

semiconductor TODAY

COMPOUNDS & ADVANCED SILICON

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**LED lighting
about to
bloom
...but will
market
overheat?**

Cree to add 6" LED line by mid-2011; demos low-defect 6" SiC
Thin-film PV efficiency up to 20.3% • TSMC breaks ground

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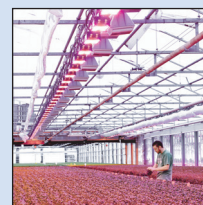
p44 Epistar's chairman, Toyoda Gosei's president and Twin Hill's president (from left to right) form joint venture.



p48 North Carolina State Governor Bev Perdue announcing 6" LED expansion at Cree's site in Durham.



p72 Walmart is adding solar energy generation at 20-30 more sites in California and Arizona, involving both CIGS and CdTe thin-film PV modules.



Cover: A pilot project covering several thousand square meters of planting area in a commercial green-house has achieved energy savings of 40% using Golden DRAGON Plus and OSOLON SSL LEDs from Osram Opto Semiconductors, which have 37% efficiency and emit in the deep red spectrum. **p51**

Technology development to ease 'over-heating' fears

Once again, the last month has seen burgeoning sales of compound semiconductor components (this issue, from optical communications device makers Finisar and JDSU on pages 62 and 64). Also, seemingly most LED makers are investing in expanding capacity (e.g. Japan's Mitsubishi Chemical and Showa Denko, as well as Taiwan's Lextar and Arima Optoelectronics, while Japan's Toyoda Gosei is forming a joint venture with Epistar in Taiwan — see pages 44–47). Most significantly, Cree is investing \$135m to expand its US base to 6" LED wafers (page 48) while also demonstrating the manufacture of low-defect 6" silicon carbide substrates (see page 23, with SiC supplier Dow Corning also moving from 3" to 4" epi).

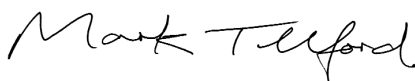
But again, most expansion is happening in Asia, with LED demand driving metal-organic precursor chemical manufacturers Chemtura and Albemarle to set up plants in Korea (pages 26–27), and MOCVD reactor suppliers growing their backlogs with orders from Taiwan (Genesis Photonics) and China (Neo-Neon, Long De Xin and Epilight in the case of Aixtron and Tsinghua Tongfang in the case of Veeco — see pages 28–31).

In the feature article on pages 94–98 of this issue we highlight the impact that Asia — and China in particular — is having on LED demand and its effect on the supply chain, with LED lighting initiatives driving investment in manufacturing plants and Chinese government subsidies spurring purchasing of MOCVD reactors.

Indeed, growth is so rapid that forecasts vary widely for MOCVD reactor sales — see Figure 5 on page 97 of the article (as well as selected individual market forecasts on news pages 6–7). Whichever is correct, even China's Ministry of Industry and Information Technology (MIIT) is wary of over-heating of the market leading possibly to over-capacity (to be addressed in its twelfth 5-year plan for industry development). The mitigating (but unquantifiable) factor is how much the LED market will grow through the adoption of LED lighting, as well as new applications that become viable through economic/technical developments, such as the improved-efficiency deep red LEDs from Osram Opto Semiconductors being used in a pilot project for plant growth (see page 51 and cover image).

Meanwhile, in the rest of this issue, we look at technical developments in nitride-based blue, green and white LEDs. These include Taiwanese researchers using nanorod arrays to boost the color rendering index, Virginia Commonwealth University and Lithuania's Semiconductor Physics Institute using staircase injector structures to thermalize hot electrons and reduce over-spill (boosting output), the University of Michigan using self-organized InGaN/GaN quantum dots to reduce green LED efficiency droop at high drive current, and UCSB reporting the first packaged blue LEDs on (30 $\bar{3}$ 1)-oriented semi-polar nitride substrates. UCSB also reports how AlGaIn quantum-well barriers can boost blue-green laser output, and possibly lead to green and yellow nitride lasers. Such developments could lead to entirely new and as-yet unknown applications and markets.

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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.

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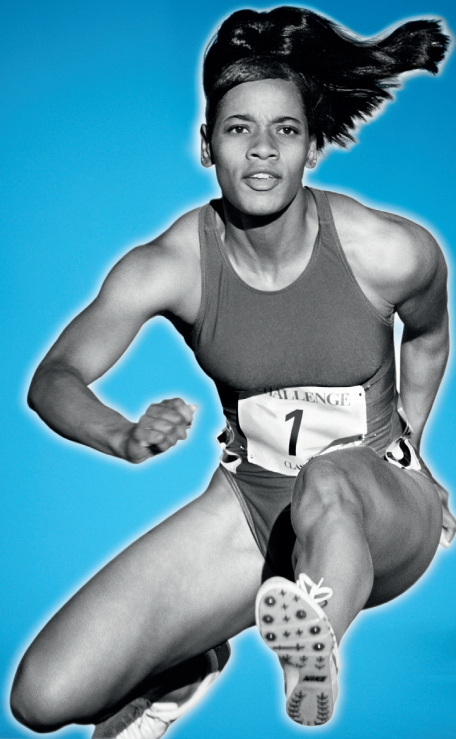
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GaAs device market to grow from \$3.7bn in 2009 to \$4.7bn in 2014

GaAs bulk & epi wafer market to rise to \$747m

Despite the recession and macro-economic trends still being in flux at the end of last year, the gallium arsenide device market staged a strong recovery toward the end of a tumultuous 2009 as a result of positive trends in wireless markets, according to the Strategy Analytics GaAs and Compound Semiconductor Technologies (GaAs) service report 'GaAs Industry Forecast 2009–2014'. A strong performance in the second half of the year meant that GaAs industry revenue managed to escape a drop for full-year 2009, remaining flat year-on-year at \$3.7bn.

Although it will see increased competition from silicon technologies in other end markets, GaAs technology will maintain its position as

the enabling technology for next-generation cellular handsets, the market research firm reckons. In particular, the smartphone category of the handset market provided a vital lifeline in 2009, boasting stronger-than-average annual growth in terminal volumes. With an increasing average number of GaAs power amplifiers per terminal as well as increasing switch complexity in this sector, GaAs device demand from next-generation handsets will grow faster than overall industry revenue growth.

"Our analysis incorporates individual wireless, consumer, infrastructure and defense market forecasts — taking into account technology trends," notes Asif Anwar at Strat-

egy Analytics. "There is no question that the improving capabilities of silicon and silicon germanium (SiGe) technologies, as well as emerging technologies such as gallium nitride (GaN), will provide increasing competition for GaAs technologies," he adds. "Despite this competition, GaAs device demand will continue to see continued growth through 2014." The market should grow at a compound annual growth rate (CAGR) of 5% to be more than \$4.7bn, concludes Anwar.

The corresponding market for GaAs wafers (bulk and epitaxial substrates) should be worth \$747m by 2014, the firm reckons.

www.strategyanalytics.com

China concerned over LED investment overheating

MOCVD reactor orders reach 1400–1600

Orders for MOCVD equipment from China have reached 1400–1600 systems, according to sources from the LED sector, and officials from China's Ministry of Industry and Information Technology (MIIT) have expressed concerns about possible overheating in LED-related investments, report Digitimes.com.

Epitaxy and LED chip production constitutes about 70% of profit generated by the LED supply chain, and LED chip packaging accounts for about 30%. Since China's LED industry is primarily in the chip packaging segment, the government has been active in supporting a move upstream to more profitable areas, offering generous subsidies to firms developing epitaxy and LED chip making capabilities. Currently, the government subsidizes 8–10m

yuan (US\$1.19–1.49m) of each MOCVD reactor installation, and has attracted many LED chip makers from mainland China, Taiwan and the USA to set up facilities in the country.

China-based players have aggressive plans to expand upstream, says Digitimes. In January Sanan Optoelectronics invested 12bn yuan to construct an LED production base and is expected to procure about 100 MOCVD reactors.

Tsinghua Tongfang has plans to invest 3bn yuan over the next three years in LED optoelectronics, with an emphasis on LED chip production, and to become China's largest supplier and one of the top three worldwide. Silan Microelectronics plans to raise 600m yuan to expand capacity for manufacturing high-brightness LED chips.

However, Taiwan-based LED companies have pointed out that LED chip production is a technology- and expertise-intensive process. Heavy investment in capacity ramps does not necessarily translate to quality products that meet industry standards. Furthermore, with rapid capacity expansion, prices from low-end to mid-range products could fall substantially, presenting another huge challenge.

MIIT officials have revealed that the government is indeed concerned that aggressive investment could overheat the LED industry. The ministry is currently designing its twelfth five-year plan for LED industry development, and is scheduled to announce up to ten new standards and policies in 2010.

www.digitimes.com/

Over 300 MOCVD reactors installed in Q2 Shipment of 4000 expected in 2010–2013

Boosted by the rapidly growing HB-LED market, more than 300 MOCVD systems were installed in second-quarter 2010, says market analyst firm IMS Research in its Quarterly GaN LED Supply Report. In excess of 4000 MOCVD systems are expected to ship in 2010–2013, corresponding to a rise in LED capacity of 352% from 2009 to 2014 to keep up with demand, driving tool shipments throughout the HB-LED supply chain.

"MOCVD is the single hottest category in the semiconductor manufacturing space, with shipments expected to rise by nearly 500% in 2010 and to keep growing through 2013," says IMS Research senior VP Ross Young. "With TVs, monitors and general lighting still early in the

adoption cycle and the Chinese government encouraging a healthy LED infrastructure with a generous \$1.5m subsidy per tool, this segment should remain hot. We now count over 80 manufacturers of epiwafers with additional companies entering soon," he adds.

According to the report, Germany's Aixtron continues to lead the multi-wafer MOCVD system market overall, with a 60% share. To meet demand, it is currently increasing its manufacturing capacity, on target for 150 systems per quarter by the end of 2010. However, while Aixtron continued to hold a dominant share in Taiwan and China in Q2/2010, it lost ground in Korea.

Between Q1 and Q2/2010, Veeco's multi-wafer system market

share has risen from 32% to 37%, due partly to share gains in South Korea, where it has a dominant position. Veeco currently plans to increase shipments to about 100 MOCVD reactors in Q3/2010 and to reach a production capacity of 120 or more by Q4.

IMS Research reports that China is the fastest-growing region, with Korea in second place. Korea's share of unyielded die capacity reached a record 36%, followed by Taiwan at 32%, with China also gaining ground, adds the report.

After a surge in Q2/2010, 4" wafer capacity is expected to account for more than a third of total wafer capacity on an area basis in Q3/2010.

www.imsresearch.com

China to add 1200 reactors, including 300 in 2010 ...but over-optimism may inflate planned number

According to the latest Report on China's LED Chip Industry in 2010 from the LEDinside research division of analyst firm TrendForce Corp, China plans to introduce more than 1200 MOCVD systems, including in excess of 300 this year alone. However, in the light of historical experience, the annual increase in the number of MOCVD systems will in practice be less than the planned number, comments the report.

The planned number reflects the extraordinary prosperity of China's LED chip industry. At least six enterprises have planned capacity of more than 100 MOCVD systems: for example, Xiamen Sanan and Elec-Tech International have already ordered more than 100 reactors each.

The main motives encouraging LED makers to introduce such enormous numbers of MOCVD tools are the subsidy policies of local Chinese government and the huge prospects for the LED market.

LED firms can receive a subsidy from their local government of RMB8–10m Yuan per MOCVD

system, which can substantially reduce the equipment purchase cost, allowing the planned number of MOCVD systems to be increased significantly. The government's subsidy policy is hence the main cause for LED makers to plan such large-scale MOCVD additions. Moreover, local government policies to attract investment, particularly the MOCVD subsidy, have effectively prompted the entry into the China market of mainstream LED chip firms from Taiwan, the USA and other regions.

Also, in addition to the enormous market potential of general lighting, new application fields are continually being developed, while the existing application markets keep maturing. In China, a market rush will always appear immediately a new industry emerges (such as with the photovoltaic sector). In the case of the LED industry, the number of chip plants in China has soared in the past year or so, so the planned number of MOCVD systems has risen correspondingly.

In the meantime, there is little understanding of the status of China's LED chip makers, e.g. the number of LED chip firms, the number of MOCVD reactors planned by each, the total number of planned MOCVD systems, the future MOCVD market volume etc. The lack of an accurate investigation of China's LED chip industry has resulted in blind entry into the industry by some players, comments the market research firm, and a degree of over-optimism about the planned number of MOCVD systems for many of the LED manufacturers.

Finally, because of the unexpected increase in the number of Chinese LED chip makers, most of which have plans to introduce MOCVD technology, the shortage of R&D personnel related to epitaxial wafer production will become a great challenge. Personnel will therefore play a key role in future market competition between China's LED chip makers, it is concluded.

http://ledinside.com/Special_Report_LED_Chip_Industry_CN_20100827

Renewed solar shakeout favors Solibro and MiaSolé in CIGS; Amonix in CPV

Lux assesses x-Si, TF-Si, CdTe, CIGS and CPV firms' prospects

Despite a strong opening to 2010 for the solar market, manufacturers are now bracing themselves for further price declines and stiffer competition, according to the new report 'Sorting Solar Module and Inverter Manufacturers on the Lux Innovation Grid' from Lux Research (part of the Lux Solar Intelligence service), which assesses the likely winners and losers among photovoltaic module and inverter makers in the renewed solar shakeout.

The market analyst firm applies its proprietary 'Lux Innovation Grid' to assess competitiveness of module makers using crystalline silicon (x-Si), thin-film silicon (TF-Si), cadmium telluride (CdTe), copper indium gallium diselenide (CIGS), and concentrated photovoltaics (CPV) technology. The report also compares inverter makers competing for residential/small-commercial

and large-commercial/utility markets. As module makers prepare for a renewed trench warfare based on production scale, inverter players aim to stake their competitive territory based on performance improvements and novel architectures, the firm comments.

"As the solar industry braces for a renewed shakeout, identifying which module and inverter makers have the greatest value is more important than ever," says the report's lead author, research associate Jason Eckstein. "The Lux Innovation Grid provides an intuitive tool for assessing the performance of individual companies and the technology space in which they compete."

One notable observation of the report is that, while familiar trends continue to advance in x-Si, TF-Si and CdTe, clear leaders have finally emerged in CIGS and CPV. Among

CIGS players, Q-Cells subsidiary Solibro and start-up MiaSolé have moved into the Lux Innovation Grid's 'dominant' quadrant. Meanwhile, in CPV, Amonix has broken away from its competitors, followed by Concentrix and Solaria, while the rest of the CPV field struggles.

In addition, start-ups appearing in the Lux Innovation Grid's 'dominant' quadrant are likely candidates for an initial public offering. Amonix, inverter maker Enphase, and CdTe module maker Abound Solar have all met critical milestones over the past year and are in strong positions to launch successful IPOs in the coming year, reckons Lux Research. Enphase is likely to move the most quickly, having already reached high sales volumes in the inverter market, the report concludes.

www.luxresearchinc.com

Installed capacity of building-integrated photovoltaics to grow tenfold to 2.4GW by 2016

High-efficiency CIGS panels and shingles boost rooftop installations

Historically, building-integrated photovoltaics (BIPV) have been relegated to a niche market because solar modules and panels have cost too much and been too difficult to install on residential and commercial roofs as well as building walls, windows, and other parts of the building structure. Also, production of BIPV products with appealing aesthetics has been limited.

However, starting this year, BIPV and building-applied photovoltaics (BAPV) market dynamics are changing, according to a new report from market analyst firm Pike Research, which forecasts that installed capacity worldwide will grow more than tenfold from just 215MW in 2009 to nearly 2.4GW by

2016, generating annual wholesale market revenues of \$4bn by 2016, under a base-case scenario.

"Rapidly falling cost per watt will be a major driver of BIPV and BAPV installations in the coming years," says senior analyst Dave Cavanaugh.

"In addition, rooftop installations are becoming much easier with the market entry of new, high-efficiency CIGS-technology [copper indium gallium diselenide] panels and shingles," he adds.

"At the same time, the aesthetic appeal of BIPV and BAPV is improving, with the introduction of solar crystalline-silicon modules and thin-film tiles and shingles that blend into building facades, atria and rooftops."

Other key growth drivers include newly instituted generous BIPV/BAPV feed-in tariffs in countries such as Italy, Japan, France, the UK, and the Canadian province of Ontario, and Cavanaugh believes it is likely that the USA will institute BIPV/BAPV incentives beginning in 2011.

Additional factors that are likely to fuel adoption of BIPV/BAPV are efficiency improvements in both c-Si modules and flexible thin-film panels and shingles, an enhanced supply chain for BIPV/BAPV solar products, much easier rooftop installation, and an increasing desire to 'go green' by owners of residences and commercial buildings, the report concludes.

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Skyworks' dual-band transceiver chipsets used in Samsung's new femtocell solutions

Skyworks Solutions Inc of Woburn, MA, USA, which manufactures linear products, power amplifiers, front-end modules and radio solutions for handset and infrastructure equipment, says that Samsung is leveraging several of its products for its newest femtocell offering, including Verizon's Wireless Network Extender.

Femtocell base stations improve 3G cell-phone coverage inside buildings by working with users' existing 3G mobile phones to provide secure, cellular service over existing broadband networks. Acting as a wireless router, the femtocell provides access to the cell phone carrier's network for multiple devices within a building.

Samsung's new code division multiple access (CDMA) plug-and-play personal base station (femtocell) for homes or small offices provides enhanced cellular coverage, helping to eliminate 'dead spots'. It also reduces the need for a landline because of its ability to manage up to three calls simultaneously, with a fourth channel reserved for emergency service calls.

Skyworks is supporting Samsung with its full suite of femtocell solutions, says Liam K. Griffin, senior VP of sales & marketing. "Our highly integrated dual-band transceiver chipset enables femtocell designers to develop cost-effective, high-performance RF-to-baseband solutions, meeting the growing demand for network capacity driven by the mobile Internet phenomenon."

With some carrier networks straining to keep up with the demands of increasing numbers of users surfing the Web from their smart phones, femtocells are seen as a cost-efficient means to improve quality of service by making more bandwidth available to support data and video applications. According to a study by iSuppli in March, femtocells are "headed toward critical mass among all major nodes of the wireless supply chain and will vault into explosive growth after reaching a decisive watershed this year". In April, Infonetics Research estimated that femtocell shipments would reach 2.5m units in 2011 and that sales of fixed mobile convergence devices and femtocells would grow at a compound annual growth rate (CAGR) of 86% from 2009 to 2014.

Skyworks' dual-band transceiver chipsets for femtocells include:

- SKY65170-11 and SKY65171-11 fully matched 0.5W power amplifiers (PAs), contained in 6mm x 6mm multi-chip modules (MCMs) that include all of the active bias and RF matching circuits. Both devices include internal power detection and operate from a single 5V supply and can be shut down via a control pin. Designed specifically for femtocell applications, the devices provide ACPR <math><-51\text{dBc}</math> at 18dBm while drawing less than 300mA.

- SKY74068-21 highly integrated transmitter for dual-band CDMA femtocells supporting 1X-RTT and

EV-DO modes in the cellular and personal communication system (PCS) bands. Packaged in a 5mm x 5mm land-grid array (LGA) is a chip that includes the baseband filter, direct upconversion in-phase and quadrature (I/Q) mixers, variable gain PA drivers, a fully integrated voltage-controlled oscillator (VCO) with local oscillator (LO) generation blocks and a dual-mode fractional-N/integer-N phase-locked loop (PLL).

- SKY74092-11 low-noise amplifier (LNA) for dual-band CDMA femtocells supporting 1X-RTT and EV-DO modes in the cellular and PCS bands. The 3mm x 3mm LGA device provides low-noise amplification with high linearity to achieve high dynamic range. Different modes, currents and gain steps of low-noise amplification are controlled by a serial three-wire bus interface.

- SKY74100-21 highly integrated tri-band receiver for CDMA femtocells supporting 1X-RTT and EV-DO modes in the cellular and PCS. Packaged in a 6mm x 6mm LGA is a chip that includes the down-converters, baseband filters with an auto-tuning loop, ultra-high-frequency (UHF) VCO, RF PLL, and DC offset correction (DCOC). The chip also integrates a full receive chain for GPS including LNA, mixer and baseband filters.

Skyworks says the devices require a minimal number of external components to complete a CDMA radio subsystem for femtocell applications.

Skyworks receives second consecutive annual award from 2Wire

For the second consecutive year Skyworks has received the Silver Gateway Supplier of the Year Award from broadband solutions provider 2Wire, for excellence in product quality and service in the Catalog Semiconductor category.

2Wire has been a customer since 2006 and its residential gateways use multiple solutions from Sky-

works' linear products portfolio, including high-end power amplifiers, switches and diodes embedded within . It has shipped more than 30 million wireless intelligent gateways to service providers in the US, Canada, Latin America, Europe, Australia and Asia, including AT&T, Telmex, BT, CenturyLink, Bell Canada and SingTel.

"We look forward to expanding our partnership," says 2Wire's executive VP of operations Martin Lynch.

"They have embraced our customized broadband solutions to support their compelling lineup of wireless residential gateways," comments Skyworks' senior VP sales & marketing Liam K. Griffin.

www.skyworksinc.com

Skyworks raises quarterly revenue guidance from \$300m to \$310m

Ahead of its Analyst Day in Boston, Skyworks Solutions Inc of Woburn, MA, USA, which makes linear products, power amplifiers, front-end modules and radio solutions for handset and infrastructure equipment, said that, given the broad-based improvements in its order

demand, it has raised its previous revenue guidance for fiscal fourth-quarter 2010 (to end-September) from \$300m (provided on 22 July) to \$310m. This is up 13% on the June-quarter's record \$275.4m and up 36% on \$228.1m a year ago.

www.skyworksinc.com

RFMD starts volume shipments of next-gen WCDMA/HSPA+ PAs for smart phones and 3G devices

RF Micro Devices Inc of Greensboro, NC, USA has started high-volume production shipments of its RF720x WCDMA/HSPA+ power amplifiers (PAs) to leading smart-phone and 3G device makers in Korea and China. The RF720x product family is currently supporting multiple new data-centric devices, and volume shipments are forecast to increase materially in 2010.

RFMD says the RF720x PAs maximize efficiency across all major 3G frequency bands (1-6, 8-11, 33, 34) to extend battery life in both voice and data operation. The PAs also feature what is claimed to be the industry's highest mid-power to high-power switch point, enabling further improvement in efficiency and higher data throughput in mid-power data modes up to 19dBm (several decibels better than existing competitive offerings).

The higher mid-power switch point is especially critical to next-generation 3G/4G smart phone makers as they seek greater reductions in output power in data-only operation. Also, by optimizing all switch points (low-, mid- and high-power) for data-centric smart phones, the RF720x product family reduces test times related to calibration, further lowering total system costs while also accelerating time-to-market, it is reckoned.

"RFMD's RF720x product family helps smart phone manufacturers

significantly enhance the consumer experience by extending battery life and enabling smaller device form factors," says Eric Creviston, president of the firm's Cellular Products Group (CPG). "The RF720x product family also lowers our customers' total system costs and helps to maximize customer-level factory throughput by minimizing design cycle times and test times," he adds. "We are particularly excited about new smart-phone programs we are supporting in Korea and China, and we look forward to ramping new design wins in the near-term in Europe and North America."

The RF720x product family includes nine high-performance PAs designed for smart phones and 3G devices implementing mode-specific, band-specific front-end architectures. It accommodates all major WCDMA/HSPA+/TD-SCDMA bands and band combinations and is optimized for seamless operation with reference designs from Qualcomm and other leading open-market 3G chipset suppliers.

RFMD's 3G product portfolio spans all major RF architectures, including existing mode-specific/band-specific and mode-specific/multi-band architectures as well as emerging multi-mode/multi-band, converged architectures.

www.rfmd.com

IN BRIEF

Femtocell revenue to reach \$4bn in 2014, driven by North America then EMEA

Shipments to grow from 1 million to 62 million units

Femtocell market revenues are forecast to reach \$4bn in 2014, according to market research firm Dell'Oro Group's 'Femtocell 5-Year Forecast Report'.

"Although we are in the very early stages of commercial femtocells deployments, we expect to see a significant increase in commercial deployments in 2011, and an inflection point in the market in 2012," says senior analyst Loren Shalinsky. "As of today, there are 14 commercial deployments around the world, with many more operators in the process of trialing femtocells service. The majority of these trials are expected to turn into commercial deployments in 2012," she adds. "While only 1 million units are expected to ship this year, we forecast unit shipments will reach 62 million in 2014, with more than 80% of those total units being WCDMA femtocells."

The report shows that North America is expected to have the highest shipment volume in 2010 due to the three largest mobile operators having already launched commercial femtocells service. However, as more operators in the Europe, Middle East and Africa (EMEA) begin deployments in 2012, Dell'Oro forecasts that shipments to this region will surpass those of North America.

www.DellOro.com

TriQuint releases 0.15 μ m TQP15 pHEMT foundry process to full production

Optical lithography cuts costs for mm-Wave applications

RF front-end component maker and foundry services provider TriQuint Semiconductor Inc of Hillsboro, OR, USA has announced the release of its latest 150mm gallium arsenide commercial foundry process to full production (after going on limited release at the end of Q4/2008).

TQP15 is targeted at the Ka-band segment and is designed for cost-effectively fabricating millimeter-wave (mmWave) monolithic microwave integrated circuits (MMICs) for applications such as VSAT, satellite communications and point-to-point radios.

Manufactured in TriQuint's high-volume GaAs fabrication facility, TQP15 is the latest offering in the firm's well-established pseudomorphic high-electron-mobility transistor (pHEMT) process portfolio. TQP15 uses optical lithography (with a gate length of 0.15 μ m) to reduce cost compared with traditional electron-beam (e-beam) based solutions. It also incorporates refractory gate metal architecture, which does not exhibit the

standard metal gate sinking failure mechanism of non-refractory gate pHEMT processes.

"The TQP15 process leverages TriQuint's mature manufacturing capabilities used in the production of millions of pHEMT-based wafers," says Steve Grant, TriQuint's VP of global operations. "TQP15 benefits from the stability of the base technology. And it is cost-effective because of the innovative use of optical lithography," he adds.

TriQuint says that, throughout the development cycle, the process has been made available to select customer designers to collect feedback and aid process characterization. "TQP15 offers us an economical high-frequency pHEMT process," comments Paul Blount, president & CEO of Custom MMIC Design Services Inc (CMDS) of Westford, MA, USA. "We have successfully used

TQP15 for high-efficiency amplifiers and control functions up to K-band frequencies, and look forward to using this process to grow our product portfolio through Ka-band," he adds.

"TriQuint is recognized as a technology leader with its broad portfolio of HBT, e-beam and optical pHEMT technologies. Adding TQP15 solidifies this position," reckons Mike Peters, TriQuint's director of marketing for Commercial Foundry. "Together with fully released optical pHEMT technologies TQPED and TQP13-N, and the soon to be released TQP25 process, TriQuint continues to enable the commercialization of mmWave markets."

In conjunction with European Microwave Week (EuMW 2010), on 27 September, TriQuint's Corey Nevers and Ed Knapp (key contributors to TQP15) hosted an interactive customer forum discussing the new foundry process' architecture, reliability and performance.

www.triquint.com/prod_serv/foundry/docs/TQP15_2010917.pdf

TQP15 is cost-effective because of the innovative use of optical lithography

TriQuint recognizes top suppliers for overall performance

At its annual Supplier Day Conference educational and networking event in Portland, OR in early September, RF front-end product maker and foundry services provider TriQuint Semiconductor Inc of Hillsboro, OR, USA announced its 'Top Supplier Awards for 2009', which recognize its overall performance including innovation, operational excellence, service levels, and industry leadership.

The categories and winners (selected by members of TriQuint's Supply Chain and Business Unit organizations) are as follows:

● Top Supplier of the Year: Ambit Microsystems of Zhongshan, China (a subsidiary of Foxconn Technology Group, the world's

largest EMS provider), which provides semiconductor assembly & test services.

● Top Supplier of the Year — Florida: NTK Technologies Inc of Santa Clara, CA, USA, which provides semiconductor packaging materials.

● Top Supplier of the Year — Oregon: Singapore-based MBE Technology Pte Ltd, a subsidiary of IQE plc that supplies epiwafers grown by molecular beam epitaxy for wireless communications and optoelectronic applications.

● Top Supplier of the Year — Texas: Vacuum Engineering & Materials Inc of Los Gatos, CA, USA, which provides manufacturing, stocking and distribution of thin-film materials.

● Supplier Excellence Award: Murata Electronics North America Inc, which is one of 54 subsidiaries of Japan-based electronic component supplier Murata Manufacturing Co Ltd.

"The capability of our strategic suppliers to provide us with zero-defect material, position capacity to support TriQuint's continued growth, and collaborate on reducing costs while developing innovative solutions greatly contributes to our ability to deliver RF solutions that improve the performance and lower the cost of our customers' applications," commented Steve Grant, VP of worldwide operations.

www.triquint.com



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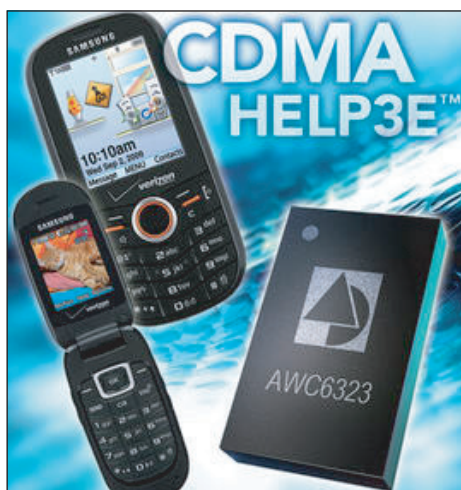
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Anadigics HELP3E dual-band CDMA power amplifier chosen for Samsung's Intensity II and Gusto phones

Broadband wireless and wireline communications component maker Anadigics Inc of Warren, NJ, USA says that its HELP3E dual-band AWC6323 power amplifier— which supports the Cell (824–849MHz) and PCS (1850–1910MHz) bands — is being implemented in Samsung's Intensity II and Gusto mobile phones.

Manufactured using indium gallium phosphide (InGaP) BiFET technology, the AWC6323 is the first product in Anadigics' portfolio of High-Efficiency-at-Low-Power (HELP) dual-band CDMA PAs in a 3mm x 5mm x 1mm footprint. It features what is claimed to be the industry's lowest quiescent current for a CDMA power amplifier (3.5mA), directly helping to increase handset talk-time performance without the need for a DC-DC converter.

The AWC6323 offers three mode states to achieve high power-added efficiencies at several power levels during phone operation. Built-in



Anadigics' AWC6323 CDMA PA with Gusto and Intensity II.

directional couplers for each band with a common coupler port help **AWC6323 is the first product in Anadigics' portfolio of HELP dual-band CDMA PAs in a 3mm x 5mm x 1mm footprint**

to eliminate the surface-mount couplers placed on the phone board.

The device also meets the stringent linearity requirements of CDMA EV-DO Revisions A and B modulations to offer very high data rates for smart phones and data cards.

Samsung's Intensity II and Gusto handsets, offered by Verizon (the largest wireless network in North America), are among its most popular mobile phones in terms of value and reliability. The slim Intensity II phone is suited to high-speed social networking with a slide-out full QWERTY keyboard that enables users to quickly connect with others via text or picture message. The Gusto flip phone features crisp display and noise suppression technology along with robust text, picture and instant messaging capabilities.

www.anadigics.com

Samsung Epic 4G smartphone using Anadigics PA for mobile WiMAX

Broadband wireless and wireline communications component maker Anadigics Inc of Warren, NJ, USA says that its AWT6264 power amplifier is driving WiMAX connectivity in Samsung's recently released Epic 4G handset.

Introduced this year, the Epic 4G smartphone, offered by Sprint and part of Samsung's Galaxy S series, is running Google's Android operating system and is enabled for mobile WiMAX services. It is also the first WiMAX-enabled smartphone for the North American consumer market featuring Anadigics power amplifiers (PAs).

The AWT6264 PA is a small 4mm x 4mm x 1mm device that delivers high output power, linearity and efficiency for high-data-rate worldwide mobile WiMAX coverage of the 2.3–2.7GHz spectrum. Specific features of the AWT6264 include:

delivering +25dBm linear output power (meeting WiMAX spectrum mask), contributing typically 2.5% EVM, providing 32dB of RF gain, and operating with typical power-added efficiency of 24%. With an integrated step attenuator and featuring fully matched RF ports, it supports faster product development cycles and requires less PC board space than other, more discrete solutions, it is claimed. The PA supports 4G wireless connectivity devices, including smartphones, mobile internet devices, netbook/notebook PCs, and PC cards/USB dongles.

"We have a valued, long-standing relationship with Samsung in providing solutions across a broad range of wireless and 3G standards," says Anadigics' VP, worldwide sales Michael Canonico. "With the introduction of the Epic smartphone,

our AWT6264 product is now playing a key role in bringing 4G features to end users as well," he adds.

According to Samsung, its Epic 4G is part of a new breed of smartphones that offer the best in screen, speed and content quality, while also providing fully integrated multimedia, messaging and social networking. It also features a very thin smartphone design with a slide out, full QWERTY keyboard and 4-inch Super AMOLED touchscreen display.

"We are very pleased to receive feedback from Samsung that our AWT6264 PA meets and exceeds their requirement for optimizing the performance of the Epic 4G," says Anadigics' president & CEO Mario Rivas.

www.samsungmobileusa.com/GalaxyS/#/epic

Presto to support characterization and production testing for WIN's GaAs foundry customers

A strategic collaboration has been agreed for semiconductor product engineering firm Presto Engineering of San Jose, CA, USA to deliver characterization and testing services for companies developing products using GaAs technology from Taiwan's WIN Semiconductors Corp, the world's largest pure-play gallium arsenide foundry.

The agreement covers wafer-level and packaged-part development activities, including design characterization and production testing. WIN's customers can now gain access to highly specialized GaAs testing services from the Presto Engineering Hubs in Silicon Valley and Grenoble, France.

"As WIN continues to see strong growth in its major market sectors it is committed to providing cost-effective solutions that meet cus-

tomers' needs," says WIN's VP of sales & marketing Brian Lee. "The collaboration between WIN and Presto Engineering is that type of innovative approach that provides our customers with a one-stop solution for fab, characterization and testing services," he adds.

"We are seeing a significant increase in our RF services business, driven by the overwhelming demand on the semiconductor industry to deliver innovative devices to meet the needs for increased communication bandwidth and cost-effectiveness," says Presto's founder & CEO Dr Michel Villemain. "Our staff are looking forward to working closely with the WIN team, as time-to-production will be critical for our mutual customer's success."

The Presto Hubs offer customers use of high-frequency test & meas-

urement equipment (e.g. network analyzer, pattern generator, BERT), as well as RF-ATE; Roos Instruments Cassini platform, supporting DC to 100GHz source and measure, and the Verigy 93K Port Scale RF test system. The firm's technical staff can also assist with test program development, probe card design using GGB and Cascade Microtech high-frequency probe systems, load board development and automatic handler support.

Additional Presto Hub services include stress testing required for engineering and product qualification, covering reliability testing for temperature, environmental and electrical stresses, as well as both physical and electrical fault isolation and failure analysis.

www.presto-eng.com
www.winfoundry.com

AML launches RF & microwave subsidiary Cal Mimix Amplifier and subsystem maker expands to AlGaAs/InGaAs pHEMTs

AML Communications Inc of Camarillo, CA, USA, a designer and manufacturer of microelectronic assemblies such as microwave amplifiers and subsystems for the defense industry, has launched its Cal Mimix Inc subsidiary.

Cal Mimix has been in existence for the last 6 months as a fabless designer and developer of RF, microwave and millimeter-wave semiconductor products for commercial and military applications. The firm has entered into manufacturing contracts with an on-shore foundry for the production of GaAs-based devices and has taken delivery of low-rate production units.

Cal Mimix is now announcing the launch of a family of AlGaAs/InGaAs low-noise pHEMT devices with operational frequencies of up to 26GHz. First to be introduced is the CM332, a high-reliability AlGaAs/InGaAs pHEMT with a nominal gate length of

0.25 μ m and gate width of 300 μ m.

The firm says that the device is equally effective for wide-band (e.g. 2–18GHz or 18–26GHz) and narrow-band applications up to 26GHz. With a minimum noise figure as low as 0.6dB at 12GHz, the low-noise device suits commercial wireless and military applications requiring low noise figure and high associated gain. The CM332 is targeted at a wide range of

Semiconductor devices are a logical extension of our business. There are clear opportunities for new products evolving from our long-term relationships with our customers and for devices that replace products no longer available

applications including broadband military EW (electronic warfare), defense communications, wireless communication infrastructure, and point-to-point microwave radios. The device is a suitable replacement for low-noise pHEMT devices from firms such as NEC, Eudyna, and Mitsubishi, the firm claims.

Sample quantities of the new die are available from stock. Other devices are in either the design or manufacturing stages and are planned for release by end-2010.

"Semiconductor devices are a logical extension of our business," comments AML's president & CEO Jacob Inbar. "There are clear opportunities for new products evolving from our long-term relationships with our customers and for devices that replace products no longer available."

www.calmimix.com
www.amlj.com

Mimix Asia becomes M/A-COM Tech Asia

As part of June's merger that added Mimix Broadband Inc of Houston, TX, USA and its subsidiaries to M/A-COM Technology Solutions Inc of Lowell, MA (which supplies semiconductors, components, and sub-assemblies for use in RF, microwave and millimeter-wave applications), Mimix Asia of Hsinchu Science-Based Industrial Park, Taiwan has changed its operating name to M/A-COM Tech Asia.

M/A-COM Tech Asia designs and manufactures products addressing microwave and millimeter-wave applications. Its facility is ISO 9001-registered and includes a Class 10,000 cleanroom for die picking and visual inspection and 8000 square feet of production

floor space. It also has an ISO 9001-registered design center in Belfast, Northern Ireland, UK for product development and qualification with comprehensive assembly & test facilities for device design.

"M/A-COM Tech Asia offers high-power and highly integrated devices," says Robert Dennehy, who has been named its managing director. "As a member of the M/A-COM Tech family of companies, we can provide complete block diagram solutions that are unmatched by our competitors, and our unique S- and X-band core chips, like the XZ1001-BD and XZ1002-BD respectively, provide a high degree of functionality that greatly simplify the design task for transmit and receive modules."

Dennehy began his career with M/A-COM Technology Solutions in 1993, was promoted to operational management positions and ultimately transitioned to product management. He has led operations and development teams addressing multiple product lines, ranging from circulators and isolators, switches, voltage-controlled oscillators (VCOs) and synthesizers to various signal processing components and passives modules.

Previously with the firm and maintaining their roles are senior director Peter J. Hales, technical director Dr Alexandre Bessemoulin, applications engineering manager Ken Golden, and general manager Min Hong Sir.

www.macomtechasia.com

M/A-COM Tech Asia launches 8.5–11GHz GaAs MMIC core chip

M/A-COM Tech Asia has launched an 8.5–11GHz GaAs MMIC core chip, consisting of integrated transmit/receive switches, an LNA, a 6-bit phase shifter, a 5-bit attenuator and a driver amplifier.

Suiting both military and weather phased-array radar and satellite communications, the XZ1002-BD

has 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 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."

Microsemi buys SiGe front-end module firm VT Silicon

Microsemi Corp of Irvine, CA, USA (which designs and makes analog/mixed-signal ICs, high-reliability semiconductors and RF subsystems) has acquired the assets of VT Silicon of Atlanta, GA, a fabless designer and supplier of multi-band RFIC solutions for the mobile wireless broadband market. VT's products leverage linearization and efficiency-enhancement technologies to enable efficient, low-cost and small-footprint intelligent front-end RFIC solutions.

The acquisition extends Microsemi's RF portfolio to next-generation WLAN and WiMax markets, says president & CEO James J. Peterson. "As the first supplier in the world to develop a monolithic front-end

RFIC in silicon germanium (SiGe), VT's technology caliber is designed to enable Microsemi to deliver innovative, highly integrated front-end modules," he adds.

According to a recent report from Strategy Analytics, the worldwide installed base of consumer wireless devices will exceed 2.6bn by 2014. This high-volume global market, which necessitates technology differentiation, typifies the kind of commercial business Microsemi is targeting. The firm says its balanced business model blends high-volume commercial market opportunities with the growth and content opportunities of its aerospace, defense and security end-markets.

Microsemi currently uses gallium arsenide, silicon and silicon carbide to make devices that manage and control or regulate power, protect against transient voltage spikes and transmit, receive and amplify signals. Products include individual components as well as ICs that enhance customer designs by improving performance and reliability, battery optimization, reducing size or protecting circuits. Principal markets include implanted medical, defense/aerospace and satellite, notebook computers, monitors and LCD TVs, automotive and mobile connectivity applications.

www.microsemi.com

www.vtsilicon.com

E-Band launches 2.5Gbps backhaul solution for carrier LTE and 3G/4G networks

E-Band Communications Corp of San Diego, CA, USA, which makes high-capacity point-to-point Gigabit Ethernet wireless transmission systems for carrier, enterprise and government networks, says that what is claimed to be the first commercially available millimeter-wave radio solution operating at 2.5Gbps over the air has completed field testing and is now available worldwide.

The E-Link 2500 is part of the new 4G Evolution Series of products optimized for LTE and 3G/4G carrier networks, which currently consists of 70/80GHz multi-gigabit-capacity products, featuring solutions for carriers that need to enhance backhaul infrastructure and transition

their existing networks to carry data-centric 4G traffic.

The latest addition to the series is an expanded line of 70/80GHz solutions (both indoor-outdoor and complete outdoor solutions) capable of up to 2.5Gbps, with what is claimed to be the industry's highest link budget (due to E-Band's exclusive MMIC technology), monitored hot standby (MHSB) and 1+1 configurations, and a new patent-pending innovation to make installation easier, faster and less costly for carriers, distributors and installers.

"The E-Link 2500 was very well received by our customers and is already being deployed in carrier networks to transmit commercial

4G backhaul traffic," says co-founder & senior VP Saul Umbrasas. Already, last year, E-Band achieved the number-one market share position for 70/80GHz point-to-point radios. "Development of the E-Link 2500 solution was driven by carriers that requested E-Band to provide more capacity for their backhaul transport rings," he Umbrasas.

"This solution, and forthcoming product announcements as part of our new 4G Evolution Series, will enable our customers to extend fiber-type capacity in urban areas where devices such as smartphones are placing tremendous demands on networks," he concludes.

www.e-band.com

SiGe launches 2nd-gen higher-efficiency WiMAX PA

SiGe Semiconductor Inc of Andover, MA and Ottawa, Canada, which supplies silicon-based RF power amplifiers (PAs) and front-end modules (FEMs), has expanded its series of power amplifiers with the SE7271T, a single high-power PA that can cover both 2.3–2.4GHz and 2.5–2.7GHz WiMAX bands, reducing bill of materials (BoM) and cost for USB dongles, data cards, mobile Internet devices and WiMAX-enabled handsets.

