midcontinent's VP of technology Jon Pederson. "The Infinera system enables us to fulfill demands quickly and easily," he adds.

The Infinera DTN is the first optical networking system powered by large-scale PICs. Deployed worldwide in long-haul and metro core networks, it combines high-capacity DWDM transport, integrated digital bandwidth management, and GMPLS-powered service intelligence in a single platform.

Infinera launches end-to-end digital OTN networking

Infinera has launched a set of end-to-end digital OTN solutions to deliver the benefits of its digital optical networks combined with full compatibility with international OTN standards. Infinera's digital OTN vision enhances the benefits of OTN by enabling OTN capabilities to be realized throughout the optical network instead of only at the edges. Infinera is delivering Digital OTN solutions with new hardware and software.

OTN (Optical Transport Network) is a set of standards developed by the ITU-T specifying optical network architecture and specific signal structures and interfaces to promote transparent multi-service transport, improved network performance and greater interoperability for wavelength division multiplexing (WDM) networks. OTN promises to simplify, flatten, and reduce capital and operating cost in optical networks. However, most vendor implementations of OTN have been piecemeal to date. With new product capabilities, Infinera offers what it believes to be the most complete OTN implementation in the industry. The Infinera DTN supports OTN switching at every node, enabling grooming and switching of OTN-encapsulated client services to maximize service reconfigurability and network performance monitoring throughout the network, for increased network bandwidth efficiency. The enhancements add the capability to support native OTN end-to-end services from metro/edge networks across backbone/core networks and standard-compliant OTN networking across multiple operator networks.

By enhancing Infinera's digital optical network architecture to support OTN service interfaces, an Infinera network offers significant benefits over a conventional OTN transport-only WDM network. With integrated bandwidth management, an Infinera network offers OTN switching in the network core. This enables capacity in the network to be used more efficiently, minimizing wasted bandwidth. In addition, the implementation of OTN solutions in both the Infinera ATN and Infinera DTN platform enables end-to-end aggregated OTN hand-offs throughout the network, from metro edge to metro core to long-haul core.

New DTN, ATN Modules and Network Management Software

Infinera's end-to-end digital OTN is enabled by the introduction of both hardware and software enhancements to Infinera's family of optical platforms. The hardware enhancements are new Tributary Adapter Modules for the DTN digital ROADM core WDM system and new Service Interface Modules for the ATN metro/access WDM system. These new modules enable OTN, Ethernet, FibreChannel, SONET/SDH, and wavelength services with per-port programmability. They are compatible with field-deployed DTNs and ATNs, simplify sparing, and expand service delivery. New software includes Infinera's latest release of the Digital Network Administrator (DNA Release 6), providing even better integration of end-to-end mixed DTN/ATN networks and a host of accelerated-workflow applications to speed and simplify common network operations tasks. The new products have already begun shipping and are planned to be generally available by next month.

"Network operators are seeking ways to reduce the cost and complexity of their networks and are excited about new OTN switching gear and automated multi-layer networking capabilities emerging in

Infinera demos end-to-end digital OTN networking and 100GbE

At the SCTE Cable-Tec Expo in New Orleans (20–22 October), Infinera featured two live demonstrations illustrating the capabilities of its Digital Optical Network.

Infinera will demonstrate end-to-end Digital OTN switching on a combined Infinera DTN-ATN network. The firm offers what it believes to be the most complete OTN implementation in the industry, with OTN grooming and switching at every node in the network, to maximize service reconfigurability and network performance monitoring throughout, and to deliver increased network bandwidth efficiency. Infinera says that its DTN and ATN platforms provide a seamless OTN network supporting point-and-click provisioning across the metro edge, metro core, and long-haul segments of the optical network.

In a second live demonstration, Infinera will transport a 100 Gigabit Ethernet (100GbE) signal from an EXFO test set to an Infinera DTN with a 100GbE module, through fiber, and then looped back to the Infinera DTN, and back to the test set to confirm the signal integrity. The prototype Infinera 100GbE interfaces are fully compliant with the IEEE 802.3ba industry standard ratified in June. Testing and verification of transmission will be performed with an EXFO FTB-85 100Gb/s Packet Blazer (the industry's first portable 100Gb/s Ethernet tester).

In the Expo area at the show, Infinera product and technology experts will be available to discuss its ATN and DTN product families as well as the latest upgrades that deliver new features and functionality. With ATN R2.0, Infinera continues to enhance the capabilities of the ATN and its interworking with the DTN to deliver an end-to-end seamless network from the metro edge to the core.

www.infinera.com

IN BRIEF

Kotura agrees pan-European distribution deal with AMS

Kotura Inc of Monterey Park, CA, USA, which has been designing and manufacturing application-specific silicon photonics components for the communications, computing, sensing and detection markets for more than four years, has signed a pan-European agreement with AMS Technologies of Martinsried, Germany, a distributor specializing in optoelectronics, thermal management and power electronics.

AMS will distribute Kotura's entire suite of integrated silicon photonic solutions including high-speed, single-channel variable optical attenuators (VOAs), high-speed VOA arrays, and WDM multiplexers for 40 and 100Gb/s Ethernet applications.

"The broad and value-rich optical functionalities offered by Kotura fit into our strategy to provide total solutions across our industry segments," says AMS' chief sales officer Jan Meise.

"AMS Technologies has a large customer base in Europe and an excellent reputation for its high-quality technical support, which is fundamental to our global expansion strategy," comments Kotura's president & CEO Jean Louis Malinge. "We look forward to working closely with AMS Technologies in Europe not only to drive success in increasing our combined businesses, but also to establish new customers and a deeper level of collaboration with them on current and future designs," he adds. "AMS Technologies will tremendously strengthen our position in these growing markets."

www.kotura.com
www.amstechnologies.com

Leti integrates CMOS-compatible plasmonic optical waveguides with silicon photonic devices

Copper waveguides enable smaller, faster, more efficient optoelectronic interfaces

Leti of Grenoble, France, the Laboratory for Electronics & Information Technology of the French government's research and technology organization CEA, has demonstrated the integration of silicon photonic devices with fully complementary metal-oxide semiconductor (CMOS)-compatible plasmonic optical waveguides.

The R&D institute reckons that the new capability sets the stage for the fabrication of smaller, faster and more efficient optoelectronic interfaces, which could ultimately allow the development of much higher-performance sensors, computer chips and other electronic components.

Leti's new devices channel light through a narrow silicon waveguide placed in close proximity to a metal waveguide, causing the light to excite small, high-frequency electromagnetic waves (surface plasmons) in the metallic structures. The resulting devices can convert optical signals in the 1.5µm communications band into plasmonic electron waves, and convert the plasmonic waves back into optical signals.

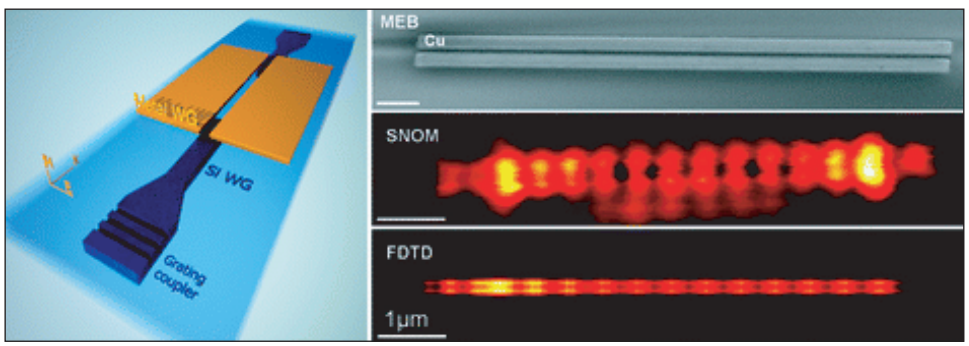
Leti's combination of extremely small plasmonic-optical interfaces that connect to standard optical fibers provides high coupling efficiencies (up to 70%) over a wide spectral range. Also, unlike previous devices that have relied on metal waveguides made from gold, Leti's metal waveguides are fabricated from copper, allowing easy integration into standard CMOS chip manufacturing processes.

"This demonstration of CMOS-compatible plasmonic-optical technology is a major milestone in the emerging field of metal-oxide-semiconductor photonics," claims Laurent Fulbert, photonics program manager at Leti. "By concentrating light into very small modes, we can provide an efficient optical interface between the macroscopic world of optical fibers and the nano-scale world of transistors and molecular electronic devices."

The plasmonic-optical devices were designed and fabricated by Leti, which collaborated with France's Université de Technologie de Troyes (UTT) for additional near-field scanning optical microscope (NSOM) testing and characterization.

The project results were presented at the 7th IEEE International Conference on Group Four Photonics (GFP 2010) in Beijing, China in early September, and published in Nano Letters (2010) vol.10 (issue 8) p2922.

www.leti.fr



Narrow silicon waveguide in close proximity to copper metal waveguide, allowing easy integration into standard CMOS silicon manufacturing process.

IMEC and UGent spin off silicon photonics firm Caliopa

The Photonics Research Group of Ghent University (UGent) and Leuven-based nanoelectronics research institute IMEC have spun off Caliopa of Zwijnaarde, Belgium. The aim is to commercialize more than a decade of research in silicon photonics by developing and marketing optical transceivers for the datacoms and telecoms markets that offer advanced functionality, higher port density and lower power consumption.

According to the latest forecast from optical communications market research firm LightCounting LLC, global sales of optical transceivers will reach $2.4bn in 2010 then rise at a compound annual growth rate (CAGR) of 13% between 2011 and 2014 as the industry catches up with the steadily growing demand for bandwidth.

"Multiple optical components can be replaced with a single optical chip by using silicon photonics, allowing us to develop small, highly integrated and low-power optical transceivers," says Caliopa's CEO Martin De Prycker. "The ability to make these silicon photonics components at standard CMOS manufacturing facilities also makes it commercially very attractive," he adds. "Key potential customers have expressed great interest in Caliopa's solutions, stating that port density and power consumption are the major concerns in driving the growth of optical networks."

Recently, UGent founded the Center for Nano- and Biophotonics (NB Photonics), a multidisciplinary research platform in photonics clustering the resources and know-how of 12 professors from four faculties. Technology transfer is handled by the Photonics Innovation Center 'Plateau', which was instrumental during Caliopa's incubation phase.

Caliopa says it will be able to build on the intellectual property and experience of years of research by UGent's Photonics Research Group and IMEC led by professor Roel Baets. It will also exploit IMEC's expertise in silicon processing.

To develop its first products, privately held Caliopa has raised €2m in initial funding from the founders together with a consortium of investors led by Baekeland Fund II, FIDIMEC (a daughter firm of IMEC that supports the incorporation of spin-offs) and PMV-Vinnof (the Flemish Innovation Fund, a subsidiary of investment firm PMV that provides seed capital for start-ups in Flanders), joined by private investors.

Caliopa currently has seven team members, composed of technical experts from IMEC/UGent and industry veterans with more than 75 years cumulative management experience in high-tech industries. However, it plans to double the size of this team in the next 12 months.

www.caliopa.com

PICO consortium wins DARPA funding to focus on Photonic Integration for Coherent Optics

The new multi-university–industry Photonic Integration for Coherent Optics (PICO) consortium — which is to focus on basic research to develop photonic technology for communications and sensing applications — is one of four consortia that has been chosen for funding by the US Defense Advanced Research Program Agency out of contenders from around the USA. DARPA is providing just over $2m annually, with the university and industry partners providing about the same amount.

The consortium is led by University of California Santa Barbara (UCSB) and includes researchers from the Massachusetts Institute of Technology (MIT), the California Institute of Technology (CalTech), the University of Virginia, Lehigh University, and 17 industry partners including HP, Intel, Corning, Teledyne, Rockwell-Collins, Infinera and JDSU.

UCSB is working to develop photonic integrated circuits (PICs), which can pack many components onto a single chip, and are intended to be the basis of powerful new optical communications and computing systems. PICO aims to build on that effort by designing and fabricating a new generation of PICs that operate on both the amplitude and phase of lightwaves.

UCSB says that such photonics devices promise to revolutionize computing and communications, enabling much greater quantities of data to be transmitted over long-distance networks and would improve the efficiency and density of shorter links in data centers or within computers.

"These coherent PICs will provide a huge increase in the amount of information that can be transmitted from or received by a single chip as well as a tremendous reduction in the size, weight, and power required by the chips," says Larry Coldren, acting dean of engineering & professor of Electrical and Computer Engineering and Materials at UCSB, who is acting as PICO's director. UCSB professors John Bowers and Mark Rodwell and research engineer Leif Johansson are also part of PICO.

PICO intends to produce several generic coherent PICs with many potential applications. The chips should be able to handle massive amounts of data (transmitting dozens of feature films in a second) and could also form the basis of detection systems sensitive enough to read the date on a dime from a mile away, says Coldren.

The chips to be developed by PICO will draw on both monolithic InP and silicon CMOS technology.

http://engineering.ucsb.edu

Senate Committee approves $5m in federal funding for GigOptix on-chip integrated photonic polymer transceiver

GigOptix Inc of Palo Alto, CA, USA, which designs modulator and laser drivers and transimpedance amplifier (TIA) ICs based on III-V materials as well as polymer electro-optic modulators for fiber-optic communications systems, has secured $5m of continued federal support for its On-Chip Integrated Photonic Polymer Transceiver program.

US Senator Patty Murray, a senior member of the Defense Appropriations Subcommittee, helped to secure the funds as part of the fiscal 2011 Department of Defense Appropriations (passed recently by the Senate Appropriations Committee, but awaiting approval by the US Senate, and subject to final legislation being passed by Congress and signed by the President).

The funding will allow GigOptix to qualify its Thin Film Polymer on Silicon (TFPS) modulators to the stringent temperature stability required by military standards. Also, the firm will begin designing and testing the second iteration of the integrated driver with the polymer optical modulator on a standard BiCMOS wafer and completing the integration of the receiver side on separate chips, all for next-generation 400Gbps optical communication systems. Current technologies are physically too large and energy intensive to sustain the anticipated levels of bandwidth growth in the coming years. The funding will accelerate important development into faster, smaller and more energy-efficient power and communications systems to provide accurate, timely information that will enable the military to maintain its edge in communications technology.

"GigOptix is the industry leader of high performance electro-optic polymer solutions, both for active and passive applications as stand-alone hybrid products as well as monolithic integrated layers onto integrated circuits (ICs)," claims Dr Raluca Dinu, VP & general manager of GigOptix Bothell. "Because of the support of Senator Murray, we are able to push forward with critical research on ultra-broadband, low-power communications systems that help the military maintain its superiority. The US Air Force and the US Government are looking for solutions to the growing problems of speed, size, integration, weight and power of current technologies. The additional funding support demonstrates confidence in GigOptix' technology as a solution for their high-speed network communication needs," he adds.

The firm will begin designing and testing the second iteration of the integrated driver with the polymer optical modulator on a standard BiCMOS wafer and completing the integration of the receiver side on separate chips, all for next-generation 400Gbps optical communication systems

"With this meaningful funding, GigOptix will enhance its work force in our development center in Bothell, thus enabling new job opportunities for highly educated and skillful American scientists, engineers and developers," comments the firm's CEO & chairman Dr Avi Katz.

"Continuous funding support by the US Government has been a key contributor to GigOptix' efforts to build a successful high-tech endeavor over the last three years," Katz adds. "This funding is an enabling financial engine that allows us to drive forward our strategic plans and continue to develop and establish GigOptix as a global industry leader in the high-speed optical communications arena."

www.GigOptix.com

GigOptix expands signs Midoriya as Japan distributor

GigOptix Inc has strengthened its presence in the Japanese telecom, datacom, consumer, PC and semiconductor markets by signing electronic component and instrument distributor Midoriya Electric Co Ltd as its sole distributor for optical and RF sales in Japan.

"Optics will replace copper interconnect technology in the future and we have been looking for a strong partner in the optical space. GigOptix has great technology and great solutions and is a good match with the Japanese optical communication customers," says Midoriya Electric president Makoto Kuroha.

"We look forward to utilizing our strong sales and engineering resources to further develop the customer base in the telecom and datacom markets and expanding their reach into higher-volume consumer, PC and semiconductor markets," he adds.

"They [Midoriya] have a strong presence that will enable us to expand our current optical market reach and provide the breadth of expertise that enables us to address new market segments such as consumer and computer devices," says GigOptix's VP of sales Jay de la Barre.

www.midoriya.co.jp

GigOptix launching 40G and 100G Bundled Solutions

GigOptix showcased its new 40G and 100G Bundled Solutions at the 36th European Conference and Exhibition on Optical Communications (ECOC 2010) in Torino, Italy (20–22 September).

The Bundled Solutions represent what GigOptix believes is an industry first for a company providing a complete solution set consisting of a transimpendance amplifier (TIA), thin-film polymer-on-silicon (TFPS) Mach–Zehnder modulator (MZM) with a matched driver for an optical application. The firm says that its Bundled Solution reduces a user's engineering expenditure, accelerates time-to-market for new products, and enables the use of GigOptix' low-power solutions with enhanced cost efficiencies. The Bundles will address 40G DPSK, 40G RZ-DQPSK as well as coherent 40G and 100G DP-QPSK applications.

"As a leading supplier of the TIAs and drivers used to implement 10G, 40G and 100G optical transponders in high-performance telecom communications systems, we have developed an excellent understanding of our customers' challenges at the system level," claims VP of marketing Padraig O'Mathuna. "Our Bundled Solutions, comprised of a driver, modulator and receiver amplifier, are a new approach representing a strong value proposition for customers as well as a competitive advantage for GigOptix as these products are not currently available from any other single supplier," he adds.

The TIA, driver and modulator designs are optimized to work together to achieve the best performance and power efficiency while reducing customers' R&D costs and development cycles

"Today's supply chain requires customers to buy a modulator from one vendor, a driver from a second and a TIA potentially from a third vendor. Ensuring that all these components are correctly matched is critical for the optimal performance of the system and poses a challenge when designing, for example, a 100G transponder for manufacture," O'Mathuna explains.

"At GigOptix, the TIA, driver and modulator designs are optimized to work together to achieve the best performance and power efficiency while reducing customers' R&D costs and development cycles," he points out. "With our TFPS MZM moving to production at our contract manufacturing partner Sanmina-SCI, GigOptix is meeting the design, logistical and cost issues challenging our customers by offering a fully integrated solution through a simplified supply chain."

www.GigOptix.com

Low-power multi-rate SMART optical sub-assemblies launched

At ECOC in Turin, Italy, GigOptix Inc of Palo Alto, CA, USA demonstrated its new family of ultra-low-power multi-rate SMART optical sub-assemblies (OSAs) for 2–14Gb/s short-reach datacom applications.

The SMART receive OSA (HXR2101A) and transmit OSA (HXT2101A) are based on a new generation of GigOptix vertical-cavity surface-emitting laser (VCSEL) driver and transimpedance amplifier/limiting amplifier (TIA/LA) chips. The firm has leveraged its mixed-signal experience in high-volume parallel optics devices to combine RF analog circuit techniques that reduce power consumption with integrated on-chip analog-to-digital convertors (ADCs) and digital-to-analog convertors (DACs) to enable a fully digitally controlled TOSA and ROSA.

This architecture simplifies the design of an optical transceiver such as an SFP+ by eliminating all analog and RF circuits from the PCB. The elimination of RF analog interfaces improves performance and reduces both power consumption and EMI within the transceiver. The new architecture also cuts cost while reducing the engineering effort associated with developing a solution, says GigOptix.

The introduction of the SMART ROSA and TOSA allows customers a seamless and low-cost deployment using the firm's 'plug and play' components, GigOptix claims.

"The devices were designed for lead customers seeking a very energy-efficient data link. Our OSAs enable pluggable solutions running at less than 200mW and intra-system links at less than 120mW," says Dr Jorg Wieland, VP & general manager of GigOptix-Helix, Zurich. "The SMART OSAs were also designed to be very easy to use. The integrated digital I2C control simplifies the engineering of an optical transceiver and reduces the components needed to only a microcontroller and our SMART ROSA and TOSA," he adds. "This will be a substantial cost saving for transceiver manufacturers," he expects. "Also, we see the potential for SMART OSAs to be used in consumer, industrial and avionics applications, since these devices will simplify the implementation of high-speed links within a system and are more robust than 10G copper."

In its most recent report on datacom components, market analyst firm Ovum forecasted that the 10G Ethernet and Fiber Channel short-reach market would increase at a compound annual growth rate (CAGR) of 22% from less than 11 million units in 2010 to more than 29 million units in 2015.