"Our proven system knowledge and device integration has enabled us to deliver this compact, small-footprint PA with unequalled power added efficiency," says Sanjiv Shah, marketing director for WiMAX Products. "With the SE7271T's low current consumption, we are delivering the battery life that consumers have come to expect in mobile devices," he adds.

The highly integrated single-die PA is fully matched with a step attenuator, power detector and harmonic filter in a small lead- and halogen-free 3mm x 3mm x 0.6mm quad flat no lead (QFN) package. The integrated impedance match

combines with the device's functionality to create a plug-and-play solution that simplifies the design of mobile WiMAX products and improves their manufacturability, says the firm. Lower current consumption and higher efficiency reduce current draw, leading to improved battery life in WiMAX-enabled handsets, mobile Internet devices and laptops. PA current consumption is critical in USB dongles, where the limits on available power supply current typically force reductions in the RF output power of less-efficient PAs, reducing network coverage and data rate.

"Competitors struggle with delivering to customers the key value points for the evolution of mobile WiMAX products," says Shah. "Competitive products are physically larger or are not compliant with the temperature range required for data cards and USB dongles. And some don't cover the complete 2.5GHz WiMAX band," he adds. "Full 2.3–2.7GHz coverage, increased efficiency at high RF power levels, –40 to +85°C operating

temperature range, reduced package height — these are critical performance areas for mobile WiMAX PA."

According to analyst firm Dell'Oro, the number of WiMAX subscribers is expected to rise from 7 million in 2009 to 69 million by 2013. "Whether using wired or wireless networks, today's consumers expect broadband speed and performance," Shah says. "WiMAX is the next-generation standard for delivering wireless high-bandwidth connectivity in fixed and mobile environments, and our RF PAs and FEMs deliver the reliability, flexibility, and performance OEMs require and WiMAX consumers demand," he continues. "The SE7271T provides our customers with an integrated solution for their designs. The reduced design time it supports, with the smallest footprint for its functionality as well as the reduction of the number of components required and cost, all make it a device of choice for USB dongles, data cards, mobile Internet devices and WiMAX-enabled handsets," Shah claims.

www.sige.com

China makes 120nm HEMTs with cut-off frequencies above 100GHz

InGaAs/InAlAs devices show promise for mm-wave devices and ICs

Researchers based in China have developed 120nm III-V HEMTs with millimeter-wave broadband and satellite communication applications in mind [Huang Jie et al, *J. Semicond.*, vol31, p074008, 2010]. The current-gain cut-off frequency (f_T) was 141GHz and the maximum power gain cut-off (f_{max}) was 120GHz.

The research was carried out by the Chinese Academy of Sciences' Institute of Microelectronics and China's Southwest University in Chongqing. The researchers see their new indium gallium arsenide/indium aluminum arsenide (InGaAs/InAlAs) devices as being "promising in millimeter-wave devices and integrated circuits".

The device structures (see Table) were grown on semi-insulating indium phosphide (InP) substrates using MBE. To make the transistors, the source and drain regions were formed first using the deposition and lift-off of six layers of alloyed metal (nickel, germanium, gold, germanium, nickel, gold). The resulting contact resistance was measured at $0.2\Omega\text{-mm}$ using the transmission line model (TLM).

The mesa isolation structures were formed by a wet chemical etch using an aqueous solution of phosphate (H_3PO_4) and hydrogen peroxide. Electron-beam evaporation was used to create the titanium-gold wiring (Figure 1).

To produce short gate lengths of $\sim 100\text{nm}$, the researchers developed a four-layer electron-beam resist process: poly(methyl methacrylate) (PMMA), polymethylglutarimide (PMGI), ZEP520, polymethylglutarimide (PMGI). ZEP520 is a high-performance resist developed by Zeon Corp of Japan. The China researchers report that use of the bottom PMGI layer helps in the clean removal of the resist layers compared with a structure that has a ZEP520 bottom layer.

Table. InGaAs/InAlAs HEMT epitaxial layer structure.

		Si doping/ cm^3	
$\text{In}_{0.53}\text{Ga}_{0.47}\text{As}$	Cap	30nm	1×10^{19}
InP	Etch stop	6nm	
$\text{In}_{0.52}\text{Al}_{0.48}\text{As}$	Barrier	10nm	
Planar Si- δ -doped			5×10^{12}
$\text{In}_{0.52}\text{Al}_{0.48}\text{As}$	Spacer	3nm	
$\text{In}_{0.7}\text{Ga}_{0.3}\text{As}$	Channel	10nm	
$\text{In}_{0.52}\text{Al}_{0.48}\text{As}$	Buffer	300nm	
SI InP substrate			

The gate (Figure 2) was recessed into the cap layer with a wet citric acid/hydrogen peroxide etch that was stopped by an InP etch-stop layer (selectivity InGaAs/InP ~ 160). The gate metal consisted of titanium, platinum and gold, which was deposited in an evaporation

not used because the researchers wanted to avoid increasing the gate capacitance and thus impact the high-frequency performance.

In DC operation, the HEMT's saturation drain-to-source current was found to be 446mA/mm . The maximum extrinsic transconductance

(G_m) of 520mS/mm was obtained under conditions where the gate-source voltage was -0.5V and the drain-source voltage was 1.5V . Subthreshold, the gate leakage — a little less than $0.1\mu\text{A}$ — is dominated by current from the drain. The pinch-off/threshold voltage is -1V (hence the transistor is 'on' at 0V).

The frequency performance was extracted from measurements made in the range $0.1\text{--}26.1\text{GHz}$. The maximum power gain cut-off was determined from measurements made at a drain-source voltage of 1.5V and a gate-source voltage of -0.5V . Parasitic effects were de-embedded from the measurements.

<http://iopscience.iop.org/1674-4926/31/7/074008>

Author: Mike Cooke

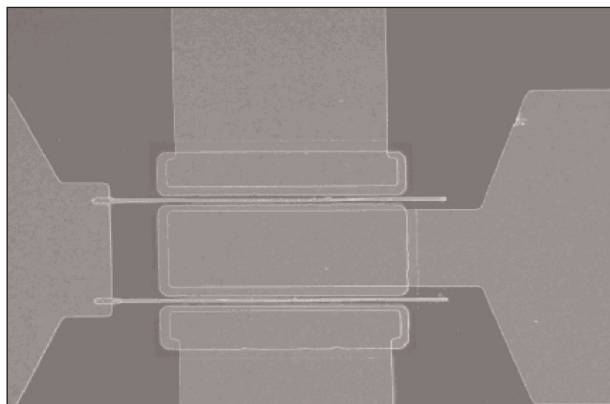


Figure 1. Partial photograph of InGaAs/InAlAs HEMT structure.

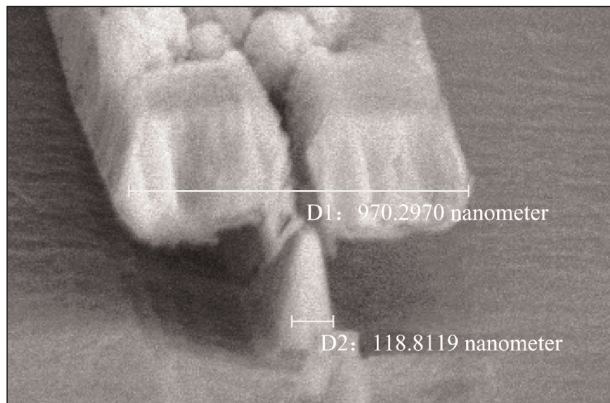


Figure 2. SEM photo of the T-shaped pattern of the InGaAs/InAlAs HEMT.

**Source
Materials**

Laser

LPE

VPE

InAs

InSb

VCSEL

MOCVD

PIN

GaAs

APD

Polycrystal

Solar Cell

HBT

InP

Hall Sensor

MBE

GaSb

LED

HEMT

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Fluoride push to nitride HEMT enhancement

Researchers in China use fluoride plasma to create normally-off HEMTs comparable to normally-on devices

Researchers at China's National Key Laboratory of Application Specific Integrated Circuit and at the University of Electronic Science and Technology of China's State Key Laboratory of Electronic Thin Films and Integrated Devices have used fluoride plasma treatment of nitride high-electron-mobility transistors (HEMTs) to create enhancement-mode (E-mode) devices with performance comparable to depletion-mode (D-mode) devices produced without treatment [Feng Zhihong et al, *J. Semicond.*, vol31, p084001, 2010].

Presently, the best performing nitride HEMTs are D-mode (normally-on) devices. However, E-mode (normally-off) devices are desirable in terms of low energy consumption. Benefits would be seen in digital and radio-frequency design if high-performance E-mode nitride HEMTs could be developed.

E-mode devices have previously been developed using recessed gates or fluoride plasma treatments in the gate region. Fluoride treatments have been used to create E-mode HEMTs by groups based at Hong Kong University of Science and Technology (HKUST) and University of California Santa Barbara, for example.

The Chinese researchers grew their devices on n-type silicon carbide wafers using metal-organic chemical vapor deposition (MOCVD). The buffer layer consisted of 1.8 μm of semi-insulating gallium nitride (GaN). A thin aluminum nitride (AlN) layer was deposited before applying a 20nm aluminum gallium nitride (AlGaN) barrier (21% Al). Finally, a 2nm GaN cap was added.

The device isolation was carried out using an inductively coupled plasma reactive-ion etch. Electron-beam evaporation was used to deposit titanium-aluminum-nickel-gold source-drain contacts.

The 1 μm non-recessed gates were

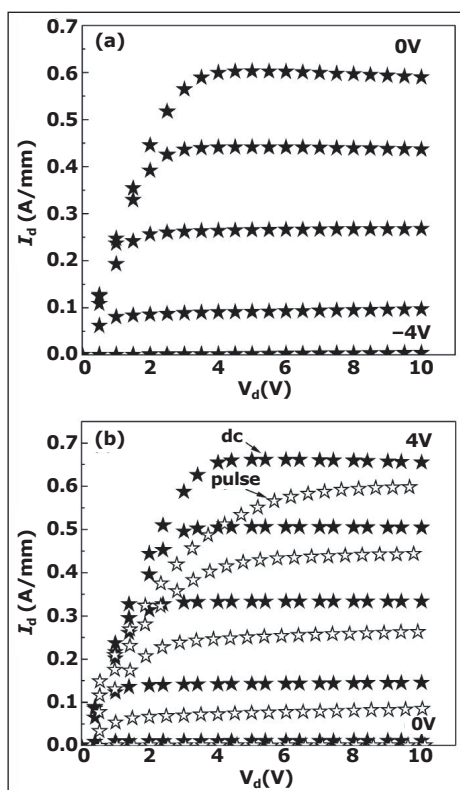


Figure 1. (a) DC current-voltage characteristics of D-mode AlGaN/GaN HEMT. (b) DC & pulsed characteristics of E-mode AlGaN/GaN HEMT.

formed in 1 μm x 100 μm windows by first treating the surface with carbon tetrafluoride (CF₄) plasma in an RIE system and then applying

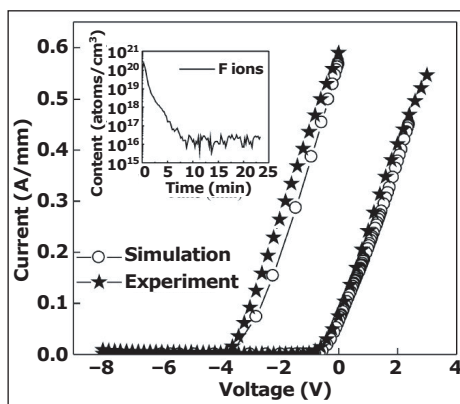


Figure 2. Comparisons of simulation and experiment of AlGaN/GaN HEMTs performance before and after fluorine plasma treatment. Inset: secondary-ion mass spectrograph (SIMS) for sample treated by fluorine plasma.

nickel-gold for the electrode. Devices were also produced without the CF₄ treatment.

A passivation layer of silicon nitride was applied using plasma-enhanced chemical vapor deposition (PE-CVD). Finally, a rapid thermal anneal (RTA) lasting for 10 minutes was carried out at 400°C.

The effect of the fluorine treatment is to push the devices from being D-mode to being E-mode (Figure 1), i.e. they block current when the gate is at zero potential (V_{gs}). The researchers report that their E-mode devices pass a similar current at 0V V_{gs} to that of the D-mode HEMT (i.e. without CF₄ treatment) at -4V.

The threshold voltage of the E-mode device is estimated to be +0.35V, compared with -4V for the D-mode device. The transconductance of the E-mode device is 201mS/mm, representing "high performance". The saturation current at $V_{gs} = 4\text{V}$ is 667mA/mm. The current gain cutoff frequency (f_T) and maximum oscillation frequency (f_{max}) are about 10.3GHz and 12.5GHz, respectively. The low performance of the maximum oscillation frequency is blamed on high parasitic capacitance deriving from the n-type SiC substrate.

The current collapse phenomenon, which can be a feature of the operation of nitride HEMTs at high bias, is described as being 'low level', with the researchers adding that this suggests there are no adverse effects associated with the fluoride-plasma-induced traps.

The researchers carried out simulations (Figure 2) that suggest that the effect of the fluorine ions can be feasibly treated as acceptor traps at 1.8eV below the conduction-band energy.

<http://iopscience.iop.org/1674-4926/31/8/084001>

www.uestc.edu.cn

Author: Mike Cooke

Nitride HEMT on silicon achieves 143GHz current gain cut-off frequency

ETH and EPFL use AlInN barrier to enhance transistor performance

Researchers in Switzerland have enhanced the high-frequency performance of nitride-based HEMTs grown on silicon wafers [Haifeng Sun et al, Appl. Phys. Express, vol3, p094101, 2010]. The researchers, based at ETH-Zürich and Ecole Polytechnique Fédérale de Lausanne (EPFL), created HEMTs with current gain (f_T) and maximum oscillation ($f_{MAX(U)}$) cutoff frequencies of 143GHz and 176GHz, respectively.

The previous record for nitride HEMTs grown on high-resistivity (HR) silicon gave an f_T of 107GHz and an $f_{MAX(U)}$ of 150GHz. The Swiss HEMTs used a structure with barriers made of aluminum indium nitride (AlInN) rather than the more traditional aluminum gallium nitride (AlGaIn). A number of applications in the past few months have made use of high-quality AlInN growth methodologies that have recently become available. An advantage of AlInN is that it can be lattice matched to the underlying GaN, in principle reducing strain-related reliability problems. AlGaIn cannot be lattice matched to GaN.

Nitride HEMTs are attractive for power amplification of radio signals, such as for base-station transmissions from wireless networks. However, such devices are generally grown on expensive substrates such as silicon carbide to achieve high-frequency performance. For example, AlGaIn/GaN and AlInN/GaN HEMTs on semi-insulating silicon carbide have achieved f_T values of 162GHz and 205GHz, respectively. For commercial use, high-performance HEMTs grown on low-cost

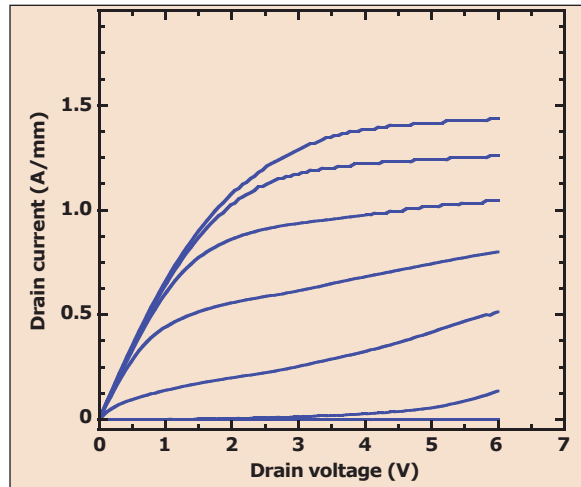


Figure 1. Drain characteristics of 2x(80x50) μ m devices for gate voltage ranging from 0V to -6V in steps of -1V.

silicon would be very attractive.

The new HEMT epitaxial structure was grown on high-resistivity (111) silicon substrates using MOCVD. The epitaxial layers started with 60nm AlN nucleation, followed by 700nm of GaN as insulating buffer/channel, a 1nm AlN spacer, and finally an 8nm near-lattice-matched Al_{0.86}In_{0.14}N barrier.

Room-temperature Hall effect measurements on the as-grown epitaxial structure give the channel electron sheet density as $1.95 \times 10^{13}/\text{cm}^2$ and the mobility as

$1060\text{cm}^2/\text{V}\cdot\text{s}$. The researchers comment: "The channel electron density is roughly twice higher than with a conventional AlGaIn barrier."

The devices were isolated by etching 200nm mesas using a 150W plasma containing chlorine, carbon tetra fluoride, helium and argon. The ohmic source-drain contacts consisted of titanium, aluminum and gold (16nm, 64nm, 50nm) that were treated using rapid thermal annealing. The 80nm Schottky T-gate contact consisted of nickel-gold centered in the $1\mu\text{m}$ source-drain space. A silicon nitride layer was used for passivation.

DC and RF measurements were carried out. As one might expect, the device operates in a normally-on (depletion) mode. At zero gate voltage (V_{GS}) the maximum drain current is 1.43A/mm. At a gate voltage of -7V and a drain voltage (V_{DS}) of 6V, the current has been pinched-off down to $4.6\mu\text{A}/\text{mm}$. The device is described as having 'well-behaved characteristics', although there is some evidence of short-channel effects with increased output conductance for gate voltages less than -4V and drain voltages greater than 5V (Figure 1).

The peak extrinsic conductance of 415mS/mm is found at a gate voltage of -4.34V and a drain voltage of 4.0V. The gate leakage is $5\mu\text{A}/\text{mm}$ at a gate voltage -8V. The ratio of on- and off-currents is 10^6 at 4V drain voltage.

The RF measurements were carried out from DC to 40GHz (Figure 2). Without de-embedding the characteristics of the HEMT from those of the contact pads, the researchers obtained f_T and $f_{MAX(U)}$ cutoff frequencies of 100GHz and 144GHz, respectively. Removing the contact pad contributions gave an f_T of 143GHz and an $f_{MAX(U)}$ of 176GHz.

<http://apex.ipap.jp/link?APEX/3/094101>

Author: Mike Cooke

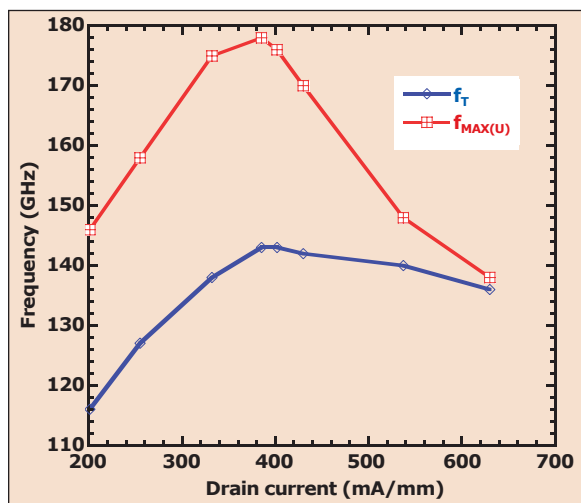


Figure 2. Dependence of f_T and $f_{MAX(U)}$ as a function of drain current at 4V drain.

IXYS claims highest-density, highest-efficiency MOSFET solution with SiC technology in isolated integrated package

Power semiconductor and module maker IXYS Corp of Milpitas, CA, USA and Biel, Switzerland has announced the integration of silicon carbide (SiC) technology and the latest super junction MOSFET technology into a single user-friendly package enabling increased power density and higher efficiency in fast switching power supplies and solar inverter applications.

"Currently the system designers in high-frequency, high-efficiency applications are forced to consider using separate discrete devices, often from different suppliers, complicating mechanical layouts and time to market," says VP of international sales Bradley Green. IXYS says that its new MKE product range effectively integrates these technologies into one part, reducing parasitic inductance and its associated losses.

"Our patented ISOPLUS i4 package, with its proven ruggedness based on the internal DCB construction,

enables the co-location of the MOSFET and SiC diode, thus also reducing real-estate requirements in power switching topologies that are getting far more focused on not only reducing power losses but also challenging the traditional restraints on power supply size," says Green. "It has better thermal impedance with lower weight than alternative solutions that use a heavier copper lead frame and bulky modules," he adds.

The first product in the MKE range is an ultrafast boost chopper which integrates a super junction COOLMOS CP MOSFET and a SiC boost diode into the ISOPLUS i4 package.

ISOPLUS technology gives the designer a discrete package with ceramic, direct copper bonded (DCB) isolation. This isolation has low thermal impedance and a higher reliability in power cycling than standard copper-based solutions and non-isolated products, IXYS says.

An example of the technology is

the MKE11R600DCGFC, which integrates a 600V COOLMOS MOSFET and a 12A 600V SiC diode in boost chopper circuit topology, which is a common combination for power factor correction (PFC) stages in high-switching applications.

Because of the absence of minority carrier injection in SiC, there is no reverse recovery of the boosting diode, providing the highest efficiency with very low switching losses, claims the firm. The use of ISOPLUS packaging allows mounting of the MOSFET and boost diode very close together, minimizing stray inductance. Layout is designed to be user friendly, as the gate and source connections are located side by side and are easily accessible.

The combination of the COOLMOS MOSFET and SiC diode within the ISOPLUS packaging creates a high-power-density, reliable design that enables a reduction in total system size and power loss, claims IXYS.

www.ixys.com

SemiSouth demonstrates 1200V, 100A, half-bridge, all-SiC-based power module

At the 8th European Conference on Silicon Carbide and Related Materials (ECSCRM 2010) in Oslo, Norway (29 August – 2 September), SemiSouth Laboratories Inc of Starkville, MS, USA (which designs and makes SiC technology for high-power, high-efficiency, harsh-environment power management and conversion applications) presented a paper 'Low Switching Energy 1200V Normally-Off SiC VJFET Power Modules' on the development of an all-SiC-based power module for use in high-frequency and high-efficiency applications, presented by director of engineering Dr David C. Sheridan.

"As SiC devices migrate to applications above 20–30kW, multi-chip power modules offer the most energy-efficient and practical solu-

tion for a wide range of applications such as high-power commercial solar inverters, electric vehicle inverters and electric actuators in aircraft," says co-author Dr Jeffrey B. Casady (co-founder & chief technology officer). "However, the high-speed transients capable in SiC devices at high voltages and currents highlight the need for careful design considerations for gate drive, wiring, layout, and module parasitics," he adds.

The module described uses SemiSouth's high-speed, normally-off 1200V SiC VJFET technology, and demonstrates what is claimed to be record low hard-switching performance (1.25mJ) in an optimized, commercially available (SP1) module configuration. Parasitic oscilla-

tions and cross-conduction were shown to be well controlled using optimized internal snubbers and a negative gate voltage rail. Using parallel combinations of enhancement-mode SiC VJFETs (36mm²) and Schottky diodes (23mm²), a total on-resistance of only 10mΩ (2.7mΩ/cm²) was achieved at drain currents of 100A in the commercially available standard module configured as a half-bridge circuit.

"A significant percentage of the targeted customers for SiC power transistors will favor devices integrated into the module form factor presented here for higher power and complexity, saving cost and area in the overall system design," reckons Casady.

www.semisouth.com

SiC Systems wins \$200,000 NSF grant to develop more efficient green LEDs with Smart Lighting ERC

The US National Science Foundation (NSF) has awarded a \$200,000 grant to SiC Systems of Golden, CO, USA to partner with the Smart Lighting Engineering Research Center (ERC) in developing LEDs with increased efficiency.

The ERC was founded in 2008 by the NSF and is led by Rensselaer Polytechnic Institute (RPI) in Troy, NY, with Boston University and The University of New Mexico as core partners, and Howard University, Morgan State University and Rose-Hulman Institute of Technology as outreach and education partners.

Incorporated in 2007, SiC Systems says that its unique ability to produce large-area, 6" silicon carbide substrates in different crystallographic orientations will be combined with the Smart Lighting ERC's capability to develop LEDs with higher performance than those routinely available on sapphire substrates. While high-power blue GaN nitride LEDs are widely used for solid-state lighting applications, there are still significant barriers to developing

efficient GaN LEDs at other wavelengths needed to achieve high-performance lighting systems with high color fidelity, says the firm.

By combining silicon carbide structures from SiC Systems with LED growth and fabrication technology under development at RPI in the research group of professor Christian Wetzel, the team aims to explore new approaches to driving GaN to higher levels of efficiency at a broader range of operating wavelengths than can be obtained currently with conventional LED growth on sapphire substrates.

The collaboration will also train and engage graduate and undergraduate researchers, at both SiC Systems and the ERC. SiC Systems anticipates that as many as 25 new jobs will be created.

The awardees acknowledge the SBIR/STTR (Small Business Innovation Research/Small Business Technology Transfer) and ERC programs for providing the funding.

www.sicsystems.com
<http://smartlighting.rpi.edu>

Dow Corning to produce 100mm SiC epi, joining 100mm substrates and 76mm substrates & epi

Dow Corning Corp of Midland, MI, USA says it will begin production of 100mm-diameter silicon carbide (SiC) epitaxy, providing a single source for SiC substrates used in power electronics device manufacturing.

The new product expands Dow Corning's product line beyond its existing offerings of 76mm-diameter SiC wafers and epitaxy and 100mm SiC wafers. The firm says that providing a single source for substrates (wafers and epi) simplifies production, ordering, and troubleshooting.

Dow Corning supplies SiC and silicone materials that can be used in high-power applications such as high-tech communications, solar and wind energy systems, large-scale electrical distribution grids, vehicles, and academic research.

"We are committed to supporting the success of our customers by developing products that enhance performance while being cost effective," says Dow Corning Compound Semiconductor Solutions' commercial manager Fred Buether.

www.dowcorning.com

IN BRIEF

Cree demos 150mm SiC wafers with micropipe densities below 10/cm² Expansion from 100mm to cut device cost and boost manufacturing output

Cree Inc of Durham, NC, USA, which makes LED chips, lamps and lighting fixtures plus gallium nitride and silicon carbide power-switching and RF/wireless devices as well as SiC substrates, says that it has achieved what it claims is a milestone in the development and commercialization of silicon carbide (SiC) technology with the demonstration of high-quality, 150mm-diameter SiC substrates with micropipe densities of less than 10/cm². Cree's current standard for SiC substrates is 100mm-diameter material.

Used in the production of lighting, power and communication components (including LEDs, power switching devices and RF power transistors for wireless communications), the significant increase in size of single-crystal SiC substrates to 150mm can enable cost reduction and increased throughput, while bolstering the continued growth of the SiC industry, says Cree.

"We expect that 150mm substrates can reduce device cost, boost manufacturing output and expand our product range," comments chief operating officer Steve Kelley.

www.cree.com

IQE revenue grows 54% year-on-year to record £33m in first-half 2010

Growth driven by smartphones, emerging VCSEL and CPV opto markets, and germanium-on-insulator and sapphire-on-silicon

Following an interim trading update in mid July, for first-half 2010 epi-wafer foundry and substrate maker IQE plc of Cardiff, Wales, UK has confirmed record revenue of £33m, up 54% on £21.4m a year ago and significantly ahead of market expectations.

This was driven mainly by strong demand for wireless components used in smartphone and tablet PC technologies (which contain much more gallium arsenide content than previous generations of handheld devices), supported by accelerating growth in optoelectronic and advanced silicon components, with strong performance in all main markets (with wireless revenue up 52% from £16.3m to £24.8m; optoelectronics up 55% from £4.6m to £7.1m; and electronics up 102% from £0.54m to £1.09m).

In particular, with wireless growth being driven by the increasing adoption of smartphones, IQE says it is designed into most top-tier smartphones by virtue of its broad customer base as well as its market share of about 30%.

Emerging optoelectronic markets are accelerating, with concentrator photovoltaic (CPV) solar up 100% and vertical-cavity surface-emitting lasers (VCSELs) for finger navigation and optical USB up 70%.

Electronics revenue growth is driven by advanced BiCMOS and initial sales of IP-rich advanced substrates such as germanium-on-insulator (GeOI) and silicon-on-sapphire (SOS).

"Our focus remains on exploiting our powerful intellectual property to deliver innovative and high-quality products to rapidly growing markets," says chief executive Dr Drew Nelson.

Gross margin rose from 17.8% a year ago to 22.2% in first-half 2010. Selling, general & administrative

expenses were unchanged at £4.6m and therefore shrank as a percentage of sales from 22% to 14%. Demonstrating IQE's highly operationally levered business model, 54% revenue growth has translated into earnings before interest, tax, depreciation and amortization (EBITDA) rising by 184%, from £1.9m to £5.4m.

Compared to an operating loss of £0.8m a year ago, operating profit was £2.7m. Cash inflow from operations rose from £0.1m to £1.9m.

Net debt has fallen year-on-year from £19m to £15.6m.

Proliferation of wireless applications such as smart meters and point-to-point communications should add further demand

IQE says that its strategy remains focused on delivering market leadership in high growth markets, protected by technology leadership and intellectual property.

The firm claims that it has established a clear leadership position in the wireless communications market, which currently accounts for 75% of sales. The wireless market currently provides IQE with high-volume sales and the expectation of continued high growth.

In particular, although smartphones represent a fundamental structural shift in mobile communications, they will still only account for 19% of the total handset market in 2010. As a result IQE sees the annual growth rate of 30–40% continuing for several years to come. In addition, the proliferation of wireless applications such as smart meters and point-to-point communications should add further demand for IQE's wireless products.

IQE adds that it is also replicating the growth of wireless-related products in other, emerging markets that are undergoing rapid development and offer further near-term, high-growth potential and product diversity. These include optoelectronic technologies such as high-efficiency LED solid-state light sources, VCSELs (for applications such as finger navigation and optical USB), advanced lasers (for applications such as pico projectors and high-density optical storage), and CPV materials for solar energy generation. IQE has correspondingly appointed Adrian Meldrum to its board, with specific responsibility for developing optoelectronics business.

IQE says that it has therefore continued making progress in extending its portfolio of intellectual property, including high-speed VCSELs for next-generation optical communications, 6" CPV solar technology, 4" gallium antimonide (GaSb) substrates and free-standing gallium nitride (GaN) substrates, including additional patents granted for the nanocolumn technology of GaN substrate subsidiary NanoGaN Ltd (acquired in October 2009).

Significant growth is also occurring in IQE's silicon-based product division, with the adoption of new engineered substrates launched in 2009 such as GeOI and SOS for next-generation ICs and high-speed devices.

"The second half of 2010 has started well, with strong demand across our full range of advanced semiconductor products leading us to have every confidence in both the short-term and long-term prospects of the business," says Nelson. Second-half sales are now anticipated to be ahead of expectations.

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Chemtura expanding MO precursor capacity and forming Korean joint venture targeting HB-LEDs

Chemtura Organometallics GmbH of Bergkamen, Germany (a subsidiary of US-based specialty chemical manufacturer Chemtura Corp) is making a number of investments in response to growing demand for precursors in the electronics, semiconductor and photovoltaic markets.

"We are further expanding our Bergkamen plant to provide a sustainable supply for tomorrow's global customer requirements of the specialty chemicals trimethylaluminum (TMA), methylaluminoxane (MAO), and diethylzinc (DEZ)," says Dr Ulrich Stewen, Chemtura's general manager & president of Organometallics.

In Bergkamen, a fully backwards-integrated production line with increased DEZ capacity started operation in second-quarter 2010 to satisfy the growing demand for custom-made, high-purity DEZ in semiconductor and thin-film photovoltaic applications. Additional production lines for TMA and MAO will become operational during 2012.

The capacity expansions for different TMA grades aims to meet growing demand for specialty applications in the electronics, pharmaceutical and polymer industries. Chemtura says that its production technology will incorporate integrated recycling capabilities for a sustainable supply, based on readily available

raw materials. Also, due to flexibility in container design, the firm adds it will continue to satisfy individual customer needs during scale-up and large-scale commercial production.

"Chemtura offers a sustainable supply of essential products and services that enable industries to smoothly transition to clean and renewable energy generation, and to support the mass production of LEDs via high-quality TMA precursors and raw material," Stewen says.

"This capacity expansion complements our plans for regional footprints for the production of organometallic specialty chemicals in the Middle East and also in Korea."

Chemtura Corp and South Korea's UP Chemical Co Ltd (the first developer and supplier of atomic-layer deposition precursors for DRAM chip making) have signed a Memorandum of Understanding (MOU) to form a joint venture to make and sell high-purity metal-organic precursors for the rapidly growing high-brightness LED (HB-LED) market, focusing particularly on South Korea and the broader Asia-Pacific region.

The JV will leverage Chemtura's capability and technology related to metal-organic precursors for polymerization and other specialty applications, together with its backward integration for TMA for HB-LEDs. This will combine with UP's

capabilities in supplying high-purity metal-organic precursors for CVD at semiconductor device makers in South Korea and the Asia Pacific.

The JV expects to begin supplying precursors to the HB-LED market by December, and to have fully integrated manufacturing capabilities for trimethylgallium (TMG) and trimethylaluminum (TMA) established in Korea in late 2011.

"Chemtura and UP Chemical will be uniquely positioned to meet the growing demand for metal-organic precursors for the high-brightness LED market," reckons Chemtura's chairman, president & CEO Craig Rogerson. "By establishing fully integrated manufacturing and distribution capability in Asia, we are addressing the expectations of customers in the region who demand local manufacturing for improved responsiveness and assurance of supply." The JV advances Chemtura's strategy for growth in the Asia Pacific, he adds.

"UP Chemical can seize a great opportunity through the partnership with Chemtura at a time when LED backlighting for LCD TVs has grown explosively and highly efficient LED lighting will replace traditional lighting in the coming years," says UP Chemical's CEO Dr Hyun Koock Shin. www.chemtura.com/organometallics www.upchem.co.kr

AXT appoints accounting and auditing expert to board

AXT Inc of Fremont, CA, USA, which makes GaAs, InP and germanium substrate and raw materials, has appointed Nai-Yu Pai to its board of directors, serving on the audit, compensation and nominating and corporate governance committees.

Pai has more than 30 years of accounting and auditing experience. He founded Pai Accountancy LLP, and has served on the boards of several technology firms, including JA Solar, EDA software provider

Sigrity Inc and 3D graphic chip designer Vivente Inc. Pai is also a Silicon Valley entrepreneur and founder and board member of Authenex and Gaia Interactive. As a consultant, he has assisted firms such as Marvell Semiconductor, @Road, Silicon Motion Inc, Accton Technology Corp, Amlogic and Global Manufacture with fundraising and mergers and acquisitions.

"His strong financial background, extensive board-level experience

and expertise in working with technology companies will provide AXT with valuable insight and perspective to aid in positioning us for further growth," says chairman Jesse Chen.

"This is a very exciting time in AXT's development, with strong growth potential in the markets that it serves, as well as solid execution in AXT's operations, contributing to positive leverage in its business model," comments Pai.

www.axt.com

Albemarle building Korean TMG plant to meet growth in HB-LEDs

US specialty chemicals maker expands metal-organic expertise

Specialty chemicals manufacturer Albemarle Corp of Baton Rouge, LA, USA has begun what it says is its largest capital investment in the fast-growing Asia Pacific region of Yeosu, South Korea.

The Yeosu site contains existing R&D as well as pilot plant equipment that will be modified to enable customer qualification efforts in 2010. The site will effectively mirror Albemarle's metallocene polyolefin (mPO) catalyst and trimethyl gallium (TMG) capabilities in Baton Rouge.

Albemarle aims to leverage its more than 50 years of experience in producing metal-organics to supply high-purity metal-organics (HPMOs) such as TMG to the high-brightness LED (HB-LED) market. "This strategic investment signi-

fies our commitment to expand our footprint in regions that provide substantial growth opportunities," says chairman & CEO Mark Rohr. By providing local manufacturing and technical service and support, Albemarle reckons that it can give customers a competitive advantage in a growing market. "We thank the governor of Jeollanam-do province and the mayor of Yeosu city for their support and advice," Rohr adds.

TMG production will begin in early 2011, with other high-purity metal-organics phased into the project throughout 2011

The Yeosu site will produce mPO catalyst lab samples followed by pilot samples for qualification trials with local customers in fourth-quarter 2010. Intermediate commercial operations will begin in mid-2011, with the facility being fully operational in 2012.

The site will produce finished catalysts, activators such as methyl-aluminoxane (MAO) and organoborons, as well as metallocene components.

The new site will also purify metal-organics, creating a portfolio of HPMOs for electronic applications. TMG production will begin in early 2011, with other HPMOs phased into the project throughout 2011.

www.albemarle.com

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Veeco authorizes up to \$200m of share repurchases

The board of directors of epitaxial deposition and process equipment maker Veeco Instruments Inc of Plainview, NY, USA has authorized the repurchase of up to \$200m of the company's common stock over the next year.

The repurchases will be funded using the company's available cash balances and cash generated from operations. In second-quarter 2010, Veeco generated about \$67m in cash from operations (up from \$42m in Q1). Also, on 16 August, Veeco said that it had agreed to sell its Metrology business (which generated 13% of the firm's total revenue in Q2) to Bruker Corp of Billerica, MA, USA for \$229m. "Our strong cash position and cash flow from operations will allow us to execute share repurchases while retaining the flexibility to continue to invest in other opportunities to grow our

business," says CEO John R. Peeler. "This authorization reflects our continued confidence in and positive outlook for our business," says Peeler. Even without revenue from the divested Metrology business (which generated \$31.7m in Q2), Veeco expects the continuing LED & Solar and Data Storage operations to generate third-quarter 2010 revenue of \$255-280m and full-year 2010 revenue of \$1bn (up from \$221.3m in Q2/2010 and just \$282m in full-year 2009 for LED & Solar and Data Storage collectively). "Our board of directors strongly believes that Veeco's stock currently presents an attractive investment for the company and its stockholders," Peeler adds.

Repurchases are expected to be made from time to time on the open market or in privately negotiated transactions in accordance with applicable federal securities laws.

The timing of repurchases and the exact number of shares of common stock to be purchased will depend upon market conditions, US Securities and Exchange Commission

Our strong cash position and cash flow from operations will allow us to execute share repurchases while retaining the flexibility to continue to invest in other opportunities to grow our business

www.veeco.com

(SEC) regulations, and other factors.

The share repurchase program does not obligate the firm to acquire any particular amount of common stock and may be modified or suspended at any time at its discretion.

China's Tsinghua Tongfang selects Veeco as primary MOCVD supplier for its new LED plant

Epitaxial deposition and process equipment maker Veeco Instruments Inc of Plainview, NY, USA says that Chinese state-owned enterprise Tsinghua Tongfang Company, a division of Tsinghua Holdings Company Ltd based at Beijing Tsinghua University, has chosen Veeco as its primary supplier of metal-organic chemical vapor deposition (MOCVD) systems for its new LED manufacturing plant. Veeco booked the initial systems from a large multi-tool purchase order earlier in August.

Tsinghua Tongfang was established and listed on the Shanghai Stock Exchange in 1997, and is engaged in information technology, energy and environment industries. "Tsinghua Tongfang has put together an exciting new enterprise, moving from the lighting engineering business directly into the manufacture of LEDs,"

comments Bill Miller PhD, executive VP, general manager of Veeco's MOCVD operations. "They have solid financial backing and an experienced technology team, and we are pleased to support their production ramp," he adds.

"After thorough evaluation of available MOCVD systems at our

Beijing LED R&D site, we selected Veeco as our primary supplier for our new production facility in NanTong, which is scheduled to be completed by the end of this year," says Tsinghua Tongfang vice president Wang Lianghai.

Tsinghua Tongfang has put together an exciting new enterprise, moving from the lighting engineering business directly into the manufacture of LEDs

According to China Knowledge, on 22 August Tsinghua Tongfang announced plans to invest about RMB2.92bn in building an LED base in Nantong Economic and Technological Development Zone, Jiangsu Province. President Lu Zhicheng said that the firm aims to become China's largest and the world's third largest LED chip producer within the next three years. The firm will manage and operate the plant via Tongfang (Nantong) Science and Technology Park Ltd.

"The TurboDisc K465i MOCVD systems were the clear winner in terms of cost of ownership and productivity," says Wang. "We have an aggressive plan to ramp production of LEDs, primarily to address backlighting demand for TVs, and Veeco's technology, tool performance and customer support best matched our needs."

<http://en.thtf.com.cn>

www.chinaknowledge.com

Riber halves loss while order backlog nearly triples

Both revenue and profit growth expected for full-year 2010

Riber S.A. of Bezons, France, which makes MBE systems as well as evaporation sources and effusion cells, has confirmed that, as reported in mid-July, second-quarter 2010 revenue was €1.5m (about half the €2.9m in Q1) and first-half 2010 revenue was €4.4m (down 26% on €5.9m in first-half 2009), due to delivering just two research reactors (worth €1.1m) compared to four in first-half 2009 (worth €3.1m).

Also, sales of evaporation sources & cells of €0.5m were half of the €1m of first-half 2009. However, revenue from services & accessories grew a record 58%, from €1.7m in first-half 2009 to €2.7m in first-half 2010.

In addition, Riber has now also reported first-half 2010 gross margin was 28%, only slightly down on 29% a year ago, reflecting the effective management of costs. Operating loss is stable at -€0.4m, while consoli-

dated net income has been halved from -€0.4m a year ago to -€0.2m.

At the end of first-half 2010, net cash (after deducting recoverable advances) tripled to €6.7m, up 220% on a year ago, as a result of advances on orders.

Two systems (including one production reactor) worth a total of €4m were produced in first-half 2010 but, due to contractual timeframes, will only be delivered and billed in second-half 2010.

Also, at the end of August, order backlog comprised 10 MBE systems (two production reactors and eight research reactors), worth a record €19.1m (up 190% year-on-year). This also includes record effusion cell orders (since this year's delivery schedule is concentrated over the second half of the year), reflecting the firm's arrival in the fast-growing solar and organic LED (OLED) sectors.

Riber says that its sound balance sheet and stronger cash position are enabling it to move forward with confidence with its strategic development, which is based on:

- capitalizing on its installed base and growing sales of epitaxy equipment, spare parts and accessories, as well as the corresponding services; and

- launching a range of high-value-added equipment and services for fast-growing applications (thin-film solar cells, OLED lighting and screens).

Riber says that, in view of its order backlog and strong visibility into second-half 2010, for full-year 2010 it forecasts growth in both profits and revenue (to over €19m, up 9% on 2009's €17.4m).

www.riber.com

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RIBER

Neo-Neon orders ten more Aixtron reactors for blue/green LED production

Deposition equipment maker Aixtron AG of Aachen-Herzogenrath, Germany says that in Q4/2009 it received an order for ten more CRIUS 31x2"-wafer configuration deposition systems from China-based Neo-Neon International Ltd, for delivery in the third and fourth quarters of 2010. The local Aixtron support team will commission the reactors at Neo-Neon's new five-story facility in Guang Dong, mainland China, where they will be used for GaN ultra-high-brightness (UHB) blue/green LED production.