JDSU led ROADM component market in first-half 2010, with 38% of revenue and 39% of shipments

50GHz-channel-spacing WSS to be half of ROADM market by 2012

In its '2010 Biannual ROADM Components' report, telecom market analyst firm Infonetics Research has identified optoelectronic chip and module maker JDSU of Milpitas, CA, USA as the leading provider of reconfigurable optical add/drop multiplexer (ROADM) products in first-half 2010, with 38% of revenue and 39% of units shipped.

"JDSU has been providing leading ROADM technology and integration capabilities to the optical market since the beginning, even back in the days when liquid-crystal wavelength blockers were first introduced," says Brandon Collings, JDSU's chief technical officer of Optical Communications. "We are committed to a continued focus on R&D and on our extensive ROADM roadmap to ensure we not only maintain market leadership but also the technology leadership our customers and service providers require for the Self Aware Networks of the future," he adds.

JDSU's ROADM products make it possible for network operators to add or drop network capacity and to flexibly support increased bandwidth needs in various parts of the network so that consumers and business can use on-demand services such as voice, video and data applications. JDSU claims to be the only firm that offers all three leading ROADM technologies, which include liquid-crystal (LC), micro-electro-mechanical systems (MEMS) and planar lightwave circuit (PLC) applications to address various market needs.

The Infonetics Research report also highlights that:

- the wavelength division multiplexing (WDM) ROADM optical equipment market will remain the fastest-growing segment of the optical equipment business;
- the key component fueling growth in the WDM ROADM sector is the wavelength selective switch (WSS), which allows wavelength route provisioning to become dynamic and protection switching to take place at the optical layer rather than the electrical layer; and
- worldwide revenue from WSS components with 50GHz of channel spacing is forecast to account for more than half of the market by 2012.

www.jdsu.com

JDSU highlights key technology at ECOC 2010

JDSU of Milpitas, CA, USA highlighted solutions from its optical communications and communications test & measurement portfolios at the European Conference and Exhibition on Optical Communications (ECOC) in Turin, Italy (20–22 September).

Its booth included a new theme 'JDSU: Enabling the Self Aware Network' highlighting key attributes of future networks. "A Self-Aware Network leverages a rich photonic infrastructure to automatically restore and rebalance bandwidth, optimizing network performance and lowering overall costs," says Brandon Collings, chief technology officer for Optical Communications. "Colorless, directionless, contentionless, and gridless architectures supporting 100G and beyond will depend on JDSU expertise and innovation to maximize the value of next-generation networks," he adds.

JDSU's optical communications solutions on display included:

- Live 100G demo — including a 100G CFP optical interface based on mature 10G technology to enable higher data rates in optical networks.
- Enhanced tunable XFP — providing enhanced performance for network transmission, including increased optical output power and improved optical signal-to-noise ratio (OSNR) performance.
- Raman amplifier — providing extended reach that is key for 100G optical networks.
- Transceiver portfolio — including pluggable solutions for emerging wireless and 40G applications.

Communications test & measurement products on display included:

- Live 40–100G demos — showcasing JDSU's 40GE/100GE/OTU3/OTU4 solutions, including its ONT 100G test solution.
- New multi-mode/single-mode QUAD optical time domain reflecto-meter — a powerful OTDR (available on the T-BERD/MTS-4000 platform) with high dynamic range and short dead zones, and a true loss test for installation, turn-up and maintenance of single- and multimode fiber links.
- High Resolution Dispersion Test Solution — available on the T-BERD/MTS-6000 and MTS-8000, an integrated solution (measuring CD, PMD and attenuation) for fiber characterization of high-speed metro and core networks offering what is claimed to be the best dispersion performance available in a field test solution.

Also, in the ECOC Market Focus speaker series, in 'Optical Network Agility' Collings discussed colorless and directionless technology, and its benefits for network operators.

www.jdsu.com

Finisar demos Flexgrid technology, plus first board-mounted optical engine operating at 240Gb/s, and SONET/SDH SFP+ transceiver error-free over 10km fiber

At the 36th European Conference and Exhibition on Optical Communications (ECOC 2010) in Turin, Italy (20–22 September), Finisar Corp is demonstrating several new technologies and products, including its new Flexgrid technology for next-generation reconfigurable optical add-drop multiplexers (ROADMs), a fully functional Board Mounted Optical Engine operating at 240Gb/s, and a SONET/SDH SFP+ transceiver for telecom networks.

Launched in early September, Flexgrid technology was being demonstrated for the first time as a software capability of the new WaveManager Application Suite (part of the WaveShaper family of programmable optical processors). Flexgrid enables dynamic control of channel center frequency and channel bandwidth within a wavelength selective switch (WSS), from 50GHz to 200GHz in 12.5GHz steps, with no penalty on performance. It is designed specifically for bandwidth-efficiency as carriers move to higher data rates in next-generation telecom networks.

"Verizon looks forward to Finisar's next-generation flexible grid WSS product and we anticipate working with them as system suppliers integrate this type of technology into future line systems," says Glenn Wellbrock, Verizon's director of Backbone Network Design.

Finisar's Board Mounted Optical Engine technology is being exhibited for the first time. As data rates on backplanes, intra-chassis, intra-board and chip-to-chip interconnects increase, the limitations of copper exacerbate the challenges faced by systems engineers and architects. Board Mounted Optical Engines enable breakthroughs in data rate, power and density for next-generation servers, routers and high-performance computing (HPC) systems, it is claimed.

Finisar says that the Optical Engine enables 240Gb/s simplex or 120Gb/s full-duplex links, and doubles the bandwidth of existing optical engines. Finisar claims to be the first company to show a working technical demonstration of this technology at this data rate and in real-world air-cooled environments.

The Optical Engine enables 240Gb/s simplex or 120Gb/s full-duplex links, and doubles the bandwidth of existing optical engines. Finisar claims to be the first firm to show a working technical demonstration of this technology at this data rate and in real-world air-cooled environments

Finisar also demonstrated its new 10G SONET/SDH SFP+ transceiver, which is designed for 10Gb/s 2km SONET/SDH SR-1 and 10km 10GBASE-LR/LW applications. The transceiver integrates re-timers on both the receiver and transmitter for superior jitter performance between 9.95 and 11.35Gb/s. Finisar says that it is one of the first manufacturers to bring 10G SONET/SDH SFP+ transceiver technology to market, enabling telecoms systems vendors to offer high-density next-generation 10Gb/s platforms.

"Vertical integration and technical innovation are key to our success and enables us to continue to focus on meeting our customers' needs with timely and cost-effective solutions," says VP of marketing Rafik Ward.

In addition, at ECOC 2010, Finisar also displayed equipment from its portfolio of optical products including transceivers, transponders, wavelength selective switches, active cables, advanced optical components, and passive devices.

www.finisar.com

Finisar receives Brocade's 2010 Customer Focus Award

Fiber-optic communications component and subsystem maker Finisar Corp of Sunnyvale, CA, USA says that, at the Brocade Supplier Summit ceremony on 14 September, it received the 2010 Customer Focus Award from network provider Brocade Communications Systems Inc of San Jose, CA.

Finisar supplies Brocade with fiber-optic transceivers and transponders that enable high-performance data transmission across networking systems.

The award honored Finisar for a "deep commitment to Brocade in providing quality products and customer support at a level unmatched in the industry".

In addition, Finisar was recognized for its high level of participation in standards committees and ultimately driving standards initiatives supporting Brocade's goals.

"We also appreciate the executive sponsorship through all functions of their company, which mirror the entire organization's commitment to our success," said Lisa Loscavio, Brocade's VP of supply chain operations.

www.brocade.com

Opnext and Ixia demo CFP transceiver running 40GbE

At the European Conference on Optical Communications (ECOC) in Turin, Italy (20–22 September), Opnext Inc of Fremont, CA, USA and Ixia, a provider of converged IP network test systems and service verification platforms, demonstrated error-free, line-rate transmission of 40GbE traffic using Opnext's new 40GBASE-LR4 CFP transceiver module and the Ixia K2 higher-speed Ethernet (HSE) test solution.

Opnext's TRC5B20 module is a pluggable optical transceiver enabling 40Gbps Ethernet and SONET traffic transmission over 10km single-mode fiber (SMF). It supports four data rates: 39.8Gbps, 41.25Gbps, 43.0Gbps and 44.6Gbps and can be used in both datacom and telecom applications. Ixia's K2 platform is a complete IEEE 802.3ba-2010 standard-compliant test solution from layer 1 through layer 7, including bit-error-rate tests as well as PCS lanes verification.

"Customers value the versatility of this module because it can be used for both 40G Ethernet and SONET/OTU3e applications in switches, routers and other transport equipment," says Opnext's director of product marketing Josef Berger. "In addition, the module incorporates Opnext's state-of-the-art uncooled direct-modulated DFB lasers, which enable a low-power solution for the market. With the help of Ixia's K2 test solution, we are showcasing the stable transmission of IP traffic via our optical transceiver," he adds.

"Higher-speed Ethernet is real and ready to go," says David Schneider, Ixia's senior manager of market development. "All the components — transceivers, cables, on-board electronics and test/system interfaces — are inter-operating well," he adds. "We expect to see 40GbE interfaces in multiple data-center products this year, especially high-speed switches. Opnext 40G optical transceiver modules are a key enabling product for these switches."

www.ixiacom.com

Camstar Enterprise Platform deployed

Opnext has deployed the Camstar Enterprise Platform of software provider Camstar Systems Inc of Charlotte, NC, USA to improve product quality and production efficiency, provide instant product tracking and traceability, and optimize supply chain operations.

The deployment at plants in Yokohama and Nagano, Japan includes Camstar Manufacturing (a manufacturing execution system for discrete manufacturers) and Operational Intelligence. Camstar's partner Mizuho Information and Research Institute Inc worked with Opnext to facilitate rapid deployment.

"The Camstar Enterprise Platform provides the visibility and control we need to expand our portfolio and production volumes," says Opnext Japan's IT director Noriyuki Goto.

"Opnext's future-focused thinking approach and commitment to advanced technology is supported by a platform that enables scaling development, production and quality," comments Camstar's VP of business development Manash Chakraborty.

www.camstar.com

Opnext and Anritsu demo first 100GBASE-LR4 module operating at 111.8Gbps

At ECOC, Opnext and Anritsu Corp gave public demonstrations of what is said to be the first 100GBASE-LR4 module operating at an OTU4 transmission rate of 111.8Gbps, plus a 40GBASE-LR4 transceiver capable of running OTU3 traffic.

Opnext's TRC5E20FNF-SF000 is a CFP optical transceiver module conforming to CFP MSA standards. It is hot-swappable and supports 100GBASE LR4 and OTU4 rates using Opnext's electro-absorption distributed feedback (EA-DFB) lasers each running up to 28Gbps. The module transmits and receives via four parallel wavelengths at 25Gbps each per IEEE 802.3ba 100GbE and at 28Gbps each per ITU-T OTU4. The TRC5E20FNF-SF000 is available for sampling now.

The TRC5B20MN-SW000 CFP transceiver can transmit 40GbE as well as SONET/OTU3e traffic using four uncooled direct modulated DFB lasers running at up to 11.3Gbps each. The OTU3 module conforms to applicable standards and is available now, expanding Opnext's 40Gbps product line for next-generation high-speed switching and routing applications.

"System vendors can confidently design 40 and 100Gbps system optical transport networks (OTN) that support end-to-end or client-to-DWDM-to client networks," says Tadayuki Kanno, president of Opnext's module business unit. "Opnext's client-side OTU3 and OTU4 technology also comes at a time when coherent 40 and 100Gbps WDM line-side technology is moving towards deployment phase," he adds.

"Anritsu's MD1260A 40GbE/100GbE Analyser has been conceived and designed to match the evolving testing needs in today's rush towards 100Gbps," says Alessandro Messina, marketing director for Anritsu's wireline solutions in EMEA. "System vendors are engaging in a new challenge to bring larger broadband in smarter next generation networks, and Anritsu is willing to provide intelligent solutions to support this effort. Together, Opnext and Anritsu today show state-of-the-art combination of Test Equipment and Compact Optical Modules to achieve these goals."

www.anritsu.com

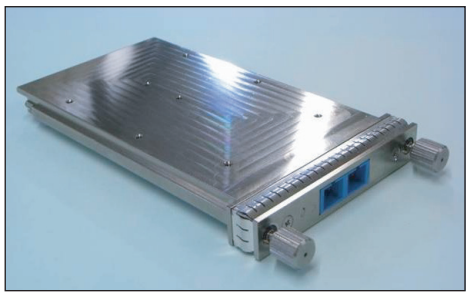
SEI extends 40GbE transceiver reach from 10km to 40km

ECOC 2010 sees first 40km 40GbE CFP, a year after first 10km CFP

Tokyo-based optical component and module maker Sumitomo Electric Industries Ltd (SEI) is expanding its optical portfolio with the introduction of a 40GbE transceiver module for 40km reach, which was showcased at the 36th European Conference and Exhibition on Optical Communications (ECOC 2010) in Turin, Italy (20–22 September).

The optical transceiver complies with CFP multi-source agreement hardware & software specifications and can support 40km link distance over standard single-mode fiber.

To alleviate future core network bandwidth shortage due to the rapid growth of the IP traffic volume, the Institute of Electrical and Electronics Engineers (IEEE) has standardized 40 and 100 Gigabit Ethernet via the 802.3ba Task Force.



The first 40GbE CFP transceiver for 40km reach.

In parallel, Sumitomo Electric — together with three other major optical component vendors, Finisar Corp, Opnext Inc and Avago Technologies — has been leading the CFP MSA for next-generation form factor, which was announced in March 2009 at the Optical Fiber Communication Conference and Exposition (OFC 2009) in San Diego.

Sumitomo Electric was previously first to release a 40GbE CFP optical transceiver for 10km reach (a year ago, at ECOC 2009). It has now developed what is claimed to be the world's first 40GbE CFP for 40km reach by using a high-speed four-wavelength coarse wavelength division multiplexing (CWDM) laser diode for the transmitter and a high-speed avalanche photo-diode (APD) for the receiver. Maximum power consumption is compliant with CFP MSA power class 1 (8W maximum) and is the same value as the 10km-reach 40GbE CFP.

SEI plans sample shipments of 40km-reach 40GbE CFP transceivers for Q1/2011 and mass production (at subsidiary Sumitomo Electric Device Innovations Inc) for Q4/2011.

http://global-sei.com

NeoPhotonics announces general availability of Integrated Coherent Receiver for 100Gbps transmission

At the European Conference and Exhibition on Optical Communications (ECOC 2010) in Turin, Italy (20–22 September), NeoPhotonics Corp of San Jose, CA, USA, vertically integrated manufacturer of photonic integrated circuit (PIC) based components, modules and subsystems for telecoms networks, is announcing general availability of its Integrated Coherent Receiver (ICR) for 100Gbps DWDM transmission systems, an integrated intradyne receiver based on its PIC technology. Initial availability was previously announced at March's Optical Fiber Communication Conference & Exposition and National Fiber Optic Engineers Conference (OFC/NFOEC 2010) in San Diego.

"The ICR is an important element in enabling ultra-high-speed network links, and NeoPhotonics is committed to a goal of meeting customer requirements for performance and availability throughout the ramp up in deployment of 100Gbps DWDM transmission equipment," says chairman & CEO Tim Jenks.

The ICR supports the requirements of the Optical Internetworking Forum (OIF) Implementation Agreement on 100G Integrated Polarization Intradyne Coherent Receivers. The device provides advanced demodulation to analyze the state-of-polarization and optical phase of a phase-modulated signal relative to an externally supplied optical reference, enabling recovery of the phase-polarization constellation of 100Gbps dual-polarization quadrature phase-shift keyed (DP-DQPSK) format signals. The ICR incorporates four sets of high-sensitivity balanced photodiodes with four differential linear amplifiers to provide four output channels at 32 Gbaud data rates.

"NeoPhotonics utilizes hybrid photonic integration to achieve the high performance required for 100Gbps applications," says VP of marketing Dr Ferris Lipscomb. "NeoPhotonics hybrid PICs use planar glass waveguides for the coherent mixing function and semiconductor chips for the detectors and amplifiers, ensuring that each function is matched to the device and material, improving both performance and yield," he claims.

As part of the ECOC 'Market Focus' program, Lipscomb is giving the presentation 'Photonic Integrated Circuit Based Coherent Receivers Represent A New Paradigm For Optical Components' covering the relationship between PIC technology and advanced data encoding (Monday, 20 September, 3:35 pm).

As well as the ICR, NeoPhotonics also offers 90° hybrid coherent mixers and DQPSK demodulators based on PIC technologies.

www.neophotonics.com

www.oiforum.com/public/documents/OIF_DPC_RX-01.0.pdf

Oclaro demos new full-band tunable XFP transceivers

At the 36th European Conference and Exhibition on Optical Communication (ECOC 2010) in Turin, Italy (19–23 September), Oclaro demonstrated its new TL8800 full-band tunable XFP transceiver, claiming that, together with its focus on vertical integration, the firm is emerging as the price–volume leader for 10Gb/s tunable modules.

"Through Oclaro's InP core technology, we continue to define the highest levels of photonic integration into our tunable products," says executive VP & division manager Adam Price. "Tunable XFP is just the first step on our high-density roadmap. Beyond scaling the tunable XFP product to high-volume manufacture with our proven world-class operations organization, Oclaro is readying itself to be a market driver with next-generation tunable products," he reckons.

The tunable XFP leverages Oclaro's in-house expertise at every level, from optical chip design and manufacture, transmitter and receiver optical sub-assembly (TOSA/ROSA) packaging, and transceiver assembly & test. The firm has traditionally delivered small-scale, high-performance 10Gb/s transmitters based on InP Mach–Zehnder (MZ) modulator technology, and this has been strengthened over the last several years as cost, size and power have become critical customer requirements. Oclaro reckons that, being able to uniquely drive the market need, it is striving to secure a large share of the key 10Gb/s tunable 300-pin market, with the new tunable XFP building on this foundation to provide a universal DWDM 10Gb/s format for the future.

The TL8800 joins Oclaro's range of tunable components and modules such as the TL5000 iTLA (integrable tunable laser assembly), TL7000 TTA (tunable transmitter assembly), and the TL9000 TSFF (small-form-factor) 300-pin transponder. The new tunable XFP product platform enables quick and easy consolidation of DWDM 10Gb/s optics onto one format, as opposed to having to split between 300-pin and fixed-wavelength XFP solutions depending on the performance required, says Oclaro. Variants will cover a range of Tx chirp, Rx options, C- and L-band coverage, and enhanced performance for challenging optical and environmental operation.

www.oclaro.com

Oclaro opens Design Center in Tucson's 'Optics Valley'

Optical component, module and subsystem maker Oclaro Inc of San Jose, CA, USA has opened its new Design Center in Oro Valley, near Tucson, Arizona (commonly referred to as 'Optics Valley').

The new center will provide global customers with specialized diode laser packaging designs, leveraging local optical expertise in the Tucson region as well as the workforce that joined Oclaro after its acquisition of the Tucson-based Newport Spectra Physics high-powered laser diode business in July 2009 through a strategic exchange of assets with Newport.

"The Tucson area is recognized as a hub of innovation for the optical industry," says Scott Dunbar, general manager of Oclaro's High Power Laser Diode portfolio. "Our new design center includes a strong local team with specialized design and packaging expertise. As a result, we expect the Tucson Design Center to contribute in Oclaro's efforts to expand our customer relationships and innovative diode laser products," he adds.

Oclaro claims that it hence now delivers the industry's most expansive portfolio of high-powered laser diodes, while achieving lower costs and higher operating efficiencies through economies of scale, greater factory utilization and its assembly & test manufacturing capabilities in Asia. The Spectra Physics acquisition also expanded Oclaro's customer base, which now includes top-tier customers in the medical and industrial markets and additional markets that are turning to lasers for new applications.

"Customers want to partner with a laser supplier that has the expertise they need to help get designs to market quickly and cost effectively," says Yves LeMaitre, executive VP & division manager. "They also prefer a supplier who is not competing with them in their markets, thus ensuring there are no conflicts when it comes to supply and intellectual property," he adds. "Our acquisition of Newport's Spectra Physics line has been a win–win for both companies, and clearly highlights the tremendous advantages that vertically integrated companies can receive by outsourcing component design and manufacturing."

To maximize cost savings and operational efficiencies, Oclaro has completed its consolidation of the former Tucson wafer fabrication facility into its fabs in Caswell, UK and Zurich, Switzerland. As part of Oclaro's global manufacturing infrastructure, the acquired product lines can now leverage economies of scale and expertise to reach competitive cost targets on leading-edge technology and manufacturing processes, the firm reckons.