"We have been enjoying the benefits of our existing Aixtron MOCVD systems for over a year now," says

Neo-Neon's chairman Ben Fan. "To comply with our future expansion plans it is time to further increase our capacity," adding that the firm returned to Aixtron because of the quality of its engineering and the responsive local support that comes as standard with CRIUS systems.

Specialising in flexible LED-based 'Neon-like' light replacement products, Neo-Neon is the world's largest decorative lighting manufacturer. It recently entered the LED streetlight market by launching the LED High Power Street Light series. Solar-powered versions are also available for areas where there

is ample sunshine to harness, store, and use. Neo-Neon has developed an optical enhancement technique to boost the luminosity of the LED Streetlight series by a gain factor of 50% on average, due to a patent-pending 'Lux Boosting Optical Technology'.

Neo-Neon Group subsidiary Xianghe mainly manufactures the LED light source, LED luminaries and other related LED-based products. Its parent company Neo-Neon International Ltd is therefore able to manufacture both LED chip and LED application products for the worldwide market.

www.neo-neon.com

Follow-on order from China's Long De Xin for GaN blue HB-LEDs

Aixtron says that in second-quarter 2010 it received an order for two further CRIUS 31x2"-wafer configuration MOCVD systems, for shipment in third-quarter 2010 to China-based firm Long De Xin. The reactors will be used for manufacturing GaN ultra-high-brightness (UHB) blue LEDs.

The local Aixtron support team will commission the new reactors at the new Long De Xin facility at their mainland China production plant.

"Since the demand for our blue LEDs has been continuously growing, we now have to significantly increase our production capacity,"

says Long De Xin's Jay Lin.

"As we have found, the Aixtron CRIUS lives up to its worldwide reputation for excellent process characteristics such as uniformity and efficiency, becoming crucial for high-end HB LED production," he adds.

www.aixtron.com

Genesis expands green and blue LED epi production with six Aixtron CRIUS II reactors

In second-quarter 2010 Aixtron received an order from existing customer Genesis Photonics Inc of Taiwan's Tainan Science-based Industrial Park for six new generation CRIUS II 55x2"-wafer configuration deposition systems, for delivery between Q4/2010 and Q2/2011. The new reactors will be commissioned at Genesis Photonics' dedicated facility by the local Aixtron support team, and used for GaN green and blue LED production.

"Genesis has always used Aixtron Close Coupled Showerhead (CCS) systems for the manufacture of our high-performance green LED wafers," says chairman David Chung.

"Genesis recently won a large order which has taken us over our existing capacity limit, so we must quickly bring in new expansion for our LED epi production line," he adds. "When we receive the first CRIUS II system at the end of this year, we will transfer our recipes from our existing systems to the new platform before applying it to the systems to be delivered in 2011. We also anticipate placing further system orders during next year as we expand to meet demand," Chung concludes.

Genesis Photonics has grown rapidly since being founded in 2002, going public in 2004. Its focus is to

provide GaN-based LED epi-wafer and chip products for applications including general lighting, electronic displays, monitor backlights and automobile lamps. The firm also has its own brand of LED light bulb (LEDplux), marketed throughout Japan, China and Taiwan.

"The new generation of Aixtron MOCVD not only doubles productivity but also provides even better epitaxial results," says Dr Bastian Marheineke, VP sales for Aixtron. "CRIUS II provides a straightforward migration path and scalability, minimizing the time-to-market steps required."

www.g-photonics.com

Epilight enters phase 5 of purchase plan by ordering four CRIUS systems

Aixtron says that in Q1/2010 it received an order for four CRIUS 31x2"-wafer MOCVD tools from Shanghai Epilight Technology Co Ltd, one of China's largest LED makers, for the production of GaN-based HB-LED epiwafers. Aixtron's local support team will commission the reactors during Q3/2010.

"We have begun a major capacity increase in our GaN high-brightness LED production, so we need a corresponding guaranteed high-quality production foundation," says Epilight's chair Wendy Liu.

As the leading enterprise in

Shanghai's National Solid-state Lighting Base, Epilight has become its main provider of InGaN epiwafers and blue and green LED chips. "We wish to build on this hard-won reputation to meet our production commitments and are looking to attract new customers," says Liu.

"With our growing business we must quickly and efficiently introduce new manufacturing capacity," she adds. "The CRIUS forms a key part of the start up of our Phase 5 purchase plan."

www.epilight.com.cn/en

Lumileds places repeat order for multiple Aixtron G4 HT MOCVD systems

In Q2/2010, Philips Lumileds Lighting Company of San Jose, CA, USA placed a repeat order for multiple Aixtron AIX 2800G4 HT MOCVD reactors (to be shipped within the next 2-3 quarters) for manufacturing epiwafers for its LUXEON power LEDs.

"We have carefully selected the Aixtron systems for our continuing capacity expansion program," says Lumileds' chief procurement officer Mike Pugh. "As we are committed

to meeting the needs of the illumination, automotive, and consumer electronics industries, the new Aixtron reactors are an important part of that program," he adds. "Our long-term successful relationship with Aixtron as a key supplier gives us confidence that we will receive the support that is needed for a quick installation and successful startup of the new tools."

www.philipslumileds.com

WEP installs wafer profiler at Aixtron's R&D Application Lab

WEP of Furtwangen im Schwarzwald, Germany says that second-quarter 2010 saw installation of its CVP21 electrochemical capacitance-voltage (ECV) wafer profiler in Aixtron's R&D Application Laboratory in Aachen. Several deposition systems are operated at the Application Lab for test and development.

The CVP21 fully automates the entire measurement process for carrier concentration profiling (including fluid handling, movement of the electrochemical cell, in-situ

imaging, and CV scan analysis) to yield reproducible results with high accuracy. The CVP21 monitors the quality of semiconductor layers and includes comprehensive self-calibration algorithms to achieve results with high reliability. It also contains a patented process for processing (Al,In)GaN samples in full-automation mode.

"There is very strong demand for CVP21 equipments worldwide," says WEP's president Thomas Wolff.

www.wepcontrol.com/cv-profiler

IN BRIEF

Aixtron reactor to be hub of PUC-Rio materials project

Aixtron has received an order for an AIX 200, 1x2"-wafer MOCVD reactor from the Pontifical Catholic University of Rio de Janeiro (PUC-Rio) in Brazil, for delivery and installation at its Semiconductor Laboratory (LabSem).

Materials to be grown are InP- and GaAs-based quantum well and quantum dot structures. Applications cover site control of quantum dot nucleation, photonic crystals, lasers, photo-detectors, solar cells, fundamental properties of quantum dots, superlattices and microcavities.

"Recent funding means we can update our facilities, and top of the list is a new MOVPE reactor," says coordinator and leader of the technology-research mission, professor Patrícia Lustoza de Souza. "It was logical that we pick an AIX 200, partly because we already have one but mostly because of its versatility... The existing AIX 200 has been running for almost two decades," she adds. "Over the years we have also developed a close working relationship with Aixtron personnel."

The new reactor will enable LabSem to grow semiconductor samples not only for its members but also for other groups within the country and abroad wishing to collaborate or source from it.

The Brazilian Government recently created the National Science and Technology Institute for Semiconductor Nanodevices (INCT-DISSE), involving several Brazilian research groups and its headquarters at LabSem. With membership including more than 20 researchers at eight institutions with long experience in specific areas, DISSE carries out applied and basic research in III-V electronic and optoelectronic devices.

www.labsem.cetuc.puc-rio.br

IN BRIEF

RIE etch order for Plasma-Therm

Plasma process equipment maker Plasma-Therm LLC of St Petersburg, FL, USA says that a leading manufacturer of high technology defense systems in the Europe, Middle East and Asia (EMEA) region recently accepted delivery of a VERSALINE RIE etch system.

This leading international manufacturer designs, develops and produces high technology defense systems for aerospace, naval and land-based applications. The VERSALINE system, which complements other Plasma-Therm process equipment at this facility, was selected for its proven reliability and reproducibility during the fabrication of devices for mission critical components. Low maintenance and process flexibility makes the VERSALINE RIE ideally suited for multiple device fabrication steps and provides the defense industry with a valuable asset for R&D and production.

The system is configured to enhance processing technology with features including Endpoint-Works developed by Plasma-Therm. Integration of EndpointWorks with the system's control software provides real-time in situ process data and reproducibility.

"The VERSALINE platform has the ability to support a number of different technologies," says Dr David Lishan, director of technical marketing. "Leading high tech companies rely on VERSALINE systems as vital elements in their device development activities for production. With systems that operate reliably and deliver consistent, industry leading results we are able to develop long-term partnerships with our customers."

www.PlasmaTherm.com

Lam announces \$250m stock repurchase program

The board of directors of plasma etch and wafer-cleaning equipment maker Lam Research Corp of Fremont, CA, USA has authorized the repurchase of up to \$250m of the firm's common stock (which trades on The NASDAQ Global Select Market under the symbol LRCX), either from the public market or in private purchases. A previous stock repurchase program of the same size was announced almost exactly two years ago, in September 2008.

The latest program may be suspended or discontinued at any time, and will be funded using available cash.

As of 27 June, Lam had about \$992m in total gross cash and cash equivalents, short-term investments and restricted cash and investments, and as of 13 August had about 124 million shares outstanding.

"This decision illustrates our confidence in the continued growth and cash generation performance of the company," says president & CEO Steve Newberry.

"A stock buyback is an effective way of returning value to Lam's shareholders," Newberry concludes.

● For the quarter ended 27 June, Lam Research reported revenue up 10% on the March quarter's \$632.8m to \$695.3m (8% from North America, 7% from Europe, 17% from Japan, 27% from Korea, and 8% from Asia Pacific).

Ongoing gross margin has risen from 46.3% to 46.7%, due mainly to improved factory and field utilization and a more favorable product mix.

Net income was \$140m, up from \$120.3m for the March quarter.

Operating cash flow was \$165.4m. Cash and cash equivalents, short-term investments and restricted cash and investments balances have risen from \$843.8m to \$991.7m.

"Market share gains and solid execution drove strong results for the June quarter," says president & CEO Steve Newberry. "We believe that we will achieve substantial shipped market share gains in both the etch and clean businesses for calendar year 2010," he adds. "We continued to win important new applications in the first-half of 2010 in both businesses."

www.lamresearch.com

Lam appoints Eric K. Brandt to board

Lam Research says that Eric K. Brandt has joined its board of directors.

Brandt has been executive VP & chief financial officer of Broadcom Corp since March 2007. From September 2005 to March 2007, he was president & CEO of Avanir Pharmaceuticals. Previously, Brandt was executive VP-finance and technical operations & chief financial officer of Allergan Inc, a global specialty pharmaceutical and medical device company, where he also held a number of other senior positions following his arrival there in 1999. He previously spent ten years with The Boston

Consulting Group, a privately held global business consulting firm, most recently as VP & partner.

Brandt is currently a member of the board of directors of public company Dentsply International Inc. He has also been a board member of public companies Avanir and of Vertex Pharmaceuticals Inc (where he was chair of the audit committee).

"Eric's wealth of management experience, combined with his extensive financial and semiconductor industry experience, offers a unique perspective that will be an asset to the board," says executive chairman James W. Bagley.

First single-port installation of EpiCurveTT on showerhead reactor

LayTec GmbH of Berlin, Germany, which provides in-situ optical metrology systems for thin-film processes, has announced the first installation of its EpiCurveTT tool on a showerhead MOCVD system on only one viewport — specifically, an Aixtron Close Coupled Showerhead (CCS) system at Fraunhofer Institute for Applied Solid State Physics (IAF) in Freiburg, Germany.

In the past, since viewports of such systems are so small, LayTec has used two separate windows: one for the measurement of curvature and one for measurement of temperature and reflectance. Now,

due to improved design, all three parameters can be measured through one standard AIX CCS viewport.

Dr Chunyu Wang and his team at IAF will use the tool to control the growth of gallium nitride on silicon substrates. The simultaneous in-situ monitoring of wafer temperature, reflectance and curvature will be used to engineer the stress in the epilayers. "The new sensor will help us to get flat and crack-free GaN layers on Si substrates for future sophisticated electronic devices," comments Wang.

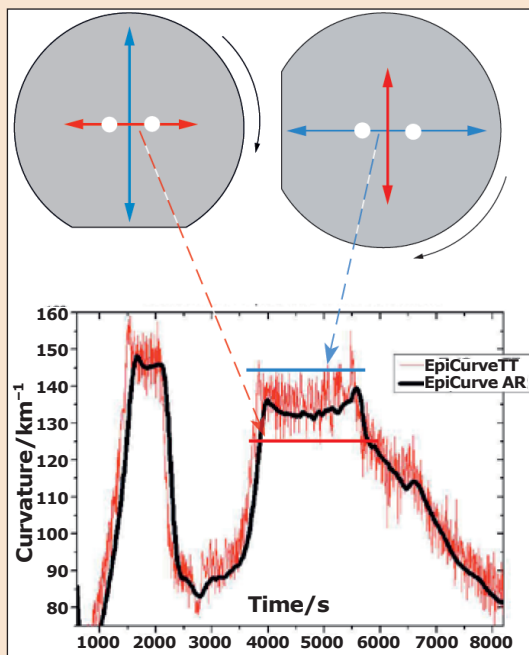
www.laytec.de

EpiCurveTT AR for advanced curvature resolution in Planetary reactors

LayTec recently launched the EpiCurveTT AR (advanced resolution) for measurement of aspherical curvature during epitaxial growth in Planetary and other gas-foil rotation MOCVD systems where the azimuth of the rotating wafers is unknown. The standard EpiCurveTT without AR measures randomly along either the major axis (larger bow — see blue arrow) or the minor axis (smaller bow — red arrow). Since the phase of rotation is unknown in a Planetary reactor, the signal is 'noisy' (red line in graph), oscillating between the maximum and minimum of the azimuthal aspherical bow.

The new AR tool measures curvature along two perpendicular axes and eliminates second-order azimuthal bowing effects. The black line shows the curvature signal of the EpiCurveTT AR sensor.

The signal-to-noise ratio of the tool with advanced resolution improves the curvature signal from $\pm 8\text{km}^{-1}$ (red line) to $\pm 0.2\text{km}^{-1}$ (black line) and measures only the main cur-



Top — Measurement with 1D detection (EpiCurveTT without advanced resolution); bottom — curvature measurements with conventional EpiCurveTT (red) and EpiCurveTT AR (black), which eliminates aspherical distortion in the signal.

vature component by eliminating the aspherical contribution.

Also, the quantity of asphericity can be extracted by analysing the advanced resolution signal.

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IN BRIEF

Multi-system order from Taiwanese HB-LED chip maker

OIPT has received a multiple system order from a major Taiwan-based LED epiwafer and chip maker, for use in the production of high-brightness LEDs.

This brings the total number of tools ordered by the customer to 25, comprising a mixture of Oxford Instruments' family of batch production solutions including the compact 800Plus PECVD system for high-quality dielectric films; the System133 PECVD batch deposition tool for thick-film deposition; and the System133 ICP tool for high-quality etching of sapphire and gallium nitride. Oxford Instruments says that their systems were chosen as they offer very high throughput and uniformity (crucial in HB-LED production).

"We are extremely pleased to supply such a major player in this area with so many of our high-quality tools, across the range, to satisfy their production requirements," says OIPT's sales director Mark Vosloo. "Oxford Instruments has been a leading supplier of equipment to HBLED manufacturers for over 10 years, and this order is testament to the continuous product and process development at the company."

OIPT's exceptional growth halts relocation plans

In October 2006, equipment maker Oxford Instruments Plasma Technology (OIPT) announced plans to move its premises from Yatton, UK to a new building being built at Locking Parklands (formerly RAF Locking), on the outskirts of Weston-Super-Mare, UK. The move was scheduled to complete in April 2008, but was since delayed. Now, according to a recent report in the Weston, Worle & Somerset Mercury, the planned move has been scrapped because the Locking Parklands site is no longer large enough.

"Since we first looked to relocate the business back in 2005 the business has more than doubled its

turnover, and by the end of the year we will employ 300 people — an increase of 50%," says OIPT's managing director Andy Matthews. "We now need a much larger and more flexible facility than we had planned at Locking," he adds.

"We are not ruling out a move to Locking but we have decided not to complete the planning application currently lodged with the council and will focus all our attention on our current growth opportunities in the short term."

OIPT adds that it now aims to be in new premises somewhere between 2013 and 2015.

www.thewestonmercury.com

Fiscal first-half exceeds expectations

At Oxford Instruments' annual general meeting on 14 September, chairman Nigel Keen reported that its research markets continue to benefit from strong demand, and that its industrial markets (which had been hard hit by recession) have now seen demand return to pre-recession levels. This sustained strengthening of demand means that industrial sector businesses are showing better performance than in the prior year.

Due to the strength of both markets, coupled with efficiency improvements from the restruc-

turing program, performance for the fiscal first half of the year (to end September) has exceeded expectations. Oxford Instruments expects adjusted profit before tax to be at least £10m.

In June, the firm reported that, at the end of year 4 of its strategic five-year plan to double business, average organic growth was on plan despite the recession, at over 10% per annum. No acquisitions have been made in the last two years but, as markets have stabilized and cash flows improved, the firm will again look at acquisitions.

High-brightness LED makers boost Oxford Instruments Austin Scientific to record order month

Austin Scientific of Austin, TX, USA, which is a subsidiary of UK-based Oxford Instruments (which also owns etch and deposition equipment maker Oxford Instruments Plasma Technology), has won an order for 56 helium compressor systems with a total value of \$1.111m.

The firm says that the product is a unique application with significant

implications in the high-brightness LED market, using helium gas as a heat-exchange medium in high-temperature processes.

Austin Scientific has also secured a further order with a major HB-LED maker for 17 cryopump systems worth a total of \$205,000. The two orders collectively have contributed to the business hitting its highest

order month in its 10 year history as part of Oxford Instruments Group.

"HB-LEDs will undoubtedly play a huge role in protecting our environment in the future, and I am delighted that our products have been chosen to support this growing market," says Austin Scientific's general manager Donald Gordon.

www.oxford-instruments.com

Indian nanoelectronics center places multi-system order

UK-based equipment maker Oxford Instruments Plasma Technology (OIPT) has received an order from the Centre of Excellence in Nano-electronics (CEN) at the Indian Institute of Science (IISc) in Bangalore for three System100 plasma etch and deposition tools (two PlasmaPro System100 ICP Cobra etch tools and one PlasmaPro System100 PECVD tool) for the new cleanroom of CEN's nanofabrication facility.

OIPT says that the System100's load-locked wafer entry allows fast wafer exchange, a wide range of process gases and an extended process temperature range. Allowing process flexibility for compound semiconductor, optoelectronics, photonics, MEMS and microfluidics applications, the System100 plasma etcher and deposition tool can have many configurations, including the ICP and PECVD options ordered by IISc.

The two ICP-RIE (reactive-ion etch) systems and the PECVD (plasma-enhanced chemical vapour deposition)

system have been configured for the widest range of processes required at CEN, which is a multi-user national facility. The etch chemistries include the capability to etch poly-silicon, silicon oxide, silicon nitride and a variety of metals. In addition to the silicon processing, the tools are also configured for gallium arsenide and gallium nitride process capability for high-speed, high-frequency power transistors. The PECVD system enables stress-engineered nitride for MEMS sensors, low-temperature oxide and very thick poly-silicon membrane as a structural material for inertial sensors.

"We chose to order Oxford Instruments' systems for their superior process uniformity, and the high level of support offered," says professor Navakanta Bhat of IISc's Department of Electrical Communication Engineering. "We were particularly impressed by the technical capabilities of the staff and their willingness to work with their customers."

The new nanofabrication facility will be unique in the country, with a cleanroom covering 14,000ft² in a new building (of 90,000ft²) for the Centre for Nano Science and Engineering (CeNSE). The cleanroom will house tools catering to the diverse needs of the researchers. "The Oxford Instruments' systems offer the breadth of processes and leading-edge technology we need," says Bhat. "Oxford Instruments' systems will enable IISc to carry out frontier research in a number of areas, including nanoscale electronics and MEMS and help achieve our aim of creating technologies that can be commercially exploited by industry," he adds.

"This second order in a year from an important Indian Research Institute results from our ability to meet our customers' needs through advanced technology and service," says OIPT's sales & customer support director Mark Vosloo.





www.nano.iisc.ernet.in

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IN BRIEF

Veeco appoints CTO for CIGS Solar Equipment business

Epitaxial deposition, process, and metrology equipment maker Veeco Instruments Inc of Plainview NY, USA says that Dr Johannes Segner recently joined the firm as chief technology officer of its Solar Equipment business.

Segner will be responsible for establishing Veeco's technical vision for CIGS solar products, leading the development of technology strategy for product platforms, technology roadmaps, partnerships, and external relationships.

Segner joins Veeco after a 30-year career as an expert in thin-film coating technology. He was most recently chief operating officer of Solibro GmbH, a manufacturer of CIGS-based solar cells that is currently producing 13%-efficient CIGS modules.

"Segner has been a visionary in the use of thermal co-evaporation for production of CIGS [copper indium gallium diselenide] solar modules, and will play an integral role in the strategic direction and development of our equipment and the future growth of the business," says David Bruns, VP & general manager of Veeco's CIGS Solar Equipment business. Segner says that he will help Veeco to drive further progress with its CIGS thermal deposition equipment.

Veeco exhibited its CIGS solar manufacturing equipment at the EU-PVSEC tradeshow in Valencia, Spain (6-9 September), where it hosted a Solar Technical Seminar at which Segner was a featured speaker, presenting 'Designing a Best-of-Breed CIGS Thermal Deposition Factory, Lessons Learned & Future Considerations'.

www.veeco.com

Solar Semi Engineering buys Edwards Chemical Management Europe

Solar and semiconductor start-up Solar Semi Engineering Ltd (SSE) has purchased the business and assets of Edwards Chemical Management Europe Ltd (CME) of Newhaven, Sussex, UK from vacuum and exhaust-abatement equipment maker Edwards Ltd of Crawley, UK.

Founded in 1967, CME employs about 30 people in the manufacturing of automated wet etch process & cleaning equipment, as well as chemical dosing systems, used mainly in the production of photovoltaic wafers for solar panels and in the semiconductor sector.

SSE is a new company founded by Tim Dodkin to provide wet process equipment to the solar and semiconductor manufacturing industries. Dodkin has more than three decades of experience in high-tech market development and international start ups, with a large major-

ity of that time spent on complex wet process systems.

"SSE will continue to market the former CME products with the addition of those new products required for high-efficiency cells and semiconductor manufacturing," says Dodkin.

"I am pleased that the CME business now has additional depth of experience behind it, and I feel sure it will prosper in this format in the years ahead," comments

SSE will continue to market the former CME products with the addition of those new products required for high-efficiency cells and semiconductor manufacturing

Edwards' CEO Mathew Taylor.

www.solsemi.com

www.edwards-cme.co.uk

Intevac appoints executive VP of Emerging Markets

Intevac Inc of Santa Clara, CA, USA says that Christopher Smith has joined it as executive VP of Emerging Markets (covering the firm's solar and semiconductor products), responsible for managing and growing Intevac's capital equipment businesses.

Founded in 1991, Intevac has two businesses: Equipment and Intevac Photonics. The equipment business designs and makes high-productivity sputtering-based 'lean' manufacturing systems. As well as supplying magnetic media processing systems to the hard drive industry, it offers systems for the semiconductor and photovoltaic industries, including a strategic partnership with copper indium gallium diselenide (CIGS) thin-film photovoltaic cell maker AQT Solar of Santa Clara, CA.

With more than 25 years of experience in the semiconductor and solar capital equipment markets, Smith joins Intevac from Oerlikon Solar, where he was senior VP sales & customer support. Previously, he held senior management positions at equipment makers Applied Materials and Cymer.

"Chris has proven general management experience as well as extensive experience managing sales, service and business development in large and emerging equipment markets," says president & CEO Kevin Fairbairn.

Luke Marusiak, who held the post of executive VP of Emerging Markets previously, returns to his earlier role as chief operating officer, with responsibility for manufacturing, materials, customer service and corporate services.

www.intevac.com

OEM opens Taiwan sales, service & manufacturing facility

OEM Group Inc of Gilbert, AZ, USA, which provides front-end equipment to silicon, MEMS, LED, RFID, power and photovoltaic device makers, has opened its new sales, service, and manufacturing facility in Taiwan.

Sited just minutes from the Hsinchu Science park, OEM Group will perform equipment manufacturing, upgrades, retrofits and conversions, spares parts, and global technical service at the facility, as well as providing onsite and offsite equipment services, preventative maintenance, and component overhaul services.

"Possessing a capable operations team in the heart of device manufacturing in Taiwan enables OEM Group to provide more responsive support for customers in all aspects of their equipment needs," says OEM Group's Taiwan general manager Michael Trotter. "OEM Group understands the importance of being close to the customer to deliver the service levels required

by the world's leading manufacturers based in Asia-Pacific," he adds.

OEM has also received final certification from the Taiwan government to perform re-manufacturing and service on ion implantation systems. The firm is the global partner to Varian Semiconductor for its Sunset implant platforms, which include Varian Implant models 200, CF/DF series, 350D/DE, 300XP, 80-10 through 160-10, the batch 80XP through 160XP, and G1500/1510.

The new Taiwan facility and governmental implant certification will position OEM Group to offer new levels of support locally for Varian Sunset customers, and also to assist Varian regionally with other product lines.

"OEM Group now owns and operates seven legacy product lines through our LEGENDS portfolio," says president Wayne Jeveli. "This represents over 3000 systems installed at over 200 customers, many of which are in Taiwan and throughout Asia.

Over half of our field service team is permanently based in regional Asian markets," he adds. In March, OEM grew its LEGENDS portfolio by acquiring the legacy thin-film etch and PVD product lines of Tegal Corp of Petaluma, CA, USA.

"Our new facility in Taiwan continues the expansion of our capabilities in Asia and is key to serving customers quickly and efficiently. This facility is also a large step forward in our global strategy of supporting the legacy implant equipment market, and specifically the Varian Sunset product lines. We are now able to offer world-class implant products including system re-manufacturing, field service, parts distribution and technical support from locations in Taiwan, Japan and North America," adds Jeveli. "Through continuous investment and expansion, OEM Group has secured our position as the leading supplier of legacy equipment."

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IN BRIEF

Kyma CTO named a 'Mover and Shaker'

Kyma Technologies Inc of Raleigh, NC, USA, which provides crystalline GaN and AlN materials, says that chief technology officer Dr Edward Preble has been named a 'Triangle Mover and Shaker'.

Sponsored by Business Leader Media (which publishes Triangle Business Leader Magazine), The Mover & Shaker Awards honor up-and-coming business leaders in the Raleigh-Durham Research Triangle Park community. Nominees must be either rising leaders within companies with more than 100 employees or C-level executives leading rising companies with fewer than 100 staff.

Preble was amongst area winners at Business Leader Media's seventh annual Mover & Shaker award ceremony in Raleigh. Winners are featured in the October issue of Business Leader magazine.

Preble joined Kyma in 2003 after PhD and post-doctoral study at North Carolina State University (NCSSU) in Materials Science and Engineering under the supervision of professor Bob Davis (who has a reputation for graduating successful Triangle area executives). Starting as a senior research engineer, Preble was promoted to VP of engineering in 2005 and to chief operating officer in 2007.

In 2009 he was voted onto Kyma's board of directors. His role recently changed to CTO to provide extra support to Kyma's product development and commercialization activities across an increasingly diverse technology space and product line.

"Kyma has grown considerably over the past few years in terms of market presence and overall growth prospects," says president & CEO Dr Keith Evans. "Ed has contributed and continues to contribute at the highest level."

<http://triangle.businessleader.com>

JPSA's laser system shipments grow 250% so far in 2010, driven by LEDs

JP Sercel Associates Inc (JPSA) of Manchester, NH, USA, which makes laser scribing and laser lift-off (LLO) systems for LED production, says that its shipments of laser processing systems for LEDs for the first three quarters of 2010 are up 250% year-on-year, with increasing demand for high-throughput 266nm front-side scribing tools for sapphire and high-brightness (HB) LED wafers driven mainly by major Taiwanese and Korean manufacturers.

"Our 266nm front-side scribing continues to dominate the market because we are able to provide LED manufacturers higher-throughput systems that enable more die to be packed onto each wafer," claims founder & chief technical officer Jeffrey Sercel. "Increased die density and reduced damage from the laser scribing produces significantly higher yields than mechanical or saw dicing methods," he adds. "To maintain our strong market presence, we continue to develop advanced processes in both scribing and laser lift-off applications."

JPSA's recently released automation platform for IX 6100 laser scribing



JPSA's IX-6100 with IAP.

and laser lift-off systems is currently shipping to LED makers. The new IAP (Integrated Automation Platform) wafer load and unload automation module provides dual-cassette wafer ports, further streamlining the manufacturing process and increasing yields.

For continued development of micromachining processes and production space, JPSA is in the final stages of expanding its headquarters, providing cleanrooms, R&D laboratories, and office space to accommodate the growing customer service and engineering teams. Completion is due in October.

www.jpsalaser.com

SÜSS MicroTec appoints VP R&D, focusing on cross-product roadmap for Coaters, Wafer Bonders and Photomask Equipment lines

Equipment and process solutions provider SÜSS MicroTec AG of Garching, near Munich, Germany has appointed Dr Rainer Knippelmeyer as VP R&D and chief technology officer, overseeing R&D and innovation management for all products. His main focus will be on the creation of a cross-product technology roadmap within the SÜSS MicroTec group.

"The constantly increasing demands for future technologies like 3D integration make it essential for the success of the company to even more tightly coordinate the product developments in our divisions," says CEO & president Frank P. Averdung.

"The creation of this new position goes hand-in-hand with the merger of our product lines Coaters, Wafer Bonders and Photomask Equipment at our Sternenfels site," he adds.

Knippelmeyer has many years of experience in R&D at various Carl Zeiss AG firms. "With his wealth of experience, Rainer Knippelmeyer will be able to further emphasize the clear focus on development activities in the strategic markets for the SÜSS MicroTec group," says Averdung. "Customers all over the world will benefit from the close linking of our development departments."

www.suss.com

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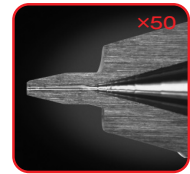
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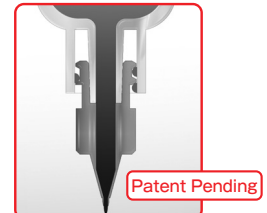
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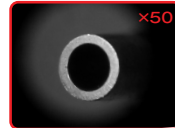
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- Alleviate bubbling



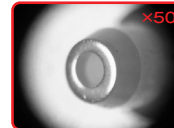
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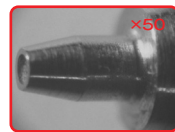
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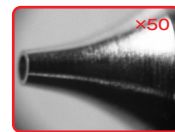
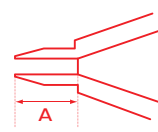
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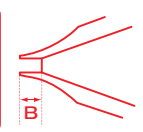
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SETI and Kyma to co-develop high-efficiency deep UV LEDs on low-defect AlGaIn substrates

Joint development agreement targets water disinfection applications

Deep ultraviolet (DUV) LED maker Sensor Electronic Technology Inc (SETI) of Columbia, SC, USA has entered a joint development agreement with Kyma Technologies Inc of Raleigh, NC, USA, which provides crystalline III-nitride semiconductor materials including GaN and AlN, to develop low-defect AlGaIn substrates and high-performance optoelectronic and electronic devices based on these substrates.

AlN and GaN substrates are preferred for device layer stacks which are AlN-rich and GaN-rich, respectively. For device layer stacks that have an intermediate preferred lattice constant (such as UV LEDs and certain next-generation high-frequency and high-power electronics) AlGaIn substrates are preferred.

SETI will center its device development efforts on next-generation

high-efficiency DUV LEDs based on these novel substrates as it grows its markets in high-power applications such as water disinfection.

SETI claims to be the world's only commercial manufacturer of deep UV LEDs and LED lamps. With a product portfolio extending from wavelengths of 240nm through to 400nm, SETI serves a wide range of markets including sensing and instrumentation. With recent announcements of high-power single-chip LEDs exceeding 30mW and with high-power lamps commercially available, SETI has been experiencing rapid growth in the disinfection/sterilization market.

"The LED performance improvements that will be enabled by developments under this agreement will help us grow the foundation we have already built in the

disinfection market, and will maintain our position as leaders in deep UV LED products," says SETI's president & CEO Remis Gaska.

SETI recently completed a US National Science Foundation (NSF) Small Business Innovation Research (SBIR) Phase I program to develop a prototype of a commercially viable all-LED-based portable water disinfection system (see below).

"We appreciate the opportunity to work with SETI to develop a low-defect AlGaIn substrate product line, which should benefit a range of advanced nitride semiconductor device technologies," comments Kyma's president & CEO Keith Evans.

SETI and Kyma both presented at the International Workshop on Nitride Semiconductors (IWN 2010) in Tampa, FL (19-24 September).

www.kymatech.com

SETI wins \$475,000 NSF SBIR Phase II award

DUV LED maker to develop drinking water disinfection units

SETI has been awarded a \$475,000 Small Business Innovation Research (SBIR) Phase II award from the US National Science Foundation (NSF) to develop point-of-use (POU) drinking water disinfection systems based on deep ultraviolet LEDs (DUV LEDs).

SETI claims to be the only commercial supplier of DUV LEDs operating in the germicidal wavelength range, and has standard UVCLEAN lamps available with optical output power of up to 50mW at 275nm.

SETI has also entered a joint development agreement with Kyma Technologies Inc of Raleigh, NC, USA, which provides crystalline III-nitride semiconductor materials including gallium nitride (GaN) and aluminum nitride (AlN), to develop low-defect aluminium gallium nitride (AlGaIn) substrates and high-performance optoelectronic and electronic devices based

on the substrates, targeting higher-efficiency DUV LEDs for applications such as water disinfection (see story above).

During the new Phase II of the SBIR project, SETI will design, develop, fabricate and demonstrate all-LED water treatment units with reduced power consumption and extended reliability. The main effort will focus on increasing the germicidal efficacy and reducing the cost of LED disinfection units through advances in LED packaging and disinfection chamber design.

Through Phase I of the NSF SBIR program, SETI recently demonstrated 99.99% disinfection of E-coli in a POU drinking water system with water flowing at 1 liter per minute using its 275nm UVCLEAN LED lamps emitting about 30mW of optical power. SETI has since begun to ship

bespoke proof-of-concept units to companies for evaluation in consumer products.

The firm says that further development of UV disinfection technology using semiconductor UV lamps will use unique device characteristics, such as controlled UV spectral power distribution, fast switching time, lower power consumption, high reliability, small size and ruggedness. SETI believes that these advantages will enable new opportunities to incorporate UV disinfection into consumer water purification systems.

Deep UV LEDs and lamps are currently commercially available from SETI at wavelengths of 240-400nm for applications including air and surface disinfection, UV curing, scientific instrumentation medical diagnosis and therapy.

www.s-et.com

SPTS takes 19.9% stake in BluGlass to develop GaN-on-glass RPCVD

BluGlass Ltd of Silverwater, Australia, which has developed patented GaN-on-glass LED technology, has agreed a joint venture deal with SPP Process Technology Systems Ltd (SPTS) of Newport, Wales, UK, the plasma etch & deposition equipment subsidiary of Japan's Sumitomo Precision Products Co Ltd (SPP).

Spun off from the III-nitride department of Macquarie University in 2005, BluGlass has developed a low-temperature process using RPCVD to grow materials including GaN and InGaN on glass substrates for the production of LEDs, with what is reckoned to be significant low-cost potential and inherent scalability. The JV will focus on completing the development and commercialization of BluGlass' proprietary RPCVD technology, which can potentially offer cost, throughput and efficiency advantages for the production of nitrides.

With more than 400 staff and 35 locations worldwide, SPTS aims to expand its product portfolio into adjacent equipment sectors. BluGlass has developed promising technology that fits well with SPTS' technical roadmap and product/customer base, believes SPTS' president & CEO Dr William Johnson. "SPTS and BluGlass intend to bring the RPCVD technology to market on field-proven production platforms, offering significant competitive advantages for customers in the rapidly expanding high-brightness LED industry," he adds.

SPTS will become a cornerstone investor in BluGlass, subscribing for about 47.7 million shares at an issue price of \$0.11 each. This will give SPTS a post-placement holding of 19.9% of the expanded issued ordinary share capital in BluGlass, to be completed in two tranches. The initial tranche of 23.297 million shares (worth \$2.562m) is to be placed within 5 days. The remaining 24.432 million shares (worth \$2.687m) exceeds BluGlass' place-

ment capability and requires approval by its shareholders (to be sought at the firm's annual general meeting on 1 November).

BluGlass has also agreed to offer SPTS the right to participate in any future issue of securities to maintain its holding at the time, and SPTS will have an ongoing right to nominate a representative to BluGlass' board (provided that SPTS maintains more than a 10% stake in the firm). BluGlass' board will hence be recommending at the upcoming AGM that Johnson is nominated for a board seat.

"SPTS is the perfect-fit partner for our technology and its commercialization," says BluGlass' CEO Giles Bourne, who adds that SPTS' existing plasma deposition equipment manufacturing expertise and capabilities, along with its substantial customer base, are complementary and synergistic to BluGlass' commercial goals. "This is a major commercial milestone for BluGlass," he believes.

The JV will be co-capitalized by the two parties exclusive and additional to the initial \$5.2m investment into BluGlass, which will maintain a majority 51% stake in the equipment-making JV and retain 100% ownership of intellectual property related to devices (e.g. LEDs and solar cells). Since the JV will focus exclusively on developing the RPCVD equipment portfolio, BluGlass will exclusively license its RPCVD intellectual property for the purposes of the JV with SPTS. BluGlass will continue to operate its Silverwater facility and, through the JV, will establish RPCVD development and demonstration equipment at SPTS' facilities.

"This joint venture will enable BluGlass and SPTS to emerge as a front runner in supplying process equipment for the LED and PV solar industries," believes Bourne.

www.bluglass.com.au

www.spp-pts.com

IN BRIEF

SETI raises single-chip germicidal UV LED output record from 30 to 100mW

In its ongoing development program to boost the power of UV LEDs operating in the germicidal wavelength range, deep ultraviolet (UV) LED maker Sensor Electronic Technology Inc (SETI) of Columbia, SC, USA has raised its record for constant-current optical output power from a large-area single-chip device from 30mW (reported in December 2009 for a device with an active region of 1mm²) to 100mW.

SETI says that, although this level of single-chip performance is not yet available in its production LEDs, high-power UV LED lamps are available under the UVCLEAN trademark with germicidal powers of up to 50mW.

SETI recently demonstrated disinfection in an 'on demand' drinking water system using 30mW LED lamps. "High-power UV LEDs are essential to achieve the level of disinfection required in point-of-use and point-of-entry water treatment systems," says president & CEO Remis Gaska. "This ongoing development of large-area high-power UV LEDs will help to reduce the price per milliwatt and allow UV LEDs to enter cost-sensitive disinfection markets," he believes.

SETI presented the latest data on its high-power single-chip UV LEDs at the International Workshop on Nitrides (IWN 2010) in Tampa, FL, USA (19-24 September).

www.iwn2010.org

www.s-et.com

Photoluminescence boosted by patterned LED lift-off

Wet chemical etch removes sapphire from nitride LEDs to increase light extraction efficiency

Taiwan's National Chung Hsing University (NCHU) has developed a chemical technique to 'lift-off' indium gallium nitride (InGaN) LEDs from the sapphire substrate used to grow the nitride semiconductor [Chia-Feng Lin et al, Appl. Phys. Express, vol3, p092101, 2010]. The resulting LEDs had a photoluminescence spectrum that was enhanced 2.2x over a standard device. The lift-off technique resulted in a GaN surface patterned with V-shape grooves.

A number of techniques have been developed in the past few years to increase light extraction from nitride LEDs. Patterning in strategic locations is widely used to reduce the reflection of light at interfaces back into devices. Also, removal of some layers, such as the sapphire substrate, can increase light output power. Laser lift-off is one technique used to do this. Other groups have experimented with various chemical lift-off (CLO) methods using sacrificial layers of materials such as chromium nitride and zinc oxide.

The NCHU group has developed a CLO using aluminum nitride (AlN) sacrificial layers. The 2-inch sapphire substrate was patterned using a 200nm silicon dioxide mask layer with 1 μ m stripes spaced 2 μ m apart. The sapphire was etched using a hot sulfuric/phosphoric acid solution and the SiO₂ mask was then removed. This resulted in a series of triangle-shaped grooves in the sapphire substrate.

The LED structures were then grown on the patterned substrates using MOCVD. The main sources were trimethyl-Ga, -In, -Al, and ammonia (NH₃). For the silicon (n-type) and magnesium (p-type) doping, silane (SiH₄) and bis(cyclopentadienyl)magnesium (Cp₂Mg) were used.

Aluminum nitride was used as a 30nm sacrificial layer for the chemical lift-off process (Figure 1). The

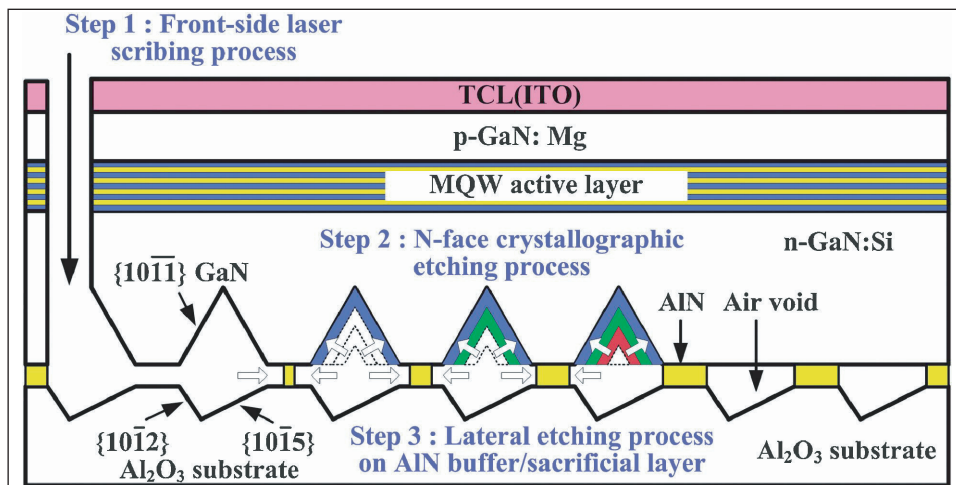


Figure 1. Schematic of the LED structure for the chemical lift-off process.

LED structure consisted of 5.5 μ m n-GaN, a 10-period multi-quantum well (3nm InGaN well, 7nm GaN barrier) light-emitting active layer and 0.2 μ m p-GaN.

The 400 μ m x 136 μ m LED mesas were covered with indium tin oxide (ITO) transparent conducting material. The mesas were produced using a laser scribe, then a hot 80°C potassium hydroxide solution was used to create grooves in the nitrogen face of the n-GaN layer. The etch stop consisted of the stable {10 $\bar{1}\bar{1}$ } face of the GaN material. The final part of the chemical lift-off process was to laterally etch the AlN sacrificial layer. After the 15-minute wet etch, the individual LED chips were removed using adhesive tape.