The Tucson Design Center will initially employ about 30 staff, and is part of Oclaro's Advanced Photonics Solutions Division (APS) as a Technology Center of Innovation for the firm's high-powered laser diode products. APS is a growth engine for Oclaro, serving the diverse and fast-growing markets for laser diodes, such as lasers for medical procedures, materials processing, consumer electronics and printing.

Emcore shrinks 3% as it concludes accounting review

September-quarter revenue to rebound 16–18%

In its delayed unaudited financial results for fiscal third-quarter 2010 (to end-June), Emcore Corp of Albuquerque, NM, USA, which makes components and subsystems for the fiber-optic and solar power markets, has reported revenue of $46.6m, up 21% on $38.5m a year ago. This was down 3% on last quarter's $48.2m, but this was due to a timing issue with a major shipment: the Photovoltaics segment experienced a quarter-end delay in shipping a satellite solar cell order to an international customer due to an "unforeseen logistics issue" (the order was shipped in August and the revenue will be recognized in the September quarter).

Of the total quarterly revenue, Photovoltaics was hence down 16% on $18m last quarter to $15.1m. Meanwhile, Fiber Optics revenue was up 4% on $30.2m to $31.5m.

Gross margin has fallen from last quarter's 32.1% to 27.5%, including 30.7% for Photovoltaics (down from last quarter's record 46.6%) and 25.9% for Fiber Optics (up from 23.6%).

Although an improvement from $7.3m a year ago, non-GAAP net loss of $3m is up from $1.8m last quarter. During the quarter, cash, cash equivalents, available-for-sale securities, and current restricted cash fell from $19m to about $16m. Working capital totaled $33.1m. Emcore adds that, over the last year, it has achieved positive cash flow from operations in two of the last four quarters, including the quarters to end-September 2009 and end-March 2010. The firm continues to maintain a $14m credit facility with Bank of America and a $23m committed and available equity line of credit facility with the Commerce Court Small Cap Value Fund Ltd.

During the quarter, order backlog fell slightly from $68m last quarter to $67.6m. This includes $42.5m in Photovoltaics (down 3% on $41.3m) and $25.1m in Fiber Optics (down 6% on $26.7m).

Neverthless, despite this slight dip, for fiscal fourth-quarter (to end-September 2010), Emcore expects significant positive cash flow from operations, based on revenue rising 16–18% sequentially to $54–55m (with revenue growth in not only Fiber Optics but also Photovoltaics).

www.emcore.com

Emcore hires CFO

The board of directors of Emcore has appointed Mark Weinswig as chief financial officer, reporting to CEO Dr Hong Q. Hou and responsible for the firm's finance and accounting functions.

"Mark brings a broad background of both finance and accounting, as well as a deep understanding of the fiber-optics industry," comments Hou.

Weinswig previously held leadership positions as controller, executive VP of business development, and interim CFO with technology firms including Coherent Inc and Avanex Corp (now Oclaro Inc). He was previously at Morgan Stanley's Institutional Equity Research Group, covering the telecoms equipment industry, and at PriceWaterhouseCoopers as an auditor. Weinswig received an MBA from the University of Santa Clara and a BS in business administration from Indiana University. He also has CFA and CPA designations.

NASDAQ Listing Rule compliance regained

On 6 October, Emcore received a letter from the NASDAQ Listing Qualifications Department saying it had regained compliance with NASDAQ Listing Rule 5250(c)(1) by filing its Form 10-Q report for Q3/2010 with the US Securities and Exchange Commission (SEC).

On 18 August, NASDAQ told Emcore it was not in compliance with its continued listing requirements after Emcore said that filing of its quarterly report had been delayed because it needed more time to complete a review of its accounting for certain inventory write-downs and the allowance against a specific account receivable that the firm had determined should be recorded.

However, Emcore subsequently filed its Q3 report on 5 October, before the 18 October deadline set by NASDAQ, so the firm has hence regained compliance with Listing Rule 5250(c)(1).

Emcore regains compliance with NASDAQ minimum bid price rule

On 26 October Emcore was notified that it had regained compliance with the minimum $1 bid price requirement set forth in NASDAQ Listing Rule 5450(a)(1).

On 23 September, Emcore was notified by NASDAQ that the minimum bid price of its common stock had been below $1 per share for 30 consecutive trading days and was hence not in compliance.

Under Listing Rule 5810(c)(3)(A), Emcore was given a grace period of 180 calendar days (until 22 March 2011) in which to regain compliance by maintaining the closing bid price equal to or above $1 for at least 10 consecutive trading days.

The firm's bid price has now achieved this, so its non-compliance with the requirement has therefore been rectified.

Spire produces record 42.3%-efficient solar cell

Production-ready cell 8 months into NREL PV Incubator subcontract

Spire Corp of Bedford, MA, USA, which provides capital equipment and turnkey production lines for manufacturing photovoltaic cells and modules, says that its subsidiary Spire Semiconductor LLC of Hudson, NH has produced a record efficiency concentrator photovoltaic (CPV) cell. The 0.97cm^2 cell was measured by the US Department of Energy's National Renewable Energy Laboratory (NREL) to have a peak energy efficiency of 42.3% at 406 suns AM1.5D, 25ºC (42.2% at 500 suns).

This exceeds the existing record of 41.6% reported by Boeing Company subsidiary Spectrolab Inc of Sylmar, CA, USA in August 2009, which had beaten the prior record of 41.1% set by the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg, Germany in 2009.

"In early 2009, Spire Semiconductor was awarded an NREL Photovoltaic (PV) Incubator subcontract to develop a high-efficiency triple-junction GaAs cell," says Spire Semiconductor's general manager Edward D. Gagnon. "In less than 18 months, we were able to validate and incorporate our new concept into a production-ready cell design with world-record efficiency," he adds.

"NREL has been extremely helpful during the entire program, with timely responses to our confirmation requests for accurate efficiency measurements," Gagnon continues. "Their continued support enabled us to validate our new bi-facial cell architecture," he adds. "This higher-efficiency, next-generation GaAs CPV cell platform is now available commercially to the concentrator systems providers."

"The availability of this new high-efficiency cell will advance next-generation CPV system performance and reduce system cost for manufacturers, helping to move solar energy ever closer to the goal of grid parity," reckons Spire's chairman & CEO Roger G. Little.

www.spirecorp.com

SolFocus CPV systems installed at Border Environment Cooperation Commission in Juarez, Mexico

SolFocus Inc of Mountain View, CA, USA has installed 16.8kW of its high-concentrator photovoltaic (CPV) systems at the offices of public sector partner the Border Environment Cooperation Commission (BECC) in the US–Mexico border city of Juarez (the first CPV installation in the Northern Mexico border region). The two arrays will produce 43.13MW-hr per year, powering a third of the office building's needs.

"At BECC, we focus on the technical, environmental and social aspects of project development, and work with communities and project sponsors in the US–Mexico border region to develop, finance and build affordable and self-sustaining projects that address a human health or environmental need," says general manager Daniel Chacón. "Bringing together SolFocus and local developer Sonnergía demonstrates the importance of bilateral cooperation between the US and Mexico on environmental and economic policies and potential business developments in clean energy technologies for this region's sustainable economic growth," he adds.

"As a local developer, we knew that SolFocus CPV technology, with its high energy yield, was the best-suited technology for the border region," comments Sonnergía's president Jose Medina. "Sonnergía's work with BECC and SolFocus demonstrates that a stable energy infrastructure is important to US–Mexico relations, border security and the regional economy of both the United States and Mexico."

The US–Mexico border region has significant solar resources that make it an ideal environment for CPV technology, says SolFocus. A constant source of intense sunrays provides an annual average of 7–8kW-hrs per square meter daily, providing enough energy to power municipalities, airports, colleges and industrial complexes. BECC targets wider-spread deployment of photovoltaics in the border region, improving the local environmental conditions, increasing employment opportunities and helping the country meet national policy goals for renewable energy deployment and greenhouse-gas reductions.

"With renewable development, the border region could easily become a showcase for sustainable economic development and trade projects," says SolFocus' president & CEO Mark Crowley.

SolFocus' CPV design uses patented reflective optics (curved mirrors) to concentrate sunlight 650 times onto GaAs-based solar cells (on germanium substrates) that have high solar energy conversion efficiency (approaching 40%, more than twice that of traditional silicon solar cells). Like its smaller SF-1000S system (approved by the CEC in September 2008), the firm's second product (the SF-1100S, launched that November) uses about a thousandth of the active solar cell material compared to traditional silicon-based PV panels.

The firm adds that, in solar-rich regions like Northern Mexico, its CPV technology yields much more energy than other technologies, but with an extremely light environmental footprint, it is claimed.

www.solfocus.com
www.cocef.org

Soitec allies with Johnson Controls for utility-scale PV

Soitec Group of Bernin, France, which makes engineered substrates including silicon-on-insulator (SOI) wafers (as well as III-V epiwafers through its Picogiga International division), says that its concentrator photovoltaic (CPV) system making division Concentrix Solar GmbH of Freiburg im Breisgau, Germany has concluded a global alliance with Johnson Controls, which delivers products, services and solutions for increased building energy efficiency.

Concentrix was founded in 2005 as a privately held spin-off of the Fraunhofer Institute for Solar Energy Systems ISE, before about 80% of its shares were acquired by Soitec last December. Its high-efficiency CPV technology (with two-axis tracking) is designed for use by large-scale solar power plants in hot and arid regions with high direct solar irradiation. Johnson Controls provides turnkey project development, engineering, procurement, construction, operation and maintenance of large energy efficiency and renewable energy projects.

Under the new collaboration, Johnson Controls and Concentrix Solar aim to identify and respond to commercial opportunities for the project development and construction of utility-scale solar energy facilities. Johnson Controls will build, operate, maintain and provide life-cycle support for solar installations using Concentrix's CPV technology.

The combination of the respective strengths of both firms (efficient and cost-effective technology on the one hand, and expertise in energy efficiency and sustainability on the other hand) should accelerate and widen the installation of solar renewable energy utility-scale plants in direct normal irradiation (DNI) regions worldwide.

"Before forming our alliance with Concentrix Solar, we studied all primary solar technologies and market participants," says Iain Campbell, Johnson Controls' VP & general manager of Global Energy and Workplace Solutions. "We concluded that the combination of Soitec's technical capabilities in engineered substrate solutions and Concentrix Solar's module design together provides the market-leading solution for solar power generation in high-DNI regions around the world."

Johnson Controls shares Soitec's vision for sustainable and economically viable, solar renewable energy, comments Soitec's chairman & CEO André-Jacques Auberton-Hervé. "Together, we understand the market opportunity and positive environmental impact that solar renewable energy power will bring to both existing and future facilities."

Concentrix Solar exhibited at the Solar Power International show in Los Angeles (12–14 October).

www.concentrix-solar.de
www.johnsoncontrols.com

New York State's NYSERDA funds Magnolia for Phase II of nanostructured thin-film PV contract

Office opened at Albany Nanotech for collaboration with CNSE & RPI

Magnolia Solar Corp of Woburn, MA, USA says that its subsidiary Magnolia Solar Inc has received funding from the New York State Energy Research and Development Authority (NYSERDA) for Phase II of an existing three-phase $1m development program (begun in March with Phase I) to demonstrate high-efficiency nanostructured thin-film solar cells.

Magnolia Solar Inc was founded in 2008 to commercialize nano-technology-based, high-efficiency, thin-film technology that can be deposited on glass or other low-cost flexible polymer substrates. The firm says that its technology — which uses non-toxic nitride-based materials — can capture a broader spectrum of the sun's energy and incorporates a unique nanostructure-based anti-reflection coating to reduce energy losses, boosting the solar cell's efficiency and reducing the cost per watt.

The Phase II funding was approved after the Magnolia team met the Phase I milestones for the development of nanostructure-based thin-film solar cells. These included the demonstration of tunable anti-reflection coatings for solar cells on glass substrates and the development of nanostructured absorber materials to capture a larger part of the solar spectrum for the high-efficiency solar cell development. For the Phase II efforts, Magnolia will continue optimizing this unique solar cell technology.

Magnolia has also opened an office at the Albany Nanotech complex on the campus of University of Albany (State University of New York) in order to allow staff to collaborate closely with the development team members at the SUNY Albany's College of Nanoscale Science and Engineering (CNSE) as well as Rensselaer Polytechnic Institute (RPI) in Troy, NY, and to better capitalize on the characterization facilities available in the New York capital region.

"Progress to Phase II represents completion of an important milestone in our development program," says Magnolia's president & CEO Dr Ashok K. Sood. "We are committed to growing in the Albany region, leveraging the tremendous infrastructure at the Albany Nanotech Center," he adds. "We intend to provide environmentally responsible, low-cost solutions for the solar power industry and to be part of the New York state's energy future."

www.MagnoliaSolar.com

OPEL and TRUENORTH to install solar fields on brownfield sites across North America

OPEL Solar Inc of Shelton, CT, USA and Toronto, Ontario, Canada, which makes high-concentration photovoltaic (HCPV) panels, and TRUENORTH Solar & Environmental LLC of Preston, CT, USA, a Native American company that designs and installs solar products and supporting technologies, have announced a strategic partnership to install utility-scale solar fields on brownfield sites across North America that have been deemed otherwise unusable.

Expansion or redevelopment of brownfield sites (generally defined as abandoned or underused industrial and commercial facilities available for re-use) is usually complicated by real or perceived environmental contamination.

OPEL says that, by installing solar installations on urban brownfield sites, cities and municipalities can transform blighted, unusable areas of land into productive green energy fields that address the growing need for energy in urban areas as well as help utilities address clean energy mandates.

"We see this initiative as another example of our strategy to enhance shareholder value by continuing to uncover new, expanded market opportunities for providing our solar technology expertise," says OPEL Solar's CEO Leon M. Pierhal. OPEL's solar solutions for these fields includes a total 'package' of services such as land assessment, engineering, EPA assistance, remediation or mitigation of the land, installation, utility company cutover and funding or power purchase agreement (PPA) assistance.

OPEL will provide its patented HCPV solar panels and tracker systems to the projects while TRUENORTH Solar will handle the land remediation and installation.

The Environmental Protection Agency (EPA) has estimated that site cleanup revenue, for companies doing the clean-up, can amount to $6–8bn annually, as experts forecast that there may be as many as 4000 brownfields in the USA (roughly equivalent to 30,000 football fields). Add in Superfund sites and the Resource Conservation and Recovery Act sites and the total jumps to more than 14 million acres that could be redeveloped as renewable energy sites.

An OPEL HCPV solar tracker.

"TRUENORTH principals see great potential for solar energy and its ability to bring renewable energy to communities throughout North America at a reasonable cost. At the same time we also see the untapped potential for using brownfields as a business development asset for creating clean energy sites," says Roland J. Harris, a principal of TRUENORTH.

OPEL will provide its patented HCPV solar panels and tracker systems to the projects while TRUENORTH Solar will handle the land remediation and installation

"Three companies formed TRUENORTH, exclusively for capitalizing on the solar energy opportunity while also enabling the remediation of brownfields," he adds.

"We want to work exclusively with OPEL Solar in New England to transform the land into solar energy fields," adds fellow TRUENORTH principal Timothy Bartha. "OPEL Solar has the expertise to manage the total project."

OPEL is looking for additional firms like TRUENORTH to be strategically placed throughout North America, and plans to announce such alliances as they develop.

"Complemented by several world-class partners who share our vision and desire to give back, OPEL Solar can manage the process of transformation for brownfields for communities and agencies that simply do not know where to begin," says Pierhal. "Not only will it generate revenue for OPEL and bring positive land remediation for communities across North America, it will also generate jobs for North Americans and get local manufacturers and suppliers moving again to support the solar development of brownfields."

Pierhal says that since announcing OPEL's Brownfield Initiative in July, he has received calls from around the world asking for assistance in establishing similar directives.

As the commitment to rejuvenate otherwise 'dead' land deepens, a broad spectrum of federal and state government grants, financing and investment incentives are available for redevelopment and remediation of these sites, says OPEL. A sample of the primary federal agencies involved includes: the EPA, the Department of Energy (DoE), the Department of Defense (DoD), the Bureau of Land Management, the US Forestry Services, the Bureau of Mines, and the Bureau of Reclamation.

www.opelinc.com

Spanish CPV firms to build Ohio production facilities

49.9MW solar array being developed on reclaimed strip mine

Ohio state governor Ted Strickland has announced agreements to create Turning Point Solar LLC, a 49.9MW solar array to be built on strip-mined land adjacent to The Wilds nature conservancy in south-eastern Ohio which, If operating today, would be the USA's largest photovoltaic array.

At signing ceremonies in Governor Strickland's cabinet room, Michael G. Morris, CEO of American Electric Power (AEP) of Columbus, OH — which is one of the USA's largest electric utilities — signed a memo-randum of understanding with Turning Point Solar LLC joint venture partners New Harvest Ventures (a renewable energy development firm led by Woodland Venture Management co-founders David Wilhelm and Craig Overmyer) and Agile Energy Inc of San Bruno, CA (which develops utility-scale photo-voltaic plants in North America) to enter into a 20-year purchase agreement for the facility's entire power output.

Pending approval of incentives to be provided by state and local gov-ernments, Spanish firms Isofoton of Malaga (which makes large, 275W concentrated photovoltaic panels) and Prius Energy S.L. of Albacete (which produces sun tracking equipment and racks for panels) have agreed to open new manufacturing facilities in Ohio to help construct the 239,400 panel solar array. About 300 jobs will be needed to build the project at peak construction. Prius and Isofoton have also agreed to locate their North American operations in Ohio, creating more than 300 permanent manufacturing jobs.

"The factory will be built with local suppliers for local end-users, and with a mandate to create good and green local jobs in close partnership with Ohio's public sector energy leaders and private sector utilities," says Isofoton's CEO Angel Luis Serrano. "We look forward to becoming a dedicated contributor to Ohio's economy, putting locally manufactured Isofoton PV cells on Prius trackers," he adds.

Ohio state governor Ted Strickland inspecting a solar installation.

"Turning Point Solar will bring renewable energy to Ohioans at a reasonable rate, utilize reclaimed mine land in an innovative way, and bring new construction and manu-facturing jobs to Appalachian Ohio," says New Harvest Ventures partner David Wilhelm.

At the end of September, Strickland signed an executive order eliminat-ing Ohio's tangible personal prop-erty tax and real property tax for advanced and renewable energy project facilities, with the aim of making it easier for energy compa-nies to do business and create jobs in Ohio. In 2008, he also signed an energy reform bill (Ohio Substitute Senate Bill 221) that calls for 25% of all energy consumed by Ohioans to come from advanced energy sources by 2025. Of that, 0.5% must be solar energy.

Construction and commercial operation of the facility will be phased in over three years. About 20MW should be in commercial operation by late 2012, 15MW added by the end of 2013, and the remaining 14.9MW online by the end of 2014.

Turning Point Solar is using a tract of at least 500 acres of reclaimed land strip-mined by the Central Ohio Coal Company between 1969 and 1991 using the Big Muskie, then the world's largest dragline and one of the world's largest mobile earth-moving machines. Big Muskie removed over 608 million cubic yards (465,000,000m^3) of overburden (twice as much earth as was moved during construction of the Panama Canal).

Turning Point Solar is adjacent to The Wilds wildlife park (which was created from 10,000 acres of the reclaimed land and opened in 1994), and occupies about 1000 fallow acres of the reclaimed land owned by the nature conservancy and the AEP. Prairie planting tests are currently being conducted as part of plans to transform the land under the solar panels into an organic carbon sink. "We can restore our land while we improve our energy diversity and security," comments Wilds executive director Evan Blumer. Zane State University and Hocking College have both developed programs to train workers in green jobs programs, including the essential skills needed to build and maintain solar operations such as Turning Point.

http://turningpointsolar.com

GaAs (SI & SC) SUBSTRATES

Ge SUBSTRATES

RAW MATERIALS

InP (SI & SC) SUBSTRATES

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Enbridge and First Solar complete world's largest photovoltaic facility and start up commercial operation

Energy distributor Enbridge Inc of Calgary, Alberta, Canada and 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, have completed the expansion of the Sarnia Solar Project (near Sarnia, Ontario) from 20MW of capacity to 80MW and initiated commercial operation, making it the world's largest operating photovoltaic facility. The expansion (involving a total system cost of about CDN$300m) was announced last December after the initial 20MW solar energy project achieved full commercial operation.

"With this project, we expect to install 145MW this year in North America," says Frank De Rosa, First Solar's senior VP of North American project development.

Enbridge owns and operates Canada's largest natural gas distribution company, providing distribution services in Ontario, Quebec, New Brunswick and New York State, and operates the world's longest crude oil and liquids transportation system, but is expanding into renewable energy technologies.

In October 2009, Enbridge agreed to acquire the initial 20MW solar energy project that First Solar had developed at the Sarnia site. First Solar developed the solar project under a fixed-price engineering, procurement and construction contract, and also provides operations and maintenance services to Enbridge under a long-term contract.

Sarnia Solar Project, expanded to 80MW, on a 950 acre site.

The Sarnia Solar Project comprises 1.3 million modules covering a total surface area of 966,000m^2 on a 950 acre site. At 80MW, Enbridge expects it to generate 120 million kW-hr of power annually (saving more than 39,000 tonnes per year of CO_2). Output is being sold to the Ontario Power Authority pursuant to 20-year power purchase agreements under the terms of the Ontario Government's Renewable Energy Standard Offer Program.

From left to right: Al Monaco (Enbridge's executive VP, Major Projects & Green Energy), Brad Duguid (Ontario Energy Minister), Maria Van Bommell MPP; and Frank De Rosa (First Solar's senior VP of Project Development, North America) at Sarnia's grand opening.

On 4 October, Enbridge held a Grand Opening of the Sarnia Solar Project attended by Ontario Energy Minister the Honourable Brad Duguid and Maria Van Bommell MPP, along with Al Monaco (Enbridge's executive VP, Major Projects & Green Energy) and Frank De Rosa (First Solar's senior VP of Business Development).

www.enbridge.com

First Solar's announces 380MW rise in orders for 2011

First Solar has signed agreements with seven key customers for a 380MW increase in orders for 2011 over previously announced volumes. The expanded contracts are with existing customers and will serve predominantly European markets.

"Our customers continue to expect robust growth in the market for solar electricity in Europe next year," says Stephan Hansen, managing director of First Solar's European sales & customer service organization. "The additional volumes will allow First Solar to continue to scale and contribute to making solar electricity more affordable globally," he believes.

The new contracts were all signed in recent weeks and follow announcements that First Solar is planning to add manufacturing capacity in Germany and France to better meet local demand and to encourage the development of the market for utility-scale solar power.

www.firstsolar.com

First Solar to build manufacturing plants in US and Vietnam totaling nearly 500MW in annual capacity

Total CdTe PV module capacity to almost double to 2.7GW by 2012

To help it to meet what it describes as strong demand, First Solar Inc of Tempe, AZ, USA, which makes thin-film photovoltaic modules based on cadmium telluride (CdTe) as well as providing engineering, procurement and construction (EPC) services, has announced plans to build two new four-line manufacturing plants that will boost its annual manufacturing capacity by nearly 500MW.

The plants are expected to be built in the USA and Vietnam and completed in 2012. Each should create about 600 new jobs and be designed to accommodate additional production capacity. Negotiations and site assessments are ongoing in both countries and will be finalized and announced at a later date.

The new factories will further extend First Solar's previously announced capacity additions, including eight lines at its facility in Kulim, Malaysia, four lines in Frankfurt an der Oder, Germany, and two lines in Blanquefort, France.

Earlier this year the firm also completed an expansion of its manufacturing plant in Perrysburg, OH, USA, which serves as its primary hub for engineering, R&D, and employs more than 1100 of the firm's 1500+ US-based associates.

The two newly announced plants, combined with these previously announced expansions, will nearly double production capacity from 1.4GW in 2010 to more than 2.7GW in 2012.

"These expansions provide proximity to growing US demand while supporting our roadmap to drive down the cost of clean, sustainable solar electricity," says CEO Rob Gillette. "Effective government policies provide long-term visibility and enable sustainable markets," he adds.

In addition to the increase in manufacturing employment, First Solar expects to generate more than 1000 construction jobs through the installation of solar power plants from the firm's 2.2GW North American project pipeline.

www.firstsolar.com

First Solar doubles revolving credit facility to $600m

First Solar has amended its existing senior secured revolving credit facility, increasing it from $300m to $600m.

Also, the term of the facility, which was oversubscribed, has been extended from three to five years and will mature in 2015. First Solar intends to use the facility for general corporate purposes, including the issuance of letters of credit.

The facility was agreed on between First Solar and a syndicate of 13 international financial institutions. J.P. Morgan Securities Inc and Bank of America/Merrill Lynch were joint lead arrangers/book runners.

Ultrasonic launches spray system for CdTe PV making

Ultrasonic spray coating equipment maker Ultrasonic Systems Inc (USI) of Haverhill, MA, USA has launched the PV-480 system for high-volume, precision coating of glass plates in cadmium telluride (CdTe) photovoltaic module manufacturing.

The PV-480 leverages USI's proprietary, nozzle-less ultrasonic spray head technology for what is claimed to be thinner, more uniform coating deposition versus conventional spray technologies. Optimized for high-volume in-line manufacturing, the system can process glass plates up to 48 inches wide at speeds of up to six feet per minute.

Ultrasonic Systems Inc's new PV-480 system for coating glass plates in CdTe PV module making.

The PV-480 delivers liquid coating with transfer efficiencies in excess of 90%, using a traversing Ultra-Spray blade head. The versatile system suits the application of cadmium chloride solution and anti-reflective coatings, as well as other low-viscosity liquids. It can be operated in-line or stand-alone, and is easy to control via a touch-screen user interface. USI says that its coating systems are industry proven, with more than 2500 installed worldwide in multiple markets.

"The PV-480 extends our unique nozzle-less spray head technology to glass plate applications critical to CdTe thin-film solar production," says president Stuart Erickson.

www.ultraspray.com

IN BRIEF

First flexible monolithic CIGS PV maker with external IEC certification

Ascent Solar Technologies Inc of Thornton, CO, USA says it has become the first manufacturer of thin-film flexible monolithically integrated copper indium gallium diselenide (CIGS) modules to receive full IEC 61646 certification, upon completion of environmental testing conducted by an independent laboratory. The modules passed the complete range of tests required, including the standard of 1000 hours of damp heat testing (85% relative humidity and 85°C temperature) set forth by IEC for performance and long-term reliability.

Ascent Solar says that this opens the door for it to penetrate building-integrated photovoltaic (BIPV) and building-applied photovoltaic (BAPV) applications for commercial, industrial and residential rooftop markets. BIPV is the fastest-growing PV segment, and should grow to $6.6bn by 2015, according to analyst firm Nanomarkets.

"We are now looking forward to demonstrating our ability to compete with existing technologies currently being used for large commercial, industrial and residential rooftop applications by adding new beta-site installations in addition to those completed with existing and new potential customers that have been waiting for this development," says Ascent Solar's president & CEO Dr Farhad Moghadam. "We have a significant advantage when it comes to power-to-weight ratios and the real capability our product has to reduce balance of systems costs, in turn reducing overall system installed cost to the end customer," he adds.

www.ascentsolar.com

DelSolar and IBM to jointly develop solar cell technology

Collaboration builds on CZTS work with TOK

DelSolar Co Ltd of Hsinchu Science-Based Industrial Park, Taiwan (a subsidiary of Delta Electronics) has signed an agreement with IBM Corp of Yorktown Heights, NY, USA to jointly develop compound semiconductor thin-film photovoltaic cells. The collaboration includes leveraging DelSolar's existing expertise in photovoltaic technology and processing as well as IBM's semiconductor technology and materials science know-how.

"This agreement is a significant step in the progress of our effort to create efficient solar cells using earth-abundant materials with novel processes," says T.C. Chen, VP of Science and Technology at IBM Research. "We already have an excellent collaboration with Tokyo Ohka Kogyo Company Ltd [TOK] for developing manufacturing tooling and the chemistries required for this technology," he adds. "Recently, IBM demonstrated record solar cell efficiencies using a copper zinc tin sulfur selenide (CZTS) material. This new collaboration between DelSolar, TOK, and IBM now puts us firmly on the path to commercially viable technologies and processes for solar cells that could bring us closer to grid parity."

Existing thin-film solar cell technologies are based earlier on amorphous silicon, cadmium telluride (CdTe) and copper indium gallium diselenide (CIGS). DelSolar says that it has not engaged in thin-film solar cell manufacturing until now partly because most of the commercially available technologies are of low efficiency or contain expensive materials or elements of limited projected availability. In addition, most existing compound semiconductor thin-film solar cells on the market still use cadmium as the photovoltaic conversion layer or buffer layer. In contrast, the new CZTS technology is based on inexpensive, earth-abundant components, circumventing the need for cadmium (which is toxic) or materials such as indium or tellurium (whose availability may be questionable for the high volume growth anticipated in the future).

"CZTS-based solar cells are a promising technology that can help ensure stable cost and a shorter path to grid parity," believes TOK's president & CEO Yoichi Nakamura. "Working with DelSolar, who has a strong PV and power management background, we have much greater capability to release this important technology to the market," he adds.

"DelSolar is pleased to combine forces with IBM and TOK for the joint-development of the game-changing technologies to enable grid-parity PV products," says DelSolar's chairman & CEO R.C. Liang. "We have confidence to achieve the agreed upon target by combining the complementary technical skills and synergies that exist among all three companies."

With the benefit of non-toxic and earth-abundant components the technology can also offer the benefits of broader spectrum sensitivity, lower working irradiance, broader temperature latitude and significantly higher net power output, it is reckoned. The light-absorbing properties can also be fine-tuned by modifying the composition of the photovoltaic conversion layers. Light in weight, the new cell will also be flexible when used with a flexible base material. A diverse range of applications for the new cell could include vaulted roof tops, curved glass curtain walls, other non-flat BIPV applications, or even extended applications such as curtains, shutters, chargers on clothing, and consumer electronics, the firms claim.

www.delsolarpv.com

Solyndra launches fast, easy-to-install rooftop system

At the Solar Power International 2010 show in Los Angeles (12–14 October), Solyndra Inc of Fremont, CA, USA, which makes copper indium gallium diselenide (CIGS) photovoltaic (PV) systems consisting of panels and mounting hardware for commercial rooftops, is launching the Solyndra 200 Series, which builds on technology proven on more than 500 rooftops worldwide to offer what is claimed to be fast, simple installation (coming complete with all mounting hardware included), a low distributed load, and low overall installed cost.

"The simple connection system allows the panels and mounts to snap together easily and significantly reduces balance-of-system costs," says president & CEO Brian Harrison. "Because the 200 Series requires no tools for installation, it is the fastest and easiest-to-install flat rooftop solar system available," he claims. "The 200 Series also demonstrates the strength of our product roadmap and ability to continue to increase panel power while lowering the cost of electricity and improving the return on investment," he adds.

Building owners with older or 'value engineered' rooftops benefit from the lightweight panels (roof load of 2.8lbs/ft^2), which have no need for penetrations or ballasting and can be installed much faster than flat panels on a typical roof, it is claimed, minimizing business disruption during installation and reducing labor costs. Shorter project duration also benefits installers who can complete more projects during critical seasons. The use of 80% fewer parts per kW than previous systems and the elimination of array grounding further lowers the balance of system (BoS) costs.

Solyndra 200 Series panel and mount.

One of the first 200 Series installations in the USA was performed by Panelized Solar, a Gold Solyndra Solutions Provider. "We knew the tool-free design would be fast, but we were still surprised by how fast and easy the 200 Series was to install," says Panelized Solar's president Keith Coonce. "Our installation team was able to finish the 238kWp installation of more than 1100 panels in just three days."

Solyndra says that optimized light collection and enhancements to the module improve the 200 Series panel's ability to capture direct, diffuse and reflected sunlight across the 360º photovoltaic module surface, making it the firm's most powerful panel (a design augmented further if combined with a reflective 'cool roof'). The wider spacing of the modules and the Solyndra design offers 'broader shoulders' or more uniform energy collection throughout the day than traditional flat panels, the firm claims.

The cylindrical module shape also allows Solyndra panels to be placed horizontally and significantly closer together than conventional panels. Panels can be oriented in virtually any direction, offering greater flexibility for rooftop applications. Solyndra says that the design of its systems also provides superior wind, soiling and snow performance. By allowing the wind to flow through the modules, Solyndra 200 Series panels require no penetrating mounts in winds up to 130mph.

www.solyndra.com

Frito-Lay's 1MW system becomes Solyndra's largest US installation

Solyndra has supplied its largest installation in the USA, a 1MW system on the rooftop of a plant in Modesto, CA owned by Frito-Lay North America Inc of Dallas, TX (the $13bn convenient foods business unit of PepsiCo).

Completed in just eight weeks, the Frito-Lay project consists of about 5600 panels, covering 247,000ft^2. At peak production, the system should reduce the plant's electricity use from outside sources by 25%, as well as reducing CO_2 emissions by 1000 metric tons per year.

"Frito-Lay is utilizing innovative technologies and renewable energy such as solar power to help minimize our impact on the environment," says Frito-Lay Modesto's technical manager Thomas Melead. "The Solyndra PV system allows us to maximize one of California's greatest natural assets — the sun – to take some of the plant off of the electrical grid."

"Frito-Lay is a tremendous example of a corporation showing its commitment to sustainability by taking advantage of unused roof space to implement a powerful renewable energy system," says Solyndra's CEO Brian Harrison. "They now have a large clean, quiet, emission-free power plant."

In addition to Solyndra, the system was installed with the support of Panelized Structures Inc, a Solyndra Certified Solutions Provider, and Pacific Solar Energy.

"The fast and easy installation of Solyndra panels ensured minimal business disruptions and allowed us to meet a very aggressive installation deadline," comments Keith Coonce, president of Panelized Structures Inc (Panelized Solar).

The rooftop system is the Modesto facility's second solar project. In 2008, it unveiled a five-acre solar concentrator field consisting of 54,000ft^2 of concave mirrors.

www.fritolay.com

BeZnCdSe pure-green 545nm laser with threshold current density of 1.7kA/cm²

II-VIs yield laser threshold current lower than long-wavelength nitrides.

Researchers in Japan have produced low-threshold-current green laser diodes using elements from groups II and VI of the periodic table, namely beryllium (Be), zinc (Zn) and cadmium (Cd) group II and selenium (Se) from group VI [Jun-ichi Kasai et al, Appl. Phys. Express, vol3, p091201, 2010].

Although research into II-VI semiconductor blue and green light-emitting devices has a long history, it has become eclipsed in recent times by the nitride III-V semiconductors using gallium (Ga), indium (In) and aluminum (Al).

A particular problem for II-VIs is creating long lifetimes for the resulting devices. It is hoped that using Be in such structures will increase device lifetimes because the resulting materials have a higher degree of 'covalency' in their chemical bonds. Higher ionicity (i.e. the opposite of covalency) in nitride devices leads to high spontaneous and piezoelectric (strain-dependent) polarization electric fields that can degrade emission efficiency.

Recently, nitride semiconductors have been used to create longer-wavelength devices than the blue–violet comfort zone by increasing the indium content of the quantum wells. However, there is a series of problems with such devices, such as efficiency droop in light-emitting diodes and relatively high threshold currents in laser diodes (Figure 1). The longest laser wavelengths for nitride lasers (~530nm) have been achieved with pulsed operation that is used to avoid self-heating effects. Continuous operation would be wanted for applications.

Green laser diodes are particularly desired for display devices. Presently, green laser light in overhead projectors uses inefficient frequency doubling of infrared laser light from semiconductor diode sources. Nitride researchers are struggling to fill this green gap with efficient direct LD emitters.

The researchers from Japan's National Institute of Advanced Industrial Science and Technology (AIST), Hitachi and Sony have used their II-VI technology to produce low lasing current density thresholds of just 1.7kA/cm^2 with a pure green emission wavelength of 545nm.

The laser diode structure (Figure 1) was grown on (001) n-type gallium arsenide (n-GaAs) substrates

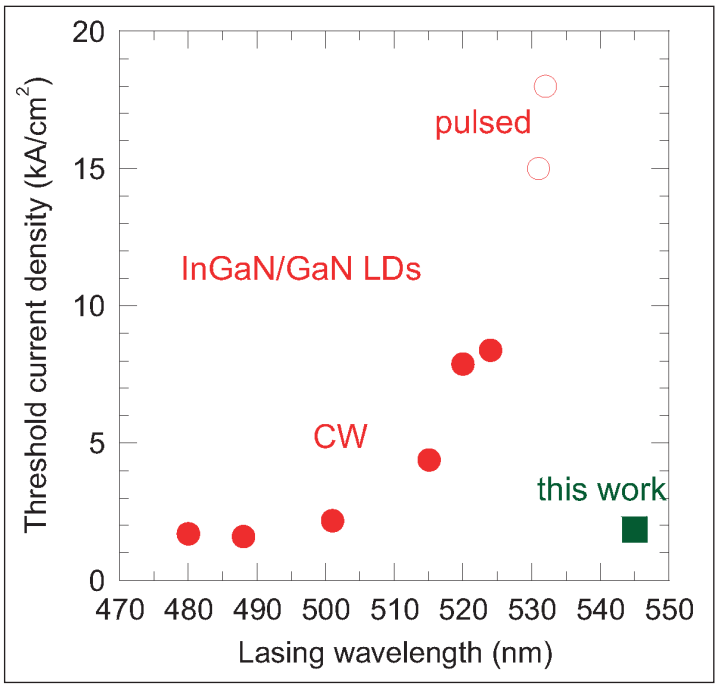

Figure 1. Threshold current density vs lasing wavelengths as achieved by various groups using InGaN LDs and (square) the new BeZnTeSe device. Solid and open circles: continuous- and pulsed-wave, respectively.

using molecular beam epitaxy (MBE). The silicon-doped n-GaAs III-V buffer layer was grown in a separate chamber from the remaining II-VI layers. The latter were grown using elemental material in the effusion cells of the MBE machine. The n- and p-type doping came from zinc chloride ($ZnCl_2$) and nitrogen, respectively.

The researchers used a separate confinement heterostructure (SCH) to provide optical confinement. The active layer consisted of a single well of BeZnCdSe material in an optical waveguide consisting of BeZnSe.

As is often the case with compound semiconductors, the p-type doping is more complicated than that for n-type material. A short-period superlattice (SPSL) consisting of a series of layers of RF-plasma-activated nitrogen-doped BeMgZnSe and ZnSe was used to achieve a higher p-type carrier concentration of 2x1017/cm^2, as estimated from capacitance–voltage measurements. The energy bandgap in the cladding layers was ~2.85eV (~435nm, blue–violet).

A BeTe buffer layer was used to reduce defects extending from the II-VI/GaAs interface into the laser diode structure. Such defects tend to damage laser diode performance. An ohmic p-type contact was formed using a nitrogen-doped BeTe/ZnSe pseudo-graded superlattice.

The quality of the crystal layers that were produced was evaluated using high-resolution x-ray diffraction. Rocking curve measurements showed that the cladding and optical waveguide layers deviated from the base GaAs crystal structure by less than 0.1%. The quantum-well lattice mismatch was 2.2%. The SPSL satellites in the rocking curve are described as 'sharp', indicating successful growth.

Gain-guided laser diodes were constructed from the epitaxial material. Two groups of lasers were constructed: one with 5μm-wide cap and contact mesas; the other, with 2μm-wide structures, was designed to reduce the width of the current path. The p-type contact metal layers were titanium/platinum/gold and the n-type layers were gold-germanium and gold. The cavity was 800μm long. The facets were coated with high-reflectivity dielectric. The laser diodes were mounted on copper heat-sinks, n-side down.

Continuous wave (CW) operation resulted in laser operation with a threshold current of 68mA and forward voltage of 10.4V for 5μm-wide devices. This corresponded to a threshold current density of 1.7kA/cm^2. For the 2μm-wide laser diode, the threshold decreased to 52mA.

The abruptness of the light output power at threshold suggests that the BeZnCdSe QW layer was not uniform in composition. It is believed that this is the result of the selenium source in the MBE machine being a Knudsen cell, which does not allow adequate optimization of the II/VI beam pressure ratio. The researchers suggest that a valved effusion cell could improve material quality.