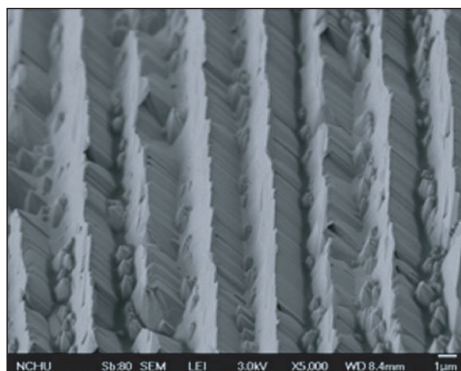


Figure 2. Scanning electron micrograph showing V-shaped grooves in lift-off GaN surface.

The resulting LEDs were inspected using optical and electron microscopy. Photoluminescence experiments with a 405nm excitation laser revealed a peak at 440.7nm (blue). LEDs created using the same process, but without removing the sapphire, had a peak at the slightly longer wavelength of 445.8nm. The peak for the CLO-LED was enhanced 2.2x over the standard device. The researchers suggest that the slight difference in wavelength between the devices was due to release of the compressive strain at the sapphire-nitride interface.

The electroluminescence (EL) peak was 455.9nm at 1mA and 453.0nm at 5mA, the blueshift being attributed to 'band filling' as the electron levels fill up at higher currents, increasing the effective energy separation between the electron and hole levels.

The relatively high forward voltage of 4.14V at 20mA was attributed to a non-optimized ohmic contact to the n-GaN lift-off layer. The EL measurements were carried out with the ITO layer connecting with a copper substrate, and the electrical contacts were made with probes.

<http://apex.ipap.jp/link?APEX/3/092101>
www.nchu.edu.tw

Author: Mike Cooke

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Toyoda Gosei and Epistar form Taiwan LED-making JV TE OPTO to target LED lighting applications

Japanese LED chip maker Toyoda Gosei Co Ltd, its Taiwan LED sales agent Twin Hill Co Ltd and Taiwan's largest LED chipmaker Epistar Corp have agreed to establish (in November) a Taipei-based joint venture — tentatively named TE OPTO Corp — to develop, manufacture and market LEDs. Ownership will be 51% Toyoda Gosei (with four directors), 40% Epistar (with two directors) and 9% Twin Hill (with one director). Initial capitalization is NT\$23m (about ¥60m).

Toyoda Gosei has worked with Epistar since 2006, outsourcing production of some of its LEDs.

Earlier in September, Toyoda Gosei and Epistar signed a cross-license agreement allowing the firms (and their subsidiaries) to use each other's patents for specific technologies in Group III-V LEDs, including InGaN-based (blue and green) LEDs and red AlGaInP-based (red and orange) LEDs. Epistar holds patents for high-brightness AlGaInP LEDs and



Epistar chairman B.J. Lee (left), Toyoda Gosei president Hajime Wakayama (center) and Twin Hill president Philip Cheng (right).

high-power InGaN LEDs, and Toyoda Gosei likewise owns patents for InGaN LEDs. Epistar and Toyoda Gosei said they had agreed to "construct an environment wherein they will respect and mutually utilize each other's technologies in order to further advance the market for LED products".

The agreement aims to allow both Epistar and Toyoda Gosei more freedom in their development efforts by eliminating the need for

concern about each other's patents. By facilitating research at both firms, new developments in LED technology are expected, including accelerating research to improve the luminosity of LEDs.

According to Epistar, Toyoda Gosei is among the five main patent holders in the LED industry (along with Japan's Nichia Corp, the US-based Cree Inc and Philips Lumileds Lighting and Germany's Osram GmbH).

Through the new joint venture, Epistar and Toyoda Gosei aim to tap into each other's strengths, combining Toyoda Gosei's LED technology with Epistar's low-cost manufacturing capabilities in order to expand the partners' sales of low-cost LED products in the growing market for illumination applications.

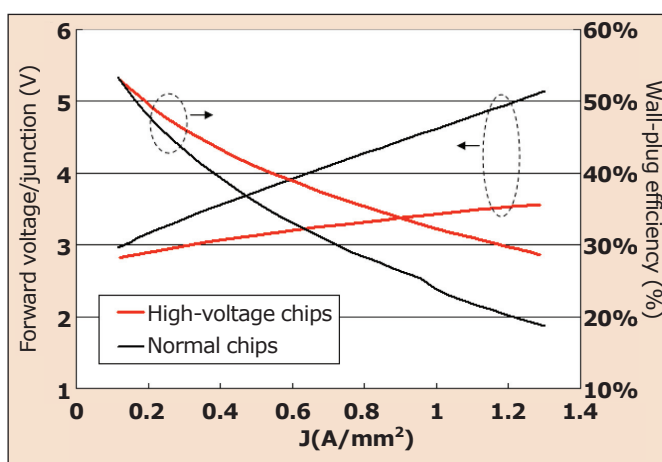
The JV's short-term target is for annual sales equivalent to about ¥5bn by the fiscal year to end-March 2012.

www.epistar.com.tw
www.nichia.co.jp/en

Epistar achieves 135lm/W white LED operation at 1W HV LED chips shipping to General Electric, Philips and Osram

Taiwan's biggest LED epiwafer and chipmaker Epistar Inc says that it has developed a high-voltage (HV) LED chip that enables white LED operation with a luminous efficacy of 135lm/W at a power of 1W. The HV LED chips have already started shipping to General Electric, Philips, Osram and IKEA, which are building them into their branded lamps.

Epistar adds that it has developed technology suitable for lighting applications to reach high efficacy using a single blue LED chip with a large size (45mil), eliminating the need for complicated packaging of many small-sized chips and their connecting wires. The technology yields a white LED with efficacy of up to 135lm/W at color temperature of 5000K.



Forward voltage (left) and wall-plug efficiency (right) versus drive current density for HV LED chips compared to normal LED chips.

To reach such high efficacy with the sort of simplified package that is desired in lighting applications,

Epistar developed a high-voltage monolithically integrated DC multi-chip array to significantly improve current spreading. Consequently, a much lower forward voltage and a higher wall-plug efficiency (WPE) are achieved at 5.5W operation compared to chips of normal power, it is claimed.

Epistar says that packaged HV LED chips can be used in general lighting and applications requiring high-efficacy white light.

www.epistar.com.tw

Arima Optoelectronics to set up new LED epitaxy subsidiary in China

Up to 150 MOCVD systems to be installed over the next five years

Taiwan-based LED epiwafer and chip maker Arima Optoelectronics Corp (AOC) is to invest up to US\$30m to set up an LED epitaxy manufacturing subsidiary in Wujiang, Jiangsu Province, China, with equipment installation due in fourth-quarter 2010 and production at year end, according to a report in Digitimes.

The new subsidiary will use an existing Arima Group plant as its

production facility, so it only needs to install cleanrooms and equipment such as MOCVD reactors, the firm says.

Arima Optoelectronics aims to install 10 MOCVD systems by the end of 2010, 10 more by mid-2011, and up to 150 over the next five years, the firm indicates.

www.aocepi.com.tw
www.digitimes.com

Showa Denko expands monthly blue LED chip production from 200 million to 340 million

Tokyo-based Showa Denko K.K. (SDK) has increased monthly production capacity of blue LED chips at its Chiba site from 200 million units to 340 million units. After completion of expansion work in July, SDK undertook a trial run to ensure product quality and stable operation. Commercial operation has since begun.

Demand for blue LEDs is expected

to grow at about 10% annually on average in the coming years due to increased usage in applications such as LCD TV backlighting and general lighting, SDK comments. The firm therefore aims to boost technical development in order to further increase LED chip output and to improve production efficiency.

www.sdk.co.jp

Mitsubishi Chemical investing \$175m to expand from 40 million to 100 million LEDs per month

Expansion follows launch of LED light bulb

Mitsubishi Chemical Corp plans to invest ¥15bn (about US\$175m) in high-brightness LED (HB-LED) production equipment by March 2016, reports Japan's Nikkei newspaper.

According to the article, by fiscal 2012 Mitsubishi Chemical will install a production line at its factory in Ibaraki prefecture, northeast of Tokyo, as well as also starting mass production of GaN substrates for LEDs.

The firm will reportedly increase its LED component production

capacity by 250%, from 40 million to 100 million units per month.

In mid-September, Mitsubishi Chemical announced that it had begun selling its Verbatim brand of LED light bulbs in the European market (after exhibiting them earlier at the IFA 2010 consumer electronics show in Berlin, Germany). The products will next be introduced in America, followed by the Asia-Pacific area (including Japan).

www.mitsubishichemical.com

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Seoul Semiconductor's Acriche A3 LEDs used in Oak Ridge Labs' ZEBRAlliance test house

South Korean LED maker Seoul Semiconductor says that its Acriche A3 AC LED is featured in solid-state lighting modules (designed by Lumenique and produced by Molex Inc) installed throughout an energy-saving home as part of the project ZEBRAlliance (the Zero Energy Building Research Alliance) at Oak Ridge National Laboratories (ORNL). On 20 September, a ribbon-cutting ceremony marked completion of the project at its site in the Wolf Creek Subdivision, Oak Ridge, TN, USA.

ZEBRAlliance is a collaborative public-private effort between Schaad LLC, the Tennessee Valley Authority, the US Department of Energy and ORNL to field-test two pairs of energy-saving residences.

The alliance aims to spotlight energy conservation efforts that can reduce the load on the existing



Ribbon-cutting outside Acriche-outfitted ZEBRAlliance house.

electrical grid and curb dependence on non-renewable energy sources. Energy use, lighting quality and maintenance requirements will be monitored for two years. Data from the house outfitted with Acriche LEDs will be compared against that of a house using compact fluorescent lights (CFLs). The results

should help buildings, lighting designers and homeowners make energy-saving lighting decisions, says Seoul Semiconductor.

Because Acriche LEDs do not use electronics to convert AC line voltage into DC (as do most other solid-state lighting devices), they are more energy- and cost-efficient lighting products than other LED options, claims the firm.

"Seoul Semiconductor is proud to support ZEBRAlliance's effort to boost the energy efficiency of residential lighting through our working partner, Molex," says Doug Hardman, Seoul Semiconductor's North American strategic marketing director. "This project will help raise awareness about LEDs and their ability to provide energy-saving, cost-efficient, and longer-lasting lighting solutions than homeowners currently use."

www.acriche.com

IN BRIEF

Nichia acts against LED bulb seller

Japanese LED maker Nichia Corp has filed four provisional injunction actions in the Tokyo District Court alleging infringement of its patent by Tsannkuen Japan (Sankun Nihon Denki Kabushiki Kaisha).

Nichia believes that white LEDs used in certain LED light-bulb products of Tsannkuen Japan, sold by G.K. Seiyu and K.K. Yamada Denki, infringe its white LED patent numbers 3724498, 3995011, 4109297 and 4530094.

The patents concern technology combining a phosphor with a blue LED, as used in many white LED products.

Nichia stresses that it will take necessary measures to protect its intellectual property rights against any firms worldwide.

www.nichia.co.jp/en

Bridgelux adds high-efficacy LED Arrays for retrofit bulb market

LED lighting and chip maker Bridgelux Inc of Livermore, CA, USA has expanded its portfolio of LED Arrays to include new high-efficacy products that meet the price and performance demands of the \$10bn LED retrofit bulb market opportunity.

Bridgelux says that it is now delivering high-brightness, energy-efficient light for both low and line (mains) voltage products to simplify system design and integration for lamp manufacturers.

The LS Array Series now includes options designed specifically for low voltage lighting. The new LS arrays enable both diffuse and directional light sources for applications including landscape lighting, residential lighting, track lighting, MR16 lamps and other 12V retrofit light bulbs. Delivering 240–360 lumens in warm white and cool white, the products are suitable as replace-

ment options for low-wattage halogen and incandescent lamps.

The ES Array Series has also been expanded to include new voltage options for both cool white and warm white to better enable the A-line and decorative lamp markets. The new ES arrays take advantage of existing electronic drivers to facilitate rapid new lamp and luminaire product introductions.

"As governments around the world rapidly move to eliminate inefficient incandescent lamps, the demand is growing for LED replacement lamps that can deliver the quality of light required by consumers," says VP of marketing Jason Posselt. "These new arrays deliver high-quality light while simultaneously helping our customers reduce design complexity and product cost for this price sensitive market," he adds.

www.bridgelux.com

Lextar's revenue grows 82% in Q2, driven by backlighting Two new LED manufacturing plants and increased in-house epi production to nearly double staffing by end-2010

For second-quarter 2010, Lextar Electronics Corp of Hsinchu Science Park, Taiwan, a subsidiary of display panel maker AU Optronics (AUO) that manufactures high-brightness LED epiwafers, chips and packages, has reported revenue up 81.8% on last quarter to NT\$2381m.

"Thanks to strong demand for LED backlights for large-sized LCD panels, our capacity was nearly fully loaded," says chief financial officer B.Y. Chang.

The firm's vertically integrated production model (from upstream epitaxy and midstream chip manufacturing to downstream packaging) and synergy from March's merger of Hsinchu-based LED-making AUO affiliate LightHouse Technology have cut production costs and boosted gross margin to 28.7%, while operating margin was 21.8%. Net profit was NT\$460m, tripling on last quarter.

Despite being faced with the rising cost of sapphire and other raw materials, the addition of new equipment has contributed to in-house chip production, Chang adds.

Founded in May 2008, Lextar currently has over 50 MOCVD reactors, but it aims to introduce more new equipment in order to raise the percentage of in-house LED chips to 70%, boosting productivity. The firm expects its number of MOCVD reactors to rise to about 80 by year end (including 6-inch reactors planned for installation).

Lextar currently has over 50 MOCVD reactors, but it aims to introduce more new equipment in order to raise the percentage of in-house LED chips to 70%

Lextar says that in future it aims to continue to evolve its product portfolio, expand into the LED lighting market, and develop new products for lighting applications. A fourth production site in Chunan, Taiwan due to start mass production in Q4/2010 (adding to existing plants in Hsinchu Science Park and the Hukou Industrial Park) is designated to be the lighting application production base, with production lines including SMT surface-mount technology and LED light module assembly. In addition, a plant currently under construction in Suzhou, China is scheduled to be equipped early next year and begin production in Q1/2011.

Lextar currently employs more than 2000 staff but, through establishing the new production plants, it expects to hire an extra 1800 new staff by the end of this year.

www.lextar.com

Japan's first LUXEON-based LED retrofit light bulb delivered by Quantum and Future Lighting Solutions

Future Lighting Solutions, which provides LED lighting components and support services for solid-state lighting products and installations (including engineering expertise, concept development, full system solutions and online tools), has announced a collaboration with Hong Kong-based Quantum Lighting Products Ltd to develop an LED retrofit for E26-base incandescent light bulbs. Using LUXEON Rebel LEDs made by Philips Lumileds of San Jose, CA, USA, the retrofits are being marketed through Japanese retail stores under the country's Elpa brand, and are available in four cool- and warm-white models designed to replace 40W and 60W bulbs.

The bulbs were designed and are made by Quantum for Asahi Electric

Corp, owner of the Elpa brand. Future Lighting provided engineering assistance, including input on LED board layout and thermal management, plus consultation on board assembly on the production line. Future also provides inventory management services to ensure that Quantum receives LEDs from selected color, flux and forward voltage bins for consistent appearance and performance.

Each 4W or 5.5W retrofit bulb contains three or five LUXEON Rebel LEDs, lasts up to 40,000 hours, and consumes one tenth of the energy of its incandescent counterpart, it is reckoned.

"We have five years of experience in designing and manufacturing LED flashlights, but expanding into LED retrofit bulbs presented new devel-

opment challenges," says Quantum Lighting's managing director Thomas Chan. "Partnering with Future Lighting Solutions enabled us to deliver a reliable product without unnecessary development cycles while also launching a new product line that will significantly build our business," he reckons.

"We have had a good working relationship with Quantum since they began developing solid-state flashlights, and that paved the way for collaboration on this retrofit project," says Future Lighting Solutions regional sales VP Winter Chan. "The bulb is already so successful that there is talk of expanding the market to North America and Europe."

www.futurelightingsolutions.com
www.philipslumileds.com

Cree investing \$135m to install 150mm LED wafer line, for product qualification by June 2011

\$4.2m in state and local incentives keep expansion in North Carolina

LED chip, lamp and lighting fixture maker Cree Inc of Durham, NC, USA says that over the next several quarters it will invest \$135m to install a new 150mm LED wafer production line in its existing facility in Research Triangle Park (RTP), targeting qualification of the first products off the line by June 2011.

The 150mm wafers are more than double the size of the existing wafers, increasing the number of LEDs per wafer and helping to make LED lighting more cost effective. "150mm LED wafers are an important step in enabling the next phase of LED lighting," says CEO & chairman Chuck Swoboda.

Cree anticipates hiring nearly 250 more staff by 2013 for the new production line expansion. The new jobs are in addition to a plan announced last October to hire 575 new workers by the end of 2012. In fact, to keep pace with the growing market for energy-efficient LED lighting, Cree has added more than 600 jobs since early 2009 (including 350 this year), surpass-



North Carolina State Governor Bev Perdue announcing the expansion and new jobs at Cree's site in Durham, NC.

ing its goal. Cree now has 1850 full-time staff at its three Durham sites, according to chief operating officer Stephen Kelley in *The Durham News*. The firm employs another 2700 staff in China, Malaysia, Japan, and Germany.

The new jobs were announced at Cree's headquarters in Durham by North Carolina State Governor Bev Perdue, in the presence of US Senators Richard Burr and Kay Hagan, Rep. David Price, Rep. Brad

Miller, and the vice chair of the Durham County Commission Ellen Reckhow.

Cree had previously considered expanding in China (where it already has a plant) and Malaysia, which allowed the firm to qualify for state incentives. Consequently, on 13 September, Durham County Commissioners approved up to \$2m in tax incentives for Cree, of which \$825,000 is reserved for training new staff (for up to 75 Durham residents).

In addition, to help pay for the estimated 244 full-time jobs and 86 jobs for contractors to be created, the North Carolina state Economic Investment Committee has awarded Cree a Job Development Investment Grant (a rebate covering a portion of state employee withholding taxes if new job creation goals are met) worth up to \$2.236m over 10 years.

www.thedurhamnews.com

Cree brings lighting-class LEDs to half-Watt LED market

Cree has announced the commercial availability of the lighting-class XLamp ML-E half-watt LED, which provides a compact and cost-effective solution for distributed LED arrays to meet the stringent US Environmental Protection Agency ENERGY STAR performance criteria, the firm says.

"When we set out to build our new linear light engine, we required the efficacy and reliability of XLamp LEDs, but wanted a smaller package size," says Markus Vockenroth, managing director of MAL Effekt-Technik GmbH. "The XLamp ML-E LED was the perfect combination of price and performance for our application," he adds.

Cree says that its ML-E delivers lighting-class performance in applications where a smooth, uniform appearance is required, such as LED fluorescent-tube replacement, ceiling-mounted panel lights and under-cabinet lighting. Unlike other low-power LEDs originally developed for consumer electronics and back-lighting applications, the ML-E delivers the color binning, efficacy, thermal resistance and long-term reliability required for ENERGY STAR luminaires and bulbs.

"The ML-E offers the lighting design community a simple and affordable solution for a major portion of the solid-state lighting market," says Paul Thieken, Cree's

director of marketing, LED Components. "Designers of applications like fluorescent-tube replacement no longer need to settle for LEDs that aren't lighting-class."

The ML-E delivers full-size features in a small package with luminous flux of up to 58lm at 150mA in cool white (5000K) and up to 48lm in warm white (3000K). Like the XLamp MX-6 and MX-3 LEDs, the ML-E provides a tightly controlled uniform angular chromaticity and a 120-degree viewing angle, optimized for distributed lighting applications. It also shares the same ANSI-compliant chromaticity binning used by the XLamp XP and MX families of LEDs.

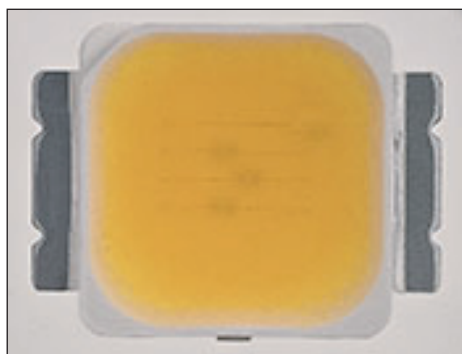
www.cree.com

MX-3 lighting-class PLCC LED suits bulbs, retail display & linear lighting

LED chip, lamp and lighting fixture maker Cree Inc of Durham, NC, USA has announced commercial availability of its new 100+ lumen XLamp MX-3 LED, extending the firm's lighting-class performance to a broader set of applications with enhanced light uniformity and LED-to-LED color consistency.

The MX-3 delivers luminous flux of up to 122lm at a drive current of 350mA in cool white (6500K) and up to 100lm at 350mA in warm white (3500K). Cree says that the new LED offers design simplicity and flexibility, sharing a common footprint with the firm's XLamp MX-6 LED, and suits LED bulbs, retail display lighting and high-flux distributed illumination such as cove lighting and wall washing.

"The XLamp MX-3 is designed for customers who demand lighting-class performance across their



Cree's new XLamp MX-3 LED.

entire product line," says Paul Thieken, director of marketing, LED components, who claims that Cree offers the industry's tightest color consistency and uniform angular chromaticity.

MX-3 LEDs are available in sample quantities immediately and production quantities with standard lead times.

www.cree.com

Cree downlight available via Home Depot

Cree says that customers of The Home Depot can now buy 6-inch LED downlights powered by its TrueWhite technology. The EcoSmart LED Downlight retails for less than \$50, delivering what is claimed to be the industry's best LED light quality and giving consumers high-efficiency lighting without compromising color accuracy and quality. The downlight is available via homedepot.com and is targeted to be available in nearly 2000 Home Depot retail stores this fall.

"With high-quality, more affordable LED downlights now offered at the world's largest home improvement retailer, consumers don't have to turn to wasteful incandescent or mercury-laden fluorescent options when they can easily choose energy-efficient lighting that delivers warm light and beautiful color," says Cree's CEO & chairman Chuck Swoboda.

"The Home Depot is now able to deliver a lighting-class, energy-efficient solution to our customers," says Bill Hamilton, electrical merchandising VP, The Home Depot.

The EcoSmart LED Downlight was designed to exceed stringent ENERGY STAR criteria and consumes just 10.5W, which is about 85% less energy than a comparable incandescent and 50% less energy than a fluorescent. Created specifically for the residential market, it is designed to last at least 35,000 hours (about 32 years with three hours of daily use), which is nearly four times longer than compact fluorescent (CFL) alternatives and up to 16 times longer than incandescent options. Easily installed into most standard 6-inch recessed housings for retrofits and new construction, the new downlight is dimmable to 5% using off-the-shelf dimmers.

IN BRIEF

Furniture retailer installs 80,000 Cree LRP-38 spotlights US-wide

The Furniture Row Companies, one of the USA's largest family owned specialty home furnishings and bedding retailers (operating over 330 stores in 31 states), is installing LED lighting from Cree throughout its 330 Sofa Mart, Oak Express, Bedroom Expressions and Denver Mattress Company specialty furniture stores across the country.

To date, nearly 13,000 Cree LRP-38 LED spotlights have been installed out of more than 80,000 planned. The 11W LED lights are replacing 90W halogen bulbs.

"We wanted new lighting that addressed our goal of being environmental stewards, but we also wanted to remain fiscally responsible," says store planning coordinator Rod Schnurr.

The first Furniture Row Shopping Center to install Cree LED lights saved \$4200 on monthly energy costs compared with the original lighting, Schnurr says. The LRP-38 spotlights also generate much less heat, saving on air conditioning costs. Furniture Row also anticipates significant maintenance savings, given the much longer service life of the LED lights, which are designed for a 50,000-hour lifetime in open applications. Prior to the LED lighting upgrade, store employees spent an estimated 15 hours per week replacing burned out halogen bulbs.

"The LRP-38 spotlight is perfect for retail environments because it offers energy efficiency and longevity without compromising on the high-quality light needed to properly illuminate merchandise," claims Craig Lofton, director of national accounts of Cree LED Lighting.

www.FurnitureRow.com

Osram chooses Vistrian's computer-integrated manufacturing software for Malaysia fab

To provide improved visibility and accountability to its processes and equipment, optoelectronics manufacturer Osram Opto Semiconductors GmbH of Regensburg, Germany has selected and recently implemented FactoryLOOK manufacturing intelligence software from Vistrian Inc of Milpitas, CA, USA to support manufacturing operations in its wafer fabrication plant in Penang, Malaysia.

"Osram Opto Semiconductors is committed to offering the most innovative, trend-setting technologies for illumination, visualization and sensing and, as such, the company is constantly launching new technologies and products," says Vistrian's CEO Ronald Allen. "As a result they are always looking at

methods to reduce costs & time to market, improving factory productivity and ensuring process compliance," he adds. "FactoryLOOK gives them the visibility and accountability information they need to do just that with just a few clicks, very little training and without the need for third-party software integrators," he claims.

"Our goal was to implement a world-class wafer fab with adequate controls to ensure the right part gets processed at the right machine with the right recipe by the right operator," says Dr Roland Mueller, Osram Opto Semiconductors' VP & general manager. "We were pleased to find a partner in Vistrian to provide us just such a solution in a cost-effective and

turn-key manner," he adds.

Vistrian's FactoryLOOK software monitors, alerts and correlates manufacturer's data while tracking the customer's manufacturing processes. The software works together seamlessly to provide cohesive, multi-screen views of the entire production process, presenting this data in easy to understand dashboards. Virtually all of the information required by the customer in their process can be accessed with just a few clicks, in real-time from any networked monitor or secure web browser. The software's easy to use monitoring and alerting technology helps companies manage their production closely and consistently.

www.osram-os.com

CERAMOS LEDs used in Dolby's professional reference monitor

Osram Opto Semiconductors GmbH of Regensburg, Germany says that 1536 of its CERAMOS RGB Multi-chip LEDs are used in Dolby's new PRM-4200 LED-backlit professional reference monitor, which is designed specifically for professional content creation applications and targeted at production and post-production of movies and TV shows. Osram claims that its LEDs provide high performance with wider color gamut, outstanding color accuracy, higher dynamic range and true deep blacks.

The Dolby PRM-4200 professional reference monitor is a 42-inch LED-backlit LCD tailored for professional applications that require accurate and true color reproduction, increased dynamic range, and deep black levels as well as excellent grayscale tracking. Osram says that the use of its CERAMOS Multi-chip LEDs, in combination with Dolby's proprietary dual-modulation and calibration technologies, enables the display to meet these demanding requirements. Conventional monitors with



Dolby's PRM 4200 monitor, which uses Osram's CERAMOS MultiLED.

CCFL (cold cathode fluorescent lamp) backlighting have limited color gamut and, for example, display deep blacks as dark gray.

Osram says that its CERAMOS MultiLEDs deliver the high performance required by the professional content creation industry. The red, green and blue chips are positioned so that the color mix

has the same appearance when observed from a wide range of angles. The ceramic package measures only 0.9mm high and 3mm x 4.5mm, suiting flat backlights, and the ceramic material makes it very stable over a long period of time, with negligible degradation in brightness or drift in colors with

lifetimes in excess of 50,000 hours.

"The trend towards LEDs for use in display applications is clear, and our analysis also shows that more than 50% of consumer TV sets will be equipped with LED backlighting in 1-2 years," says Winfried Schwedler, marketing manager at Osram Opto Semiconductors.

www.dolby.com

Deep-red LEDs provide 37% efficiency for plant growth pilot project

In cooperation with Fionia Lighting A/S in Denmark, a pilot project covering several thousand square meters of planting area in a commercial greenhouse has achieved energy savings of 40% using Golden DRAGON Plus and OSOLON SSL LEDs from Osram Opto Semiconductors which, with efficiency of 37%, are among the most efficient light sources on the market in the deep red spectrum (660nm wavelength), it is claimed.

For plants to grow well in greenhouses they need the right temperature and also the right light. Light in the deep red spectrum plays a key role in plant growth because the absorption of chlorophyll in this spectral range is very high. Osram says both its Golden DRAGON Plus and OSOLON SSL LEDs now provide this deep-red light with particularly high efficiency, with typical power of 330mW at an operating current of 400mA. The chips are based on the firm's thin-film technology and, with a life of 100,000 hours, they offer maintenance-free operation for many years.

The Golden DRAGON Plus has a wide beam angle of 170° and can be used with good effect in reflector systems for illuminating large areas under cultivation. The OSOLON SSL has a smaller footprint and a narrow beam angle of 80°, so they can be arranged close to one another. They can also be equipped with external optics. Osram says their unique characteristics suit special applications such as 'multi-layer cultivation', in which salad plants are grown on stacked levels, and it is important for the lighting to be both compact and uniform.

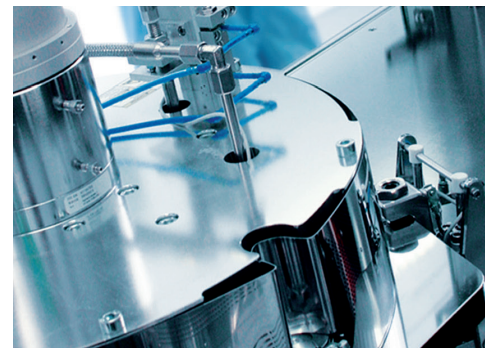
The pilot project, in cooperation with Fionia Lighting and Osram distribution partner Arrow in Denmark, confirmed the energy-saving potential of LEDs in horticultural applications, says Osram. As part of the project, Fionia Lighting developed a luminaire system specifically for greenhouses that was equipped with a total of



about 50,000 Golden DRAGON Plus LEDs. Over a cultivated area of several thousand square meters it was possible to reduce power consumption by 40%. "Flowers cultivated under LED lighting developed just as quickly as the control specimens under conventional lighting," says Fionia Lighting's Thomas Rubaek. "Also, the flowers cultivated under the LED lights had more buds, which attracted higher sales prices," he adds. "At the same time we were able to reduce the use of chemicals such as growth regulators."

The colors red and blue are particularly important for plant growth. The emission curve of the new red LED is a good match for the spectral sensitivity of chlorophyll. Depending on the type of plant and the growth phase, the ratio of red and blue has to be individually adjusted between 10% and 30%. "If the emission curve of the light source is mapped against the spectral sensitivity curve of the plant (according to DIN 5031-10), the system luminous efficacy with LEDs is 60% higher than with the high-pressure sodium lamps currently used," explains Dr Christoph Gärditz of Osram Opto's SSL Business Development department. "Combination of deep red and blue LEDs offers impressive energy savings in this project as well."

www.fionalighting.dk



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Epistar licenses PhlatLight technology from Luminus

Luminus Devices Inc of Billerica, MA, USA, which develops and makes large-chip PhlatLight (photonic lattice) LEDs for illumination applications, has announced a licensing agreement that enables Taiwanese LED maker Epistar to manufacture LEDs on the PhlatLight platform.

This is Luminus' third individual licensing agreement with other LED makers, following Taiwan's Formosa Epitaxy (Forepi) in March and Japan's Nichia Corp in January 2009. The firm claims that this demonstrates that LEDs fabricated using the PhlatLight technology platform offer unparalleled levels of brightness and reliability, as well as further validating the strength of its patent portfolio (which now contains

more than 40 issued patents and 100 more applications).

"This licensing agreement further strengthens the existing partnership between Luminus and Epistar and enables Epistar to commercialize LEDs based on the PhlatLight technology platform," says Luminus Devices' chief technology officer Alexei Erchak. "Epistar is at the forefront of solid-state lighting development and PhlatLight technology will improve their LED performance. Meanwhile, Luminus will continue to focus on manufacturing big-chip LEDs for applications where LED arrays don't provide enough brightness," he adds.

"We are pleased to broaden our partnership with Luminus, as their

strong IP portfolio includes LED patents that enable unmatched levels of brightness and reliability," comments Epistar's president Ming-Jiunn Jou.

PhlatLight big-chip LEDs are used in display applications by some of the world's largest electronics and lighting companies such as Acer, Guth, LG, Philips Lighting and Samsung, says Luminus. PhlatLight big-chip LEDs are also 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.

www.epistar.com.tw

Luminus receives SBIR grant for SSL driver technology

The US Department of Energy (DOE) has awarded six Small Business Innovation Research (SBIR) grants and one Small Business Technology Transfer (STTR) grant targeting advances in solid-state lighting (SSL) technology. The SBIR/STTR program seeks to increase the participation of small businesses in federal R&D.

Of the seven awards, six are Phase I (to explore the technical

merit or feasibility of an innovative concept or technology) and one is Phase II (to expand on Phase I results and enable awardees to evaluate the commercial potential of new technology).

The Phase I awards include an SBIR grant to Luminus Devices Inc of Billerica, MA, USA (which develops and makes large-chip 'PhlatLight' photonic lattice LEDs for illumination applications) for the project

'Smart and Efficient Drivers for Big-Chip Photonic Lattice LEDs', which aims to design conversion electronics specifically targeted to driving single-junction, high-current diodes. The product should accelerate the ability of small luminaire manufacturers to use and develop products that can take advantage of big-chip photonic-lattice LEDs, it is hoped.

www.ssl.energy.gov/sbir_str_grants.html

Luminus hires Philips Lighting North America veteran as general manager, Global Commercial Markets

Luminus Devices says Jim Hunter has joined as VP & general manager, Global Commercial Markets, responsible for increasing its presence in the general lighting, UV and display lighting markets. He joins following several senior management posts in Philips Lighting North America's lighting division.

"Jim brings a diverse and deep skill set to Luminus and we're excited he's joined the company as we continue a record-setting year of growth," says president & CEO Keith T.S. Ward. "Jim's experience



and success managing marketing within the lighting division of Philips' North America is extremely important for Luminus as we continue to expand our portfolio of big-chip PhlatLight LEDs into tomorrow's lighting applications."

As VP of marketing for Philips Lighting and area marketing officer for Philips North America, Hunter managed a team of 70 split

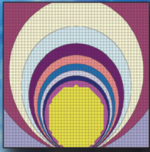
between channel marketing, marketing communications, market intelligence and pricing. Previously, he held several senior level marketing positions at Philips Lighting in both the USA and Canada.

"Luminus is developing the world's only big-chip LEDs and today work with many of the world's biggest names in the lighting and electronics industry," says Hunter, who aims to help Luminus penetrate new solid-state lighting markets.

www.luminus.com

FerroTec

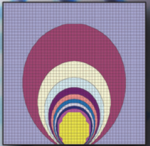
Temescal is now a
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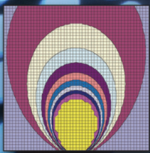
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For more information, visit us at www.temescal.net



Temescal

LumaSense acquires Opsens fiber-optic sensor technology

GaAs-based IR sensors improve transformer reliability and management of grid assets

LumaSense Technologies of Santa Clara, CA, USA which designs and makes infrared and fiber-optic temperature and gas sensing solutions for end-users and original equipment manufacturers (OEMs) in industrial, energy, medical and clean tech applications, has acquired fiber-optic sensing technology from Opsens Inc of Quebec, Canada that is used to help energy firms identify transformer hot spots and perform critical high-voltage equipment temperature monitoring.

LumaSense says that the deal for Opsens' PowerSens system gives it a fiber-optics portfolio designed to help utilities improve power grid reliability involving generation, transmission and distribution assets.

"As global energy demand increases, transformer and electrical asset reliability is a growing priority," says LumaSense's CEO Vivek Joshi. "Transformer makers and utilities are looking for a wide range of options for improving system reliability

across all sizes of transformers, distribution units included," he adds.

The PowerSens system uses gallium arsenide sensors to measure temperature. LumaSense's overall fiber-optic measurement portfolio for utilities also includes the ThermAsset2 and LumaSmart systems based on Fluoroptic phosphor technology, which provides reliable temperature measurement in critical, large transformers, whereas GaAs is a cost-effective alternative for smaller projects that do not require as high a level of proven durability.

Opsens' PowerSens system gives it a fiber-optics portfolio designed to help utilities improve power grid reliability involving generation, transmission and distribution assets

PowerSens customers will now have access to LumaSense's larger portfolio of temperature-measurement technology, as well as its global support network of application engineers, comments Opsens' president & CEO Pierre Carrier.

"For Opsens, this gives us the perfect opportunity to focus on serving the needs of our customers in our main fields with our fiber-optic technology," he adds.

In the electrical industry, LumaSense's fiber-optic temperature (FOT) measurement technology is used on transformer winding hot spots.

FOT uses rugged probes to directly measure winding temperatures more accurately than conventional methods, which have errors from inferring hot spots by trying to simulate or calculate the temperature versus measuring it directly.

www.lumasenseinc.com/EN
<http://opsens.com>

Digi-Key to distribute Opto Diode's products worldwide

Opto Diode Corp of Newbury Park, CA, USA, which manufactures visible and infrared (IR) LEDs, LED arrays, silicon and gallium aluminum arsenide (GaAlAs) photodiodes and optoelectronic assemblies, has entered into an agreement for electronic components distributor Digi-Key Corp of Thief River Falls, MN, USA to distribute its products worldwide.

Opto Diode products are now in stock and available via Digi-Key's global websites, and will also be featured in future print and online catalogs.

Typical applications include photoelectric controls; medical, scientific and industrial fluorescence; guided

missile systems, ophthalmology, LED-based tracking systems for surgery, vending machines and aviation lighting.

"This new partnership with Opto Diode affirms Digi-Key's commitment to work with the world's leading suppliers and provide the distribution industry's widest selection of electronic components to our global customers," says Dave Doherty, Digi-Key's vice president of semiconductor. Digi-Key serves a global customer base from its 600,000ft² facility.

"Opto Diode is looking forward to the many customer benefits of teaming with an international

distributor that strives to keep all parts in stock," says Opto Diode's general manager Russ Dahl.

Founded in 1981, Opto Diode Corp was acquired in October 2008 by Illinois Tools Works Inc (ITW) of Glenview, IL, joining in ITW's Opto Electronics Group with fellow subsidiaries Lumex, which designs and manufactures user-interface technology (optoelectronic components, devices and displays), and Cal Sensors, which makes lead selenide (PbSe) and lead sulfide (PbS) infrared detectors, arrays and emitters.

www.digikey.com
www.optodiode.com

EU BIANCHO project to cut network component power consumption

Dilute bismide and nitride alloys of GaAs and InP to make lasers, SOAs and EAMs more efficient and temperature tolerant

Five organizations have partnered in the Europe-wide consortium BIANCHO (BIsmide And Nitride Components for High temperature Operation), a three-year, €2.88m R&D initiative (from July 2010 to end-June 2013) supported by €2.19m through the Framework 7 program of the European Union (EU).

The project aims to develop new semiconductor materials to enable lasers and other photonic components to become more energy efficient as well as more tolerant of high operating temperatures. The objective is to reduce the power consumption of telecoms and data networks (which are estimated to consume as much as 3% of European electricity). With optical communication systems becoming the principal way to deliver ever-increasing data-rich broadband services to homes and businesses, power reduction is becoming vital.

According to the project members, many current photonic components for telecoms applications have major intrinsic losses. For example, about 80% of the electrical power used by a 1.55µm laser chip is emitted as waste heat, necessitating the use of thermo-electric coolers and an air-conditioned environment to control the device temperature, cascading the energy requirements by more than an order of magnitude.

The energy losses are due mainly to

- (i) Auger recombination in semiconductor optical amplifiers (SOAs) and lasers (a consequence of the band structure of the semiconductor materials used) and
- (ii) the temperature dependence of the energy gap in electro-absorption modulators (EAMs). Over many years, incremental approaches have sought to reduce the consequent inefficiencies with-

out addressing their fundamental cause, but these approaches have reached their limits.

BIANCHO therefore proposes a radical change of approach: to eliminate Auger recombination and to reduce the temperature dependence of the energy gap by manipulating the electronic band-structure of the semiconductor materials through the use of novel dilute bismide and dilute nitride alloys of gallium arsenide (GaAs) and indium phosphide (InP). This should allow the creation of more efficient and temperature-tolerant photonic devices that could operate without the power-hungry cooling equipment that existing networks demand.

The five project partners have complementary expertise in epitaxy, structural characterization of materials, device physics, band-structure modelling, advanced device fabrication, packaging and commercialization. They include:

- project coordinator Tyndall National Institute of Cork, Ireland (which has expertise in semiconductor band structure modelling);
- Germany's Philipps Universitaet Marburg (focussing on material growth and characterization);
- Semiconductor Research Institute of Vilnius, Lithuania (responsible for the design, manufacture and characterization of bismide-based epitaxial structures);
- the UK's University of Surrey (which contributes unique characterization facilities and modelling expertise); and
- CIP Technologies of Ipswich UK (a component maker with a long history of applied photonics innovation, particularly in the telecoms sector), which will lead commercialization of the project results.

www.biancho.org

IN BRIEF

VI Systems ships first circular VCSEL arrays for datacoms, with 7x 5G channels

VI Systems GmbH of Berlin, Germany has started to ship to selected customers the first circular arrays of its vertical-cavity surface-emitting lasers (VCSELs). The customized chip features seven independent channels with data rates of up to 5Gbit/s per channel, with VCSEL light emitters (with a specified operating wavelength of 850nm) arranged in a ring-like 6+1-channel configuration with one emitter in the center.

Designed for wire-bonding as well as for flip-chip bonding, the VCSEL arrays can be contacted directly from the top and feature a high-speed pad layout.

Originally spun-out of the Technical University of Berlin and the A. F. Ioffe Physico-Technical Institute in St Petersburg, Russia, VI Systems is a fabless developer and manufacturer of ultra-high-speed optoelectronic components, offering laser and photo-detector chips and modules for applications in optical data communications, industrial and consumer applications.

Target applications of the new circular VCSEL arrays are short-reach and very-short-reach optical receivers and transceiver modules used in optical communication networks as well as in chip-to-chip optical interconnects in the computer industry. Future serial standards at data rates of 28Gbit/s are currently being developed within Common Electrical Interface (CEI-25/28Gbit/s), Fiber Channel 32Gbit/s and Ethernet IEEE 40/100Gbit/s standards, as well as for a number of custom-specific applications.

www.v-i-systems.com

GigOptix expands 100G DWDM portfolio and samples quad-channel 7.5V_{pp} MZM driver for DP-QPSK

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, has announced the availability for sampling of its new GX62455, a quad-channel 7.5V_{pp} Mach-Zehnder modulator (MZM) driver designed for 100G DP-QPSK (dual-polarization quadrature phase-shift keying) long-haul optical transmitters.

GX62455 is a high-voltage-output 32Gb/s quad MZM driver in a compact form-factor (25mm x 32mm) GPPO module that includes integrated low- and high-frequency chokes and requires no external components for fast and easy application, the firm says. The connectors have been designed to be form-factor compatible with industry-leading 100G multiplexer and modulators for easier system integration.