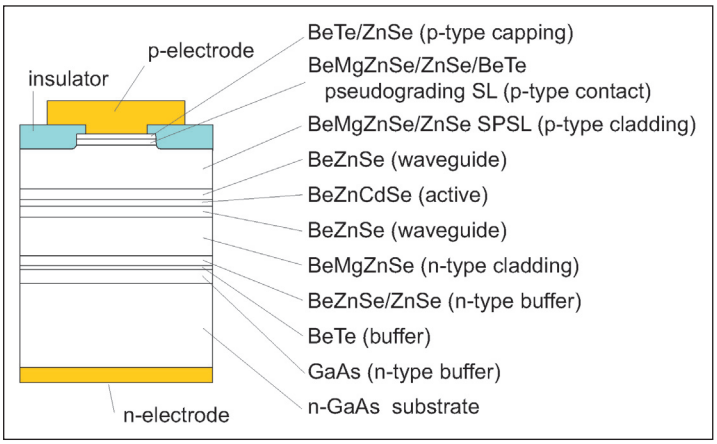

Figure 2. Schematic of BeZnCdSe QW laser diode.

There were also some kinks in the light output curve with increased current, possibly arising from the gain guiding structure being slightly wider than desired. The light output power is about 19mW at 100mA in the 5μm laser diodes.

The forward voltage is about twice as high as that achieved in 1998 for blue–green ZnCdSe LDs (5.3V). The researchers believe that the forward voltage of their green LD could be improved using an optimized BeTe/ZnSe pseudo-grading.

The researchers point out that room-temperature CW operation of ZnCdSe/ZnSe/ZnMgSSe single-QW SCH LDs at a wavelength of 524nm with a threshold current density of 1.4kA/cm^2 was achieved in 1993. Using their own system, they envisage that reducing the cadmium content in the well could reduce the strain in the active layer, giving shorter-wavelength devices without increasing the threshold current.

http://apex.ipap.jp/link?APEX/3/091201

The author Mike Cooke is a freelance technology journalist who has worked in the semiconductor and advanced technology sectors since 1997.

UCSB achieves CW operation of AlGaN-cladding-free nonpolar lasers

UCSB reports the first continuous-wave operation from pure-blue nonpolar nitride lasers with GaN-only cladding.

University of California Santa Barbara (UCSB) has succeeded in producing continuous-wave pure-blue (461nm) nonpolar (m-plane) laser diodes without using aluminum gallium nitride (AlGaN) cladding [Kathryn M. Kelchner et al, Appl. Phys. Express, vol3, p092103, 2010].

AlGaN cladding is used in commercial laser diodes since such layers have a suitable refractive index contrast to allow the indium gallium nitride or gallium nitride (InGaN/GaN) waveguide layers to confine the optical field and create the conditions for stimulated (laser) emission. However, there are a number of problems arising from its use.

Thick layers of AlGaN are slow to grow and have a large lattice mismatch with the underlying GaN crystal structure. The lattice mismatch tends to result in cracking of the layer as the thickness of the AlGaN layer increases. Also, p-type doping with magnesium is less effective than for pure GaN, leading to higher operating voltages and energy loss. Further, the aluminum precursors used to grow AlGaN can cause parasitic reactions in some reaction chambers.

The focus of present nitride laser diode development is for full-color display and mobile projector systems. Nitrides already provide the blue component, and much work is underway to extend this capability into green wavelengths.

Desired qualities for such laser diodes are spectral purity, thermal stability, efficiency and compactness. Traditional nitride laser diodes grown on c-plane nitride substrates suffer from high internal electric polarization fields due to strain-dependent effects. These piezoelectric polarization fields reduce the recombination efficiency for the electron–hole transitions that produce light. Also, there is a severe blue-shift in the emission wavelength as the injection current increases. The polarization fields can be eliminated by using nitride layers grown in the nonpolar m-plane direction.

Reducing the Al-content in nitride laser diodes has increased the maximum output power and reduced catastrophic optical damage by expanding the optical field in the transverse direction. Reliability studies in arsenide (As) laser diodes show that Al-free devices resist facet degradation and oxidation effects. The UCSB researchers suggest that similar improvements in manufacturability and reliability could be seen for high-power InGaN/GaN laser diodes.

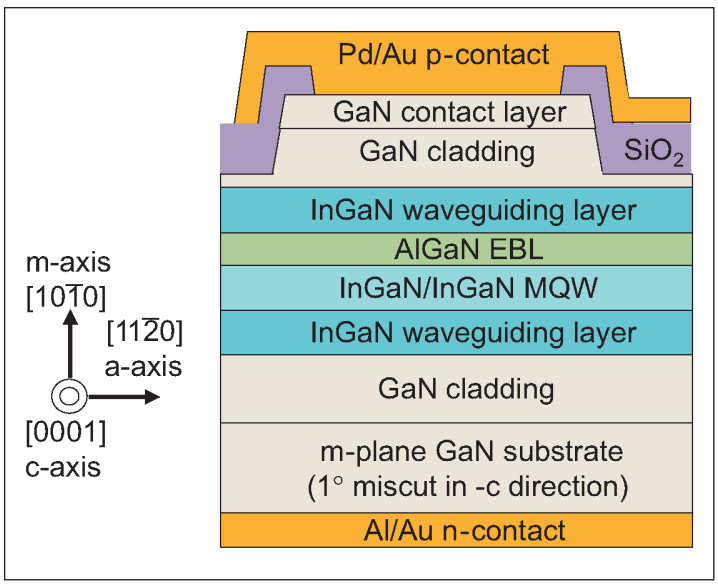

Figure 1. Schematic cross-section of UCSB ridge-waveguide laser diode.

UCSB has been developing AlGaN-cladding-free nitride laser diodes on nonpolar (m-plane) and semi-polar substrates from its first reported device in 2007.

The UCSB laser diode (Figure 1) has an active region consisting of a three-period $In_{0.18}Ga_{0.82}N/In_{0.03}Ga_{0.97}N$ multiple quantum well (MQW) with 5nm wells and 10nm barriers. A 10nm electron-blocking layer (EBL) of p-AlGaN was put on top of the MQW to reduce electron overshoot into the p-contact region. Such overshoot leads to non-radiative emission and reduced laser efficiency.

The 50nm separate confinement heterostructure (SCH) waveguide layers on each side of the active region (Figure 1) consisted of $In_{0.18}Ga_{0.82}N$, doped appropriately with silicon (n-type) and magnesium (p-type). The doped cladding consisted of GaN, 4μm thick on the n-side and 500nm on the p-side. A heavily doped 100nm p-contact layer of GaN completed the structure.

The layers were grown on free-standing low-defect-density m-plane GaN substrates manufactured by Japan's Mitsubishi Chemical Corp using atmospheric-pressure metal-organic chemical vapor deposition (AP-MOCVD). Layer compositions were determined from x-ray diffraction measurements on calibration samples grown separately.

The epitaxial material was processed into 4μm-wide, 500μm-long ridge waveguide laser diodes oriented parallel to the c-direction of the nitride semiconductor crystal structure. Mirror facets on the ends of the laser cavity were produced by coating with high-reflectivity coatings of alternating quarter-wavelength layers of silicon dioxide and tantalum pentoxide (front power reflectivity ~0.85, back ~0.90).

Testing of the device was carried out using on-wafer probing with a temperature-controlled stage. At 20°C, the threshold current for continuous wave (CW) operation (Figure 2) was 87mA, corresponding to a density of ~4.1kA/cm^2. The emission wavelength was 461.1nm, with a full width half maximum (FWHM) of 0.25nm. The threshold voltage was 9.8V. The slope efficiency was 'characteristically low', at 0.3W/A.

The threshold density was lower than previous AlGaN-cladding-free devices and comparable to more tradition m-plane laser diodes with AlGaN cladding. The researchers attribute the improvement to optimized growth conditions and the use of substrates that were intentionally misoriented by 1° towards the [000$\bar{1}$] c-direction. Such misorientation tends to improve the growth process in terms of surface morphology and lateral InGaN uniformity.

Measurements in the spontaneous emission region (below threshold) give a blue-shift of the emission wavelength of 9nm/decade. The researchers comment that this value is smaller than the blue-shift reported for c-plane devices emitting at a similar wavelength and can be attributed to the elimination of the 'quantum confined Stark effect' (QCSE) that arises from piezoelectric polarization fields.

The characteristic temperature of the shift in threshold current (T_0) was determined to be 156K by using pulsed operation (1μs pulse, 0.1% duty cycle) to avoid self-heating effects. This value compares with other nitride pure-blue laser diodes that fall in the range 141–170K. Spectral measurements show a thermally induced red-shift of 0.05nm/K. The estimated thermal impedance of the device was ~60K/W.

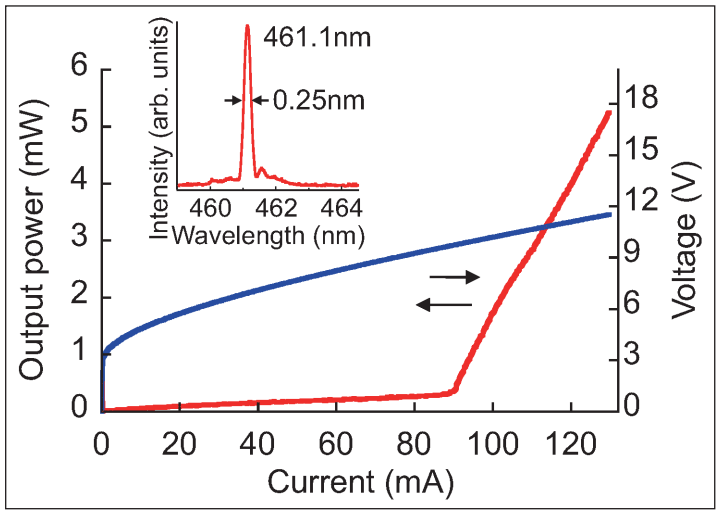

Figure 2. Dependence of output power and voltage on current under CW conditions. Inset: CW lasing spectra.

Apart from using UCSB facilities, the researchers also used funding from the US National Science Foundation (NSF) and the Visible InGaN Injection Lasers (VIGIL) program run by the US Defense Advanced Research Program Agency (DARPA).

http://apex.ipap.jp/link?APEX/3/092103

The author Mike Cooke is a freelance technology journalist who has worked in the semiconductor and advanced technology sectors since 1997.

Semi-polar light extraction comparable to conventional LEDs

UCSB uses conical structures to boost LED output power by up to 2.8x.

Researchers at University of California Santa Barbara (UCSB) have improved the extraction efficiency of LEDs grown on semi-polar nitride substrates to the level of conventional c-plane devices [Yuji Zhao et al, Appl. Phys. Express, vol3, p102101, 2010]. At a drive current of 20mA, the devices emitted 31.1mW, with an external quantum efficiency (EQE) of 54.7%.

Non-polar and semi-polar nitride materials are expected to produce improved light-emitting devices because of reduced spontaneous and strain-dependent (piezoelectric) polarization fields. Such polarization fields tend to pull electrons and holes apart in the light-emitting active region, reducing the chances of recombination occurring as photons.

Semi-polar material has been used to create in the laboratory some of the longest-wavelength-emitting nitride LEDs (up to ~531nm, green), where conventional c-plane material fails to produce working devices. However, up to now the efficiency of semi/non-polar devices emitting blue or violet light has not reached that of traditional c-plane devices.

Often, such devices are limited by the extraction efficiency. The critical angle for the escape cone from a smooth gallium nitride-air interface is low (23°) due to the large difference in refractive indices of the respective substances (2.5/1). Surface texturing/roughening of the gallium nitride (GaN) or sapphire escape surface has been used widely to improve extraction efficiency. These techniques have been widely applied to c-plane devices, but not to the presently non-commercial laboratory demonstrations of semi/non-polar devices.

In their latest work, UCSB (with Kenji Fujito of Mitsubishi Chemical Corp) has produced semi-polar LEDs with conical surface roughening structures that can increase light extraction efficiency and output power by up to 2.8x. The scientists comment: "Semi-polar GaN LED technology is now comparable to commercial c-plane blue LED technology, not only in terms of internal material properties but also in terms of chip processing techniques."

Mitsubishi Chemical supplied the free-standing $(10\bar{1}\bar{1})$ GaN substrates. MOCVD was used to deposit the epitaxial nitride semiconductor structures (Figure 1). The n-type (silicon-doped) GaN contact layer was 1μm thick. A 16nm p-type (magnesium-doped) $Al_{0.15}Ga_{0.85}N$ was deposited after the three-period InGaN/GaN quantum well to block electrons from entering the p-contact region. Such electron overshoot reduces LED efficiency by allowing recombination to occur via routes other than through the desired photon emission. The p-GaN contact layer was 60nm thick. Indium tin oxide (ITO) was evaporated onto the p-GaN.

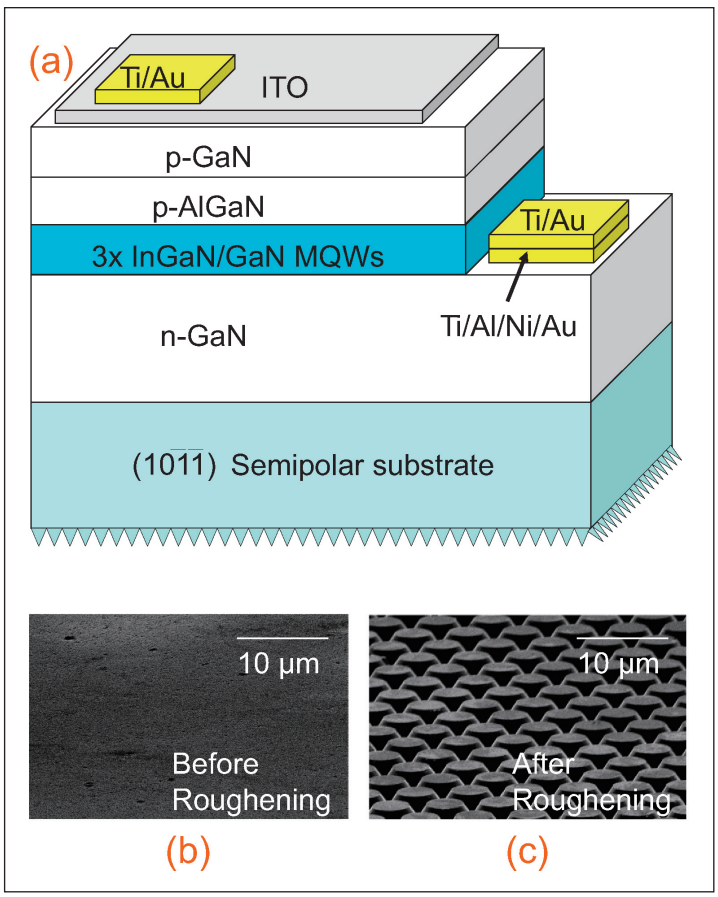

Figure 1. (a) Schematic of semi-polar $(10\bar{1}\bar{1})$ LED device with backside roughening structures. SEM images of the backside of the GaN substrate (b) before and (c) after roughening, from a 10° tilted angle.

LEDs were fabricated by etching 490μm x 292μm and 2000μm x 500μm mesas using a chlorine-based inductively coupled plasma (ICP). The metal contacts were formed using evaporation and lift-off.

The roughening into cone structures was achieved by using lithography and ICP etching. The plasma consisted of a boron trichloride and chlorine mix designed to produce sidewalls with 58° slopes. The roughening

was optimized by varying the density ($5.8x10^5/cm^2$, $9.0x10^5/cm^2$ and $1.6x10^6/cm^2$, with top diameter 3μm) and top diameters (2μm, 3μm and 4μm, with density $1.6x10^6/cm^2$) of the cones. The output power increased with density, but the improvement with feature diameter saturated for 4μm diameter cones.

Comparisons between experiment and ray-tracing simulations suggest that increasing the feature density to $2.0x10^6/cm^2$ could prove beneficial. Although the paper does not give spectral information on the experimental LEDs, the simulations were based on a Gaussian spectrum with a peak emission of 455nm (blue) and full-width at half-maximum (FWHM) of 15nm.

Although the trends were similar between experiment and simulation, the absolute values were discrepant (experimental enhancement over smooth surface was greater). The researchers suggest that this was due to c-plane material parameters without including polarization and birefringence effects of the $(10\bar{1}\bar{1})$ material actually used.

On the basis of the optimization experiments, the researcher created 500μm x 2000μm LEDs with 4μm diameter cones at a density of $1.6x10^6/cm^2$. The chips were diced and assembled into vertical stand transparent packages.

Electroluminescence measurements were carried out at room temperature using a pulsed current source (1% duty cycle) to avoid self-heating effects. The light output power for the packaged LED (Figure 2) measured in an integrating sphere was 31.1mW at 20mA (external quantum efficiency of 54.7%). By 354mA, the external quantum efficiency has dropped to 45.4% (output power 458mW).

The researchers comment: "All of the above numbers are the highest ever reported for semi-polar or non-polar LEDs, and are comparable to those of the best state-of-the-art c-plane LEDs. Moreover, the roughened devices demonstrated a better performance by having a sixfold increase of the output power after packaging, compared with a fourfold increase in the case of conventional devices mainly due to the dramatic enhancement of photon extraction from the backside of the substrate."

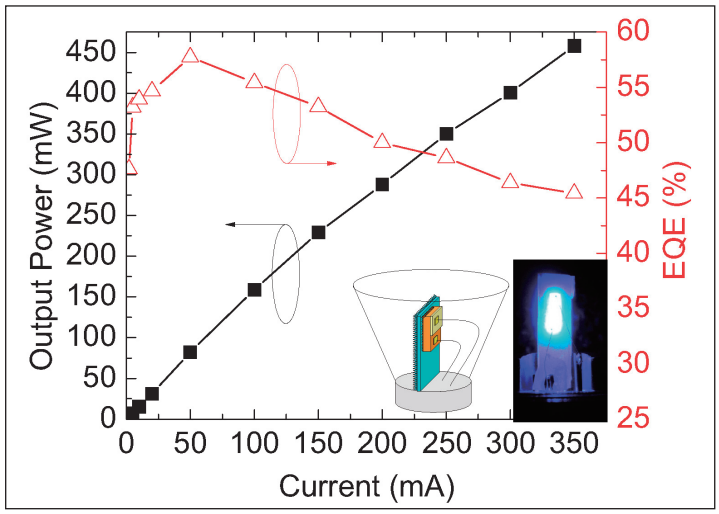

Figure 2. Light output power vs current and EQE vs current for packaged $(10\bar{1}\bar{1})$ LED with backside roughening under pulsed conditions. Insets: schematic graph (left) and optical micrograph (right) of working blue LED in transparent packaging.

On the basis of their work, the UCSB team concludes: "Our work shows that semi-polar devices are now capable of competing with c-plane devices in the visible spectrum and, with future optimization, higher performance can be expected from these devices."

http://apex.ipap.jp/link?APEX/3/102101

The author Mike Cooke is a freelance technology journalist who has worked in the semiconductor and advanced technology sectors since 1997.

Trapezoid wells effect reduced LED droop and lower cross-over point

Korean researchers find trapezoidal-well LEDs emit more light than conventional device at 5A/cm².

Researchers at Gwangju Institute of Science and Technology and Samsung LED in the Republic of Korea have used non-rectangular quantum wells to reduce the efficiency droop effects in blue LEDs [Sang-Heon Han et al, J. Phys. D: Appl. Phys., vol43, p354004, 2010].

A further positive feature of the 'trapezoidal-well' devices that have been produced is that they emitted more light at lower currents than conventional rectangle-well LEDs produced for comparison. As is usually the case, the conventional LED performed better at very low current densities. However, the cross-over point for improved performance from the trapezoidal structure was very low — a current density of just 5A/cm^2. With other attempts at reducing droop effects, the cross-over point can be as high as 80A/cm^2.

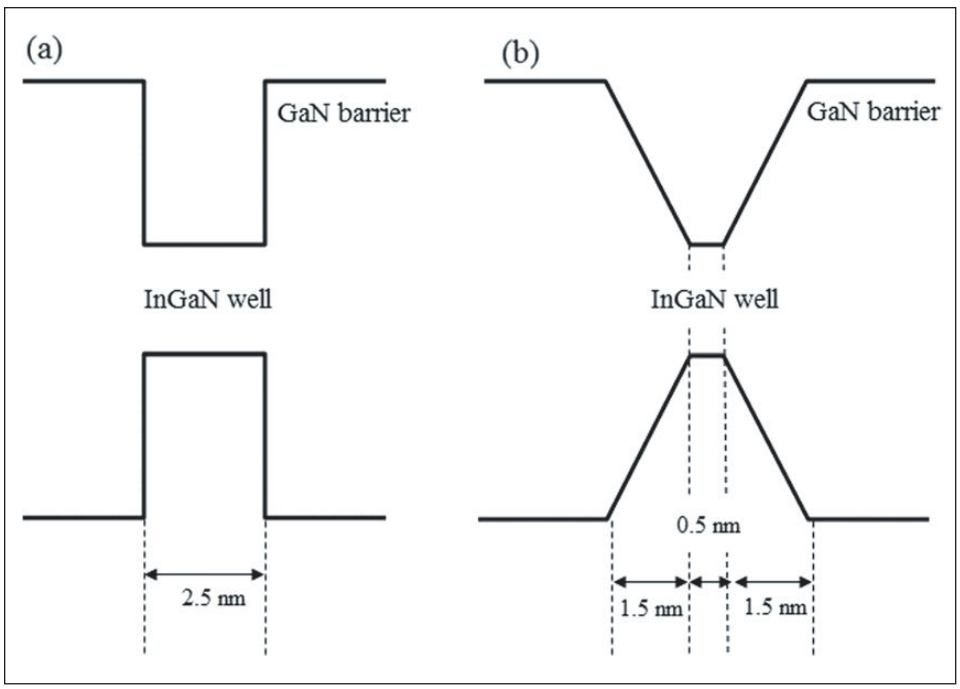

Figure 1. Schematic band diagrams of MQWs of (a) rectangular-shaped well and (b) trapezoidal-shaped well.

MOCVD was used to grow the nitride layers on sapphire substrates. The initial 30nm gallium nitride (GaN) buffer was grown at 570°C, followed by high-temperature annealing. Then 5μm layers of undoped and silicon-doped GaN were grown at 1150°C. The multi-quantum well consisted of five pairs of indium gallium nitride (InGaN) wells (820°C) with GaN barriers (900°C). The trapezoidal wells (Figure 1) were formed by grading the indium fraction for 1.5nm, growing at constant In fraction for 0.5nm, and finishing by grading back to GaN for another 1.5nm. The GaN barriers were 7nm thick. For comparison purposes, LEDs with rectangular wells with InGaN well layers of 2.5nm thickness were also grown. The grading was achieved by varying the flow rate of the trimethyl-indium source. After the wells, a 40nm aluminum gallium nitride (AlGaN) electron-blocking layer and n-GaN contact layers were applied.

The LEDs were made by etching 550μm x 550μm mesas from the material with inductively coupled plasma to expose the n-GaN layer for contacting. The p-GaN layer was coated with indium tin oxide transparent conductor material.

The dominant wavelength of the LED at 20mA injection current was 440nm (blue). The light output power was measured in an integrating sphere so that absolute values could be obtained. The devices were operated in 1ms pulsed mode to avoid self-heating effects. No encapsulation was used.

The maximum external quantum efficiencies were 30.5% at 2A/cm^2 and 30.6% at 12A/cm^2 for the conventional and trapezoidal LEDs, respectively. In additional to having its maximum EQE at higher injection current density, the fall-off beyond the maximum is slower in the trapezoidal device (Figure 2).

Between current densities of 35A/cm^2 and 70A/cm^2 (corresponding to 350mA and 700mA for 1mm x 1mm devices), the EQE of the trapezoidal device is better than the conventional device. The drop in EQE compared with the respective maximum at 70A/cm^2 is 32% for the conventional LED and 19% for the trapezoidal structure. The forward voltage for the trapezoidal structure was also lower than for the rectangular well LED — 4.07V compared with 4.17V at 200mA (66A/cm^2) — giving calculated series resistances of 4.8Ω and 5.2Ω, respectively.

The researchers also performed simulations in an effort to understand how the trapezoidal structure improves performance. The model included the strain-dependent piezoelectric polarization fields that are particularly strong in nitride materials. These fields tend to pull the electrons and holes apart, reducing their chances of recombining to produce light. The overlap of the electron and hole wavefunctions were found to be increased in the trapezoidal structure: 41.6% rather than 37.2% for the conventional rectangular wells. The distance between the maxima was also decreased from 1.5nm to 1.1nm.

Although other researchers have found that increasing the volume of wells can improve light emission, the Korean group point out that their trapezoidal wells are effectively 20% smaller in volume compared with those of the rectangular device. The group comments: "This indicates that the decreased piezoelectric field in trapezoidal wells at high current densities has a more dominant effect on the improvement of efficiency droop compared with the non-radiative Auger effect."

The Auger effect is a recombination mechanism that is often used to explain nitride LED efficiency droop. It involves recombination of the charge carriers that is effected by transferring the energy released to another carrier rather than emitting light. The pure Auger effect is expected to have a very small coefficient, but some researchers believe that it can be enhanced by resonant effects, particularly in longer-wavelength (e.g. green) devices.

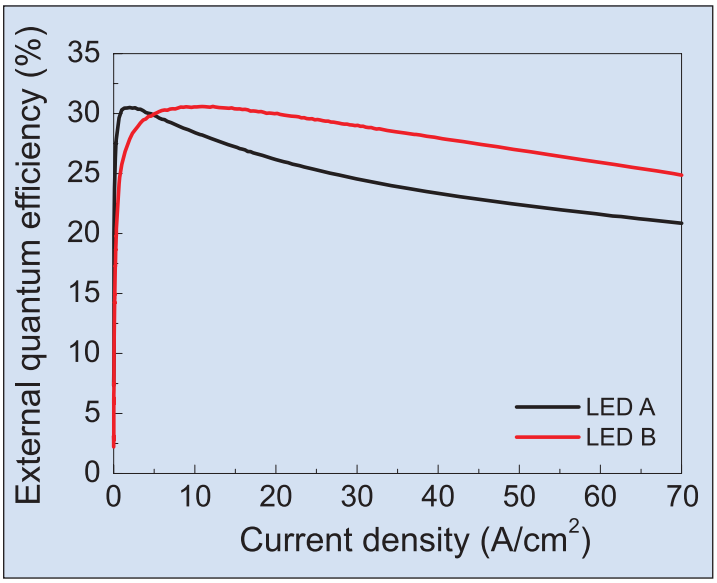

Figure 2. External quantum efficiency vs current density for rectangular-well LED A and trapezoidal-well LED B.

http://iopscience.iop.org/0022-3727/43/35/354004

Author: Mike Cooke

Use of distributed Bragg reflectors and patterned sapphire substrates boost violet LED light output

Supported by the Ministry of Knowledge Economy's New Growth Engine Smart Project Program, researchers at the Korea Electronics Technology Institute, Samsung Advanced Institute of Technology, Samsung LED and Chonbuk National University have developed a distributed Bragg reflector (DBR) coating to boost light output from violet LEDs [K. H. Baik et al, J. Appl. Phys., vol108, p063105, 2010].

The researchers aim to make solid-state lighting more energy-efficient, longer-lasting and cost-effective than conventional lighting for general illumination.

Much nitride LED research has focused on increasing light extraction from LEDs, rather than improving light generation efficiency. Recently, the flip-chip configuration has been in vogue, where light is emitted through the substrate. However, light generation in the active layers is not directed in a specific direction. To increase output, it is necessary to reflect light going away from the substrate back into a useful direction.

DBRs use constructive interference of light waves to create reflection effects. Interference effects often come through creating precise layers of alternating materials with different refractive indices. DBRs are widely used to confine light in waveguides and optical fibers.

Another problem with flip-chip light extraction is that reflection at the substrate–external interface can stop light leaving the device. For some of their devices the researchers used a patterned sapphire substrate, which can increase light extraction efficiency by reducing reflection back into the device at the substrate-external interface.

The LEDs (Figure 1) were grown by MOCVD on sapphire (unpatterned or with hemispherical patterning), starting with a 4.5μm undoped GaN layer, followed by 3μm of n-GaN. The active region consisted of a 5-period InGaN multi-quantum well (MQW) with GaN barriers. The electron-blocking layer was a combination of p-GaN and p-AlGaN. Nitride layers completed with 0.14μm of p-GaN.

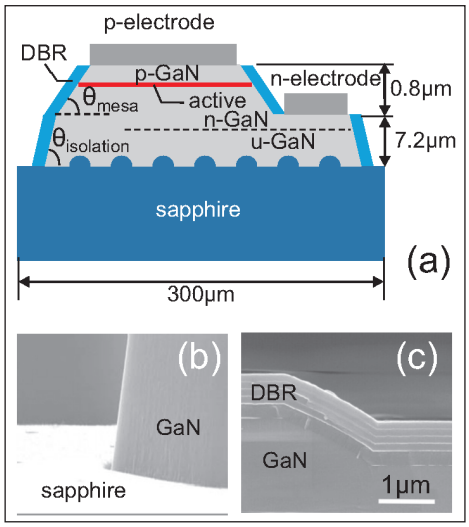

Figure 1. (a) LED cross section. (b) SEM images of isolation-etched mesa sidewall. (c) SEM cross-sections of shallow mesa sidewall, coated with five SiO_2/TiO_2 layer pairs forming DBR.

Layer construction was followed by inductively coupled-plasma reactive-ion etching (ICP-RIE) to create 300μm x 300μm isolation mesas (73° wall angle). The n-GaN layer was exposed by creating a shallow mesa on top of the isolation (26° wall angle) for deposition of the titanium/aluminum electrode. The p-electrode consisted of a reflective 300nm silver-copper layer. The 5x SiO_2/TiO_2 (73nm/38nm) DBR layer was deposited by electron-beam evaporation. The contacts were exposed using ICP-RIE.

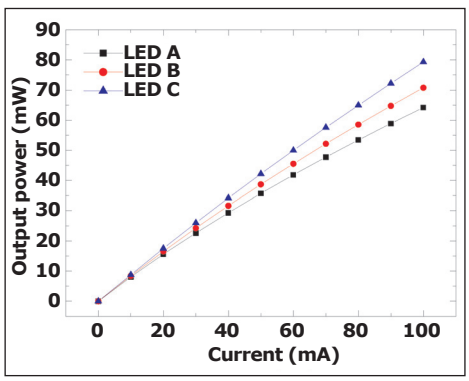

Figure 2. Output power vs injection current of LEDs A, B, and C after 5mm UV-epoxy packaging.

For packaging, the chips were flipped and bonded to silicon sub-mounts and encapsulated in UV-epoxy using conventional 5mm packaging techniques. At 20mA drive current the peak emission wavelength was 400nm (violet).

The DBR structure was designed using optical transfer matrix calculations that suggested that 68nm/40nm SiO_2/TiO_2 quarter-wavelength layers would give the best results.

Various LED configurations were tested: no DBR, DBR on isolation walls only, and DBR on both isolation and shallow mesa sidewalls. These reflections directed the light emission through the sapphire substrate. These options were provided in LEDs grown on both planar and patterned sapphire.

The planar LED's output without DBR (a) was taken as the normalization of 1 for the measurement set-up. The effect of adding DBR layers to the isolation wall (b) was to boost output by a factor of 1.29. Adding a DBR onto the shallow mesa wall (c) raised this to 1.36. The outputs for patterned sapphire LEDs were enhanced by factors of 1.75, 2.04 and 2.31 over the normalization device for planar sapphire diodes (a) with no DBR (A), DBR on isolation walls (B), and full DBR (C), respectively.

Packaged devices were created from the patterned LEDs and the output powers measured (Figure 2). At 20mA injection, outputs were 15.59mW, 16.54mW and 17.52mW for LEDs A, B, and C, respectively. The reduction in the effectiveness of the DBR enhancement (1.12 = 17.52/15.59) is attributed to the effect of the epoxy refractive index (1.5) being intermediate to that of sapphire (1.8) and air (1).

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Author: Mike Cooke

MOCVD automation and fab integration

You've heard it many times before. But this time it's true... the LED industry is at a key inflection point, writes Dr Rainer Beccard of Aixtron.

The end-application drivers are changing; in a very short period of time we have seen the original momentum — coming from mobile phone applications — progress to the backlighting applications that are so dominant today and now increasingly coming from emerging solid-state lighting applications.

The manufacturers of LEDs are also changing, as new players emerge, bigger than we have seen before, and, perhaps significantly; some of them are coming from the traditional silicon or display sector.

This development brings with it some positively disruptive changes in the manufacturing process, in particular in connection with MOCVD (metal-organic chemical vapor deposition) technology, which remains the key enabling technology in this field.

As we saw with the evolution of silicon wafer sizes, we are now clearly seeing the start of the transition of gallium nitride (GaN) LED manufacturing processes from 4" to 6" diameter sapphire wafers and beyond. This widescale development will also require an acceleration of the integrated automation of MOCVD processes, maximizing the throughput of high-volume-manufacturing MOCVD systems and minimizing human intervention.

Manufacturing fabs will inevitably become much bigger and with a high likelihood of multi-site LED fabs, each of them equipped with multiple, but identical, MOCVD tools delivering consistent and precise process control.

To deliver that control in a high-volume manufacturing environment creates specific challenges with respect to the manufacturing volume, coupled with the required yield improvement. To achieve such a challenging objective, fab integration is a must, as this allows a manufacturer to manage and analyze process data and control tools from a central and even, potentially, a remote location.

These novel technological approaches may appear radical to some existing LED manufacturers, but it is a perfectly logical step for many new customers. Indeed, automation of single MOCVD tools and clusters as well as MES (manufacturing execution system) fab integration is not new and is already available from Aixtron.

As a manufacturer of both silicon-related CVD (chemical vapor deposition), ALD (atomic later deposition) tools and III-V MOCVD systems, we have for many years already delivered tools with front-end cassette-to-cassette automation and with interfaces for full fab integration. Critically, these integrated automation solutions have been delivered to LED-making customers based on what is already our well proven III-V MOCVD technology.

Figure 1. 300mm MOCVD cluster tool with two process modules for III-V on silicon processes.

The details of these technologies — MOCVD automation, clusters and fab integration — will be discussed in the following sections.

Compound semiconductor MOCVD and automation

The concept and the potential benefits of automation are obvious today. The best example is the car industry, which was one of the first sectors to move to robot-assisted manufacturing.

The silicon industry has also taught us that, at a certain level of maturity, automation becomes a must, in order to maintain leadership in terms of throughput, yield and cost. By looking into the short history of compound semiconductors, we can see that, even in this relatively young industry, automation is not entirely new.

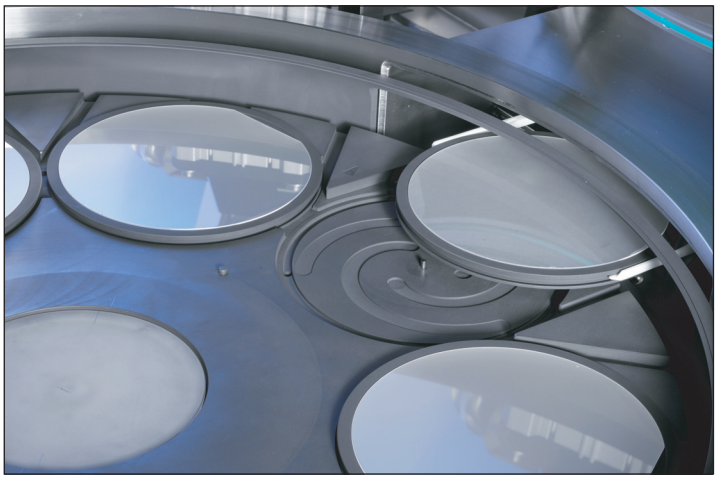

Figure 2. Automated loading and unloading of an Aixtron G5 HT MOCVD reactor. The transfer system picks up the entire wafer platform satellite disk pre-loaded with wafers. The reactor shown here is opened for demonstration purposes only.

There are many motivations to take the automation approach. On a pure time perspective, for any given MOCVD process, once the cost-reduction benefits of saving wafer loading and unloading time is larger than the additional equipment cost, an automation solution economically makes sense.

This was the case in HEMT and HBT production in the late 1990s, when Aixtron introduced the world's first true cassette-to-cassette wafer handler for its III-V MOCVD systems. As these processes were based on relatively short growth cycles, the benefits of reduced loading and unloading times by automation were significant. But it wasn't just a question of saving time; from a process quality perspective, the consequent very low particle counts achieved also led to significantly improved yields.

More recently, in another semiconductor application, an Aixtron automation solution was also introduced in a very successful manner. III-V on silicon for future CMOS applications is particularly challenging and requires advanced MOCVD processes on 200mm or 300mm wafers. Needless to say that, in this particular customer case (involving high-mobility materials in logic circuits), silicon-style automation was a pre-condition.

Aixtron developed a new concept 300mm III-V on Si cluster MOCVD tool, merging decades of compound semiconductor MOCVD experience with state-of-the-art silicon automation standards (see Figure 1). This tool consists of a standard 300mm wafer handler with a front-opening unified pod (FOUP) equipment front-end module (EFEM), connected to two specially developed MOCVD modules.

Drawing on this and similar experiences, Aixtron was in a strong position to be able to develop dedicated automation solutions for high-brightness LED (HB-LED) manufacturing. As a starting point, a comprehensive analysis of current and emerging market requirements, limitations and benefits of automation was conducted in detail, talking to customers from all regions.

The most obvious benefit of automation is the reduced loading and unloading time. In an Aixtron G5 HT reactor, for example, as many as 56x2" wafers (or 14x4" or 8x6" wafers) have to be exchanged after each process run. Manually, this can only be done after cooling the reactor down to workable operating temperatures and by purging the reactor with an inert gas. The automated solution that we have developed allows unloading at temperatures as high as 600°C under hydrogen atmosphere, saving significant time.

The concept that we adopted is based on a robot that handles the entire wafer platform satellite rather than each individual wafer, achieving a complete wafer exchange in just a few minutes (Figure 2).

There are good reasons why the Aixtron G5 HT reactor was chosen to be the first generation of reactors with automation as a standard option. Apart from the increased wafer capacity, the reactor design is such that it allows continuous growth runs without any cleaning, baking or the exchange of parts between runs — a clear pre-requisite for any kind of automation. Furthermore, it also offers a new capability to use very high growth rates, shortening the total LED growth time. By exploiting the potential of automated processes, in terms of increased throughput at lower cost per wafer, we are able to increase our customer's competitiveness and reduce their cost of ownership.

There are some less obvious factors which make adopting automation attractive. A manual wafer loading operation has always been linked with a degree of process variation, which in turn leads to reduced yield. This can be completely eliminated by automatic loading.

Operator resources and utilization can be managed more efficiently, as the loading/unloading schedule is no longer determined by the growth sequence. Finally, using large wafers (6" and above) will be more technically and commercially feasible earlier, if standardized, automated handling procedures are adopted.

All these benefits potentially occur as soon as one MOCVD system is linked to an automatic transfer module (as shown in Figure 3, top). However, it does not stop there. Further benefits can be achieved through clusters (i.e. more than one MOCVD process module served by one automatic transfer module). Offering the opportunity to share the automation capital cost, they offer greater and more efficient utilization of the transfer system and on a smaller footprint per tool (Figure 3, bottom). Additionally, the LED growth process can be split into separate processes run in separate MOCVD modules (e.g. to grow the buffer layer in one module, and the rest of the LED epi structure in the other ones), leading to even higher efficiency of the processes.

Figure 3. Single MOCVD module with automated transfer system (top) and MOCVD cluster tool with two process modules (bottom).

Fab integration

The efficient operation of multiple MOCVD tools, even if they utilize the automation options described above, depends critically on the correct exchange and management of data (such as recipes, process and log data) and on the co-ordinated control of the tools throughout the entire fab.

Again, it makes sense to adopt the fab integration approach that the silicon industry has developed to meet the challenge of delivering consistently high-quality, high-volume product.

Our approach is to use an MES, i.e. a system that controls tools and manages and analyzes data in real time in a central, remote location for a complete fab or fabs.

The MES requires appropriate interfaces in the individual tools. In Aixtron MOCVD systems, these interfaces can be provided easily as part of the individual control system of the MOCVD tool — or whenever an automated/cluster solution is chosen — as part of the Cluster Tool Controller (CTC). MES interfaces are individually configured for a specific fab. Aixtron's MOCVD systems generate huge amounts of data through the MES interface, such as mass flow controller (MFC) settings and actual values, as well as temperature, pressure and statistical process control (SPC) data. We can also add and manage additional events which can be communicated to and from the MOCVD tool to the MES, e.g. alarms, warnings or specific log data. Process recipes can be managed centrally, and finally the individual MOCVD system can even be remote controlled through the MES.

Because of the modular structure by which we manage this kind of data exchange and control, it is feasible for any size of fab, running any number of MOCVD tools, and even for multiple fabs run in different locations — ensuring that absolutely identical processes are performed on all MOCVD tools, with the highest possible reproducibility and yield.

Summary

We are evidently at a significant crossroads in the development of the LED industry.

LED applications are expanding rapidly from the mobile applications of old to new generation displays and emerging general lighting applications.