Key features include: data rates up to 32Gb/s per lane for 100G DP-QPSK applications; low RMS jitter; adjustable single-ended V_{out} to 7.5V_{pp}; adjustable eye cross point; a wide range of input voltage levels; and typical power consumption of 6W at V_{out}=7.5V_{pp}.

"We are ramping production of our first-generation 100G driver and have now extended our offering with the GX62455 to support the higher output voltage of 7.5V while maintaining industry-leading power consumption within the market's smallest footprint," says vice president Pdraig O'Mathuna. "This MZM driver, in conjunction with our current 100G

GX3222 transimpedance amplifier, offers customers a one-stop-shop for 100G DP-QPSK applications, and we intend to further develop system 'bundles' consisting of a driver and a TIA with future modulators that are tailored for specific DWDM applications," he adds. GigOptix is providing a complete physical-layer solution to enable customers to achieve what is claimed to be not only optimal system performance with the smallest size but also the lowest power with the most cost-competitive solution on the market.

In a recent report on 100G components, market research firm Ovum forecasted that the 100G DWDM line-side market would launch in 2010 and grow at a compound annual growth rate (CAGR) of 140% to more than 16,000 units by 2015.

www.GigOptix.com

We intend to further develop system 'bundles' consisting of a driver and a TIA with future modulators

Pre-production samples available of dual-channel SMT 100G driver

GigOptix has made available pre-production samples of its new dual-channel surface-mounted technology (SMT) GX62255 8V_{pp} Mach-Zehnder modulator (MZM) driver, designed for use in 100G optical transponders.

The GX62255 integrates two 32Gb/s 8V_{pp} driver channels into a single small-form-factor solution. A 100G transponder requires four drivers, while GigOptix' highly integrated dual-channel solution significantly reduces both the area needed to implement the driver section and the electromagnetic interference (EMI) within the system, it is claimed. Each 100G transponder uses two GX62255 devices to amplify the data signals from the transmitter's multiplexer to drive the optical MZM. The GX62255 is specifically designed to interface easily with industry-standard 100G DP-QPSK (dual-

polarization quadrature phase-shift keying) MZMs, providing optimal signal coupling.

Key features of the GX62255 include:

- less than 1.8W power dissipation per channel at 7.5V_{pp};
- optimized for bit rates up to 32Gb/s;
- low RMS jitter degradation;
- adjustable output amplitude; and
- adjustable eye cross point.

"The GX62255 further expands GigOptix' growing portfolio of 40G

This highly integrated solution leverages the expertise gained in developing the GX62455 100G quad driver to enable an innovative surface-mounted dual-channel 100G driver solution

and 100G Bundled Solutions," says VP of marketing Pdraig O'Mathuna. "This highly integrated solution leverages the expertise that we have gained in developing the GX62455 100G quad driver to enable an innovative surface-mounted dual-channel 100G driver solution. This product specifically addresses the needs of transponder manufacturers who are seeking to reduce the size, EMI, cost and power dissipation within their transponder designs, while also providing a migration path to SMT for current customers of our GPPO connectorized GX62455," he adds.

"We expect the GX62255 100G driver to be a significant contributor to our future growth and to position GigOptix as the sole provider of 100G TIA and driver solutions in both GPPO and SMT form factors," O'Mathuna concludes.

Ultra-low-power 14G VCSEL driver and limiting TIA receiver chipset debuted for short-reach 2–14Gb/s SFP+

GigOptix is sampling its new pre-production chipset for short-reach 2–14Gb/s serial optical interconnects. Building on the firm's expertise in providing low-power 40G and 100G parallel short-reach devices, the newest offering provides a complete serial link solution for applications up to 14Gb/s.

Consisting of the HXT4101A VCSEL driver and the HXR4101A multi-rate receiver, the chipset is designed to not only enable ultra-low-power consumption of less than 150mW for 100m links and 250mW for 300m links but also minimize the components required to implement a transceiver in order

to reduce costs.

The HXR4101A receiver is a limiting TIA with pre-emphasis output that eliminates the need for the post-amplifier required in existing industry solutions and supports multiple rates from 2Gb/s to 14Gb/s, suiting systems requiring backward compatibility. The HXT4101A VCSEL driver supports up to 14Gb/s data rates while consuming less than 65mW, delivering 7mA average and 7mA modulation current. The easy-to-use and compact designs enable applications to extend from datacom into avionic and consumer applications.

The new chipset uniquely addresses

current and future datacom short-reach needs, claims Jörg Wieland, VP & general manager of GigOptix-Helix in Zurich, Switzerland. "We developed these highly innovative products to address customer demand for high performance, lower power and better cost-efficient solutions," he adds. "Taking a fresh look at how we as an industry implement our transceivers, we leveraged the latest process technologies to optimize the architecture of the devices to improve performance while at the same time reducing power consumption and system cost."

www.GigOptix.com

Civcom ships GigOptix modulator driver in small-form-factor 10G 300-pin transponders

GigOptix' GX6155 modulator driver has been adopted by optoelectronic component and module maker Civcom of Petach Tikva, Israel in its small-form-factor (SFF) 10G 300-pin multi-source agreement (MSA) transponders.

The GX6155 is a 12.5G Mach-Zehnder modulator (MZM) driver for metro and long-haul LiNbO₃ optical transmitters. It includes features such as MSA-compatible supply voltages, low power dissipation, high input sensitivity, low jitter degradation, and the ability to precisely set the output amplitude and eye crossing point. It is also RoHS-6 compliant and backward compatible with non-RoHS soldering.

"GigOptix' GX6155 provides the features, performance and value we require to respond to the growing market demand for Civcom's family of 10G SFF 300-pin MSA Free Light DWDM transponders," says Civcom's CEO Gabby Shpirer. "GigOptix has an extensive component-level portfolio that offers us the opportunity to extend cooperation with

GigOptix beyond 10G applications into forthcoming 40G and 100G applications," he adds.

The GX6155 is used in Civcom's Free Light long-reach tunable SFF 10G 300-pin MSA transponders. The Free Light transponder family is designed for DWDM applications offering equipment manufacturers high performance in a cost-effective SFF device, says Civcom. The SFF transponder uses a widely tunable laser covering the entire C-band over distances up to 80km. Availability with a lithium niobate modulator gives equipment makers the flexibility to choose optimal solutions based on customer needs, the firm adds.

GigOptix' CEO & chairman Avi Katz notes the strong market traction that Civcom is experiencing. "We look forward to supporting and contributing to Civcom's success and extending our partnership with them as they aggressively roll out 10G and 40G solutions," Katz adds. "Joint activities in this direction are ongoing," he comments.

www.civcom.com

GigOptix wins NI's Supplier Award for 2nd year running

At NIWeek 2010, GigOptix received the Global Supplier Award for 2010 from National Instruments (NI) of Austin, TX, in recognition of exceptional performance in quality and reliability of ASIC products supplied to NI.

GigOptix has been an NI partner for over six years, with its solutions designed into multiple NI products addressing end markets including test & measurement, industrial and medical. This is the second consecutive year that GigOptix has received the award.

"The Global Supplier Quality Award recognizes key suppliers who have demonstrated outstanding product quality," says Scott Christman, director of Global Supply Chain at NI.

"We strive to provide our customers with the highest-quality products, while also providing excellent customer service and design support," says GigOptix's director of marketing Anil Chaudhry.

www.ni.com

OIF projects to shrink tunable laser assembly and ease control plane deployment

At their third quarter meeting, members of the Optical Internet-working Forum (OIF) in Fremont, CA, USA started two new projects.

The first provides a specification for a micro integrable tunable laser assembly (μ ITLA). The OIF says that the new form factor for tunable lasers is needed as the industry moves to an XFP form factor with reduced power dissipation. The second project addresses OSS Control Plane Management. Both projects will provide equipment vendors and carriers with key tools for bringing products to market and deploying control plane technology, says the OIF.

At the meeting, Dana Cooperson, practice leader for Network Infrastructure at analyst firm Ovum, spoke to 115 OIF members about the key technology themes and challenges that factor into the evolution to the next-generation, converged packet-optical network. She cited the widely adopted '100G Framework' as a "key example

of how the OIF helps accelerate the technology adoption cycle", adding that "the OIF will continue to play a critical role in increasing network and market efficiency".

The new μ ITLA project will propose changes to the assembly electrical interfaces, optical specifications, and mechanical specifications. The μ ITLA implementation agreement (IA) will provide an alternative laser solution for ITLA customers contemplating the integration of a specific vendor 'gold box' laser on the host PCB due to space constraints. A greater than two-fold reduction in the base-plate area of the μ ITLA relative to the ITLA-MSA-1.2 IA is desired.

The output of the new OSS Control Plane Management project will be a white paper or framework document that addresses the OSS Control Plane challenges associated with optical transport evolution. As networks evolve from TDM to packet and to MPLS-based transport, there will be additional

challenges associated with OSS (operations support systems) integration and management of control plane-initiated services spanning multiple layers (TDM OTN and SONET, photonic and MPLS). Adding to the OSS challenges are the operational challenges associated with these converged networks. The new project will address these OSS challenges in making operational the TDM control plane including multilayer TDM CP (SONET/SDH, OTN).

The OIF meeting also saw elections to the following posts:

- Technical Committee Chair: Jonathan Sadler of Tellabs (beginning October 1);
- Technical Committee Vice Chair: Klaus-Holger Otto of Alcatel-Lucent;
- Market Awareness & Education Chair, Networking: Dave Brown of Alcatel-Lucent; and
- Market Awareness & Education Chair, PLL: Rod Smith of Tyco Electronics.

www.oiforum.com

OneChip opens regional office in Shenzhen

Privately held firm OneChip Photonics Inc of Ottawa, Canada, which develops and manufactures optical transceivers based on monolithic photonic integrated circuits (PICs) fabricated in indium phosphide (InP) for access networks and other mass-market broadband applications, has opened a regional office near Shenzhen's High-Tech Park, China to support critical operations of local customers.

Featuring an on-site lab, the new facility will enable OneChip to offer testing, debugging and demonstrations for addressing the immediate technical needs of regional customers.

OneChip has also established relationships with ACE Broadband Technology Chengdu Co Ltd and Shenzhen Milli-tech Electronics Ltd to

act as distributor and manufacturer's representative, respectively. OneChip says that this illustrates its understanding of the efficiencies of a local network and the benefits of working in unison with partners that know their customers.

"Our commitment to delivering immediate, top-level support in China, combined with our synergistic cooperation with ACE and Milli-tech, demonstrates our vision to foster and actively contribute to the overall success of our clients' operations and product development," says Yit Lee, general manager for Asia Pacific & VP of business development.

The new regional office in China offers effective and speedy product support

OneChip says that the creation of a new operational home base in China is a milestone in its growth as a global supplier. The new regional office in China offers effective and speedy product support, it adds.

The new office will house field application engineers, software customer support, and manufacturing and process support personnel who, with access to the on-site lab, can respond quickly and provide readily available technical feedback. OneChip also says that the housing of its own team of experts in China enables it to not only understand the needs of current customers, but also to be responsive to future needs and manage the reliability of its solutions offerings locally.

www.onechipphotonics.com

Infinera and XO complete 1348km field trial of coherent 100G transmission on photonic integrated circuits

Infinera Corp of Sunnyvale, CA, USA, a vertically integrated manufacturer of digital optical network systems incorporating its own indium phosphide-based photonic integrated circuits (PICs), has completed a field trial of 100Gb/s coherent transmission over a 1348km route between Denver and Dallas on the nationwide network of XO Communications of Herndon, VA, USA (a provider of communications services for businesses and communications services providers).

The trial used Infinera's new 500G PICs, which each integrate five 100G channels. The firm believes that the field trial marks a significant step towards commercial deployment of PIC-based optical systems based on 100G coherent transmission to deliver upgrades in total fiber capacity as well as the disruptive economics of photonic integration.

The field trial involved the 500G PICs transmitting and receiving a 100G signal on a 1348km production route between Denver and Dallas on the XO optical fiber network. The route is built with Infinera's 100G-ready ILS wavelength division multiplexing (WDM) line system, which provides scalable fiber capacity up to 8 Terabits per second.

During the trial the ILS system was carrying 10G and 100G channels simultaneously. The 100G channel was transmitted using phase-modulated quadrature phase-shift key (PM-QPSK) modulation and coherent detection to enable error-free unrepeated transmission over ultra-long-haul distances. Infinera believes this to be the world's first demonstration of 100G coherent transmission using fully integrated optical 500G PICs at both transmitter and receiver, including the use of integrated local oscillators in the PIC receiver.

"XO Communications looks forward to the increased capacity and superior efficiency we anticipate these 100G systems will deliver, as we work to meet growing bandwidth demands from our enterprise and wholesale service provider and mobile wireless customers," says XO's chief technology officer Randy Nicklas.

"This trial marks an important milestone in our plan to deliver 100G communications and the next generation of multi-Terabit/s digital optical networks based on 500G PICs," says Infinera's CEO Tom Fallon. "These new systems will become a disruptive force in the optical market, just as our 10G systems were when we introduced them in 2004."

Infinera reckons that the introduction of 100G PIC-based systems will have key implications for the economics of future networks, which will require many more optical functions per wavelength than existing networks. This requirement stems from the advanced modulation formats needed for 100G transmission, and can be expected to lead to increased network cost and complexity if implemented using conventional optical components.

To solve this problem, Infinera's 500G PICs incorporate more than 600 optical elements on a pair of indium phosphide chips, delivering significant benefits to next-generation Internet-centric networks, says the firm, and providing an effective means for service providers to scale network capacity while simultaneously obtaining lower space consumption, lower power consumption, increased reliability, and better network economics.

In the longer term, without photonic integration, ever-increasing bandwidth demand would continue to drive up network complexity, making photonic integration key to achieving superior carrier economics, says Infinera.

www.infinera.com

Colt and Infinera complete first Euro trial of 100GbE client services

In partnership with European business communications and IT managed services provider Colt, Infinera has completed its first European field trial of 100 Gigabit Ethernet services.

The trial consisted of prototype 100GbE client interfaces in Infinera systems in London and Frankfurt. The 100GbE service was passed over the 861km route from London to Frankfurt on Colt's low-latency network. The prototype Infinera 100GbE interfaces are fully compliant with the IEE 802.3ba industry standard ratified in June. Testing and

verification of transmission were performed with an EXFO FTB-85 100Gb/s Packet Blazer tester.

"It is important that we support the development of next-generation optical transport technologies that will allow us to meet customer demand for very high-speed Ethernet services," says Colt's chief technology officer Luke Broome.

The next generation of Infinera photonic integrated circuits (PICs) will have data capacity of 500Gb/s. Infinera says it is aiming to develop all the technologies required to deliver next-generation optical

systems to support exponentially growing bandwidth demand.

"Infinera's 100GbE interfaces, our 500G PICs delivering 100G channels over the long-haul network, and our Bandwidth Virtualization capability to manage this bandwidth more flexibly and efficiently will enable us to deliver next-generation optical systems that can scale to meet the needs of our customers and the global Internet with the unique scalability and disruptive economics of photonic integration," notes Infinera's co-founder & chief technology officer Drew Perkins.

IN BRIEF

Oclaro launches dynamic spectrum WSS enabling telecom network speed upgrade

Optical component, module and subsystem maker Oclaro Inc of San Jose, CA has launched a new dynamic spectrum wavelength selective switch (WSS) that provides telecoms operators an upgrade path to deliver increased bandwidth in the future without having to replace costly networking equipment.

In the past, operators were limited to WSS with fixed bandwidth plans, but the new dynamic spectrum 2x1 WSS is designed to support multiple and future modulation schemes for different filter widths, enabling operators to quickly, easily and inexpensively meet the increasing demand for higher transmission speeds, claims Oclaro. The new dynamic spectrum product is fully compatible with Oclaro's 2x1 WSS modules currently shipping to customers.

"Consumer demand for higher bandwidth continues to grow at a steady rate and operators worldwide are scrambling to provide the highest speeds at the most affordable price points," says Dr Krishna Bala, executive VP WSS Division. "We designed our dynamic spectrum 2x1 WSS to meet these needs by enabling an easy and inexpensive way to increase bandwidth in the network without having to change out the WSS," he adds. "We are also developing dynamic spectrum for Oclaro's high-port-count WSS to extend this capability to all ROADMs [reconfigurable optical add-drop multiplexer] applications," Bala concludes.

www.oclaro.com

Oplink's margins dip as it expands to meet growing demand

Increased R&D spending targets 40G and 100G products

For its fiscal 2010 (to end-June), optical networking component, module and subsystem maker Oplink Communications Inc of Fremont, CA, USA has reported revenue of \$138.8m, down 3.4% on \$143.7m. However, fourth-quarter revenue of \$38.9m was up 16% on Q3's \$33.6m and up 20% on \$32.4m a year ago (as well as exceeding the forecast \$35-38m), although this included \$2.1m from Taiwan-based AMIT Technology (acquired last quarter).

The three 10% customers were Tellabs, Alcatel-Lucent, and Huawei (accounting for 41% of revenue collectively), although there were also strong contributions from Sienna, Fujitsu and Cisco. Of total revenue, 33% was from North America, 22% from Europe and 45% from Asia.

"It was a strong quarter across all lines and geographies," says president & CEO Joe Liu. "Worldwide carriers are spending more on next-generation optical tools to increase bandwidth and service to many new applications," he adds. "Business is strong in both access and metro markets, FTTx is growing, and so is the metro core and the metro edge," continues Liu.

"We have experienced these demand trends for several quarters now, and we were able to ramp up our production capacity as a result of our ongoing expansion efforts... We expect these demand trends to continue."

Non-GAAP gross margin rose from just 27.4% in fiscal 2009 to 33.7% in fiscal 2010. In particular, Q4 was 33.5% (up on 30.6% a year ago). However, this was down slightly on Q3's 34.5%.

This was due to Oplink increasing manufacturing and R&D headcount substantially (from 3446 to 3821) in order to expand production capacity. As Oplink continued to invest in R&D and new product

initiatives, non-GAAP operating expenses have risen from \$6.3m a year ago and \$6.6m last quarter to \$7.4m, partly due to R&D expenditure rising by \$456,000 (although OpEx also included a full quarter of expenses from AMIT).

Net income has risen from just \$249,000 a year ago and \$2.6m last quarter to \$3.6m. This took fiscal 2010 net income to \$11.1m, compared with a net loss of \$13.8m in fiscal 2009.

During the quarter, cash, cash equivalents and investments fell \$24.4m to \$160.3m. However, this was due mainly to repurchasing 1.5 million shares of common stock for \$22m (of which \$20.8m was paid during the quarter, and the remainder after quarter end).

"The outlook for the current quarter is good; however, long-term visibility is still limited," says Liu. "Hence, we remain cautiously optimistic about the growth trends we are experiencing," he adds. "The environment for our products is picking up, and we are planning for sequential increases in revenue," comments chief financial officer Shirley Yin.

For first-quarter 2011 (to end-September 2010), Oplink expects revenue to grow 21-29% to \$47-50m (including \$2m of sales unable to be shipped in fiscal Q4 due to capacity and supply constraints, plus \$3m from AMIT). Despite this, gross margin will remain flat, due to product mix and increased labor costs in China manufacturing facilities (although Oplink's headcount addition will probably be limited to no more than 200 during the quarter, says Liu). Also, operating expenses should continue to rise as the firm continues to increase spending on R&D, targeting 40G and 100G products.

www.oplink.com

Finisar and Source Photonics settle patent dispute with cross-license

Fiber-optic communications component and subsystem maker Finisar Corp of Sunnyvale, CA, USA has entered into a settlement and cross-license agreement with optical communication product maker Source Photonics Inc of Chatsworth, CA, USA (a subsidiary of system maker MRV Communications Inc). This resolves a lawsuit brought by Finisar claiming infringement of its portfolio of digital diagnostics and transceiver module patents. The agreement also provides a general release to MRV Communications Inc.

Under the terms of the settlement agreement, Source Photonics will pay a license fee to Finisar amounting to \$14.5m for a fully paid-up license to the Finisar digital

diagnostics and transceiver module patents through end-December 2015. Payment in full is to be made by end-September.

The settlement agreement also provides a fully paid-up license to Finisar of certain Source Photonics patents and a mutual covenant not to sue for certain products currently made or sold by Source Photonics or Finisar, in each case through end-December 2015.

If Source Photonics is subject to a change in control, then shipments subject to the license granted by Finisar to its digital diagnostics and transceiver module patents will be limited to a 20% annual revenue growth rate.

www.finisar.com

www.sourcephotonics.com

Source Photonics launches CWDM GPON OLT and ONT transceivers

At the 12th China International Optoelectronic Exhibition (CIOE 2010) in Shenzhen (6–9 September), Source Photonics Inc of Chatsworth, CA, USA launched its CWDM (coarse wavelength division multiplexing) GPON OLT and ONT transceiver product family.

Source Photonics claims that its CWDM GPON OLT (optical line termination) and ONT (optical network terminal) provide an alternative cost-effective solution to expand total capacity to 10Gb/s or beyond in gigabit passive optical networks (GPON). It is based on existing mature GPON technology using multiple CWDM channels to expand total capacity in a single fiber. CWDM provides a flexible network architecture and pay-as-you-go for service providers, enabling increased bandwidth from 2.5Gb/s to 12.5Gb/s downstream and from 1.25Gb/s to 6.25Gb/s upstream. The CWDM GPON transceivers are compliant with the existing GPON

ITU standard G.984.2.

"With continuing bandwidth demand to support internet video and 3G wireless network growth, 10G EPON [10 Gigabit Ethernet PON] and XG-PON [10 Gigabit-capable PON] are emerging in the market," says Darron Young, senior director of Product Line Management.

"However, 10G PON technology has not yet reached maturity and a competitive cost point," he adds.

"Our CWDM GPON transceivers are based on the existing mature GPON products, and provide an immediate, alternative solution to allow service providers to expand their bandwidth with minimum investment."

The CWDM GPON products complement Source Photonics' existing 10G PON and 10G EPON product portfolio, so the firm now offers all next-generation PON solutions. The new transceivers are sampling now and are expected to be fully released for production in early 2011.

www.sourcephotonics.com

IN BRIEF

Connector Optics starts development of MBE-based VCSEL and photodetector plant

Optical component maker Connector Optics LLC of St Petersburg, Russia has signed contracts for the design of new facilities in the Parnas industrial area. St Petersburg-based A Plus Development will be in charge of project management and Zelenograd-based SKTO Promproekt will be general designer. Some technology solutions will be provided by CRT Oy CleanRoom Tech of Tampere, Finland. Completion of the plant is scheduled for spring 2011.

Connector Optics was established in 2009 and owns intellectual property rights for the production of 850/980nm ultra-high-speed (up to 40Gb/s) vertical-cavity surface-emitting lasers (VCSELs) and photo-detectors for data transmission via local-area networks (LAN), storage-area networks (SAN), active optical cables (AOC), supercomputers, and optical interconnects (USB 3.0, 4.0).

The new facilities will incorporate 400m² of cleanroom space, equipped with industrial molecular beam epitaxy (MBE) systems for the mass production of GaAs-based epitaxial heterostructures, to be used in high-speed (up to 40Gb/s) active optical components (VCSELs and photodetectors).

According to the firm, the devices will be used in next-generation fiber-optic communications (such as the optical interconnects of supercomputers, data centers, HDMI and DisplayPort optic cables, and future USB cables).

www.connector-optics.com

Finisar's fifth quarter of double-digit growth yields record revenue of \$207.9m

Higher-speed products and ROADMs drive record margins and profit

For its fiscal first-quarter 2011 (ended 1 August 2010), fiber-optic communications component and subsystem maker Finisar Corp of Sunnyvale, CA, USA has reported another revenue record for continuing operations of \$207.9m, up 10.3% on \$188.5m last quarter and up 61.5% on \$128.7m a year ago (representing the fifth consecutive quarter of double-digit growth).

Of the \$19.4m increase in revenue from last quarter, sales fell by \$0.2m (3.9%) for products for cable TV applications and \$4.2m (5%) for products for applications less than 10Gbps, but rose \$20.1m (27.2%) for products equal to or greater than 10Gbps and \$3.6m (13.5%) for reconfigurable optical add-drop multiplexer (ROADM) products, as unit shipments of wavelength selective switch (WSS) products grew faster than higher-priced ROADM linecards containing a WSS. "The mix of WSS components and ROADM linecard business last quarter tends to mask the progress we made in terms of adding capacity

as overall unit shipments increased by more than 25%," comments CEO Eitan Gertel.

On a non-GAAP basis, gross margin has risen from 28.8% a year ago and 32.6% last quarter to a record 35.2%. This reflects a favorable shift in product mix (due to the growth in revenues from higher-speed products and ROADM-related products), along with the benefits of being vertically integrated, according to Gertel.

As a proportion of revenue, non-GAAP operating expenses have fallen from 26.2% a year ago and 22.9% last quarter to 21.3%, due mainly to revenue growth. Operating income has risen from \$3.3m (an operating margin of 2.5% of revenue) a year ago and \$18.3m (9.7% of revenue) last quarter to \$29m (a record 14% of revenue). Non-GAAP net income has risen from just \$1.8m a year ago and \$16.7m last quarter to \$25.8m.

"We reached our previous target financial model earlier than we had predicted," says executive chairman Jerry Rawls. "We achieved company

records for revenues, gross margin, operating margin and EPS [earnings per share]," he adds. "Furthermore, the demand environment continued to be very strong for us, particularly for our higher-data-rate transceivers and our ROADM products," he adds. "As a sign of that ongoing strength, our book-to-bill ratio in the quarter continued to be above 1.0."

Capital expenditure has continued to rise, from \$3.1m a year ago and \$10m last quarter to \$12.1m. "Adding capacity continues to be a top priority for us next quarter, particularly for our ROADM products, where demand currently exceeds our ability to supply," says Gertel. "We intend to add significant ROADM capacity again in the second quarter based on a number of initiatives that went into effect toward the end of last quarter."

For fiscal second-quarter (to end-October 2010), Finisar expects revenue to rise a further 3–10% to \$215–230m and non-GAAP operating margin to be 14–15%.

www.finisar.com

New WSS technology targets flexible bandwidth-capable ROADMs

Finisar has launched Flexgrid technology, which enables dynamic control of channel center frequency and channel bandwidth within a wavelength selective switch (WSS), from 50 to 200GHz in 12.5GHz steps, with no WSS performance penalty. Flexgrid draws on the inherent flexibility and performance of Finisar's Liquid Crystal on Silicon (LCoS) optical engine to address carrier demand for flexible bandwidth-capable ROADMs.

The need for increased network capacity, efficiency and flexibility is driving the use of higher data rates, new transmission formats, and channel management technologies, all requiring flexible bandwidth-capable ROADMs (e.g. the intro-

duction of coherent techniques enables 100Gb/s transmission within a 50GHz channel). However, higher-speed traffic, including future 400Gb/s and 1Tb/s signals, will not fit in such a narrow channel. To maximize network capacity and future-proof a carrier's investment in transmission hardware, the channel bandwidth in both the WSS and add-drop components required for contentionless, directionless, colorless (CDC) architectures must hence be dynamically variable to accommodate new transmission formats and data rates.

"Channel-width flexibility is increasingly sought by major telecom carriers as a way to maximize bandwidth-efficiency in the network,"

says Andrew Schmitt, senior analyst with Infonetics Research. "Flexible Grid functionality offered by leading suppliers like Finisar allows an optical network to accommodate advanced optical transmission techniques," he adds.

"With the introduction of Flexgrid, Finisar continues to provide the most comprehensive WSS product line on the market," says product line manager Craig Cameron. "We believe the combination of advanced optics, compact packaging, and powerful software with a versatile LCoS optical engine provides a flexible wavelength switching solution of unmatched performance and functionality to meet carrier needs, both now and in the future."

Finisar buys Broadway for EPON 'system on transceiver' Pluggable transceiver allows direct CPE connection to PON networks

Fiber-optic communications component and subsystem maker Finisar Corp of Sunnyvale, CA, USA has acquired Broadway Networks Ltd in an all-cash transaction.

Broadway Networks was founded in 2006 to develop transceiver products incorporating additional 'system level' functionality for FTTx networks. The firm has developed a pluggable transceiver incorporating an Ethernet passive optical network (EPON) optical network unit (ONU) in a small form-factor pluggable (SFP) module and enables switches, routers and other customer premises equipment (CPE) to connect directly to PON networks. This 'system on a transceiver' approach offers advantages for PON networks deployed for broadband services to multi-dwelling units, businesses and for wireless backhaul, it is claimed.

Finisar says that it expects to follow a product roadmap that will eventually extend Broadway's technology to the GPON (Gigabit passive optical network) market. According to industry analyst Ovum, about 65% of new EPON

subscribers and a smaller but growing percentage of GPON subscribers reside in multi-dwelling units.

Broadway has also developed a 'Smart SFP' with built-in remote management functionality designed to enable telecom carriers to monitor and diagnose the fiber links connecting customer sites, and reduce operating costs in the process.

"Broadway's EPON Stick puts networking capability inside the pluggable transceiver," says Ovum principal analyst Karen Liu. "Because it is based on a ubiquitous standards-based form factor, it immediately creates a new market. Combining with a market leader like Finisar, who can scale this technology going forward, is a great move for the whole industry," she comments.

"As a customer of both companies and as a leading provider of EPON equipment, this acquisition is great news," states Takashi Mori, president, Hitachi Communication Technologies America Inc. "With Finisar's sales, marketing, and engineering support, this combination should greatly accelerate the

adoption of these innovative EPON stick products," he adds.

"Broadway's technology fits nicely with our strong position in digital diagnostics and our strategic goal of continuing to incorporate more functionality inside a transceiver," says Finisar's executive chairman Jerry Rawls. "We're also impressed by the long list of customers who have already qualified Broadway's products," he adds, while noting that revenues are just getting started.

The acquisition should bring about broader acceptance of the products to a growing PON market, reckons Broadway's CEO Dr Jianhui Zhou, who becomes Finisar's VP & general manager, Fiber Access Products.

Finisar does not expect the acquisition to have a significant impact on revenue or earnings in the near term. Broadway's operating locations include San Jose, CA, USA and Beijing and Suzhou, China, so the acquisition will expand Finisar's footprint in China beyond its existing operations in Shenzhen and Shanghai.

www.finisar.com

www.broadwaynetworks.com

Opnext's 40G differential quadrature phase-shift keying MSA module moves into full production

Opnext Inc of Fremont, CA, USA says that its 40Gbps differential quadrature phase-shift keying (DQPSK) module has moved into full production and is now shipping in volume.

According to the firm, the demand for 40G interfaces continues to grow due to increases in IP and video networks driving the upgrades of regional, long-haul and submarine networks. In a recent report, Ovum forecasted that the 40G DWDM market for DQPSK modules will rise at a compound annual growth rate (CAGR) of 16% from \$175m in 2010 to more than \$360m in 2015.

In particular, 40G DQPSK is one of the fastest-growing segments in optical communications, being deployed within metropolitan networks to economically address the bandwidth bottlenecks caused by the exponential

A large percentage of carrier fiber plants require increased dispersion tolerance that is provided by our DQPSK module in conjunction with tunable dispersion compensation

growth in enterprise and consumer traffic generated by the increased usage of smartphones and video.

"A large percentage of carrier fiber plants require increased dispersion tolerance that is provided by our DQPSK module in conjunction with tunable dispersion compensation (TDC)," says Tadayuki Kanno, president of Opnext's modules business unit. "For this reason, the Opnext 40G DQPSK MSA module is being widely adopted and implemented by our system vendor customers in addition to our successful Opnext DPSK module."

www.opnext.com

JDSU grows 20%, despite supply and capacity constraints

Production capacity to be raised by 33% over next 12 months

On a non-GAAP basis (including \$15.7m from the acquisition of the Network Solutions Division from Agilent Technologies in early May), for fiscal 2010 (ended 3 July) JDSU of Milpitas, CA, USA has reported revenue of \$1373.4m, up 7% on fiscal 2009's \$1284.6m. Fiscal Q4 revenue was \$398.1m, up 19.6% on \$332.9m last quarter and 45.2% on \$274m a year ago.

"We continued to see robust demand across all of our segments," says CEO Tom Waechter. "For the fifth quarter in a row, overall book-to-bill for the company was above 1. Each of our three segments also had a book-to-bill greater than 1, with particular strength in our Communications & Commercial Optical Products segment [especially for reconfigurable optical add-drop multiplexers]," he adds, as demand for optical products outpaces supply.

Advanced Optical Technologies revenue was \$54.6m (13.7% of total revenue), down 6.8% on last quarter's \$58.6m but up 8% on \$50.8m a year ago. Including the \$15.7m from Network Solutions, Communications Test & Measurement revenue was \$186.2m (46.8% of total revenue), up 27.7% on last quarter's \$145.7m and up 40.4% on \$132.6m a year ago.

Communications & Commercial Optical Products (CCOP) revenue was \$157.3m (39.5% of total revenue), up 22.3% on last quarter's \$128.6m and 74% on \$90.7m a year ago. CCOP's operating margin was 12.1% (now within the targeted 10–15%), based on operating income of \$19.1m.

Within CCOP, Commercial Lasers revenue was \$22.6m (up 20.7% on last quarter's \$18.7m and double the \$11.4m a year ago), driven by growth in semiconductor and micro-electronic materials processing end-markets, with gross margin rising from 41.3% last quarter to 44.6% due to improved utilization.

Optical Communications revenue was \$134.7m (up 22.6% on last

quarter's \$109.9m and up 70% on \$79.3m a year ago), despite supply and capacity constraints thwarting more than \$10m of shipments. All geographic regions grew, including record sales in China for the fourth consecutive quarter. Ten out of 11 product lines grew sequentially, with ROADMs growing 24% to over 25% of Optical Communications revenue. Products less than 2 years old have grown to over 50% of Optical Communications revenue. In particular, the next-generation 50GHz ROADM continues to ramp and more than doubled in revenue, while tunable XFP sales almost tripled (shipping to 32 customers and 43 design slots) and Super Transport Blade sales grew 50% sequentially. Gross margin rose from 26% last quarter to 28.5%, driven by favorable product mix and improved fab utilization, as well as continued supply chain optimization.

Fiscal 2010 was a year of accelerating revenue growth, driven by demand recovery in several key markets, and portfolio expansion for JDSU through innovative products in all the firm's segments, says president & CEO Tom Waechter. "We completed two important acquisitions [including Finisar's Network Tools business in July 2009] and introduced a number of innovative products that resulted in higher market penetration," he adds. "At the same time, we continued to execute against our stated strategic priorities, resulting in a more profitable operating model and sustained cash flow."

Overall gross margin has risen from 42.2% a year ago and 44.1% last quarter to 45.5% in fiscal Q4, with improvement in all three segments but driven by higher factory utilization in both the CCOP and AOT segments. Operating margin has improved from -1.2% a year ago and 6.6% last quarter to 9.3% (at the high end of guidance), based on the firm's highest quarterly operating income since December 2007 (\$37m).

On a non-GAAP basis, compared with net loss of \$1.5m a year ago, net income has risen from \$23.2m last quarter to \$33.1m. For fiscal full-year 2010, net income has more than doubled to \$91.9m from fiscal 2009's \$42.6m.

Operating cash generation was \$119.2m for full-year fiscal 2010, including \$46.9m in Q4. So, despite paying \$165m for NSD, during Q4 total cash and investments only fell from \$713.1m to \$600.1m.

"We enter fiscal 2011 with order momentum and an industry-leading product portfolio," says Waechter. For fiscal Q1/2011 (to 2 October 2010), JDSU expects non-GAAP revenue of \$410–425m (up 37–42% year-on-year and 3–6.8% quarter-to-quarter, as the material supply shortages subside) and operating margin of 8.5–10.5%.

JDSU's operating model targets operating margin of 11–14% on revenue of \$415–425m and gross margin of 46% by the end of calendar 2010, including CCOP operating margin of 10–15% on \$150m of revenue. The firm believes that, for Optical Communications in particular, gross margin can exceed 30% on quarterly revenue reaching \$150m.

JDSU says that, to meet increased demand, it has initiatives in place to boost production capacity by 33% in fiscal 2011, particularly in areas where it has significant product differentiation such as tunable XFPs, ROADMs and Super Transport Blades as well as gesture recognition.

"This capacity will be the result of the combination of improved utilization in yields and selective equipment purchases, while we maintain our current fabrication process footprint," says Waechter. Capital expenditure is expected to be about 5% of revenue for the next several quarters while buying equipment for the NSD acquisition and investing to expand capacity for the CCOP and AOT segments.

www.jdsu.com

JDSU debuts its CPV cell technology

Opto device maker working with solar system integrators

Optoelectronic chip and module maker JDSU of Milpitas, CA, USA has announced the availability of concentrator photovoltaic (CPV) cells designed to capture concentrated sunlight within solar panels for electrical power generation. The firm says that it is working with leading solar system integrators that will use its CPV cells in solar modules installed at power generation facilities worldwide.

JDSU says that CPV is a cost-effective technology that is emerging as a solution for solar power generation. According to the 'CPV Industry Report 2010', CPV system installations in the USA will be worth \$70m in 2010 and are expected to grow to more than \$3bn by 2015. The CPV market is initially being driven by use in power plants at college campuses, shopping centers and industrial buildings that generate power in the 500kW to 10MW range, compared to residential roof-top housing market installations that use about 5kW per home.

"Electrical power needs will skyrocket over the next 20 years, requiring new forms of power generation that are more efficient, affordable and environmentally friendly," says Alan Lowe, president of Communications & Commercial Optical Products at JDSU. "The CPV cell from JDSU brings a viable technology to the solar market that leverages our strong history of semiconductor experience and volume manufacturing expertise," he adds.

"Initial demonstrations of CPV technology have proven successful and now larger projects are starting to ramp," says Greg Sheppard, chief research officer at analyst firm iSuppli. "CPV installations will represent 100MW in 2011, and we

CPV installations will represent 100MW in 2011, and we expect that number to grow to 1GW by 2015

expect that number to grow to 1GW by 2015," he adds. "CPV will have a particular advantage in sunny regions, such as in the desert, over other solar technologies."

JDSU's CPV cells are optimized to capture different parts of the sun's spectrum in multiple junctions, resulting in conversion efficiencies approaching 40% (an ideal range for solar system integrators). The CPV cells are designed specifically to capture concentrated sunlight at 500–1000 times its original power. Additional benefits include a small footprint, improved temperature performance, less use of semiconductor materials, and lower cost per kW compared to other photovoltaic technologies.

In addition to its new CPV technology for land installations, JDSU has been providing solar power products to the satellite industry for several decades. JDSU also provides photovoltaic solutions for the digital monitoring of smart-grid power plants.

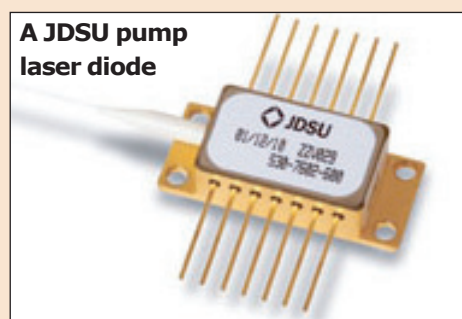
www.jdsu.com

JDSU delivers its one millionth 980nm pump laser

Telecoms infrastructure provider ADVA Optical Networking is the recipient of the millionth 980nm pump laser made by optoelectronic chip and module maker JDSU of Milpitas, CA, USA. The milestone establishes JDSU as the leading pump laser supplier for more than a decade, the firm claims.

Pump lasers are used to power erbium-doped fiber amplifiers (EDFAs), regenerating weakened network signals traveling long distances over optical networks. JDSU says that service providers are deploying optical networks with flexible infrastructures that can meet increasing consumer demand for the voice, video and data applications that are driving higher internet traffic levels.

The firm's latest pump laser, the



SP platform, is designed to provide high performance to network equipment manufacturers in a reliable and low-cost package. The SP platform also operates at up to 660mW, more than four times the optical power output of the first pumps JDSU introduced more than a decade ago. This drastic increase in performance is needed to support increasing bandwidth demands, the firm stresses.

"ADVA Optical Networking has one of the most flexible and scalable optical transmission platforms in the industry," says ADVA's chief technology officer Christoph Glinzinger. "Unlike most other system vendors, we design and manufacture our own modules, delivering leading-edge performance for backhaul, metro core and long-haul networks. JDSU has been a key optical components supplier to ADVA Optical Networking over the past decade," he adds.

"JDSU is shipping high-power 980nm pump lasers at an all-time record pace, while rapidly ramping our SP platform to meet customer demands for more bandwidth," says Toby Strite, marketing director for Transport Components.

www.advaoptical.com

Emcore postpones reporting June-quarter results Aims to restructure China fiber-optics JV deal to avoid termination fee

On 16 August, Emcore Corp of Albuquerque, NM, USA, which makes components and subsystems for the broadband, fiber-optic, and solar power markets, told the Securities and Exchange Commission (SEC) it was delaying its report for fiscal Q3/2010 (to end-June).

Executive chairman & interim chief financial officer Reuben Richards said Emcore was reviewing accounting for inventory write-downs in the allowance against an account receivable that the firm determined should be recorded. Emcore is considering the effect and significance of these adjustments with respect to prior reporting periods, and these issues need to be completed for it to file its quarterly report, says Richards.

Also, Emcore has identified material weaknesses related to the inventory write-downs and revenue cutoff transactions as of 30 June. The firm said it intended to file its quarterly report as soon as practicable.

Nevertheless, for its fiscal fourth-quarter 2010 (to end-September), Emcore expects revenue to rise to \$54–56m (versus \$48.2m in fiscal Q2), with increases in both segments for a second consecutive quarter: Fiber \$33–34m (up on \$30.2m in fiscal Q2); Photovoltaics \$21–22m (up on \$18m in fiscal Q2).

* At the beginning of August, Emcore agreed with San'an Opto-electronics Co Ltd of Xiamen, China to form the joint venture Suncore Photovoltaics Co Ltd, in order to develop, manufacture and distribute its concentration photovoltaic (CPV) receivers, modules and systems for terrestrial solar power applications.

Also, after in February agreeing to sell 60% of its Fiber Optics business to Tangshan Caofeidian Investment Corp (TCIC) to create a joint venture in China, in June the firms withdrew their joint filing with the Committee on Foreign Investment in the United States (CFIUS) because of the latter's "regulatory concerns". By 2 August, the proposed transaction was officially terminated.

According to the share purchase agreement, Emcore is obliged to pay TCIC a fee of \$2.8m in the event of a termination due to Emcore's inability to secure certain regulatory approvals. "We are working very actively with TCIC to contemplate a restructuring of the deal which does not require the same export control licensing and CFIUS review, and as a result of that the termination fee will be waived," says Emcore's president & CEO Dr Hong Hou.

www.emcore.com

Emcore receives NASDAQ notice for delay in filing quarterly report

On 18 August, Emcore received a letter from the NASDAQ Stock Market indicating that it was not in compliance with the continued listing requirements under NASDAQ Listing Rule 5250(c)(1).

The letter was issued because the firm did not file its Form 10-Q report for its fiscal third-quarter 2010 (to end-June) with the US Securities and Exchange Commission (SEC) on time.

Emcore said on 16 August that filing of its quarterly report has been delayed because the firm needs 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 has determined should be recorded. Emcore intends to file the report "as soon as practicable" upon completion of its review.

The firm is required to submit, by 18 October, a plan to regain compliance with NASDAQ's requirements for continued listing.

Emcore wins Supplier Excellence Award from Space Systems/Loral

Emcore has received a Supplier Excellence Award from Space Systems Loral (SS/L). Emcore has been a supplier to SS/L for the past 12 years and is currently under a long-term supply agreement contract to manufacture and deliver multi-junction solar cells for SS/L's satellite programs.

"Over the years, Emcore's product performance, delivery track record and overall support have been outstanding," says Vivian Mackintosh, VP of material at Space Systems/Loral.

Emcore has also received a Platinum Supplier Award from Northrop Grumman Corp.

Emcore is currently under a long-term supply agreement (LTSA) with Northrop Grumman's Aerospace Systems sector to manufacture and deliver multi-junction solar cells for Northrop Grumman satellite programs. The firm's solar cells will help to provide power for Northrop Grumman's space-based global climate monitoring capabilities and other satellite missions. The period of

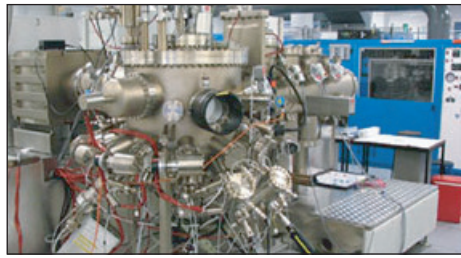
performance for the supply agreement is 2009 through 2012, with a potential value of more than \$17m.

Northrop Grumman has been using the LTSA to look across programs and accelerate orders to improve production efficiency in Emcore's production line. "We are grateful for Northrop Grumman's proactive support of Emcore," says Emcore's chief operating officer Christopher Larocca. "We value the long-standing relationship we have enjoyed with them for the past 10 years."

UK research center wins £10m, 5-year contract renewal Funding to continue research including QW solar cells and QCLs

The UK Engineering and Physical Sciences Research Council (EPSRC) National Centre for III-V Technologies, based at the University of Sheffield's Centre for Nanoscience and Technology in its Department of Electronic and Electrical Engineering, has received a renewal contract worth £10m over the next five years (from 1 July 2010) to support continued research in III-V semiconductor materials and devices by researchers throughout the UK.

III-Vs research has been taking place at the university's facility (which benefited in 2006 from a £6.5m university-funded cleanroom) for 32 years. Nearly 800 scientific publications have resulted over the last 10 years. The facility serves all universities and scientists across the UK, enabling research in the physical, engineering and biomedical sciences. Current applied projects include studies of solar cells via QuantaSol Ltd of Kingston-upon-



National Centre for III-V Technologies, showing MBE and MOCVD reactors.

Thames, UK (a spin-out firm from Imperial College and the University of Sheffield), which uses strain-balanced quantum-well (QW) techniques to produce high-efficiency solar cells.

The facility is also active in the development of a more efficient production technique for quantum cascade lasers (QCLs), which are used for gas detection, pollution monitoring and oil exploration (as the technology can detect very small quantities of gases given off by oil deposits). Possible other

applications in the future include their use in car exhausts to monitor pollutants and feed back to the engine to adjust fuel flow, reducing emissions and improving efficiency.

"Much of the research will result in improvements in quality of life for everyone in the future," says professor Peter Houston, director of the EPSRC National Centre for III-V Technologies, about the work that will be enabled by the new funding.

The facility's work on high-efficiency III-V solar cells comes as the University of Sheffield launches the venture 'Project Sunshine', which aims to unite scientists in finding ways to harness the power of the sun and tackle one of the biggest challenges facing the world: meeting the increasing food and energy needs of the world's population in the context of an uncertain climate and global environment change.

www.shef.ac.uk/eee/research/nc35t <http://shine.sheffield.ac.uk>

CPV system maker Concentrix joins Transgreen Initiative

Soitec Group of Bernin, France, which manufactures 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 joined the Transgreen Initiative.

Transgreen was launched on 5 July within the context of the European Union's Mediterranean Solar Plan to stimulate the development of a Trans-Mediterranean electric power transmission network in order to respond to the significant need that is expected for electricity exchange between the two sides of the Mediterranean.

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 CPV technology is designed for use by large-scale solar power plants in hot and arid regions. The firm says the systems are efficient, modular, flexible and suited to the challenges of the Mediterranean region for producing low-cost electricity.

"We are looking forward to working with this ecosystem of companies and the countries of the Mediterranean region to demonstrate the value of CPV," says Concentrix Solar's CEO Hansjörg Lerchenmüller. "We have an opportunity to make a significant contribution to the region's energy needs for renewable energy sources and to export energy to European countries," he adds.

With 25% AC system efficiency, Concentrix's CPV systems provide what is claimed to be the highest efficiency of all solar technologies

available. Particularly at locations with extremely hot ambient temperatures, CPV systems perform better than conventional solar systems, guaranteeing high and constant power production throughout the day, says the firm. Because they do not need cooling water, Concentrix's systems are suited to power plant installations in arid areas like in the Mediterranean region.

Also, due to the technology's high scalability, it is possible to commission CPV power plants in different phases, shortening time to operation. After connecting the first units to the grid, the systems start to produce energy while the installation of the power plant is still in progress.

Concentrix Solar exhibited its CPV systems at the SolarMed trade show in Paris, France (15-17 September).

www.transgreen.eu
www.concentrix-solar.de

Emcore and Amonix CPV projects endorsed for 'Solar Zone' at University of Arizona Tech Park

Arizona Corporation Commission (ACC) says that, in less than a year, The Solar Zone at the University of Arizona Science & Technology Park (UA Tech Park) has moved from an on-paper concept to a bustling, solar-centric business zone that is advancing solar energy innovation and production.

The Solar Zone is the intended site of four of the 10 new solar power projects developed through contracts with Tucson Electric Power (TEP) endorsed by the ACC. The projects will combine with two previously announced systems to expand the Solar Zone's total solar generating capacity to nearly 20MW, making it one of the largest contiguous solar facilities in the USA. Together, the systems should generate enough energy to power more than 4600 Tucson homes annually.

The four new Solar Zone tenants join Bell IPC (announced in January). Site preparation and construction, valued at about \$2m, begins in September.

The new projects include:

- Connecticut-based CTC Electric, which plans a 5MW, fixed photovoltaic installation;
- Emcore Corp of Albuquerque, NM (a manufacturer of compound semiconductor-based components and subsystems for the fiber optics and solar power markets), which plans a 2MW concentrated photovoltaic (CPV) system;
- Foresight – Solar Point LLC (a joint venture of Foresight Solar LLC and Solar Point Partners LLC with corporate offices in San Francisco, CA and a development office in Flagstaff, AZ), which will develop a solar facility of about 5MW; and
- Amonix Inc of Seal Beach, CA, USA (a manufacturer of utility-scale CPV systems using III-V multi-junction cells), which will build a 2MW CPV system project.

ACC says that the Solar Zone will provide TEP with a unique opportunity to evaluate different types of

solar power systems, including a 5MW concentrating solar thermal power plant with integrated storage being built by Bell Independent Power Corporation of Rochester, NY, under a previously approved contract with the utility. TEP will also own and operate a 1.6MW single-axis tracking PV array being developed at the Solar Zone this year by solar system manufacturer and integrator Solon of Tucson, AZ.

"We'll be able to track how these technologies perform side by side, under identical operating conditions, to determine which systems work best for our company and our customers," says Paul Bonavia, chairman, president & CEO of TEP and its parent company UniSource Energy Corp. "The Solar Zone is becoming a valuable resource as we work to establish TEP as a renewable energy leader," he adds.

"The selection of the Solar Zone by these cutting-edge power producers is significant validation of our vision to bring different aspects of the solar industry together in a supportive and competitive environment," says University of Arizona president Robert N. Shelton. "The Solar Zone has created an exceptional atmosphere that dovetails with UA's core mission of access, quality and discovery," he adds. "The Solar Zone's rapid acceptance and movement from concept to construction is impressive confirmation of the need for and viability of The Solar Zone," Shelton concludes.

"Tucson is home to one of the best solar-resource locations in the USA... The U of A Solar Zone, along with Tucson Electric Power, presented a working arrangement that is supportive of rapid deployment of new solar power technologies," comments Emcore's chief operating officer Christopher Larocca. "Tucson Electric has been very aggressive incorporating innovative technologies into their renewable energy portfolio," he adds. "We appreciate the

Arizona Board of Regent's efforts to support renewable energy technologies, the U of A Solar Zone demonstration and the selection of Emcore's solar technology."

"With five new solar projects locating here establishes The Solar Zone at the UA Tech Park as the largest multi-tenant, multi-technology demonstration site in the nation," reckons Bruce Wright, UA's associate VP for University Research Parks. "TEP's selection of our site demonstrates that the Solar Zone is the ideal environment to create, test and deploy current and future solar technologies."

"With 350 days of Tucson sun and all the attributes of this solar-centric business zone, this is an optimal setting for solar energy generation," reckons Amy LeGere, Foresight Solar Director of Development. Likewise, Amonix says that its proven CPV systems suit sunny and dry climates like Tucson, claiming that its systems use no water in power production, use land better and generate more energy per acre than any other solar technology.

"A comprehensive, integrated solar park at this level does not exist elsewhere," believes John D. Grabo, UA Tech Park's director of business development. Of the UA Tech Park's 1345 acres, 222 are designated as the Solar Zone. Grabo expects further manufacturers, researchers, start-up companies, and educational institutions to be attracted to the Solar Zone.

The Solar Zone will feature a demonstration garden and public awareness center that will display how solar power works, how it can be used, and how it helps the environment. Its education goal will extend to on-site classrooms where local institutions can develop workforce training programs with industry input for solar energy-related jobs, such as technicians and installers.

www.uatechpark.org

Stanford combines thermal and PV processes

Photon-enhanced thermionic emission could boost efficiency to 60%

Researchers at Stanford University have devised a process that can simultaneously use the light and heat of solar radiation to generate electricity in a way that could double the efficiency of existing solar cell technology, potentially reducing the costs of solar energy production enough for it to compete with oil as an energy source, it is claimed (Nature Materials, 1 August 2010, doi:10.1038/nmat2814).

Unlike existing photovoltaic technology used in solar panels (which becomes less efficient as the temperature rises) the new 'PETE' (photon-enhanced thermionic emission) process excels at higher temperatures, promising to surpass the efficiency of existing photovoltaic and thermal conversion technologies.

"This is really a conceptual breakthrough, a new energy conversion process, not just a new material or a slightly different tweak," says assistant professor of materials science and engineering Nick Melosh, who led the research group. Also, the materials needed to build a device to make the process work are cheap and easily available. "We showed this physical mechanism does exist," Melosh adds.

Most photovoltaic cells that use silicon to convert energy from photons into electricity can only use a portion of the light spectrum, with the rest just generating heat. This heat, plus inefficiencies in the cells themselves, account for a loss of more than 50% of the initial solar energy reaching the cell. Harvesting this wasted heat energy could boost solar cell efficiency. However, heat-based conversion systems require high temperatures, which decreases solar cell efficiency rapidly.

Until now, no one had devised a way to combine thermal and solar cell conversion technologies, but Melosh's group figured out that coating semiconducting material with a thin layer of the metal cesium made it able to use both light and heat to generate electricity.

"What we've demonstrated is a new physical process that is not based on standard photovoltaic mechanisms, but can give you a photovoltaic-like response at very high temperatures," Melosh says. "In fact, it works better at higher temperatures. The higher the better," he adds. While most silicon solar cells are rendered inert before the temperature reaches 100°C, the PETE device doesn't reach peak efficiency until it is well over 200°C.

Because PETE performs best at temperatures well in excess of what a rooftop solar panel would reach, the devices will work best in solar concentrators such as parabolic dishes, which can get as hot as 800°C. Dishes are used in large solar farms (similar to those proposed for the Mojave Desert in southern California) and usually include a thermal conversion mechanism as part of their design, which offers another opportunity for PETE to help generate electricity, as well as minimizing costs by meshing with existing technology, the researchers say.

"The light would come in and hit our PETE device first, where we would take advantage of both the incident light and the heat that it produces, and then we would dump the waste heat to their existing thermal conversion systems," says Melosh. "So the PETE process has two really big benefits in energy production over normal technology."

Photovoltaic systems never get hot enough for their waste heat to be useful in thermal energy conversion, but the high temperatures at which PETE performs are perfect for generating usable high-temperature waste heat, say the researchers. Melosh calculates that the PETE process can achieve 50% efficiency or more under solar concentration but, if combined with a thermal conversion cycle, could reach 55% or even 60% — almost triple the efficiency of existing systems.

The team would like to design the devices so they could be easily bolted on to existing systems, making conversion relatively inexpensive.

The researchers used gallium nitride in the 'proof of concept' tests. The efficiency achieved was well below the calculated potential efficiency for PETE, which they had anticipated. But they used GaN because it was the only material that had shown indications of being able to withstand the high temperature range and still manifest the PETE process.

With the right material (most likely gallium arsenide) the actual efficiency of the process could reach the calculated 50–60%. The researchers are already exploring other materials that might work.

Another advantage of the PETE system is that, by using it in solar concentrators, the amount of semiconductor material that is needed for a device is quite small. "For each device, we are figuring something like a 6-inch wafer of actual material is all that is needed," Melosh says. "So the material cost in this is not really an issue for us, unlike the way it is for large solar panels of silicon." The cost of materials has been one of the limiting factors in the development of the solar power industry, so reducing the amount of investment capital needed to build a solar farm is a big advance, the researchers reckon.

"The PETE process could really give the feasibility of solar power a big boost," Melosh says. "Even if we don't achieve perfect efficiency — let's say we give a 10% boost to the efficiency of solar conversion, going from 20% efficiency to 30% — that is still a 50% increase overall." That is still a big enough increase that it could make solar energy competitive with oil, it is reckoned.

www.stanford.edu
www.nature.com/nmat/journal/voap/ncurrent/full/nmat2814.html

GaAs
(SI & SC)
SUBSTRATES



Ge
SUBSTRATES

RAW
MATERIALS

InP
(SI & SC)
SUBSTRATES



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Walmart to add solar energy generation at 20–30 more sites in California and Arizona

Both CIGS and CdTe thin-film PV modules to be installed

Wal-Mart Stores Inc plans to add to its 31 existing solar installations in California and Hawaii with solar generating systems at another 20–30 sites in California and Arizona, mostly featuring lighter, lower-cost thin-film photovoltaic technology.

“By leveraging our global scale to become a more efficient company, we are able to lower our expenses and help develop markets for new technologies,” says Kim Saylor Laster, VP of energy for Walmart, which has more than 8400 retail units in 15 countries, yielding sales of \$405bn in fiscal 2010. “Developing and incorporating new renewable energy sources, like thin film, reduces energy price risk.”

When complete, the project is expected to: supply up to 20–30% of the total energy needs for each location; produce up to 22.5 million kW-hrs of energy per year (enough to power more than 1750 homes annually); and avoid producing more than 11,650 metric tons of carbon dioxide equivalent annually (equal to taking more than 3000 vehicles off the road for a year).

SolarCity, which will design, install, own and maintain the new solar power systems on Walmart locations, was selected through a request for proposal (RFP) process spearheaded by Walmart and the



Solar panels on Walmart rooftop.

national environmental group Environmental Defense Fund (EDF). The goal was to identify the most innovative solar technologies that would create benefits on three fronts: to the environment, technology, and financial viability.

The new Walmart projects will use both copper indium gallium diselenide (CIGS) and cadmium telluride (CdTe) thin-film modules. The firm reckons that its large-scale on-site installation of CIGS could help to further the development of the technology and bring it to market more quickly, while its use of CdTe could help to make the case for other businesses to adopt the technology for on-site commercial use.

“The combination of Walmart’s market power and EDF’s rigor could

provide the scale and credibility needed to bring next-generation solar technology more fully into the marketplace,” believes Gwen Ruta, EDF’s VP for corporate partnerships. “It’s the kind of innovation we need to reduce dependence on foreign oil and cut carbon pollution.”

In addition to the 500 jobs the project installations will create or support in California and Arizona, the projects are also supporting jobs at facilities in Ohio and California, where most of the thin-film PV modules are manufactured, says Walmart.

“Thanks in part to the economies of scale created by pioneers like Walmart, it’s now possible for many American businesses and homeowners to adopt solar power and pay less than they currently pay for electricity from polluting sources,” says SolarCity’s CEO Lyndon Rive. “This project was made possible in part by financing from PG&E Corp and National Bank of Arizona, as well as incentives from the APS Renewable Energy Incentive Program [which offers financial incentives to customers adding renewable energy systems to their homes or business] and the California Solar Initiative.” The program is funded by APS customers and approved by the Arizona Corporation Commission.

www.walmart.com

5N Plus signs long-term CdTe supply agreement with Abound Solar

5N Plus Inc of Montreal, Canada, a provider of high-purity metals and compounds for electronic applications, has signed a long-term supply agreement to provide cadmium telluride (CdTe) to Abound Solar Inc of Loveland, CO, USA for the manufacture of its thin-film photovoltaic modules.

“This agreement has been signed following the memorandum of understanding with Abound Solar

that we announced in January,” says 5N Plus’ president & CEO Jacques L’Écuyer, who adds that the agreement reinforces 5N Plus’ position as a supplier of CdTe to the solar industry.

5N Plus said in January that it would provide recycling services for solar modules and manufacturing scrap produced by Abound (with the output being recyclable glass and raw chemicals, ready to

be processed into new finished products).

Earlier this year, in March, via its subsidiary 5N PV GmbH of Eisenhüttenstadt, Germany, the firm also signed a long-term supply and recycling agreement with CdTe thin-film PV module maker Calyxo GmbH of Bitterfeld-Wolfen, Germany.

www.5nplus.com

www.abound.com

Sunovia accuses partner EPIR of fraud, misappropriation of funds and non-performance

Counterclaim filed to EPIR's complaint of breach of research, development and supply agreement

Sunovia Energy Technologies Inc of Sarasota, FL, which is commercializing cadmium telluride on silicon (CdTe/Si) solar technology as well as LED lighting products, has filed a response to a legal complaint by EPIR Technologies Inc of Bolingbrook, IL, USA, which develops infrared sensor, biosensor and solar photovoltaic products.

EPIR filed the lawsuit in a federal district court in Chicago in response to what are claimed to be multiple breaches by Sunovia of the firms' research, development and supply (RDS) agreement. EPIR says that in July, having delivered on all of its obligations, it terminated the RDS agreement for Sunovia's various breaches, including Sunovia's failure to make payments required under the agreement.

"EPIR initiated and worked tirelessly to amicably resolve the parties' dispute, but ultimately they were unsuccessful when Sunovia terminated discussions," says EPIR's president Dr Chelva Kumar. "With this litigation, we seek to

enforce EPIR's rights," he adds.

"As a shareholder in Sunovia, we are deeply concerned about the direction of Sunovia, and we will vigilantly guard our rights."

Sunovia's counterclaims include allegations against EPIR, CEO Dr Sivalingam Sivananthan (who founded EPIR in 1998 to develop infrared materials based on mercury cadmium telluride for US military imaging applications), and Sivananthan Laboratories Inc (an Illinois company incorporated by Sivananthan on 9 September 2009 with operations adjacent to EPIR).

Sunovia alleges that EPIR:

- diverted funds paid by Sunovia, and then attempted to conceal them when Sunovia requested information to which it was entitled;
- fraudulently concealed from Sunovia patent applications claiming technology developed under the agreement; and
- attempted to destroy or appropriate Sunovia's investment in EPIR and the joint development effort.

"Sunovia and EPIR established

and agreed upon timeframes, in writing and signed by both companies, that required EPIR to deliver a 1-3MW pilot production facility in early 2010 for solar CPV CdTe wafers. This date was not met by EPIR," said Sunovia's chairman & CEO Carl Smith earlier in June.

"We did everything within our power to resolve these issues amicably; however, it became apparent that a fair and reasonable resolution would not be possible without a legal fight," says Smith now. "We are prepared to vigorously protect and defend Sunovia against the complaints filed by EPIR, and will continue to pursue a resolution to this matter that is in the best interest of Sunovia's shareholders," he adds.

"We will do everything in our power to prove such allegations to be false and pursue any and all other claims that we have against Sunovia based on its conduct and its counterclaims," comments EPIR's Kumar.

www.epir.com

www.sunoviaenergy.com

Sunovia appoints new CEO to add Wall Street credibility

Art Buckland has joined Sunovia as CEO. The firm says that Buckland's leadership has resulted in corporate turnarounds, hundreds of millions of dollars of revenue growth, billion-dollar increases in book value, initial public offerings (IPOs) and leveraged buy-outs (LBOs). He has also raised \$175m in private and public capital while starting nine companies, completed 36 merger & acquisition (M&A) transactions worth over \$1.45bn, and turned around seven companies.

Recently, in his two years at Soliant Energy, Buckland pioneered the development of a strategic vision for the next generation of

solar panels that could generate distributed electricity at utility costs without government subsidies.

Sunovia says that Buckland brings experience in operations and governance spanning renewable/solar and traditional energy firms, advanced semiconductors, supply chain and value-added distribution and capital equipment. He has also held CEO, CFO and board chairman roles in startups and NASDAQ, NYSE and LSE firms.

"The opportunity to lead a company with this much potential while uniquely operating in this large and dynamic clean-tech energy space and poised for rapid growth,

is an ideal fit," says Buckland.

"I expect to grow Sunovia efficiently and effectively to realize the tremendous value that has already been created in EvoLucia [LED lighting fixtures] and look forward to the challenge of realizing the value in our solar initiative."

"Art brings the executive pedigree and Wall Street credibility that I feel have been missing from the company," comments outgoing CEO Carl Smith (who continues as chairman). "His experience and reputation with both institutional investors and large banks will be critical to the company as we enter a phase of rapid growth," he adds.

ZSW raises thin-film solar cell efficiency record to 20.3% German institute boosts CIGS PV efficiency from 20.1%

Scientists at the Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (Centre for Solar Energy and Hydrogen Research, ZSW) in Stuttgart, Germany have raised their thin-film solar cell efficiency record to 20.3%. ZSW's prior record of 20.1% (achieved in April) had surpassed the US Department of Energy's National Renewable Energy Laboratory (NREL), which had held the record for the previous 16 years (latterly 19.9%, achieved in March 2008).

ZSW's latest record copper indium gallium di-selenide (CIGS) thin-film solar cells shrink the efficiency advantage of multi-crystalline solar cells (still dominating the market) to just 0.1%. The increased efficiency should significantly improve

the cost-effectiveness of CIGS thin-film photovoltaics over the medium term, it is claimed.

The ZSW solar cell has an area of 0.5cm², and the semiconducting CIGS layer and the contact layers have a total thickness of just 4µm, making them 50 times thinner than standard silicon cells. "Our researchers have made the cells in a CIGS laboratory coating plant using a modified co-evaporation process, which in principle can be scaled up to commercial production processes," says Dr Michael Powalla, member of the board at ZSW and head of its Photovoltaics Division. The latest efficiency figures have been confirmed by Fraunhofer Institute for Solar Energy Systems ISE in Freiburg, Germany. However, it will be some

time before the increased efficiency of the CIGS solar cells can be utilized commercially, Powalla cautions.

Experts reckon that, within the next years, the efficiency of the relatively low-priced CIGS thin-film solar modules will rise from about 11% to about 15%. Compared to 2008, the market share of thin-film power plants is expected to double by 2012, reaching about 30%.

Together with industrial partner Würth Solar, ZSW has developed its CIGS thin-film solar module technology to enable industrial production. In 2006, Würth launched what is claimed to be the world's first mass production of CIGS solar modules (in Schwäbisch Hall, Germany).

www.zsw-bw.de

TSMC breaks ground on thin-film solar R&D center & fab CIGS PV module capacity of 200MW targeted for 2012, then 700MW

After approval by its board of directors on 10 August for an investment of US\$319.6m in its first LED and solar production facilities (US\$101.6m for LEDs and \$218m for thin-film photovoltaic modules), Hsinchu-based Taiwan Semiconductor Manufacturing Company Ltd (the world largest silicon IC manufacturing foundry) has broken ground at a 5.2 hectare site in Taichung's Central Taiwan Science Park (CTSP) on its Thin Film Solar R&D Center and Fab. The development lays the foundation for TSMC's entry into the thin-film photovoltaic (PV) market.

After entering the solar sector by purchasing a 20% stake in silicon solar cell maker Motech Industries Inc in January and subsequently becoming that firm's largest shareholder, in June TSMC invested \$50m to acquire a 21% stake in US copper indium gallium diselenide (CIGS) thin-film photovoltaic cell

firm Stion in exchange for a license on its CIGS cell technology.

"TSMC's New Businesses team has reached many important milestones since it was formed last year, first with our LED facility in Hsinchu," says TSMC's chairman & CEO Dr Morris Chang. "Our solar and LED businesses will not only bolster TSMC's revenue and profit growth in the coming decades, they also play a key role in TSMC's corporate social responsibility by making products that support a greener earth," he added. "Construction of this solar R&D center and fab, along with our Fab 15 Gigafab next to it, means Taichung's Central Taiwan Science Park will become home to much of TSMC's most advanced and innovative production," he points out.

"The research performed at this R&D center will help us achieve our goal of offering a leading thin-film solution and the production at this

fab, drawing on TSMC's wealth of manufacturing know-how, will pave the way for us to become a top provider of solar PV modules," believes Dr Rick Tsai, TSMC's president of New Businesses.

With a building area of 110,000m² and a production area of 78,000m², TSMC plans to invest US\$258m for the first phase of the Thin Film Solar R&D Center and Fab, which is scheduled for equipment move-in in second-quarter 2011 and achieve initial volume production of 200MW per year in thin-film photovoltaic modules in 2012.

TSMC also plans to add a second phase to the facility and expand production to more than 700MW, employing about 2000 staff in total. In addition, the R&D center will continue to develop the CIGS technology licensed from Stion. TSMC will offer its solar products worldwide under its own brand.

www.tsmc.com

MiaSolé hits record 14.3% efficiency for commercial-scale CIGS module

MiaSolé of Santa Clara, CA, USA, which was founded in 2001 to make copper indium gallium diselenide (CIGS) thin-film photovoltaic panels, says that, according to the US Department of Energy's National Renewable Energy Laboratory (NREL), its large-area (1m²) production module has achieved the highest independently confirmed efficiency for any commercial-scale CIGS module technology (14.3%).

"We continue to make progress in the execution of our technology, cost reduction and manufacturing roadmaps," notes CEO Joseph Laia.

MiaSolé says that it now offers bank-financeable solar modules with efficiency comparable to polysilicon, combined with the lower manufacturing costs of thin-film modules.

The firm says that its unique manufacturing process deposits CIGS on a flexible stainless-steel substrate and produces all of the layers required for the solar cell in a single continuous process. MiaSolé is the only thin-film solar firm that uses sputtering processes at every step for coating the solar modules, reducing manufacturing time and cost of production, it is claimed.

MiaSolé's products are designed for utilities and independent power producers to use in industrial-scale deployments such as large-scale rooftop and ground-mount installations. The firm has two manufacturing facilities and shipped 6.5MW in first-half 2010, and will ship 22MW in full-year 2010, as it plans to open a third plant by year-end.

www.MiaSolé.com

MiaSolé signs 600MW long-term framework agreement with juwi

MiaSolé says it has completed a multi-year purchase agreement to supply its copper indium gallium diselenide (CIGS) thin-film photovoltaic modules to renewable energy project developer juwi Solar GmbH of Mainz, Germany.

This follows an announcement of purchase agreements to supply juwi with 7.5MW of modules for use in the third and fourth quarters of 2010 for ground-mounted and rooftop projects throughout Germany, following 1MW of modules delivered to juwi in Q2/2010 for projects in Germany and San Antonio, TX, USA.

The new agreement outlines 50MW of shipments in 2011 and a total of 600MW to be shipped over the period of the deal. The framework agreement represents the next step in what has been a long-term relationship between the two parties.

"juwi has an excellent history of developing and executing projects

on a number of continents," says MiaSolé's CEO Joe Laia. "We are happy to align our corporate strategy with their history and experience," he adds.

juwi has been designing, building, financing and operating solar, wind and bio energy plants since 1996. juwi Solar in particular has so far installed about 1300 PV systems with a total capacity of over 500MW, including one of the world's largest solar power plants in Eastern Germany.

"The long-term nature and volumes outlined in the current supply agreement with MiaSolé enable juwi to continue its plan of rapid growth," juwi Solar's managing director Lars Falck. "In the prevailing unpredictable environment, MiaSolé is proving to be an outstanding partner... Quality and professionalism will enable MiaSolé to quickly gain market share," he comments.

www.juwi.com

ISET begins pilot production of printable CIGS PV modules

International Solar Electric Technology Inc (ISET) of Chatsworth, CA, USA says it has begun pilot manufacturing to validate its proprietary low-cost printing technology in preparation for expansion to volume production of its copper indium gallium diselenide (CIGS) thin-film photovoltaic modules.

Since being founded in 1985, ISET has focused over 25 years of development on cost-effective methods of producing PV modules, targeting grid parity. The firm claims that its patented non-vacuum nanoparticle ink-based process for printing solar cells on glass offers substantial cost advantages over competing high-vacuum technologies due to efficient use of semiconductor materials and low-cost capital equipment.

ISET's pilot line produces monolithically integrated CIGS modules on glass substrates with an area of 1ft². Recent production runs have achieved 11% cell efficiency on average, and ISET's R&D team has fabricated laboratory devices with 14.3% efficiency. Research efforts are on track to reach 16% in the near term, according to founder, president & CEO Dr Vijay K. Kapur.

The pilot line is "a critical step in transferring our unique technology from the lab to large-scale production without requiring heavy capital investment," says Kapur. "By demonstrating high quality and performance through this intermediate step, we have significantly reduced the possibility for costly delays in implementing our capacity ramp," he believes. "We have also identified valuable methods of improving performance, yield, throughput, and materials utilization."

ISET reckons that its 24,000ft² facility can accommodate expansion in annual capacity to 30MW while generating over 100 new jobs.

www.isetinc.com

IN BRIEF

Solyndra gains ISO 9001 certification

TÜV Rheinland has awarded ISO 9001:2008 certification to Solyndra Inc of Fremont, CA, USA, which makes CIGS solar systems consisting of panels and mounting hardware for commercial rooftops.

ISO 9001:2008 provides a set of requirements that must be in place to have a quality management system, regardless of the organization's size, product or service line, or public or private status. Certification to the standard is voluntary, and organizations must complete a rigorous auditing process by a third-party registrar.

"To meet strong product demand we are ramping our Fab 2 facility, and this certification recognizes the strength of the processes and procedures that we have put in place to ensure the highest levels of quality as we rapidly scale our business," says Ben Bierman, executive VP of operations and engineering. "ISO certification demonstrates our commitment to continuous improvement and delivering the highest levels of service and product quality."

Solyndra's thin-film solar panels are built from cylindrical tubes. This 'self-tracking' design — with a 360° surface that can absorb direct, diffuse and reflected light — captures more sunlight from low-slope commercial rooftops than conventional flat-surfaced panels, which need costly tilted mounting devices to improve the capture of direct sunlight, offer poor collection of diffuse light, and fail to collect reflected light. Also, gaps between tubes and frame let wind through, reducing the need for heavy, roof-penetrating fastenings or anchoring; their lighter weight allows installation on scantier roofs. Simple horizontal mounting hardware also allows fast and economical installation.

www.solyndra.com

Global Solar rolls out 300W flexible CIGS building-integrated photovoltaic module for roofing industry

Global Solar Energy Inc of Tucson, AZ, USA, which manufactures copper indium gallium diselenide (CIGS) thin-film photovoltaic cells, has unveiled the PowerFLEX BIPV flexible building-integrated photovoltaic module.

Specifically designed for commercial and industrial rooftops, Global Solar claims that its PowerFLEX BIPV modules can deliver more power per rooftop than any other solar solution, enabling rooftops to quickly and cost-effectively start generating clean energy.

With aperture efficiency of 12.6%, PowerFLEX BIPV delivers the highest efficiency in the flexible module industry, claims the firm, adding that the large format (5.75m x 0.5m) and high power density (300W) enables it to outperform other flexible solar roofing solutions on the market, including 50% more energy and power than the current amorphous silicon standard.

Global Solar says that its PowerFLEX BIPV module directly addresses the biggest concerns posed by the roofing industry regarding solar integration. It is lightweight and can be applied directly to a roofing surface, requiring no mounting hardware, no roof penetrations, and creates no additional wind load. Designed especially for roofs, PowerFLEX BIPV maintains the integrity and aesthetics of a building structure. Its large format and high power density can also lower installation and balance of system (BOS) costs.

Although traditional glass solar modules are too heavy for many commercial applications, they have been one of the few options available to the building industry for solar energy generation, says Global Solar. Unlike conventional glass modules, which are heavy, rigid and typically installed at an angle on racks, PowerFLEX BIPV

Global Solar's flexible CIGS PV module



modules are lightweight and flexible, and installed flat directly on the roofing surface. This allows the modules to cover a greater amount of rooftop space that, depending on the location of the building, can equate to 50–100% more power and energy per rooftop than a tilted solar array, the firm reckons. This advantage is particularly acute at higher latitudes.

"We recognized that the building industry has not been able to fully optimize the real estate on the rooftop with solar solutions currently available," says CEO Dr Jeff Britt. "We worked closely with roofing professionals when we designed the PowerFLEX BIPV, and their experience mattered to us," he adds. "Leveraging their input, we now offer a high-powered module that will create the most powerful rooftops in the world," Britt reckons.

Industry research shows that the BIPV market is heating up. Lux Research reckons that the BIPV market will grow to \$5.7bn by 2013. Solutions that will succeed are those that meet the power, design and cost requirements set by the building and roofing industries, Global Solar comments.

Global Solar showcased its PowerFLEX BIPV at the 25th European Photovoltaic Solar Energy Conference and Exhibition (25th EU PVSEC)/5th World Conference on Photovoltaic Energy Conversion (WCPEC-5) in Valencia, Spain (6–9 September).

www.globalsolar.com

Sulfurcell unveils first prototype large-format CIGSe PV module with efficiency above 10% Thin-film PV maker switches from CIS; targets 14% by 2015

At the 25th European PV Solar Energy Conference and Exhibition (EU PVSEC 2010) in Valencia, Spain (6–10 September), Sulfurcell Solartechnik GmbH of Berlin, Germany unveiled prototypes of its new product line: 1.25m x 0.65m modules with a much increased energy conversion efficiency of 10.7% and a peak output of 86.8W (confirmed by the German technical inspection agency TÜV Rheinland).

Sulfurcell was founded in 2001 by Nikolaus Meyer and Ilka Luck as a spin-off of the Hahn-Meitner-Institut (now the Helmholtz Centre Berlin for Materials and Energy). In 2002 it raised €9m from private investors, followed in 2003 by R&D grants of €7m from the Senate of Berlin. The firm subsequently set up pilot production, leading to market introduction in 2005.

In July 2008, the firm raised €85m in an equity fundraising round including Intel Capital and the BEU fund supported by Vattenfall Europe and Gaz de France, which was used to construct new production facilities and for R&D. The firm now claims to be one of the world's three leading makers of thin-film solar power modules based on copper indium sulphide (CIS) semiconductors.

However, in developing the new modules, Sulfurcell relied on a reconfigured semiconductor layer: for the first time the firm is producing thin-film modules based on CIGSe (copper, indium, gallium diselenide). In contrast to its first production line, Sulfurcell is using selenide instead of sulphur in its new modules. It will be converting part of its production to CIGSe in 2011 and will then market the product on a megawatt scale.

After an intensive development phase lasting just four months, in July Sulfurcell produced the first prototypes of large-format CIGSe

solar modules with efficiencies greater than 10%. Very few manufacturers of thin-film solar modules are currently capable of producing high-quality modules with efficiencies in double figures, notes the firm.

The latest development was possible because Sulfurcell was able to build on experience gained from five years of producing and marketing CIS modules, says CEO Dr Nikolaus Meyer. "The high module efficiency demonstrates that we will also be able to compete in the very top league of thin-film specialists in future," he reckons.

Scientists have already produced CIGSe solar cells with efficiencies greater than 20% under laboratory conditions. To exploit this potential, Sulfurcell's CIGSe process deploys co-evaporation techniques. The manner in which it uses these depends, however, on proprietary design and components. A major advantage of the process is that the CIGSe layer properties can be precisely configured, enabling the material's potential to be exploited to the full, says Sulfurcell. The firm is already aiming to surpass the 11% threshold in 2011 and the 12% threshold in 2012. Module efficiencies exceeding 14% are realistic by 2015, it reckons.

Sulfurcell continually exchanges expertise with the Helmholtz Centre Berlin, says Meyer. For developing and optimizing production processes for CIGSe-based thin-film modules, Sulfurcell also works exclusively with 44solar of Nantes, France, which is headed by CIGSe specialist professor John Kessler. With Kessler and his colleagues, Sulfurcell is already planning the construction of new, highly productive machines in order to further develop the CIGSe technology and maximize efficiencies.

www.sulfurcell.com

IN BRIEF

CIGSSe PV maker Johanna Solar Technology renamed Bosch Solar CISTech

Johanna Solar Technology GmbH of Brandenburg an der Havel, Germany will become known as Bosch Solar CISTech GmbH when the firm's new name is entered into the Commercial Registry on 1 September, largely completing its integration into the Solar Energy Division of Bosch Group.

Johanna Solar was founded in 2005 by IFE Solar Systeme GmbH of Oldenburg, Germany. In August 2005, it licensed thin-film technology based on copper, indium, gallium, sulfur and selenium (CIS/CIGSSe) from Photovoltaic Technology Intellectual Property Ltd (PTIP), a spin-off of South Africa's University of Johannesburg, where it had been developed over a period of 13 years by professor Vivian Alberts and his team. In November 2008, Johanna Solar started production using its thin-film photovoltaic modules, which are based on p-type CIGSSe absorbing layers on Mo-covered glass substrates.

The Bosch Group entered the photovoltaics industry in 2008 when it acquired the Erfurt-based ersol group (now known as Bosch Solar Energy AG), which makes silicon-based solar cells and thin-film solar cells based on silicon. It further expanded its photovoltaics operations in August 2009, after securing majority stakes in both Johanna Solar and Oldenburg-based aleo solar AG, which was formed in 2001 to manufacture silicon-based solar systems and modules and in 2006 acquired a 19% stake in Johanna Solar.

www.bosch-solarenergy.de
www.johanna-solar.com/en

Odersun secures €10m of loan guarantees from Germany's Brandenburg State

Odersun AG of Berlin, Germany, which designs and manufactures flexible thin-film solar cells and modules using proprietary CISCuT (copper indium disulfide on copper tape) reel-to-reel manufacturing technology, has received €10m worth of loan guarantees from the Federal State of Brandenburg. The firm says that the raising of credit enables it to advance its production ramp-up and market entry with customized solar products based on its proprietary technology.

"The continuous commitment of our investors and the trust of the state government in the capability of our technology and strategic approach ensure secure funding in the course of our company's market entry," says CEO Dr Hein van der Zeeuw.

Odersun is currently commissioning its production facilities in Fürstenwalde/Spree, which have an annual capacity of 20MW. The four production lines are already installed and will be in operation by the end of this year. Besides manufacturing standard thin-film modules, Odersun is also working on a portfolio of customer-specific solar modules with special formats applicable to direct integration into buildings. Odersun's first building-integrated photovoltaic (BIPV) module projects should be realized in 2011.

● Odersun has appointed Doede Vierstra as chief financial officer and board member.

Vierstra brings experience of executive finance and international

management. He joins from the Dutch energy provider Nuon (now part of the Vattenfall Group), where he was CFO and board member.

"I strongly believe in renewable energy and solar power in particular, as a main driver in the global transition from fossil to sustainable energy supply," says Vierstra.

"Odersun is a very promising company, whose products make an important contribution in that process," he adds.

"Vierstra is a great addition to our management team as the company enters the market and continues its growth," says van der Zeeuw.

Vierstra succeeds Peter van Bommel, who was responsible for the firm's finances from early 2009.

www.odersun.com

SoloPower first to receive UL certification for flexible CIGS thin-film photovoltaic module

SoloPower Inc of San Jose, CA, USA, which makes flexible copper indium gallium di-selenide (CIGS) thin-film photovoltaic (PV) cells and modules, has announced UL certification for its modules, which is claimed to be a first for the industry.

"SoloPower's advancement demonstrates that California is leading the way in technology innovation for the green economy," comments Governor Arnold Schwarzenegger.

This is the first UL-certified product in a line of high-power flexible modules being introduced initially to European and North American markets. Their flexibility and high-power rating allows a reduction in balance-of-system and installation costs, while lightweight and application features will facilitate solar installations where they are otherwise impossible, reckons SoloPower.

"The certification of SoloPower's flexible CIGS module is an important step toward the realization of lightweight, high-power, flexible solar

modules with potential to expand the roof-top solar market and reduce balance of system costs," says Dr Rommel Noufi, principal scientist at the US National Renewable Energy Laboratory. "I feel very gratified to see, after a 30-year career in thin-film CIGS PV at NREL, the technology become mature."

UL certification was granted following testing at an independent laboratory to UL 1703, the standard for safety for PV module manufacturing. In addition, SoloPower has conducted extensive internal testing that well exceeds the safety, quality and reliability standards established by these tests. In June 2009, the firm was the first manufacturer to gain UL certification for rigid modules based on flexible CIGS PV cells.

SoloPower's line of lightweight, flexible PV modules includes multiple form factors: the SFX1 module (80Wp, 0.3m x 2.9m, 2.3kg/5lbs), the SFX2 module (170Wp, 0.3m x 5.8m, 3.6kg/8lbs), and the SFX3

module (260Wp, 0.9m x 2.9m, 6kg/13lbs).

"With low-cost and low-capital expenditure requirements, SoloPower's core manufacturing process will enable rapid scale-up during our next phase of expansion," says CEO Tim Harris. "The company is in the process of adding a second manufacturing line that will significantly increase capacity."

Simultaneously, SoloPower is in discussions with the US Department of Energy to potentially obtain a loan guarantee under EPACT 2005 Section 1703 to support the construction of an additional multiple-line production facility.

The firm's modules were displayed at the European Photovoltaic Solar Energy Conference in Valencia, Spain (6-9 September 2010), where chief technology officer Dr Mustafa Pinarbasi spoke about 'Roll-to-Roll Manufacturing of Flexible CIGS Cells and Panels'.

www.solopower.com

Larger building blocks yield 320W 5m-long BIPV/BAPV modules

Ascent Solar Technologies Inc of Thornton, CO, USA, which manufactures flexible thin-film photovoltaic modules based on copper indium gallium diselenide (CIGS), has launched its new WaveSol series of 5m-long modules to complement its existing portfolio of building-integrated (BIPV) and building-applied (BAPV) photovoltaic products.