The customer base is also changing equally rapidly, as the lead customers of a few years ago are getting bigger and new customers from the silicon or display industries are influencing the speed and direction of the industry.

These evolving market changes require new solutions for the LED manufacturing process. Aixtron's MOCVD systems, as one of the key enabling technologies in this process, offer solutions that are tailored to meet the new challenges. The availability of efficient and precise automated loading of MOCVD tools, novel MOCVD cluster architectures and additional options for powerful fab integration are already available today, ensuring that the LED industry is fully prepared for the opportunities ahead. ■

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ZnO mixes it up with nitride semiconductors

Mike Cooke reports on recent research that combines ZnO with nitride semiconductors for transparent conduction, light emission and as a substrate.

Zinc oxide (ZnO) has potential for conductive coatings, electrodes, substrates and for light emission. It is a low-cost transparent compound semiconductor compared with those containing rare elements such as gallium and indium. Low-cost thin-film transistors using ZnO are a common topic of research, along with nanostructures such as nanowires. ZnO, in ceramic form, is already the basis for varistor components that direct power surges away from sensitive circuitry.

Industry analyst firm NanoMarkets is predicting that the ZnO electronics market could grow more than a factor of three, giving a sales value of $1.3bn in 2015, and $2.3bn in 2017. NanoMarkets believes that the market for ZnO LEDs could reach more than $415m in 2015, while at the same time use as transparent conducting layers (TCLs) could exceed $220m in 2015.

Here we look at recent research into using ZnO as TCLs, nano-LEDs and substrates.

TCL for nitride LEDs

For transparent conductive layers (TCLs), ZnO is attractive in cost terms compared with indium tin oxide (ITO), which is widely used for this purpose in displays, LEDs and solar cells to increase the amount of light either leaving or entering the device. In nitride LEDs, thin layers of nickel (Ni) and gold (Au) can be used to create TCLs, but the transparency is rather low at 60–75%.

The desired qualities for a TCL are high transparency and low resistivity: these qualities can be achieved with ZnO films with aluminum, gallium or indium doping. However, ZnO films generally have an n-type character. Unfortunately, there is presently no process available to produce p-type ZnO layers with any measure of stability.

Korean researchers have been developing zinc oxide (ZnO) as a TCL for use with nitride light-emitting diodes (LEDs) with the aim of increasing photon extraction [1]. The researchers come from LED illumination firm Lumimicro Co Ltd, Kyungpook National University, the Korea Photonics Technology Institute, and Pukyong National University.

For use in nitride LEDs one needs the TCL to make ohmic contact (at least approximately) with the p-type gallium nitride (GaN) that is normally the top layer of nitride LEDs. Unfortunately, with n-ZnO on p-GaN one expects a Schottky contact behavior that increases the forward voltage (indicating energy loss/high contact resistance) and also deterioration of performance with temperature.

A further quality needed for the use of doped ZnO as a TCL is a low deposition temperature, since one doesn't want to disturb the previous hard work that has gone into depositing high-quality nitride layers.

It is possible to make ohmic contact between n-ZnO and p-GaN using a thin metal layer, but this requires an undesirable high-temperature anneal step. The Korean researchers preferred to use a silicon-doped (n-type) tunnel junction as an intermediary between the p-GaN and ZnO TCL.

The Al-Ga co-doped ZnO (AGZO) TCL was applied to commercial 2-inch LED epiwafers from Korean supplier Epivalley. The layer structure consisted of undoped GaN (3μm), heavy silicon-doped (n^{++}) GaN (2μm), n-GaN (0.5μm), GaN/InGaN multi-quantum well (MQW) active region, magnesium-doped (p) GaN (0.2μm), and a 10nm tunnel junction layer. The tunnel junction consisted of a three-period GaN/$In_{0.17}Ga_{0.83}N$ structure.

A 300nm AGZO layer was deposited on the epiwafer as TCL using RF sputtering. LED chips were fabricated, along with comparison devices using nickel-gold TCLs. A conventional packaging using epoxy encapsulation was employed.

Before creating the LEDs, experiments were carried out on sapphire to optimize the AGZO deposition process with the aim of low resistivity and high transparency. Sputtering with an argon partial pressure of 1.5mTorr created AGZO films with 96.3% transparency at 460nm wavelengths (blue) and $6.8 \times 10^{-4}\Omega$-cm resistivity (carrier concentration $4.9 \times 10^{20}/cm^3$).

The AGZO TCLs on the LEDs were characterized with various levels of annealing (Figure 1). Without the anneal, the AGZO-TJ contact was close to ohmic, with a small difference between work functions — i.e.

4.6eV for the AGZO and 4.2eV for the TJ layer. A slight improvement in the ohmic behavior was seen for annealing at 550ºC, but Schottky-type behavior occurred at 650ºC. The researchers comment that Ga-doped indium oxide (In_2O_3) and indium tin oxide (solid solution of In_2O_3 and SnO_2) TCLs show similar trends with annealing temperature.

The LEDs produced using an AGZO contact had an increased forward voltage (meaning higher contact resistance) than the Ni/Au comparison devices (Figure 2). For example, at 20mA driving current the forward voltage was 3.84V, which is 0.67V higher than for the Ni/Au LED. The specific contact resistance between AGZO and TJ layers is estimated at 10^{-2}–$10^{-3}\Omega$-cm^2. In general, AGZO on GaN has a contact resistance up to two orders of magnitude higher than that of Ni/Au on GaN.

Although the higher resistance of the AGZO contact suggests energy losses, the light output power, with a peak at a wavelength of 453nm, is higher than for the comparison Ni/Au contact. At 20mA, the AGZO LED had an output power of 12.6mW and the Ni/Au LED 7.6mW. These give external quantum efficiencies of 23.0% and 13.9% respectively (23.0% = 1.65x13.9%). This improvement for the AGZO device is due to the higher transparency of the contact layer: 96.3% rather than 70% for the Ni-Au layer at 460nm.

Although the researchers see AGZO thin films as being promising TCLs, leading nitride LEDs without tunnel junction have achieved external quantum efficiencies of more than 60%, so obviously commercial use is going to need more development.

Nano-wire lights up

Rather than producing ZnO films, National Institute of Standards and Technology (NIST) researchers Babak Nikoobakht and Andrew Herzing have developed ZnO nanowires on p-GaN substrates to yield 'nano-LEDs' [2].

The nanowires are grown at 900ºC using solid-vapor-liquid-solid deposition in a tube furnace with a gold catalyst previously deposited and patterned on the GaN substrate. The GaN substrate was a commercial product (from TDI) with p-type magnesium doping (Mg concentration ~ 5x10^{17}/cm^3). The zinc source comes from a ZnO-graphite mixture placed on a silicon substrate. Ultra-dry nitrogen is used as a carrier gas.

Unlike many ZnO nanowire growth methods, NIST creates ZnO nanowires in the plane of the GaN substrate, rather than perpendicular/vertical forests of nanowires. As the NIST ZnO wire grows it pushes the gold nanoparticle along the GaN surface. The direction of growth depends on the crystal structure of the substrate and also on the direction of flow of the carrier gas — the growth tends to be into the wind. Further control of the growth direction can be achieved by laying down lines of gold to block growth in particular directions.

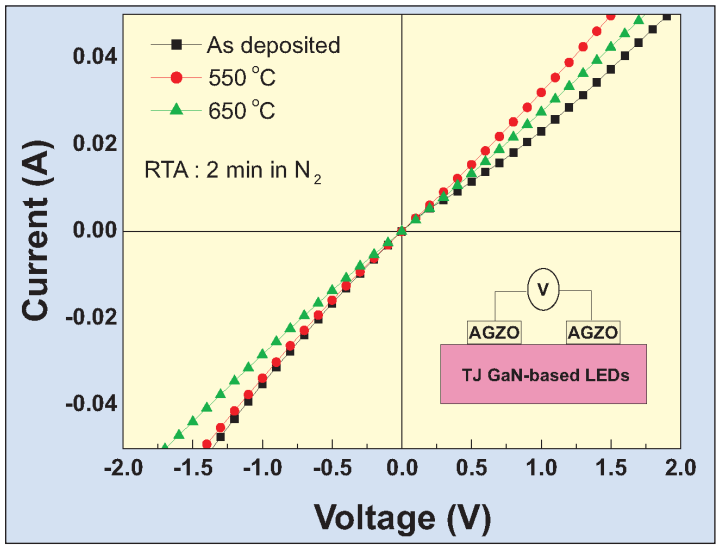

Figure 1. Current-voltage characteristics of TJ GaN-based LEDs with AGZO transparent conducting layer as a function of annealing temperature. Inset shows schematic configuration for measurement.

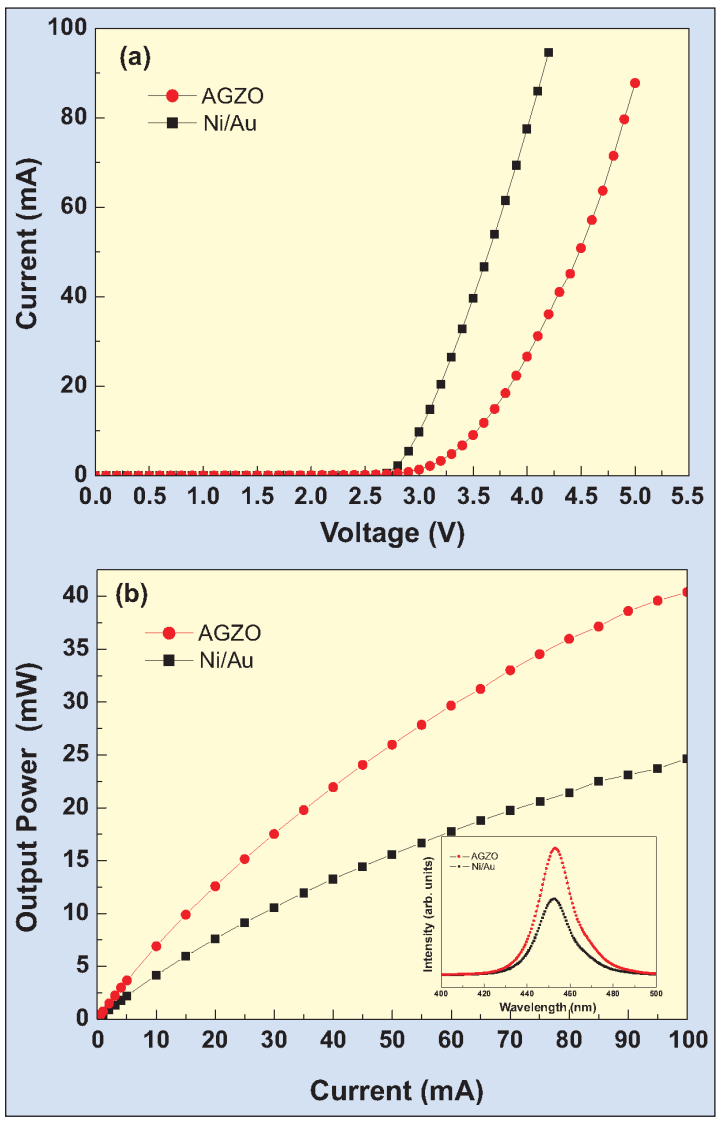

Figure 2. Comparisons of AGZO (300nm) and Ni/Au (5/5nm) TCLs: (a) current–voltage, (b) light output power vs current, and (inset) emission spectra.

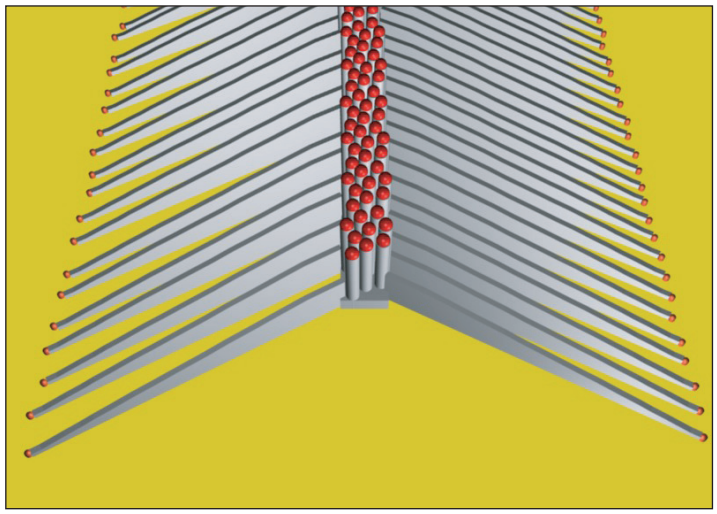

Figure 3. Single row of nanowires (cylinders with red tops) with fin-shaped nanowalls extending outward.

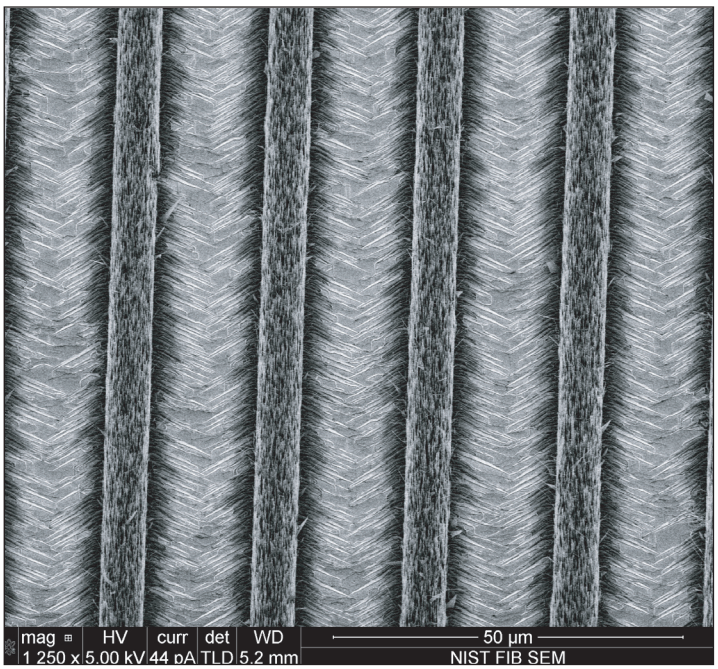

Figure 4. Transmission electron micrograph (TEM) shows four rows of nanowires and their corresponding nanowalls. The distance across the micrograph is approximately the diameter of a human hair.

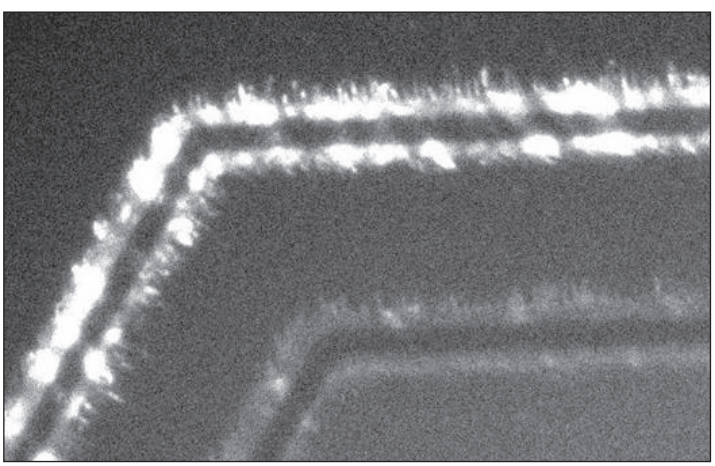

Figure 5. TEM image of nano LEDs emitting light.

In previous work, NIST researchers used an 8nm nanoparticle catalyst. In the new research, they increased the nanoparticle size to 20nm for some of their experiments. This resulted in wires that grew secondary shark-like 'dorsal fins' or 'nano-walls' (Figures 3 and 4). The height of the nano-wall gradually decreases as one goes toward the leading edge where the nano-particle is. This suggests that the further growth is due to a slower self-catalytic process on the wire created by the nano-particle.

The ZnO material in these structures has an n-type conduction characteristic with an electron density of ~10^{18}/cm^3. The individual heterojunctions measure about 10µm long and 80nm wide. Various characterizations were performed — such as selected-area diffraction (SAD) and x-ray energy-dispersive spectroscopic (XEDS) imaging — that suggested that the junction between the ZnO and GaN crystal structures was abrupt.

When charge crossed the p-n GaN-ZnO junction, light was emitted (Figure 5). The current was injected with titanium-gold electrodes for the n-ZnO contact and nickel-gold for the p-GaN contact. Under forward bias the emission was around the violet 390nm (3.18eV) wavelength (32nm full-width half-maximum) that is related by the researchers to the ZnO exciton (electron–hole bound state with a binding energy ~60meV). The strong exciton emission would suggest that most of the forward bias recombination occurred in the ZnO crystal structure with holes being injected from the underlying p-GaN.

Light was also emitted under reverse bias — around an orange wavelength of 640nm (1.95eV). The intensity of the radiation reduced in smaller devices with better rectifying behavior and higher breakdown voltage (9V rather than 4V). The researchers suggest that this emission could result from a transition between an intrinsic shallow state to a deep state such as those associated with oxygen vacancies. The researchers say that the reverse bias emission is 'still under study'.

Nikoobakht and Herzing hope to improve the nano-LEDs in future by using better geometries and material design. The researchers want to apply the devices in a number of contexts, giving light sources and detectors for photonic devices or lab-on-a-chip microsystem platforms. These devices could be powered by nano-generators. For example, zinc oxide is commonly used in prototype nano-generator systems that depend on vibration, since it has a powerful piezoelectric effect (strain-dependent polarization electric field). Meanwhile, nitride semiconductors are being developed by some as solar cell materials. The researchers suggest similar techniques could be used to grown ZnO nano-structures on other nitrides such as indium gallium nitride or aluminum gallium nitride.

Multi-emissions from nitride on ZnO

Rather than depositing ZnO on GaN, earlier this year researchers reported for the first time growth of p-type nitride semiconductor layers on ZnO substrates, enabling the creation of two sets of diode devices with light emission at two wavelengths (near-UV and yellow, green and blue) [3]. The researchers came from Virginia's Old Dominion University (ODU), Georgia Institute of Technology (GaTech), State University of New York at Buffalo, Korea University and substrate maker Cermet Inc of Atlanta, GA, USA.

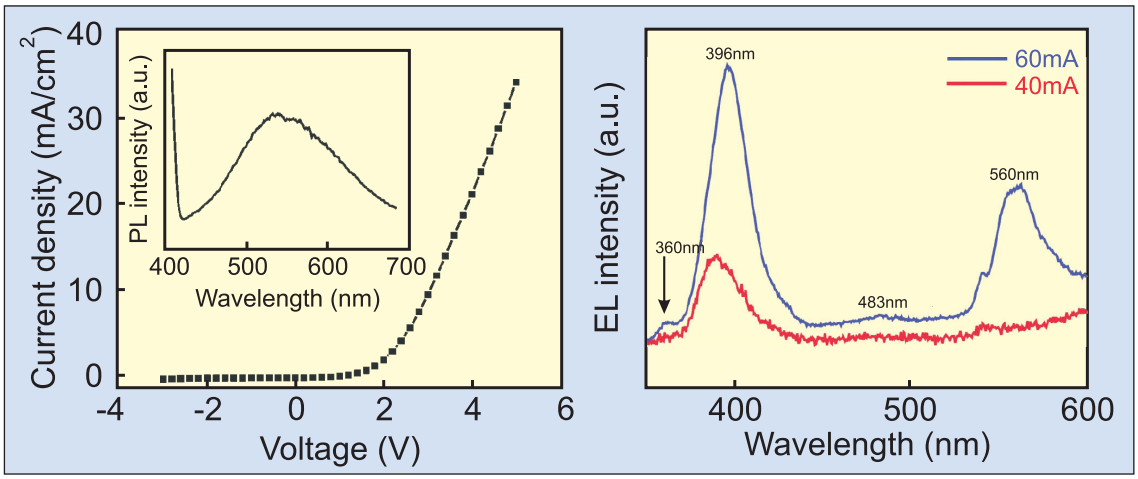

Figure 6. I–V characteristic (a) and EL spectra (b) of p-GaN/In GaN/n-ZnO with different forward currents. Inset of (a) shows photoluminescence of p-type GaN/InGaN/ZnO structures measured at room temperature. The peaks at higher current are attributed to emissions from the GaN band edge (360nm), InGaN band-edge (396nm), Mg-related defects (560nm), Zn deep-acceptors in InGaN (483nm).

Theoretically ZnO is an attractive substrate for growing nitride semiconductors. The c-axis mismatch to GaN is only 0.4% and the a-axis mismatch is 1.9%. By contrast, the lattice mismatch for GaN/sapphire growth is about 14%. Large-diameter ZnO wafers can be prepared at relatively low cost using hydrothermal growth.