WaveSol WSLB 3200-190 is claimed to be the highest-power 5m flexible and lightweight CIGS module available and another example of Ascent's flexible lightweight CIGS modules with large format (5.0m x 0.6m), high power (320W), high voltage (up to 190V) and high specific power (50W/kg).

The new series of products is enabled by recent advances in Ascent's CIGS monolithic integration process, resulting in new 30cm x 60cm building blocks that are four times the size of the existing building block sub-modules. The module family hence consists of fewer parts that reduce overall

internal power losses and significantly reduces manufacturing and testing operations, the firm says.

The new product is specifically designed to meet the needs of large commercial-scale rooftop installations by providing unique attributes that reduce balance-of-system (BOS) costs and ease integration into roofing components, it is claimed. Ascent will showcase the new product at October's Solar Power International conference in Los Angeles, CA, USA.

"We intend to maintain our leading position as the pre-eminent manufacturer of flexible, lightweight CIGS modules for BIPV/BAPV solutions by translating advances in production into world-leading modules that will enable the proliferation of solar while making it a cost-effective solution," says Ascent's president & CEO Farhad Moghadam. The firm plans several beta-site installations with existing customers, he adds.

www.ascentsolar.com

Ascent signs China distribution agreement for integration of CIGS PV modules into Radiant's metal roofing and façade systems

Ascent Solar Technologies Inc of Thornton, CO, USA says that Radiant Holding Ltd will begin distribution of its lightweight, flexible thin-film copper indium gallium diselenide (CIGS) solar modules for building-integrated photovoltaic (BIPV), automotive and portable power solutions in China.

Ascent says that the agreement gives it access to multiple market segments in China's emerging solar market, including direct integration into Radiant's line of building materials for residential and commercial solutions. Radiant plans to install Ascent modules on

its metal roofing demonstration site immediately in order to show the unique characteristics of the flexible, lightweight CIGS modules to its customers.

"This relationship will give us access to a very large and rapidly growing market for BIPV applications in China," reckons Ascent's president & CEO Farhad Moghadam. "We also expect that other products in our lineup of flexible, lightweight CIGS modules will be marketed through this relationship," he adds. "Radiant has a sound building materials business and is an excellent partner to have for distribution of our products in China."

IN BRIEF

Ascent externally certifies module encapsulation material for flexible CIGS PV laminate

Ascent Solar Technologies says that its packaging solution for its flexible monolithically integrated CIGS modules has passed a critical environmental testing milestone.

An independent laboratory conducted a series of tests on its modules under the requirements of the IEC 61646 standards. All test requirements were passed, including the rigorous standard of 1000 hours of damp heat testing (85% relative humidity and 85°C temperature) set forth by the International Electrotechnical Commission (IEC) for performance and long-term reliability.

Ascent has begun external certification under IEC 61646 by submitting product intended for building-integrated photovoltaic (BIPV) and building-applied photovoltaic (BAPV) applications for use in commercial and residential rooftop markets. Preparation for submission under UL certification is also underway. Once certified, the firm's flexible CIGS PV modules will be the first of their kind to achieve such certification, positioning them for entry into the largest markets, the firm reckons.

"The majority of BIPV and BAPV demand resides in flexible CIGS solutions incorporating a certified flexible package," believes president & CEO Dr Farhad Moghadam. "Our demonstration of the first flexible CIGS package which meets the IEC testing opens the door to penetration into these large market opportunities."

www.ascentsolar.com

Simulations cast light on CIGS solar cell efficiency puzzle

German researchers find segregation effects/non-uniformity in CIGS stronger in gallium-rich material.

Computer simulations of copper indium gallium diselenide alloy ($\text{CuIn}_x\text{Ga}_{1-x}\text{Se}_2$, or CIGS) suggest that indium segregation effects may play a key role in reducing the conversion efficiencies of photovoltaic/solar cell devices based on the material [Ludwig et al, Phys. Rev. Lett, vol105, p025702, 2010].

Despite these problems, the best CIGS solar cells have achieved efficiencies of 20.1%, although commercial devices fall somewhat short of this (up to ~14%). The theoretical maximum is around 30%. CIGS is one of the leading contenders for low-cost production of relatively high-efficiency cells.

Calculations were carried out by researchers at Johannes Gutenberg-Universität Mainz, IBM and Universität Duisburg-Essen. In fact, the lead author of the paper, Christian Ludwig, used a mainframe for his investigations that was recently donated to Mainz University by IBM as part of a Shared University Research (SUR) science award.

The starting point for the study was the observation that, despite an optimal bandgap for solar radiation absorption suggesting that a CIGS material with 70% Ga should yield the highest efficiency, in fact 30% Ga is experimentally found to be best. The estimate is based on the bandgaps of the non-alloyed materials CuInSe_2 (1.0eV) and CuGaSe_2 (1.7eV).

Indium segregation is a common problem for nitride semiconductors used to create green-blue-violet-ultra-violet light-emitting devices. Indium segregation refers to variations in the balance of indium and the other group III materials (such as gallium) in the alloy material.

The effect of indium segregation is not always negative — in some nitride light-emitting devices it is thought that the segregation effect creates localized states that can boost emission efficiencies in some cases. However, in the case of solar cells such effects are almost certainly detrimental, particularly in leading to fluctuations in the material's bandgap energy value.

The simulations used a hybrid of density functional theory (DFT), cluster expansion and Monte Carlo methods to simulate larger samples than usual with pure DFT. The cluster expansion is used to extract interaction energies from the DFT results that are used in the Monte Carlo of larger systems.

Dr Thomas Gruhn, head of the theory group involved in the work, explains the methods used: "Density func-

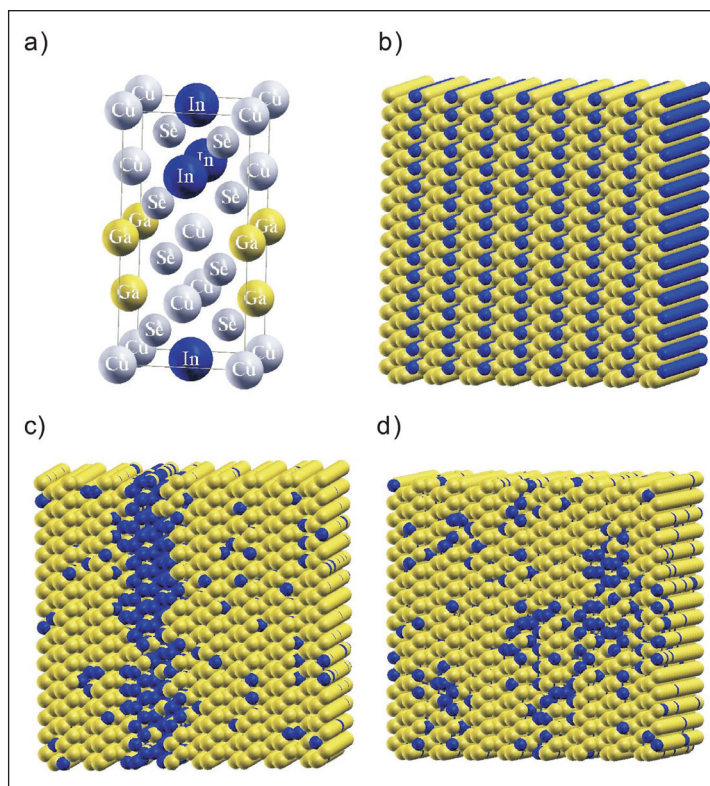


Figure 1. (a) CIGS unit cells showing positions of atoms in series of unit cells. Snapshots of: (b) a system of periodic unit cells; (c) the Ga-rich system at 348K; (d) the Ga-rich system at 406K (Ga atoms are yellow; In atoms are blue). Cu and Se are not displayed in the snapshots, and the size of the spheres is arbitrary.

tional calculations make it possible to assess the energies of local structures from the quantum mechanical point of view. The results can be used to determine temperature effects over wide length-scale ranges with the help of Monte Carlo simulations."

Calculations ignore possible defects of the Cu and Se atom sites, concentrating on the effects of variations in the Ga/In site occupation in the crystal structure (Figure 1a). The formation energies of 32 CIGS structures were calculated using DFT methods. The Monte Carlo used supercells with up to 32 atoms with a simulation box measuring 16x16x8 (8192) active atoms. The temperature range of the simulations was between 290K (room temperature-ish) and typical CIGS process temperatures of 870K. The resulting inhomogeneity was assessed using cubic segments consisting of 16

atom sites. The standard deviation was used as a measure of inhomogeneity.

Two alloy systems were studied: 'Ga-rich' $\text{CuIn}_{0.25}\text{Ga}_{0.75}\text{Se}_2$ and 'In-rich' $\text{CuIn}_{0.75}\text{Ga}_{0.25}\text{Se}_2$. At low temperatures (290K) a histogram of the segment compositions show two peaks — one being around a few atoms of the non-rich atom, the other a small peak for the non-rich atom at around 15 (Figure 2). This is an indication of segregation with regions of unalloyed material — CuInSe_2 (CIS) and CuGaSe_2 (CGS). At higher temperatures, this behavior decreases and the alloy becomes more homogeneous.

The segregation effect at low temperature is found to be worse for Ga-rich material, perhaps explaining the poorer performance of 70% Ga compared with 30% Ga CIGS solar cells. The mean value for both types is 4 non-rich atoms per box. The standard deviation is always higher for Ga-rich CIGS, again indicating higher inhomogeneity (Table 1).

These results suggest that fast cooling of high-temperature processed material could minimize bandgap fluctuations, leading to better solar cell performance. The authors comment: "The lack of phase separation in actual solar cells shows that the In-Ga distribution is 'frozen' in a high-temperature state. Thus, higher production temperatures and a reasonably fast cooling will lead to better efficiencies, which has recently been shown experimentally."

In practice, such fast cooling has been limited by the heat resistance of the glass used as a substrate for CIGS solar cells.

This research forms part of the com-CIGS project, which is looking to optimize CIGS solar cells with funding from the Federal German Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU). The project involves IBM Mainz and Schott AG, along with Johannes Gutenberg-Universität Mainz, the Helmholtz Center Berlin for Materials and Energy and Jena University.

To enable faster cooling of CIGS solar cells, Schott AG has developed a special glass with which the process temperature can be increased to well above 600°C. The cells that result are considerably more homogeneous, opening the way to cells with greater efficiency levels.

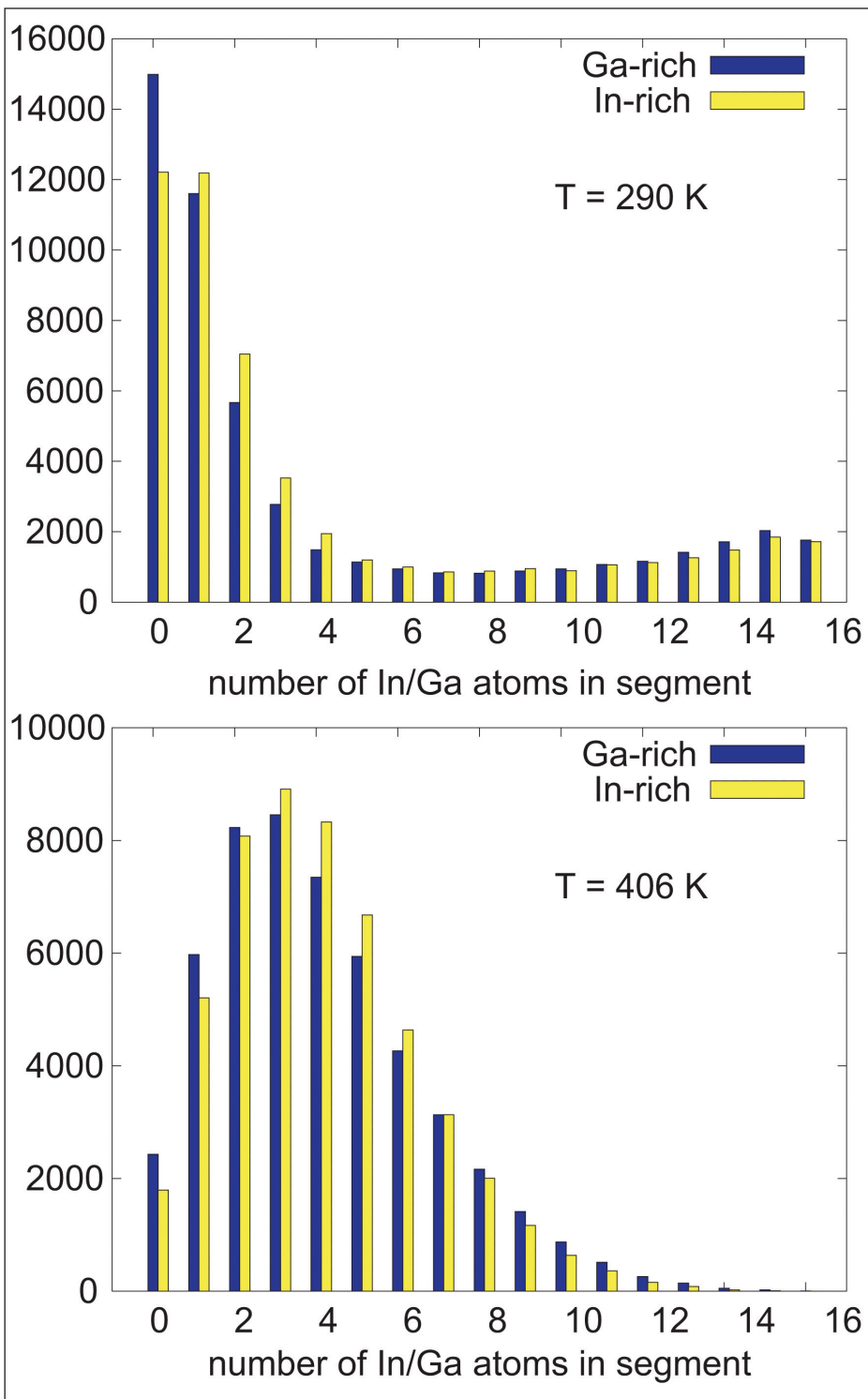


Figure 2. Histograms showing number of cubic segments in simulation box that contain 1–16 atoms of a certain type. Blue is the distribution of In atoms in Ga-rich CIGS, and yellow is the distribution of Ga atoms in In-rich CIGS at temperatures of (a) 290K and (b) 406K. A perfectly ordered In-rich or Ga-rich system would have 4 Ga/In atoms in every segment — the histogram would then have all entries in bin 4.

Gruhn reports: "We are currently working on large-format solar cells which should outperform conventional cells in terms of efficiency." ■

<http://link.aps.org/doi/10.1103/PhysRevLett.105.025702>
www.uni-mainz.de/eng/13695.php

Author: Mike Cooke

Texas Tech ‘significantly’ improves InGaN solar cell performance

Results indicate ‘strong potential’ of InGaN-based MQW solar cells for CPV applications.

Texas Tech University scientists have developed an indium gallium nitride (InGaN) solar cell with characteristics ‘significantly higher’ than previously reported values for devices with similar indium content in the QWs (~35%) [R. Dahal et al, Appl. Phys. Lett., vol97, p073115, 2010].

Theoretically, nitride semiconductors should be able to extract light over the range of energy bandgaps from indium nitride (InN, ~0.65eV) through gallium nitride (GaN, ~3.4eV) to aluminum nitride (AlN, ~6.2eV). This covers wavelengths from infrared and visible to ultraviolet (2000–200nm). One could envisage a series of different nitride solar cells designed to extract most efficiently a range of different wavelengths.

Even for single cells, one could tune a photovoltaic cell that could achieve better than 50% solar energy conversion by using InGaN alloy with 40% indium fraction. Unfortunately these remain theoretical hopes because it is very difficult to grow high-quality InGaN with high indium contents. The problem is that the lattice mismatch between InN and GaN is high (~11%). Layers with appreciable indium contents tend to segregate into regions with high and low indium content (phase separation). This is one of the difficulties that have hindered the extension of nitride light-emitting technology to longer wavelengths.

Despite the difficulties, university groups across the world are developing nitride semiconductors for use in solar cells. In 2009, the US firm RoseStreet Energy Labs Inc announced a tandem nitride–silicon solar cell [www.semiconductor-today.com/news_items/2009/OCT/RSLE_131009.htm].

The Texas researchers used a 12-period multi-quantum well (MQW) structure consisting of InGaN/GaN (3nm/16nm) with the In content of the well targeted at 35% (Figure 1). The layers were deposited by MOCVD on sapphire. The wavelength of the electroluminescence from the structure was around 533nm (green).

The devices were created by first depositing a semi-transparent layer of nickel/gold by electron-beam evaporation. Then the 2.3mm x 2mm mesas were formed using chlorine-based inductively coupled plasma etch. The semi-transparent p-contact was annealed to give an ohmic characteristic. A nickel-gold grid electrode (6µm wide, 170µm) was deposited on the mesa. The

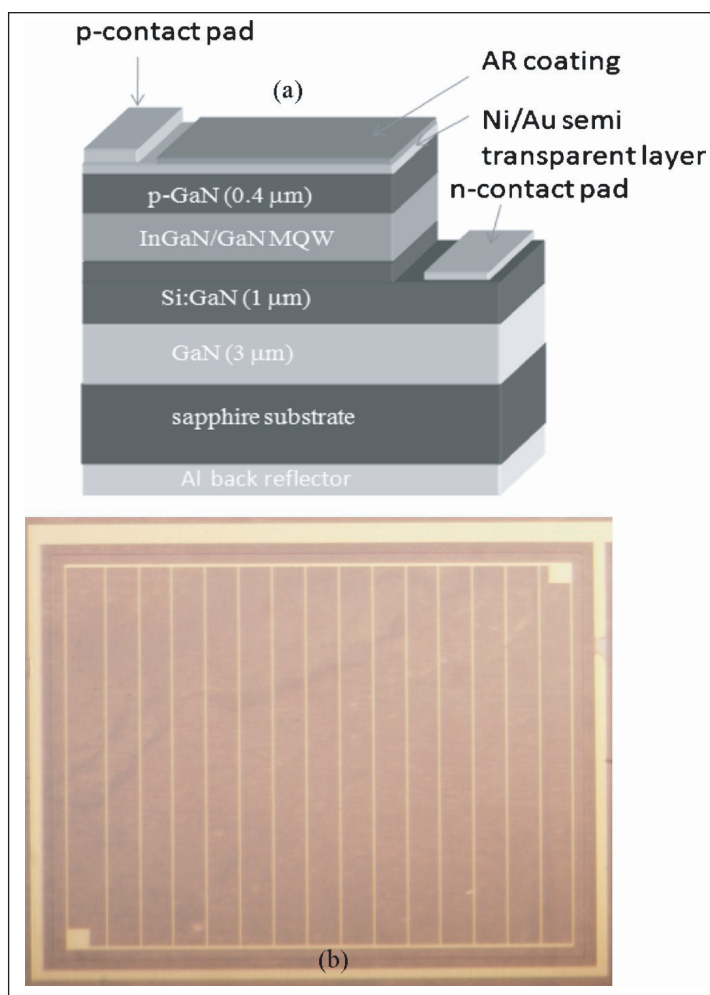


Figure 1. (a) Layer structure of InGaN/GaN solar cells with 12 periods of 3nm-thick $\text{In}_x\text{Ga}_{1-x}\text{N}$ (x approximately 0.35) QW and 17nm GaN barrier, and (b) optical microscopy image of a fabricated solar cell with 2.3mm x 2mm mesa size.

n-contact consisted of titanium/aluminum/nickel/gold. A 100nm silicon dioxide anti-reflection coat was added with plasma-enhanced CVD. The contact windows were opened in the SiO_2 using a wet etch. The sapphire substrate was coated with aluminum to provide a back-reflector.

The device was tested under standard 1.5 air mass (AM) conditions, representing ‘normal’ solar light characteristics at the earth’s surface at mid latitudes (i.e. solar zenith ~48°, seen as a rough average for conditions in US, Europe and Japan).

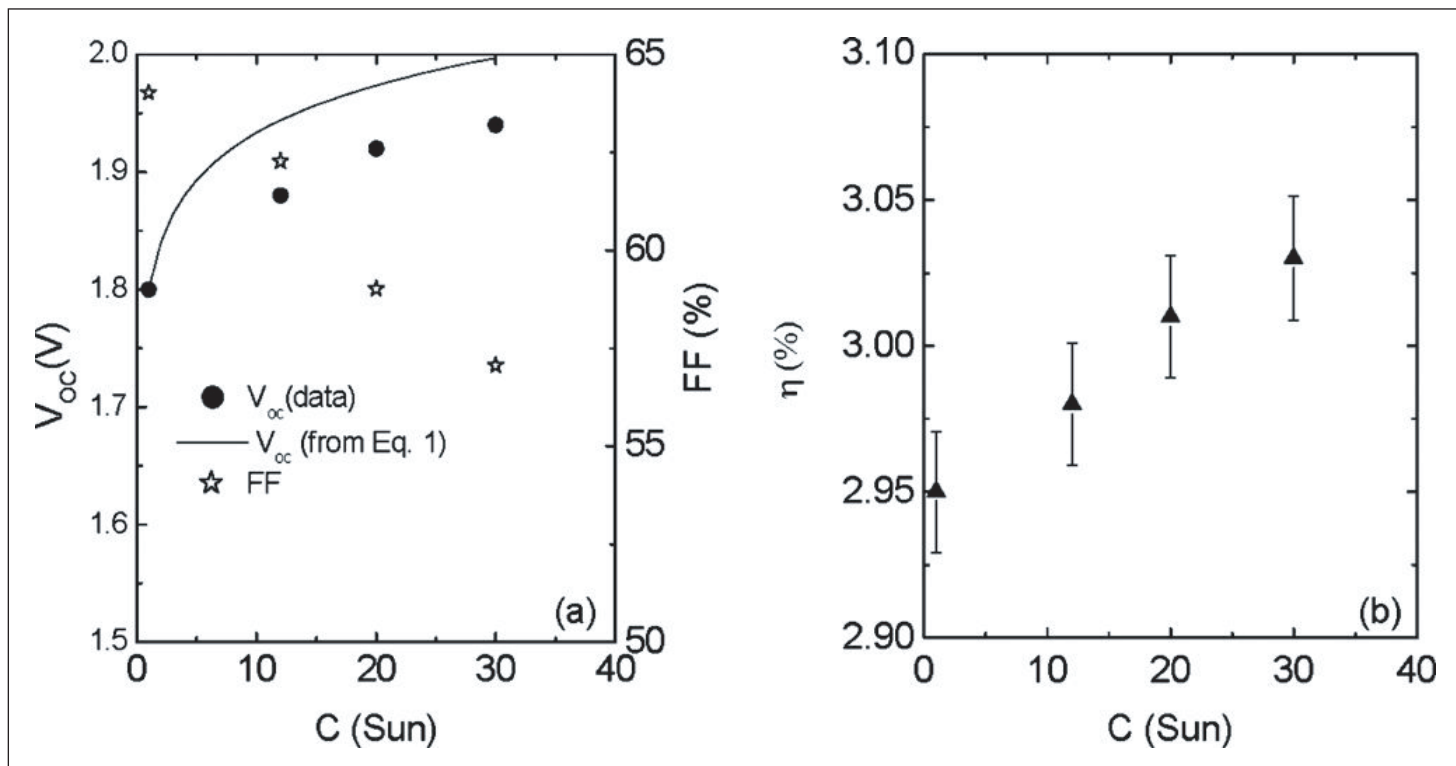


Figure 2. (a) Open-circuit voltage (V_{oc}) and short-circuit current density (J_{sc}) as functions of solar concentration (C). (b) Solar-energy-to-electricity conversion efficiency (η) as function of C.

With an incident intensity of $100\text{mW}/\text{cm}^2$, the characteristics were: open-circuit voltage 1.8V, closed-circuit current density $2.56\text{mA}/\text{cm}^2$, maximum power $2.95\text{mW}/\text{cm}^2$. This gives a fill-factor of 64% ($2.95/1.8/2.56$).

The conversion power efficiency of 2.95% falls short of the $\sim 8\%$ theoretical maximum for the frequency characteristics of the device, but the characteristics are claimed as being 'significantly higher than previously reported values for InGaN/GaN MQWs solar cells with similar In content in the QWs'. The improvement is attributed to improved InGaN material quality. One of the reasons for the still too low efficiency is the small thickness of the well regions ($12 \times 3\text{nm} = 36\text{nm}$). Complete light absorption would require at least 200nm. Evidence for this came from comparing devices with and without a back-reflector. The reflector added 15% to the photocurrent density by effectively doubling the thickness of the well region.

The researchers comment that "obtaining InGaN/GaN MQW structures with a total InGaN light-absorption layer thickness of around 200nm is another challenging task".

Nitride semiconductors should be able to extract light over the range of energy bandgaps from indium nitride (InN, $\sim 0.65\text{eV}$) through gallium nitride (GaN, $\sim 3.4\text{eV}$) to aluminum nitride (AlN, $\sim 6.2\text{eV}$)

The researchers also studied the device performance under concentrated light conditions of up to 30 suns. The short-circuit current density increases approximately linearly at $2.48\text{mA}/\text{cm}^2/\text{sun}$. The solar energy conversion efficiency should improve due to a logarithmic increase in the open-circuit voltage with the number of suns (assuming constant fill-factor). The efficiency increased to 3.03% under 30-sun illumination.

The open-circuit voltage increased 8%, falling short of the $\sim 11\%$ expected. This is attributed to a reduction in the fill-factor with increased illumination intensity (57% at 30 suns). The decrease in fill-factor is related to increased recombination at interfaces as a result of the higher carrier densities at higher levels of illumination.

"However, the results indicate the strong potential of InGaN-based MQW solar cells for concentrated photovoltaic (CPV) applications," the researchers comment.

The research group believes that the efficiency under concentrated sunlight could be further enhanced by improving the interfacial quality between InGaN and GaN by reducing the dislocation density at the interface through further growth and device processing optimization. ■

<http://link.aip.org/link/APPLAB/v97/i7/p073115/s1>
www2.ece.ttu.edu/nanophotonics

The author Mike Cooke is a freelance technology journalist who has worked in the semiconductor and advanced technology sectors since 1997.

Quantum wells with AlGaIn barriers boost blue-green laser light output

University of California Santa Barbara sees pathway to high internal quantum efficiency in green and yellow wavelengths.

The University of California Santa Barbara (UCSB) has reported improved 516nm 'green' laser diode performance from using aluminum gallium nitride (AlGaIn) for the quantum well barriers [You-Da Lin et al, Appl. Phys. Express, vol3, p082001, 2010].

Normally, gallium nitride (GaN) or indium gallium nitride (InGaIn) is used for quantum well barriers. AlGaIn generally has a wider bandgap energy than either of these alternatives. It is widely used for electron-blocking layers in light-emitting diodes and laser diodes to reduce unwanted recombination in the p-type contact region. UCSB's wells used traditional InGaIn material with narrower bandgap energies.

Much research work has recently been directed to producing green lasers with wavelengths longer than 520nm — the UCSB device is therefore more strictly 'blue-green'. The aim of this work is to produce projector systems that produce the red, green and blue light directly from laser diodes. Presently in commercial projector systems, the red and blue light comes from laser diodes, but the green component is produced from infrared lasers using frequency-doubling arrangements. This is complex, costly and less compact than desired.

Although c-plane nitride semiconductor laser diodes have reached 532nm under pulsed operation, the wall-plug efficiency is low. One factor hindering the performance of such devices is the high polarization fields in the c-plane direction in nitride semiconductors that tend to pull the electrons and holes apart, reducing their ability to recombine as light. UCSB has been among those research groups that have looked to laser devices grown in alternative crystal directions to reduce or eliminate this 'quantum confined Stark effect' (QCSE).

So far, the wavelengths of these devices have been restricted to less than 500nm, largely because it is difficult to grow high-quality material. Growing InGaIn wells is particularly hard — indium incorporation tends to create non-uniform regions of high and low concentrations (indium segregation), and basal stacking plane faults are easy to create in non-polar m-plane grown devices.

UCSB has tried semi-polar growth directions using free-standing GaN material supplied by Mitsubishi. In its latest work it has used (20 $\bar{2}1$) substrates. Last year,

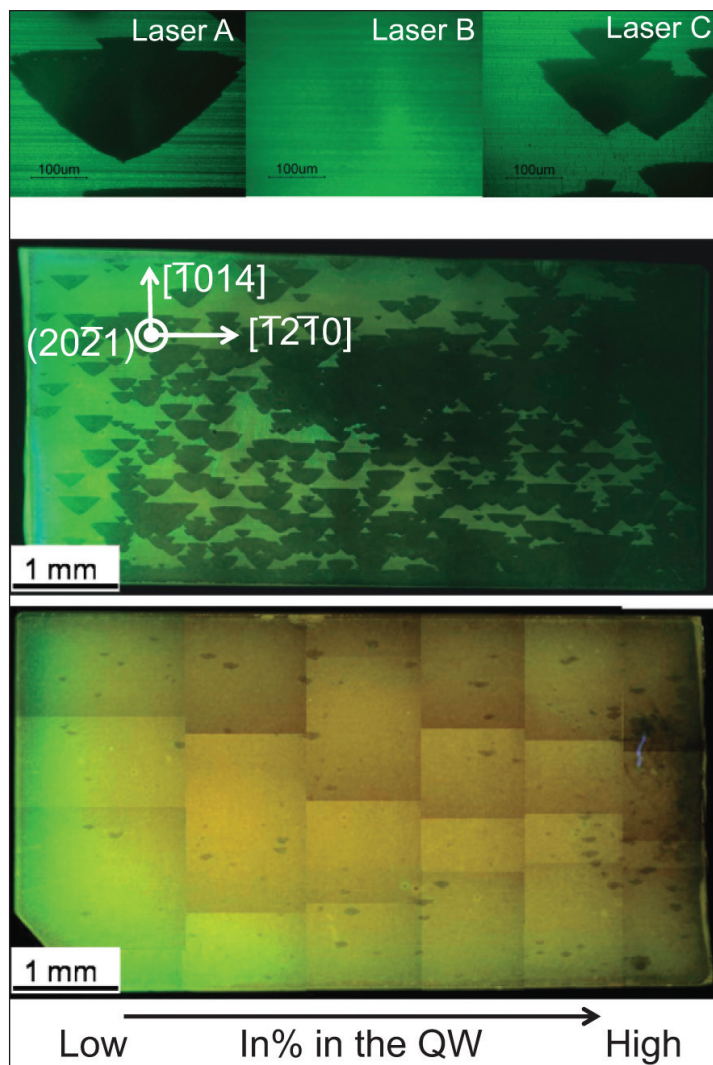


Figure 1. Fluorescence micrographs of small regions of laser material A, B and C (top) and for whole epiwafer (middle, laser A; bottom, laser B). The increase in photoluminescence wavelength from left to right is unintentional. The increase indicates higher indium content in the alloy.

Sumitomo reported such (20 $\bar{2}1$) devices that emitted 531nm-wavelength light under pulsed operation, and UCSB spin-off Kaai Inc reported continuous-wave devices emitting at 523nm earlier this year at the SPIE conference.

The new research from UCSB compared devices with GaIn (laser A), Al_{0.05}Ga_{0.95}In (B) and In_{0.03}Ga_{0.97}In (C) barriers. The active region consisted of three-period

quantum wells with 4.5nm InGaN wells and 10nm barriers. The EBL consisted of 10nm of $\text{Al}_{0.2}\text{Ga}_{0.8}\text{N}$. The n-contact consisted of $1\mu\text{m}$ of silicon-doped GaN grown before the cladding, waveguide and active layers. The p-contact was 100nm Mg-doped GaN grown after the EBL, waveguide and cladding. The cladding and waveguide layers were doped GaN and InGaN, respectively. The laser cavities were $2\mu\text{m} \times 1200\mu\text{m}$ ridges with the end facets cleaved and coated with distributed Bragg reflectors of successive layers of silicon dioxide and tantalum pentoxide. The reflectivities for the front and rear facets were 97% and 99%, respectively.

Inspection of the material under optical and fluorescence microscopes showed $\sim 100\mu\text{m}$ non-luminescent triangular regions which were attributed to defects that presumably would give rise to non-radiative recombination and hence low output power for laser diodes. The material for lasers A and C showed large triangles, while that for the laser B material using AlGaN barriers shows uniform QW emission without non-luminescent regions (Figure 1). A wider-field inspection on the wafer-level did find some small triangular regions in the B sample. In fact, the wafers were non-uniform in the density of triangular regions, which is an effect attributed to non-uniformity in the growth process temperature.

The electroluminescence (EL) spontaneous emission peak wavelength for laser B was well within the green region at 527nm. The AlGaN barrier increased the EL of the devices significantly compared with those made of GaN or InGaN. The UCSB researchers believe that the use of AlGaN barriers "provides a pathway to high internal quantum efficiency in the green and yellow spectrum regions."

The researchers tested the lasing properties under pulsed operation with a 0.01% duty cycle (Figure 2). Sample device B had a threshold of 720mA corresponding to a current density of $30\text{kA}/\text{cm}^2$. Spontaneous emission at a driving current of 20mA showed a peak at 528nm; this blue-shifted to 516nm above laser threshold.

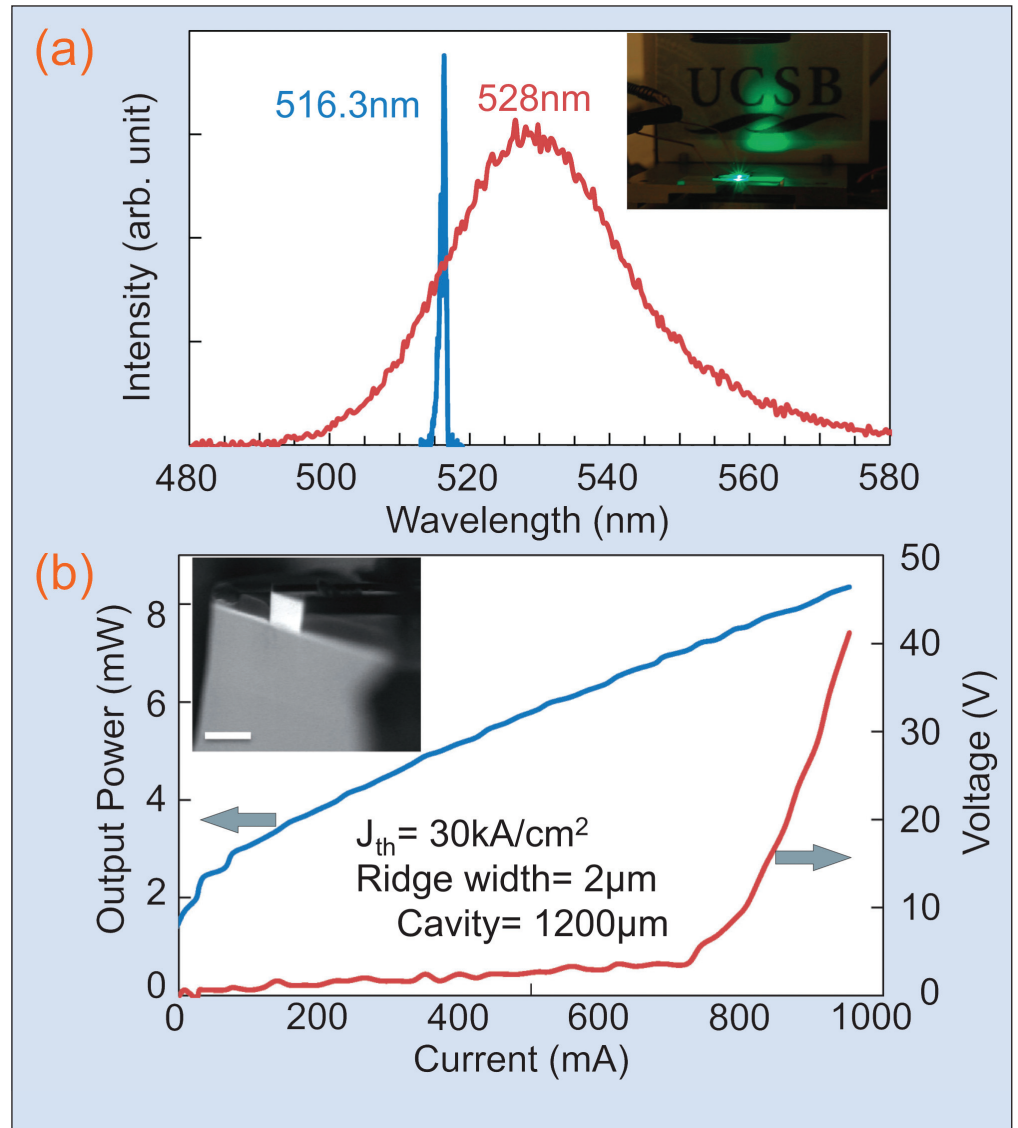


Figure 2. (a) Representative spectra of spontaneous emission with drive current of 20mA and 516nm stimulated emission with drive current above threshold of the laser with AlGaN barriers. Inset: far-field pattern of 516nm laser diode. (b) Light output power-current-voltage (L-I-V) curves of LDs under pulsed operation (duty cycle = 0.01%). Inset: representative scanning electron microscope image of cleaved facet.

Based on simulation work, the researchers believe that optical confinement could be improved by increasing the indium content in the guiding layers and by reducing the aluminum content in the barriers. However, the minimum aluminum composition in the AlGaN barrier that is needed in order to improve the emission uniformity and internal efficiency is 3%.

One of the researchers involved in the UCSB research is also of Sharp Corp, and another came from Mitsubishi Chemical Corp. ■

<http://apex.ipap.jp/link?APEX/3/082001>

<http://engineering.ucsb.edu>

<http://www.kaai.com>

The author Mike Cooke is a freelance technology journalist who has worked in the semiconductor and advanced technology sectors since 1997.

Self-organized quantum dots reduce green efficiency droop

University of Michigan produces nitride LEDs using QDs with 'superior optical qualities' and smaller blue-shift at high current.

Green LEDs based on layers of self-assembled quantum dots (QDs) in indium gallium nitride (InGaN) have been produced at the University of Michigan's Center for Nanoscale Photonics and Spintronics [Meng Zhang et al, Appl. Phys. Lett., vol97, p011103, 2010]. Among the characteristics that are seen are a reduced blue-shift at higher currents and a smaller 'efficiency droop' compared with traditional green LEDs.

Normally, green LEDs are produced from layers constituting single-quantum-well/double heterostructures (QW/DH) or multi-quantum-wells (MQWs) of InGaN material sandwiched between GaN or wider-bandgap InGaN barriers. One nasty feature of green LEDs is an efficiency droop that occurs at higher injection current density.

Although efficiency droops are seen at shorter emission wavelengths, they are generally not as severe.

Various explanations have been advanced for this droop. One of the most popular is Auger recombination where, instead of recombining as light, electrons and holes transfer their energy to a third charge carrier. This process is more likely at higher injection currents.

Another drawback of InGaN layers sandwiched between GaN is that the lattice mismatch sets up large strains that create large piezoelectric polarization fields. These polarization fields tend to work against the recombination of the electrons and holes, reducing the light emission. Theory suggests that the use of QDs could reduce the problem of piezoelectric fields, and one might hope that increased light emission could result from their use.

The Michigan devices (Figure 1) were grown on GaN/sapphire substrates using plasma-assisted molecular beam epitaxy (PAMBE). The silicon-doped (n-type) substrates were produced using hydride vapor phase epitaxy (HVPE). The self-assembled QD layers had a dot density in the range $2\text{--}5 \times 10^{10}/\text{cm}^2$ in different samples. The dot base width and height

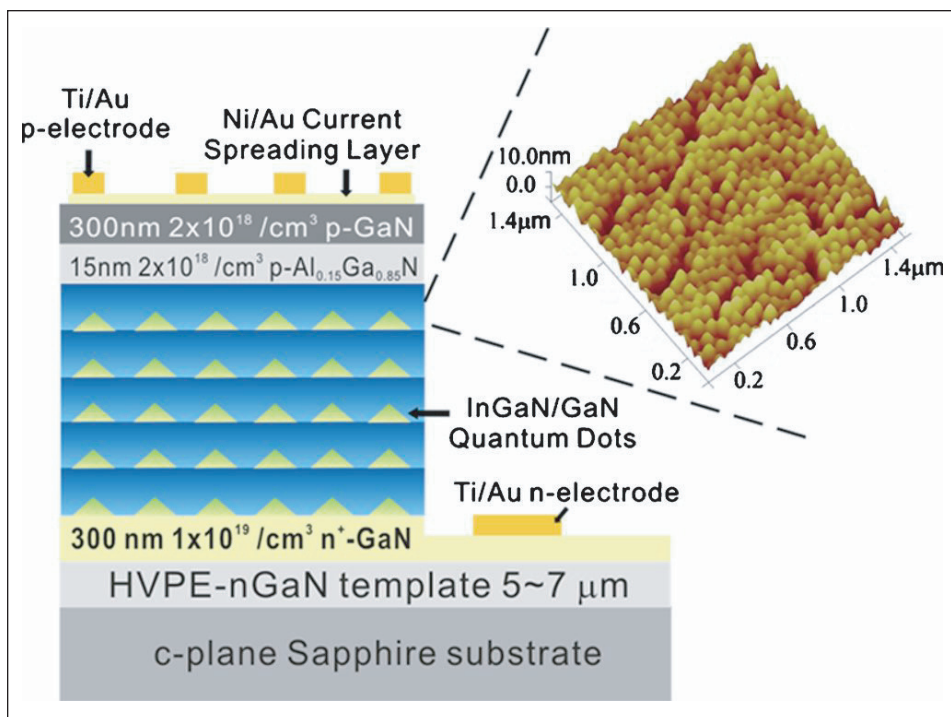


Figure 1. InGaN/GaN quantum dot LED heterostructure grown on GaN-templated c-plane sapphire substrates. Inset: AFM image $1.5\mu\text{m} \times 1.5\mu\text{m}$ of uncapped self-organized $\text{In}_{0.25}\text{Ga}_{0.75}\text{N}/\text{GaN}$ QDs.

ranges were 50–100nm and 3–4nm, respectively. Transmission electron microscopy gave a dislocation density in the surrounding GaN material of $10^9/\text{cm}^2$, giving an estimated dislocation-free environment for the radiative recombination of electrons and holes in the QDs of more than 95%.

The LEDs include an aluminum gallium nitride (AlGaN) electron-blocking layer (EBL) to avoid electron overshoot into the p-contact region, where they would recombine non-radiatively or at parasitic non-green frequencies.

Photoluminescence (PL) measurements on the LED epitaxial material suggest an internal quantum efficiency (IQE) value for the structure of 32% with a peak wavelength of 500nm (blue-green). The recombination lifetime, derived from time-resolved PL (TRPL) measurements, is given as 0.57ns. Combining this result with the IQE figure gives a radiative lifetime of 1.78ns and a non-radiative lifetime of 0.84ns. The researchers compare this with typical figures from traditional InGaN/GaN multi-quantum-well structures of

about 380ns and 120ns, respectively. A shorter lifetime implies a higher recombination rate.