Unfortunately standard nitride semiconductor growth techniques such as metal-organic chemical vapor deposition (MOCVD) or even molecular beam epitaxy (MBE) are difficult to use with ZnO substrates. Previous attempts to grow p-type semiconducting nitrides have foundered on the volatility of ZnO and compensation of the p-type conduction in GaN by oxygen migration into the nitride layers.

Namkoong et al used low-temperature (500–550ºC) molecular beam epitaxy (MBE) to grow nitrides on Zn-face ZnO substrates produced by Cermet. A 50nm layer of $In_{0.07}Ga_{0.93}N$ was followed by 0.4μm of p-GaN (Mg-doped to hole concentrations of 3–5x10^{17}/cm^3). Both layers were produced using 'metal-rich' conditions. The substrate, as delivered, had an electron concentration of 3x10^{16}/cm^3. A comparison nitride semiconductor LED on sapphire was also produced with 0.15μm Mg-doped p-GaN (3x10^{17} holes/cm^3) on 1μm silicon-doped n-GaN (1x10^{18} electrons/cm^3).

Photoluminescence (PL) and electroluminescence (EL) studies were carried out. First electronic characterization of the diode properties showed increased (~4x) forward current for given voltage, comparing the nitride-on-ZnO device with a nitride-on-sapphire arrangement. However, blocking of reverse current was not as good in the hybrid III-N/ZnO device. The forward current is enhanced with the ZnO substrate both by its greater electrical and thermal conductivities. Sapphire is insulating and has poor thermal conductivity.

The EL spectra of the hybrid ZnO/nitride LEDs show two main peaks (Figure 6) at high currents (60mA): one at 396nm (near-UV); the other at 500nm (yellow). A weak peak at 483nm (blue) is also observed. Energy dispersive spectroscopy (EDS) suggested that the blue peak was due to inter-diffusion at the InGaN/ZnO interface, in particular deep acceptor states from Zn that had migrated into the InGaN layer. The near-UV is attributed to band-edge emission of the InGaN material. There is also band-edge emission in the GaN layer at 360nm.

Further devices were grown with higher indium content ($In_{0.14}Ga_{0.86}$) that gave blue and green emissions (Figure 7). The 516nm green emission was dominant at 40mA. The green emission was attributed to Zn-related band emission in the InGaN layer. At 60mA and 100mA, a shorter wavelength peak appears that blue-shifts from ~432nm (2.87eV) to 411nm (3.01eV) with increasing current. Non-optimal growth conditions are a likely source of non-uniformities of the emissions seen in Figure 7(b).

The researchers concluded that "multi-quantum well (MQW) structures in the active layer may produce bright dual wavelengths if impurities from the ZnO diffusing into the InGaN active layer are carefully controlled".

Further work would involve reducing dislocation densities, increasing hole conductivity, and controlling interfaces between III-nitride and ZnO substrates. This could enable brighter dual- or even triple-wavelength devices, if combined with MQW structures. Gon Namkoong, the corresponding author on the research, based at ODU, reported that work had been carried out on phosphor-free white LED emissions.

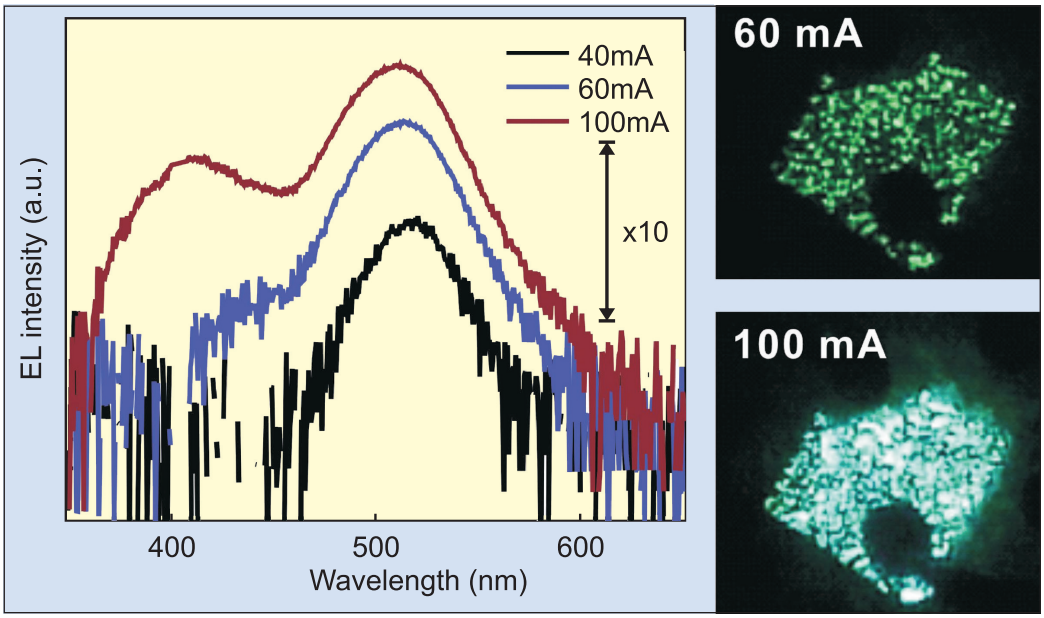

Figure 7. EL spectra (a) of p-GaN/$In_{0.14}Ga_{0.86}N$/ZnO LEDs and photographs (b) of LEDs at different forward currents. In (a), intensity scale is logarithmic.

r-GaN on ZnO

Another area where ZnO substrates may come in handy is for producing green laser diodes. In producing LEDs and laser diodes (LDs), many groups are working to eliminate, or at least mitigate the quantum-confined Stark effect (QCSE). In GaN MQWs there are high electric polarization fields in the material due to strain (piezoelectric) of the mismatched lattices of the well/barrier layers. These fields shift the electron and hole energy bands, but worse they tend to separate the oppositely charged carriers, reducing their ability to recombine into a photon.

These effects are at their worst in c-plane nitride semiconductors — the standard growth direction in commercial production. In the past few years, substrates that allow growth of structures with different nitride crystal orientations have become available. These structures have enabled longer wavelength (green) LDs and more efficient LEDs. Green LDs have been produced by Sumitomo using {20$\bar{2}$1} plane substrates. However, it has been predicted that the most effective devices would be produced on substrates where the growth direction is around 45º to the c-direction. This angle is close to that of the r-plane {1$\bar{1}$02}.

Such r-plane films have been grown on ZnO substrates using pulsed laser deposition (PLD) by researchers at University of Tokyo's Institute of Industrial Science and Japan Science and Technology Agency' CREST organization [4]. PLD is used because ZnO is not an ideal substrate medium for nitride growth using either MOCVD or MBE because the process conditions used tend to attack the substrate.

The ZnO substrates were subjected to chemo-mechanical polishing (CMP) and annealing in air at 1250ºC for 3.5 hours inside a box made of ZnO. Degreasing in ethanol was carried out for 10 minutes. Once in the PLD vacuum chamber, a further 800ºC anneal was carried out for 30 minutes. GaN layers were deposited at room temperature to create a buffer. The deposition temperature was then increased to 700ºC. The laser deposition consisted of ablating liquid gallium with a krypton-fluoride excimer laser (248nm, 20ns pulse) and depositing on a substrate 5cm away. PLD is hence a variation on physical vapor deposition. The nitrogen source consisted of RF plasma generated radicals.

Various characterizations were carried out: reflection high-energy electron diffraction (RHEED), atomic force microscopy (AFM), high-resolution x-ray diffraction (XRD), and low-temperature (15K) photoluminescence (PL). It was found that 1μm GaN films produced on ZnO substrates that had been prepared using both CMP and annealing in the ZnO box had 5x the PL response due to near-band-edge emission compared with films on ZnO substrates just subjected to CMP.

Peaks that have been related by other groups to prismatic stacking faults or partial dislocations were reduced in films on ZnO substrates that had been annealed in the ZnO box. The PL peak at 3.44eV at room temperature is indicative that Zn diffusion into the main GaN layer is blocked by the buffer layer

Also, the strength of peaks that have been related by other groups to prismatic stacking faults (PSFs) or partial dislocations (PDs) were reduced in films on ZnO substrates that had been annealed in the ZnO box. The researchers also believe their PL peak at 3.44eV at room temperature indicates that Zn diffusion into the main GaN layer is blocked by the buffer layer. ■

Mike Cooke is a freelance technology journalist who has worked in semiconductor and advanced technology sectors since 1997.

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Advances in p doping and polarity control for GaN and ZnO

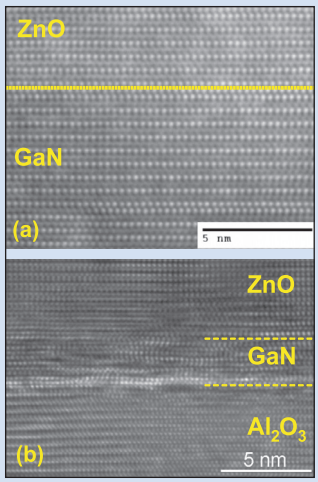
Creating holes is a problem for both GaN and ZnO. However, in nitride semiconductors a workable solution was developed, creating the nitride semiconductor industry from the 1990s up to the present day. The magnesium doping used in GaN is not ideal and forms one of the road-blocks to higher-efficiency devices. Hydrogen is implicated in passivation of the Mg doping, limiting hole concentrations to less than $10^{18}/cm^3$. There are a number of theories on why p-ZnO is so difficult to realize, including a hydrogen-based concept.

A nickel film deposited on top of p-GaN can be used as a catalyst to desorb hydrogen from p-GaN material, but in thermal treatments above 600ºC it has a nasty tendency to also desorb nitrogen, leaving vacancies in the nitride crystal structure that reduce the hole concentration.

Chinese Academy of Sciences' Semiconductor Lighting Technology Research and Development Center has also looked at alternative hydrogen desorption catalysts — namely platinum and molybdenum [Tongbo Wei et al, Jpn. J. Appl. Phys., vol49, p100201, 2010]. The metal films were deposited on p-GaN layers with Mg concentration ~$10^{20}/cm^3$. The doping was then activated in a quartz tube furnace in nitrogen for 15 minutes at 720ºC. These metals resulted in higher hole concentrations (~$5x10^{17}/cm^3$) compared with p-GaN layers without treatment (~$2x10^{17}/cm^3$) or with a nickel catalyst (~$3x10^{17}/cm^3$). However, platinum resulted in better ohmic properties than the other options (see Table).

For ZnO, a team coming from China's 'Key Laboratories' for 'Superhard Material' and 'Excited State Processes' claim to have produced single wurtzite p-type $Zn_{1-y}Cu_yO_{1-x}S_x$ alloy films ($0.081 < x < 0.186$ and $0.09 < y < 0.159$) with 'very stable' p-type conductivity with hole concentrations in the range $4.31–5.78x10^{19}/cm^3$, a resistivity of 0.29–0.34Ωcm and a mobility of $0.32–0.49cm^2/Vs$ [H. L. Pan et al, Appl. Phys. Lett., vol97, p142101, 2010]. The deposition process was magneton sputtering on quartz.

These researchers believe the p-type conductivity to a Cu^{+1} substitution at a Zn site, creating an acceptor state with an ionization energy of 53meV. They comment that this is much less than for Cu-doping of ZnO. The small energy is thought to result from the heavy Cu-doping and the lifting of the valence band maximum induced from the alloying with S.



HRTEM images of ZnO/20nm-GaN (a), ZnO/3nm-GaN (b) around interface between ZnO and GaN.

Control of the polarity of ZnO layers grown on GaN can be important. For example, the incorporation and doping efficiency of nitrogen for creating p-type ZnO is affected by the polarity of the crystal structure.

Researchers at China's State Key Laboratory of Artificial Microstructure and Mesoscopic Physics (Peking University) and University of Michigan in the USA have studied ZnO layers grown on sapphire with a GaN interlayer [X. Q. Wang et al, Appl. Phys. Lett., vol97, p151908, 2010]. Samples were grown using RF-plasma-assisted molecular beam epitaxy performed at Japan's Chiba University.

Using coaxial impact collision ion scattering spectroscopy (CAICISS), these researchers found that 3nm GaN interlayers produced Zn-polar ZnO, while thicker (20nm), better quality interlayers resulted in O-polar material. It is thought that these results are due to Zn-polar ZnO being more stable on an amorphous interface where some O atoms replace N in the GaN structure. For the thicker interlayer, where the interface is much smoother, the ZnO growth follows that of the underlying GaN, leading to O-polarity.

The MBE process was preceded by a nitridation process where the sapphire substrate was exposed to nitrogen plasma at 400ºC for two hours, forming a thin AlN layer with N-polarity. This step thus tends to create GaN layers also with N-polarity, as opposed to the Ga-polarity that is usual in MOCVD-grown nitrides. (MOCVD-grown ZnO tends to show Zn-polarity.)

The researchers believe that these results could be the basis for a useful method to create ZnO layers with given polarity. They comment: 'The advantage of this method is the following: (1) the polarity of ZnO is well controlled by modifying the growth parameters of the GaN layer; and (2) the quality of ZnO can be improved due to the same lattice structure and small lattice mismatch between ZnO and GaN.'

Hall-effect results of Mg-doped GaN films activated without and with metal catalytic films at 720ºC.

p-GaN condition	Resistivity (Ωcm)	Hole concn ($10^{17}cm^{-3}$)	Hole mobility (cm^2/Vs)	Specific contact resistance ($10^{-2}Ωcm^2$)
No metal	1.77	2.2	26.1	12.2
With Ni	0.75	3.4	23.2	8.2
With Pt	0.48	5.3	23.6	2.9
With Mo	0.46	5.1	24.8	13.6

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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,
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UK
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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.

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95873 Bezons Cedex,
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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.

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Eden Prairie,
MN 55344,
USA
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Fax: +1 952 934 2737
www.svta.com

Temescal, a part of Ferrotec
4569-C Las Positas Rd,
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CA 94551,
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Fax: +1 925 449-4096
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Woodbury, NY 11797, USA
Tel: +1 516 677 0200
Fax: +1 516 714 1231
www.veeco.com

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
E-mail: sales@microchem.com
www.microchem.com

Power + Energy Inc
(see section 8 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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Fax: +44 (0) 1389 879 042
www.logitech.uk.com

Oxford Instruments Plasma Technology
(see section 6 for full contact details)

Power + Energy Inc
(see section 8 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

Synova SA
Ch. de la Dent d'Oche,
1024 Ecublens,
Switzerland
Tel: +41 21 694 35 00
Fax: +41 21 694 35 01
www.synova.ch

TECDIA Inc
(see section 16 for full contact details)

Tegal Corp
2201 S McDowell Boulevard,
Petaluma, CA 94954, USA
Tel: +1 707 763 5600
www.tegal.com

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 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
3626 W. Liberty Rd.,
Ann Arbor,
MI 48103,
USA
Tel: +1 734 668 4644
Fax: +1 734 668 4663
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.

LayTec GmbH
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

KLA-Tencor
160 Rio Robles, Suite 103D,
San Jose,
CA 94538-7306,
USA
Tel: +1 408 875 3000
Fax: +1 510 456 2498
www.kla-tencor.com

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

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

J P Sercel Associates Inc
220 Hackett Hill Road,
Manchester, NH 03102,
USA
Tel: +1 603 518 3200
Fax: +1 603 518 3298
www.jpsalaser.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

23 Services

Henry Butcher International
Brownlow House, 50–51
High Holborn,
London WC1V 6EG, UK
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

WSR Optical Device Solutions
P.O. Box 248,
Flemington,
NJ 08822,
USA
Tel: +1 908 428 4986
www.wsr-ods.com

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

3–4 November 2010
Photonex 10
The International Centre, Telford, UK
E-mail: info@photonex.org
www.photonex.org

10 November 2010
1st EPIA International Conference on Concentrated Photovoltaics (CPV)
Munich, Germany
www.epia.org/events/upcoming-events

16–17 November 2010
OIDA's 19th Annual Forum: 'The Future of Telecom and US Competitiveness'
Arlington, VA, USA
E-mail: info@oida.org
http://oida.org

18–19 November 2010
3rd Concentrated Photovoltaics Summit
Sevilla, Spain
E-mail: maria@cpvtoday.com
www.cpvtoday.com

30 November – 2 December 2010
Photovoltaics USA 2010
Santa Clara Convention Center, CA, USA
E-mail: info@IDTechEx.com
www.idtechex.com/printedelectronicsusa10/pv.asp

6–8 December 2010
IEEE International Electron Devices Meeting (IEDM 2010)
Hilton Washington and Towers, San Francisco, CA
E-mail: iedm@his.com
www.ieee.org/conference/iedm

8 December 2010
Photonic Sensors Symposium
Boston, MA, USA
E-mail: info@oida.org
http://oida.org

19–21 January 2011
Lighting Japan: the 3rd LED/OLED Lighting Technology Expo
Tokyo Big Sight, Japan
E-mail: light-e@reedexpo.co.jp
www.lightingjapan.jp/english

22–27 January 2011
SPIE Photonics West 2011
San Francisco, CA, USA
http://spie.org/photonics-west.xml

25 January 2011
2nd International Conference on PV Module Recycling
Madrid, Spain
www.epia.org/events/upcoming-events

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28–30 January 2011
International Symposium on Semiconductor Materials and Devices (ISSMD-2011)
Vadodara, Gujarat, India
E-mail: cjpanchal_msu@ssmd.in
www.ssmd.in

16–17 February 2011
PHOTON's Solar Terawatt-hours Conference Series 2011 USA, including PHOTON's 3rd Thin Film Conference
San Francisco, CA, USA
E-mail: info@photon-expo.com
www.photon-expo.com/en

20–24 February 2011
IEEE International Solid State Circuits Conference (ISSCC 2011)
San Francisco, CA, USA
E-mail: isscc@ieee.org
http://128.100.10.145/isscc

22–24 February 2011
Strategies in Light 2011
Santa Clara Convention Center, CA, USA
E-mail: lubah@pennwell.com
www.strategiesinlight.com

22–24 February 2011
SNEC 5th International Photovoltaic Power Generation Conference & Exhibition (SNEC PV POWER EXPO 2011)
Shanghai, China
E-mail: info@snec.org.cn
www.snec.org.cn

1–4 March 2011
LED CHINA 2011
Guangzhou, China
E-mail: led-trust@ubm.com
www.LEDChina-gz.com

6–10 March 2011
OFC/NFOEC 2011 (Optical Fiber Communication Conference and Exhibition/ National Fiber Optic Engineers Conference)
Los Angeles Convention Center, CA, USA
E-mail: info@ofcconference.org
www.ofcnfoec.org

13–17 March 2011
OTST 2011: International Workshop on Optical Terahertz Science and Technology
Santa Barbara, CA, USA
E-mail: support.otst@gmail.com
http://otst2011.itst.ucsb.edu

15–17 March 2011
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

20–23 March 2011
Euro-MBE 2011: 16th European Molecular Beam Epitaxy Workshop
Alpe d'Huez, France
E-mail: embe2011@grenoble.cnrs.fr
http://embe2011.neel.cnrs.fr

28 March 2011
3rd Thin Film Solar Summit Europe
Berlin, Germany
E-mail: matt@thinfilmtoday.com
www.thinfilmtoday.com/europe

4–6 April 2011
CPV-7 International Conference on Concentrating Photovoltaic Systems
Las Vegas, NV, USA
E-mail: info@cpv-conference.org
www.cpv-conference.org

13–15 April 2011
11th Fiber Optics Expo (FOE 2011)
Tokyo Big Sight, Japan
E-mail: foe@reedexpo.co.jp
www.foe.jp/en

14–15 April 2011
3rd Photovoltaics Thin-Film Week, including:
— International Workshop on CIGS Solar Cell Technology
— 3rd Thin-Film Industry Forum (TIF 2011)
Berlin, Germany
E-mail: info@solarpraxis.de
www.solarpraxis.de/en/conferences

16 – 21 April 2011
54th Society of Vacuum Coaters Annual Technical Conference (2011 SVC TechCon)
Chicago, IL, USA
E-mail: svcinfo@svc.org
www.svc.org

18–20 April 2011
Semiconductor and Integrated Opto-Electronics Conference (SIOE'11)
Cardiff University, Wales, UK
Abstract deadline: 1 February 2011
E-mail: K.A.Shore@bangor.ac.uk
www.astro.cardiff.ac.uk/research/pm/events/?page=sioe


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