Electroluminescence (EL) measurements were carried out on an LED that emitted at the green wavelength of 524nm with injection currents between 20mA and 500mA. The LED temperature was controlled at 278K ($\sim 5^\circ\text{C}$).

As the current increases to 350mA there is a small blue-shift by 4.8nm, after which current the wavelength remains constant. This compares with blue-shifts of between 20nm and 30nm typically in MQW devices grown on c-plane sapphire. The QD blue-shift is comparable with the smaller values seen in more recent MQWs grown on non-polar m-plane bulk GaN substrates. The small blue-shift suggests a polarization electric field in the QDs of $\sim 90\text{kV/cm}$, compared with fields of $\sim 2\text{MV/cm}$ in c-plane grown MQW LEDs.

The QD devices also showed less fall-off in efficiency at higher currents ('efficiency droop') beyond its peak value at 51.1A/cm^2 current density, compared with traditional green LEDs (Figure 2). The measured values are compared with a model for the IQE (Equations 1 and 2) including unwanted Shockley-Read-Hall (A) and Auger (C) non-radiative recombination processes and the wanted radiative process (B). The Shockley-Read-Hall process is most significant at lower currents, but the Auger process only becomes important at higher current densities.

The value of 'Auger' recombination (i.e. the constant C) in 407nm near-ultraviolet LEDs has previously been found by Michigan to be $1.5 \times 10^{-30}\text{cm}^6/\text{s}$. The value for the coefficient is believed to be enhanced for green light emission by a resonance effect to give an enhanced 'Auger-like' behavior. Hence the Auger coefficients for QWs and QDs may well be similar in value.

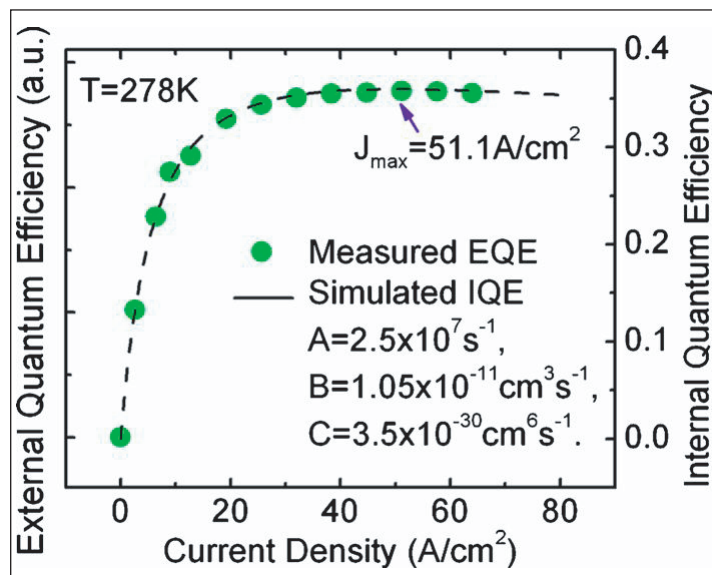


Figure 2. Measured EQE in arbitrary units peaking at 51.1A/cm^2 . Calculated IQE, based on the ABC recombination model (Equations 1 and 2) and shown by the dashed curve, is in good agreement with the EQE. The recombination constants assume the recombination thickness of each dot layer to be 3nm.

The route to reducing this effect would then be creating higher rates of light emission from lower carrier densities.

The researchers also believe that tunnel injection might be a useful way of pushing suitable carriers into the QDs. Such techniques have been used to reduce hot-carrier effects in laser and LEDs, thus improving performance. ■

<http://link.aip.org/link/APPLAB/v97/i1/p011103/s1>

Author: Mike Cooke.

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UCSB reports first packaged blue LEDs on $(30\bar{3}\bar{1})$ nitride substrates

University of California Santa Barbara researchers show how a new semi-polar orientation is viable for high-performance LEDs and lasers.

University of California Santa Barbara (UCSB) researchers have reported data on what are claimed to be the first blue (452nm) packaged high-power/efficiency semi-polar $(30\bar{3}\bar{1})$ nitride LEDs [Ingrid L. Koslow et al, *Jpn. J. Appl. Phys.*, vol49, p080203, 2010]. In the past year, UCSB has been developing LEDs and laser diodes using a number of different semipolar crystal orientations in efforts to improve performance over traditional polar c-plane devices.

With maximum external quantum efficiencies (EQEs) that can be of the order of 60%, c-plane devices can seem hard to beat. Some of this is the advantage of maturity — growing material in other crystal directions is still at a relatively early stage, meaning that these materials tend to have higher defect levels ($\sim 10^{10}/\text{cm}^2$) compared with c-plane. The operating conditions can also be rather special to create headline EQEs (e.g. a particular current, temperature control, etc). What are needed are devices that can operate at high efficiency and power over a broad range of operating conditions.

It is believed that non-polar and semi-polar materials may produce better devices because the electric fields across the active region are reduced. In polar devices, these fields cause a 'quantum-confined Stark effect' (QCSE), separating the electrons and holes and hence making the lifetime for radiative recombination longer compared with other mechanisms, hence reducing efficiency. The fields can arise from spontaneous and piezoelectric (i.e. strain-dependent) polarization in nitride semiconductors.

The UCSB researchers note that the $(30\bar{3}\bar{1})$ plane used in their latest work is only 5° away in crystal orientation from $(20\bar{2}\bar{1})$ material that has recently shown promise for green laser diodes at Sumitomo Electric Industries in Japan (Figure 1).

UCSB works with Japan's Mitsubishi Chemical, which supplied the free-standing $(30\bar{3}\bar{1})$ semi-polar substrates,

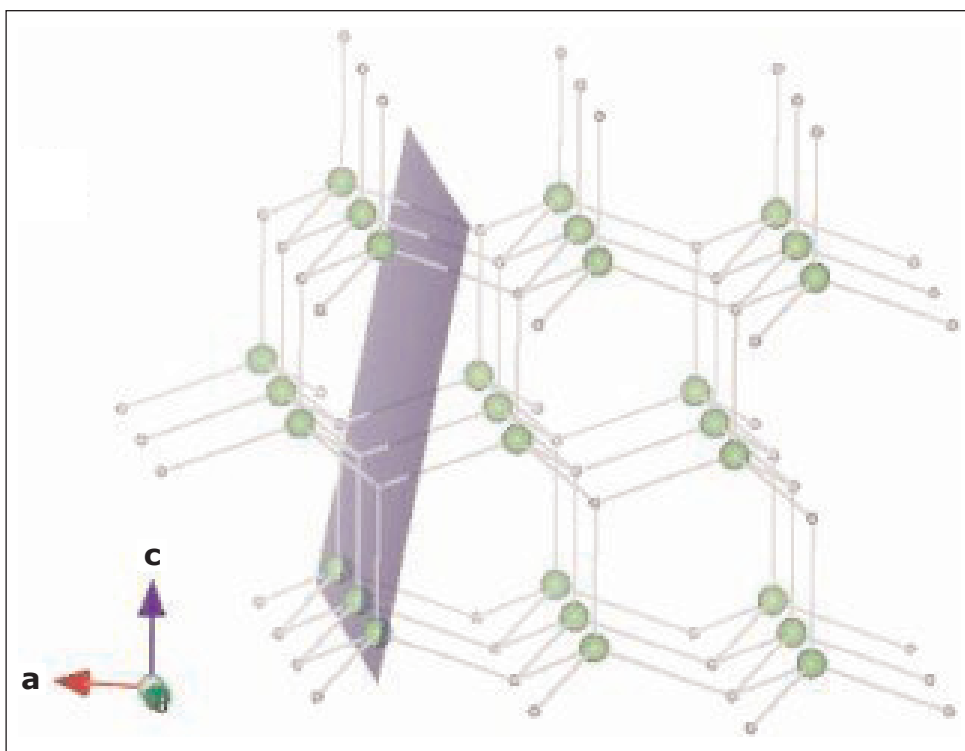


Figure 1. Schematic of $(30\bar{3}\bar{1})$ crystal plane.

grown by hydride vapor phase epitaxy (HVPE). Based on its measurements, the manufacturer estimates a threading dislocation density of less than $5 \times 10^6/\text{cm}^2$ for the material. The substrate was polished using chemical and mechanical processes.

UCSB performed its MOCVD under atmospheric pressure, using conditions similar to those employed for growing c-plane LEDs, with silicon providing n-type and magnesium p-type doping. The structure (Figure 2) was fairly typical for indium gallium nitride (InGaN) LEDs with a three-period multi-quantum well InGaN/GaN (3nm/20nm) light-emitting active region (Figure 1).

A 16nm p-AlGa_N (aluminum gallium nitride) layer was used to block electrons from overshooting the active region. Without an electron-blocking layer, GaN LEDs generally exhibit reduced efficiency, as electron-hole recombination in the p-contact region is non-radiative or at a parasitic wavelength.

The n-GaN layer was grown at 1140°C, the active region at 870°C and the p-GaN at 960–990°C.

Tin oxide-doped indium oxide (SnO₂-doped In₂O₃,

indium tin oxide (ITO) transparent conducting material was applied to the p-GaN to spread the current from the p-electrode. The LED contact structures were applied to 200 μm x 500 μm mesas using conventional means. The mesas were formed using a chlorine-based inductively coupled plasma etch.

The wafers were thinned and then scribed to release the individual devices. The LEDs were put on silver headers and encapsulated in silicone with a truncated cone format.

Measurements were carried out using DC current, and the power and emission spectra were determined using an integrating sphere. The peak EQE for the device was found to be 27.8% at 5mA injection current. At 20mA, the EQE was 26.5% and the output power was 14.48mW. The forward voltage at 20mA was 5.4V, which is seen as being a little higher than desired. The researchers see this as being due to unoptimized growth conditions for the final p-GaN and ITO layers.

Spectral measurements indicate a peak wavelength red-shift of less than 1nm for currents in the range 5–100mA. This small shift is typical for devices grown on non-polar and semi-polar (10 $\bar{1}\bar{1}$) substrates. By contrast, devices grown on traditional c-plane GaN have blue-shifts of tens of nanometers (an effect attributed to energy shifts in the band structure arising from the quantum confined Stark effect).

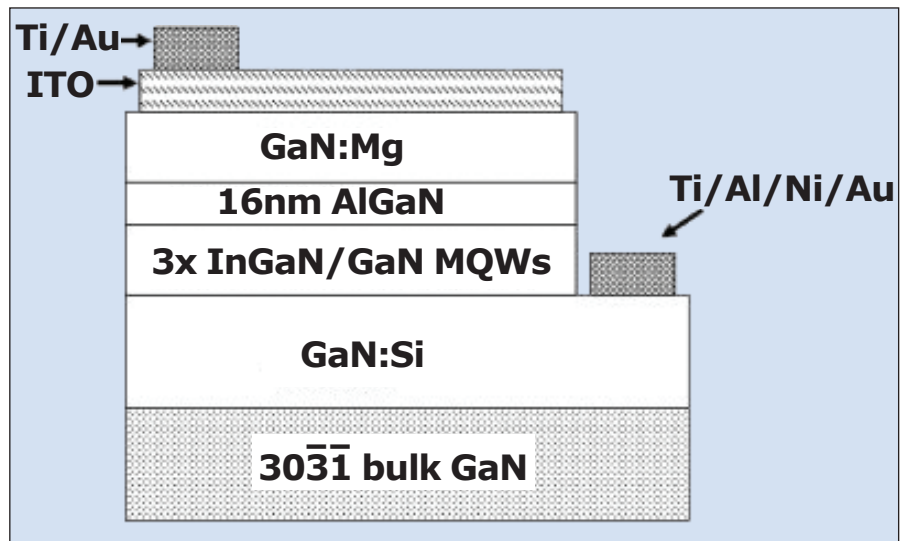


Figure 2. Schematic of (30 $\bar{3}\bar{1}$) LED device structure.

The full-width at half-maximum (FWHM) of the emission spectrum is less than 25nm at low current. This increases at higher currents to ~33nm at 100mA. The researchers see this behavior and the small red-shift in peak wavelength as being due to thermal effects arising from the inefficiencies indicated by the high forward voltage.

The researchers conclude: "Although LED growth on this plane has not yet been optimized, these results demonstrate the viability of high-performance GaN LEDs and laser diodes grown on substrates of this orientation." ■

<http://jjap.ipap.jp/link?JJAP/49/080203>

Author: Mike Cooke.

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Unveiling hot-electron over-spill in nitride LEDs

Staircase injector structures used to thermalize electrons, improving light emission performance in InGaN diodes.

Researchers at the US Virginia Commonwealth University and Lithuania's Semiconductor Physics Institute believe that hot electrons may be more important in nitride LEDs than previously considered [X. Ni et al, J. Appl. Phys., vol108, p033112, 2010]. In line with their ideas, they have developed LED structures that reduce these effects and improve light emission efficiency.

Normally, nitride LEDs are modeled with electrons that are in thermal equilibrium with their immediate surroundings. For this to be an accurate representation, the electrons need to interact with these surroundings as they enter the active region. If instead the electrons do not interact, they will be 'hot' and will cross the active region at a higher energy than expected and could even spill over into the p-contact region where they recombine (Figure 1), most-likely without radiating light, or with unwanted parasitic wavelengths.

Such hot or 'ballistic' electrons are also less likely to be blocked by electron-blocking layers (EBLs) that are commonly a feature of such devices designed to reduce over-spill. The researchers' models also suggest that 'quasi-ballistic' electrons that have undergone only one interaction with a longitudinal optical (LO) phonon could also contribute to overflow into the p-contact.

"We would like to underscore that consideration of hot electrons, and their ballistic and quasiballistic transport across the active region, is revolutionary when it comes to light emitters such as those discussed here," the researchers comment.

Electron-phonon interactions in nitride semiconductors are particularly strong due to the more ionic nature of

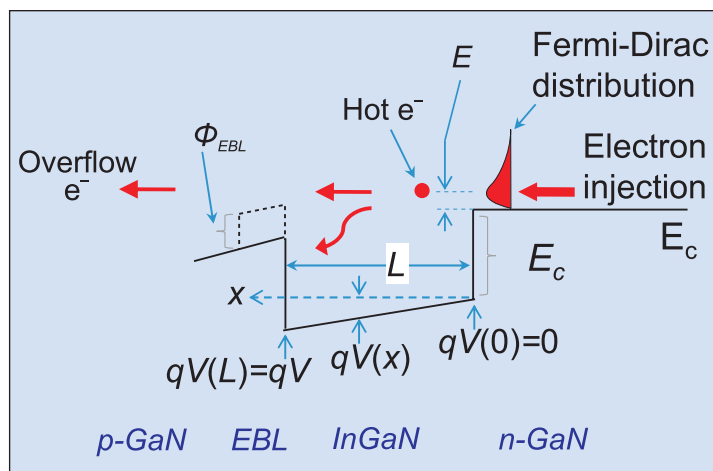


Figure 1. Schematic of electron overflow caused by ballistic or quasi-ballistic transport across InGaN active region. Hot electrons can traverse the active region ballistically and quasi-ballistically, avoiding recombination inside InGaN (contributing to the electron overflow), or be thermalized and captured inside the active region through interactions with LO phonons.

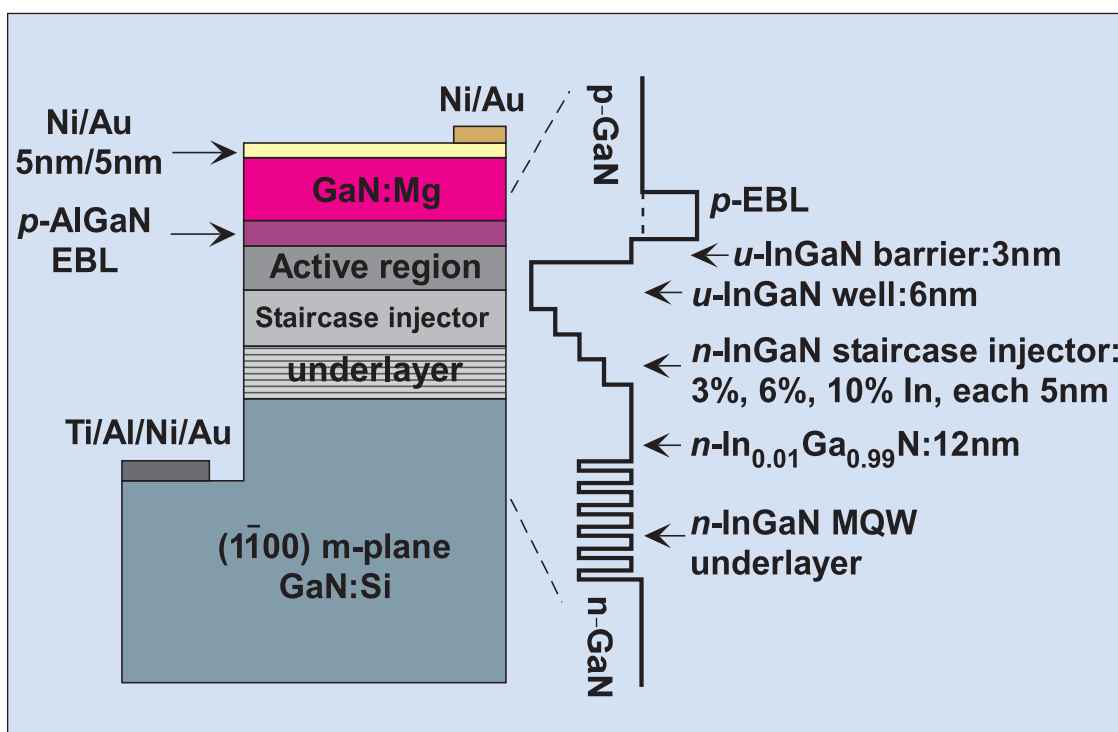


Figure 2. Schematic for two m-plane LEDs with InGaN SEI before active regions. The SEI is designed to thermalize injected electrons from n-GaN layers. Devices with and without EBL were compared.

bonds in the crystal. This means that LO phonons, rather than acoustic phonons, form the main route to thermalization in high electric fields.

To test their ideas and models, the researchers grew a series of double-heterostructure LED structures. Some were produced on free-standing m-plane GaN supplied by Kyma Technologies using low-pressure metal-organic chemical vapor deposition (MOCVD); others were grown on c-plane sapphire. The active region of the m-plane devices consisted of 6nm of undoped $\text{In}_{0.2}\text{Ga}_{0.8}\text{N}$, giving a peak wavelength of $\sim 440\text{nm}$ (blue). The c-plane active region consisted of 6nm of undoped $\text{In}_{0.15}\text{Ga}_{0.85}\text{N}$ with peak wavelength $\sim 410\text{nm}$ (violet).

The active layers of both device types were followed by a 3nm undoped $\text{In}_{0.01}\text{Ga}_{0.99}\text{N}$ layer. Before these layers (i.e. on the n-side of the diode), a silicon-doped $\text{In}_{0.01}\text{Ga}_{0.99}\text{N}$ underlayer was used. Various heights of electron blocking were used by varying the aluminum content in a 10nm $\text{Al}_x\text{Ga}_{1-x}\text{N}$ layer ($x = 0\%$, 8% or 15%) deposited before the magnesium-doped p-GaN contact ($\sim 100\text{nm}$).

Devices with and without a three-level staircase electron injector (SEI) were produced (Figure 2). The SEI consisted of 5nm layers of n-InGaN with In compositions of 3%, 6% and 10% before the active region. The first step from the 1% In underlayer was very close to or smaller than the energy of the $\sim 88\text{meV}$ longitudinal optical phonon assumed to be responsible for thermalization.

To avoid degradation of the material quality by the insertion of the SEI, a six-period multi-quantum well (MQW) was incorporated into the underlayer.

The epitaxial materials were processed into LEDs with $250\mu\text{m}$ -diameter mesa formation and contact metal deposition. Tests were performed with pulsed operation to avoid self-heating effects that degrade performance. The detection geometry was kept the same throughout the experiments, but not all photons were collected so the results indicated relative efficiencies only.

Without the SEI, the EBL had a big effect in increasing the relative external quantum efficiency of the devices: the devices without an EBL had EQEs reduced by a factor of three to five. However with the SEI there was little difference in the emissions with or without an EBL in the m-plane device set-up (Figure 3). This is taken as indicative that only negligible thermionic emission remains to allow electrons to cross the barrier (i.e. the SEI arrangement has successfully thermalized the electron distribution).

With the c-plane devices with SEI there is some difference in behavior but not at the level shown by devices without an SEI (Figure 4). The researchers note: "Somewhat unexpectedly, in the c-plane case the LED without EBL shows even higher EQE than that with the EBL when the current density is below $1700\text{A}/\text{cm}^2$."

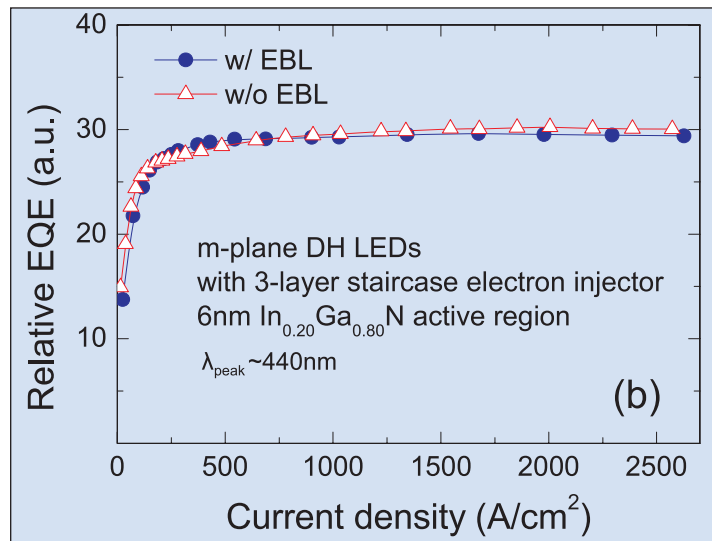


Figure 3. Relative EQE of two m-plane LEDs with SEI, with and without EBL (pulsed current, $1\mu\text{s}$ pulse width, 0.1% duty cycle).

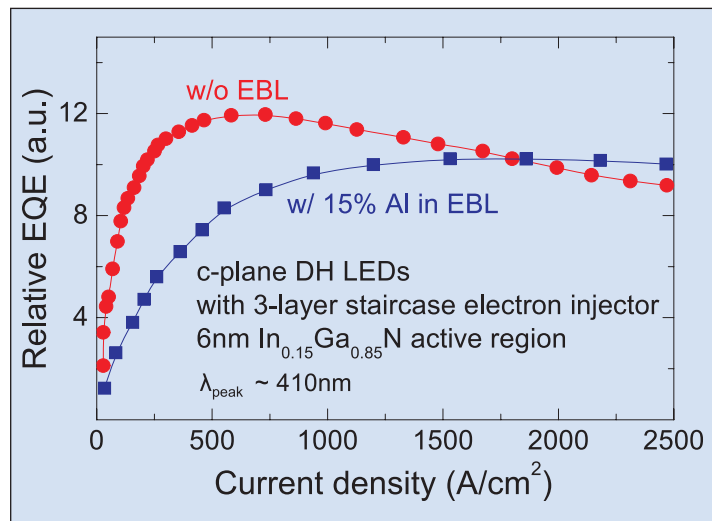


Figure 4. Relative EQE of two c-plane LEDs with SEI inserted under active region: with and without EBLs (pulsed current, $1\mu\text{s}$ pulse width, 0.1% duty cycle).

The reduced EQE above $1700\text{A}/\text{cm}^2$ is attributed to factors such as 'current filamentation' (inhomogeneity perpendicular to the direction of current flow). Also, the EBL may block the holes from entering the active region due to their heavier effective mass and low concentration in the c-plane case. The degradation in performance of the device without EBL above $500\text{A}/\text{cm}^2$ may also suggest that the c-plane orientation may require more thermalization to avoid electron overflow due to polarization field effects.

The researchers suggest that these results should also be applicable to the design of laser diodes where high threshold current densities make the carrier thermalization an even more important issue. ■

<http://link.aip.org/link/JAPIAU/v108/i3/p033112/s1>
www.pfi.it/index_e.html

Author: Mike Cooke

Taiwan researchers show nanorod route to white LEDs

Proof-of-concept shows ‘unique possibility’ for high-CRI white LEDs.

Taiwan National Tsing-Hua University researchers believe that they have found a “unique possibility to fabricate nanorod array LEDs with high color rendering capability” [Hon-Way Lin et al, Appl. Phys. Lett., vol97, p073101, 2010].

Rather than using planar multi-quantum well (MQW) indium gallium nitride (InGaN) light-emitting devices, the Taiwan group is developing vertical, self-aligned, catalyst-free gallium nitride (GaN) nanorod arrays grown on 3-inch n-type silicon (111) substrates. The researchers grew their nanorod arrays using plasma-assisted molecular beam epitaxy (PAMBE).

The nanorods are used as ‘nano-structured compliant templates for growing strain-free InGaN nanodisks’. The strain-free nature arises because the nanodisks can be grown thicker (tens of nanometers) than usual planar MQW InGaN layers (2–4nm). When LEDs based on InGaN nanodisks are produced there is a spread in emission wavelengths, with the peak depending on the growth temperature and In/Ga beam fluxes.

Although there has been recent work that has enabled the whole range of InGaN compositions (In 0–100%) to be produced on nanorods (resulting in blue to red LEDs), until now white light has not been achieved due to difficulties in arranging appropriate light-mixing conditions.

The new approach is to stack nanodisks with different emitting properties to achieve appropriate mixing to obtain white light (Figure 1). Because of the strain-free nature of the nanodisks, the researchers are not limited to the active-layer thicknesses of a few nanometers common for normal planar MQW designs. Instead, the nanodisk active layers can be in the range 10–25nm. The thick disks also reduce another planar MQW defect — carrier overspill into the contacts, most usually electrons recombining in the p-contact, reducing light-emission efficiency.

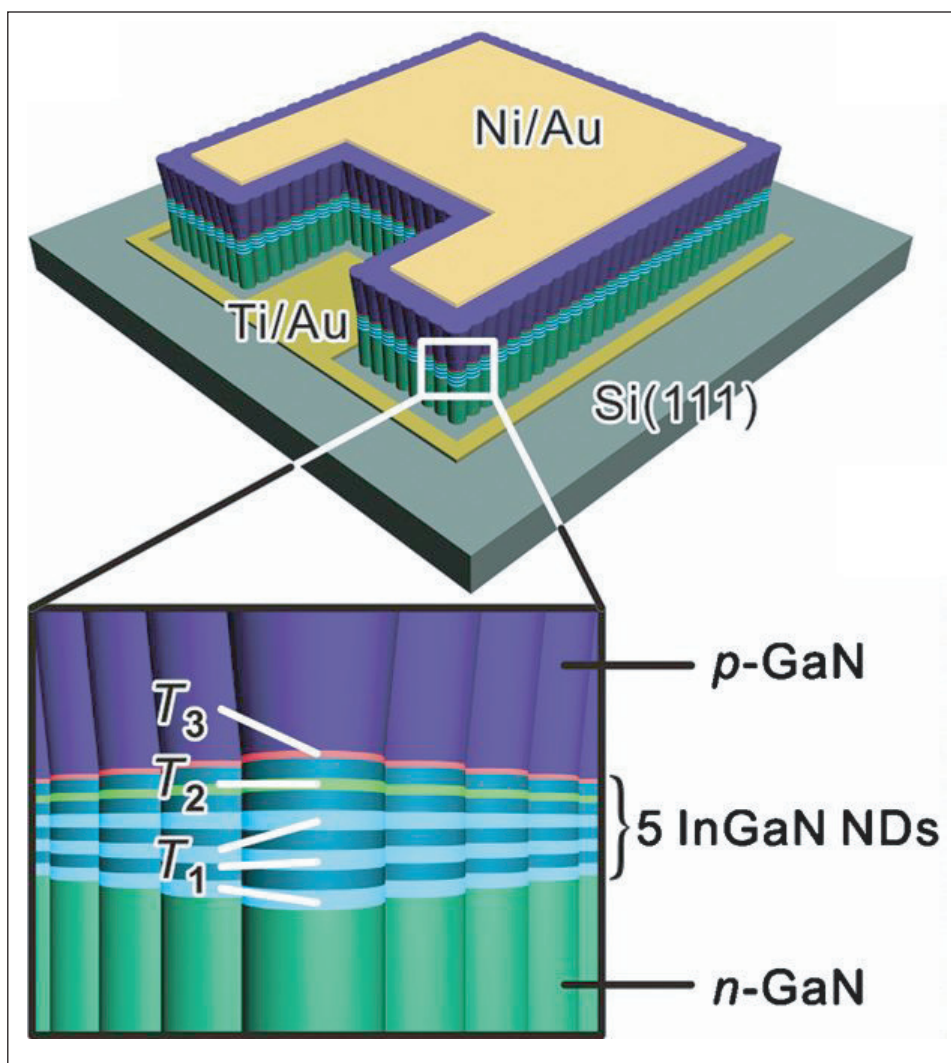


Figure 1. Schematic of nanorod-array LED structure for generation of white light. Active regions contain multiple InGaN nanodisks.

The researchers are not limited to the active-layer thicknesses of a few nanometers common for normal planar multi-quantum well designs... Instead, the nanodisk active layers can be in the range 10–25nm

At the present proof-of-concept stage, the emissions from the arrays are ‘spotty’ (Figure 2). Even so, there are localized full-color emissions from the array. The researchers believe this demonstrates the “unique possibility to fabricate nanorod array LEDs with high color rendering capability”.

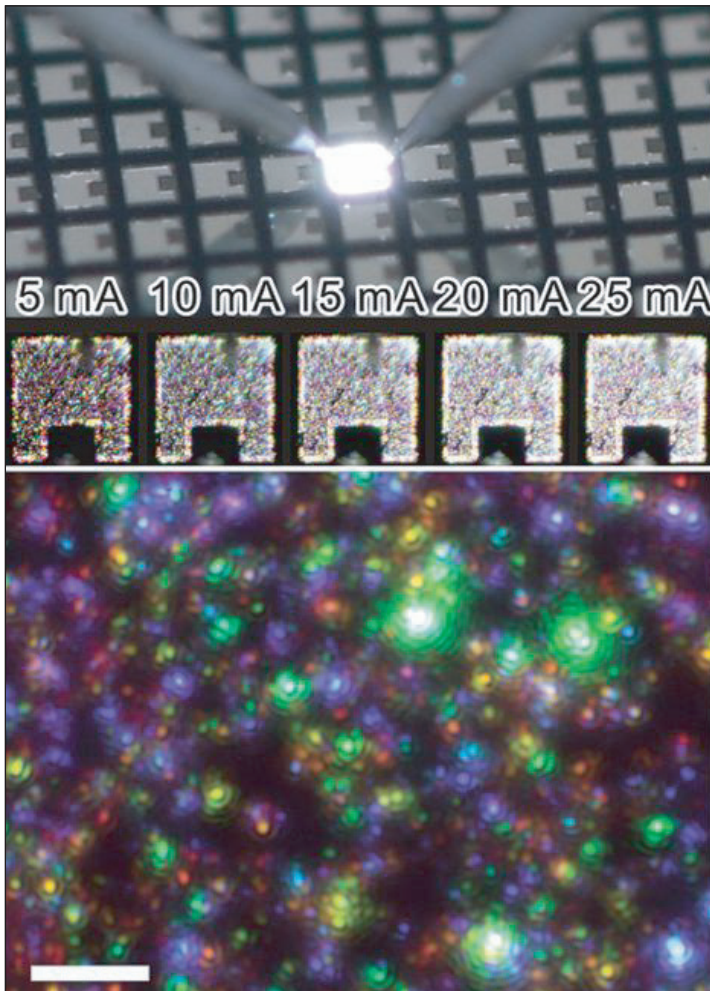


Figure 2. (Top) Photo of nanorod-array LED emitting white light at 20mA injection current. Micro-EL images below are acquired under a 10x objective lens at various injection currents. (Bottom) Micro-EL image (20mA) under 100x objective lens revealing full-visible-spectrum emissions from white LED. Scale bar: 10µm.

For planar white LEDs, one generally uses an ultraviolet (UV) or blue LED combined with a phosphor emitter to produce a broad range of wavelengths of light.

One reason for using this inefficient arrangement is the difficulty in filling the green–yellow gap with efficient direct light-emitting devices.

To obtain high color rendering indices (CRIs) with normal

The nanorod LEDs were tested over the injection current range 5–25mA. Spectral analysis revealed that the ensemble of emitters contained major peaks at blue and yellow wavelengths, with a third weaker ensemble contribution extending into red wavelengths. The blue-shift for the blue light is 1.3nm, and for the yellow it is 2.4nm (normal green LEDs can show shifts of tens of nanometers)

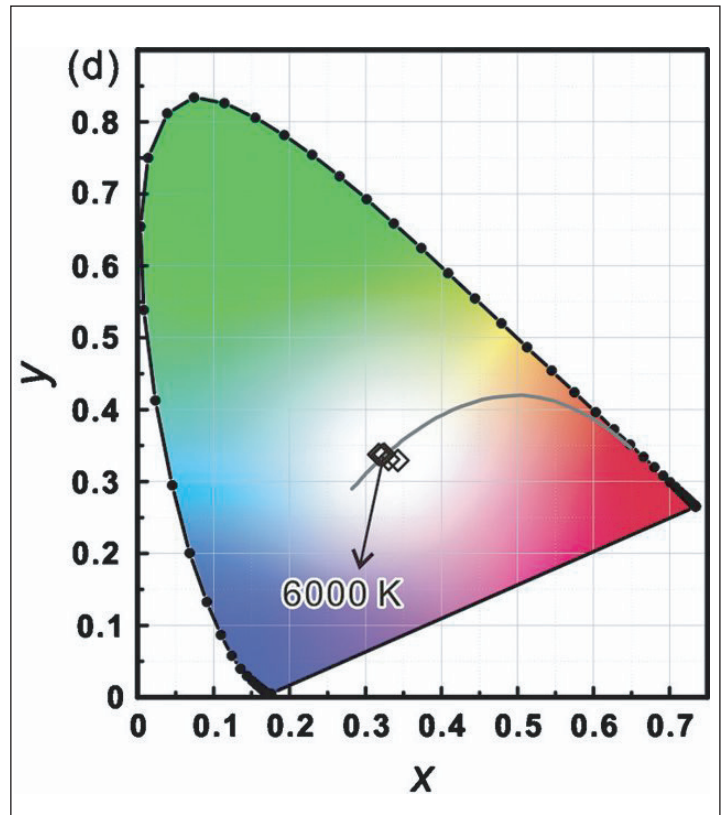


Figure 3. Commission internationale de l'éclairage 1931 chromaticity coordinates at injection currents from 5mA to 25mA. The correlated Planckian color temperature stays near 6000K (natural white light) for injection currents larger than 5mA.

UV/blue LEDs requires a wide array of phosphors with appropriate temperature stability, quantum efficiency, and chemical robustness.

The nanorod LEDs were tested over the injection current range 5–25mA and showed “negligibly small spectral blue-shifts” in emission with increasing current. The spectral analysis revealed that the ensemble of emitters contained major peaks at blue and yellow wavelengths, with a third weaker ensemble contribution extending into red wavelengths. The electroluminescence depends in a linear fashion on the injection current.

The blue-shift for the blue light is 1.3nm, and for the yellow it is 2.4nm (normal green LEDs can show shifts of tens of nanometers). The researchers believe that the small shifts seen in their nanorod devices may be due to small spontaneous polarization mismatches between the InGaN and GaN materials. The correlated color Planckian temperature remains near 6000K (natural white light) for injection currents larger than 5mA (Figure 3). ■

http://apl.aip.org/resource/1/applab/v97/i7/p073101_s1
www.phys.nthu.edu.tw/en

The author Mike Cooke is a freelance technology journalist who has worked in the semiconductor and advanced technology sectors since 1997.

Chinese burn into LED market driving MOCVD

Times are good for the two main metal-organic chemical vapor deposition system makers Aixtron and Veeco. Demand from China for their MOCVD tools is booming, thanks in part to hefty subsidies from the Chinese government. Mike Cooke reports.

China is coming to the end of its 11th five-year plan (2006–2010). Not only is the country advancing its industrial base, it wants to increase energy conservation, and one way is seen as being the use of 'green lighting', e.g. by installing LED-based street and traffic lighting. To support these ambitions, the Chinese state has set up four LED industrial areas, seven national LED Industrial Parks, and 21 showcase pilot cities.

It is estimated that the epitaxy and chip value component for LED production is about 70% of profits, while the remaining 30% comes from the packaging. China has until now been stronger in the lower-value packaging stage, but it wants to move in on the higher rewards of epitaxy through subsidizing MOCVD equipment purchases by CNY8–10m each (Chinese yuan/renminbi 'people's currency', CNY8–10m ~ \$1.2–1.5m, CNY6.7 ~ \$1). This subsidy can represent almost half of the equipment cost. Beneficiaries have been domestic firms, joint-ventures and foreign settlers.

Some reports put current orders for MOCVD equipment at up to 1600 sets. Sanan Optoelectronics announced recently that it plans to invest CNY12bn (about \$1.7bn) to build an LED manufacturing plant in Wuhu, and it plans to purchase 200 MOCVD systems over the next 3 to 4 years. Tsinghua Tongfang plans to invest CNY3bn over the next three years. Silan Microelectronics plans to buy 30 MOCVD tools and has raised CNY575m to expand LED production, along with replenishing its working capital. Elec-Tech in Shenzhen has made a

Table 1. Solid-state lighting legislation and subsidies (production-equipment related in China and Taiwan). Based on Sterne Agee 2010, World Bank 2009, OECD 2010, and LEDinside.

Country	Legislation	Subsidy	Ban	GDP rank
US	Yes	Yes	<2020	1
EU	Yes	Yes	<2012	2
Japan	Yes	Yes	2012	3
China	Yes	Yes	2017	4
Canada	Yes	Yes	2012	5
Russia	Yes	Yes	<2014	7
Australia	Yes	No	2010	8
Korea	Yes	Yes	2013	10
Taiwan	Yes	Expired	2012	16

Table 2. Residential light cost comparisons (Citigroup Global Markets June 2010, Sterne Agee 2010, BETAled, LEDinside, and Aixtron).

Residential lighting	LED	Incandescent	CFL
No. of lightsources	5–12	1	1
Cost of bulb	\$20–35	\$1–2	\$8–12
Power requirements	7–10W	60W	10–12W
Energy consumption (kWh/yr)	8	61	11
Annual electrical bill (at \$0.15/kWhr)	\$1.2	\$9.2	\$1.7
LED payback: no lifetime adjustment	—	<2.5yrs	<2.5yrs
LED payback: 3yr lifetime adjusted	—	<1yr	<1yr
LED payback: 5yr lifetime adjusted	—	<0.5yr	<0.5yr

Table 3. Commercial light cost comparisons (Citigroup Global Markets June 2010, Sterne Agee 2010, BETAled, LEDinside, and Aixtron).

Commercial lighting	LED	Incandescent	CFL
No. of lightsources	5–12	1	1
Cost of bulb	\$20–35	\$1–2	\$8–12
Power requirements	7–10W	60W	10–12W
Energy consumption (kWh/yr)	22	180	11
Annual electrical bill (at \$0.15/kWhr)	\$3.4	\$27.0	\$5.0
LED payback: no lifetime adjustment	—	<1yr	<2yrs
LED payback: 3yr lifetime adjusted	—	<4 months	<1/2yr
LED payback: 5yr lifetime adjusted	—	<1 quarter	<4mths

joint venture cooperative agreement with South Korean firm EpiValley to develop the Chinese LED market. US–Taiwan firm SemiLEDs began building a \$350m plant in Nanhai district of Foshan, Guangdong in March 2010. ▶

Overheating of the market, resulting in over-supply of LEDs, is a leading concern arising from such developments. Over-supply could lead to rapid price falls and the loss of profitability (and hence return on investment). The Chinese government is reportedly cognizant of the problem and is expected to address it in the national plan for the next five years (No.12). However, one may be skeptical that 'planned economies' will be any better at dealing with the temptations of semiconductor boom & bust than their 'free market' counterparts.

The Chinese government is not alone in subsidizing the LED industry for general lighting (Table 1), along with shutting down the production of much less efficient incandescent light bulbs through legislation.

Market reports

Of course, over-supply won't be a problem if new markets/demand can be found or developed. Although arguments can be made for LED lighting in terms of lower running and replacement expenses, the up-front cost for these components is still high (Tables 2 & 3). However, as LED costs come down, the balance will tip in favor of LEDs. For example, some Taiwanese firms are selling white light LED bulbs at \$12-15, compared with the \$20-35 LED bulb cost presented in Tables 2 & 3.

While general illumination may be the future for high-volume LED production (Figure 1), there are significant contemporary applications (Figures 2 and 3) in street, traffic and architec-

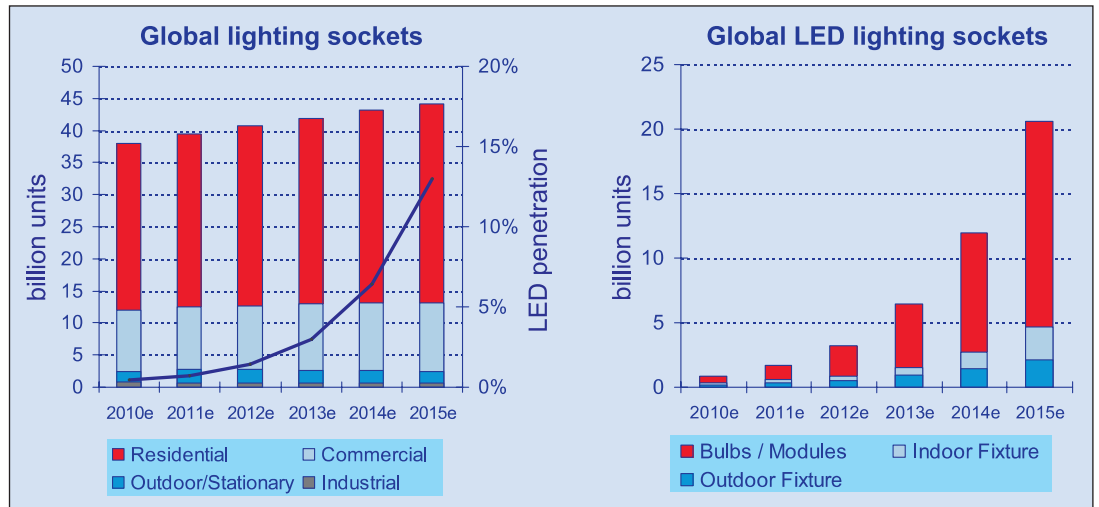


Figure 1. Solid-state lighting market estimates based on data from Sterne Agee 2010, Citigroup Global Markets June 2010, and Clinton Foundation.

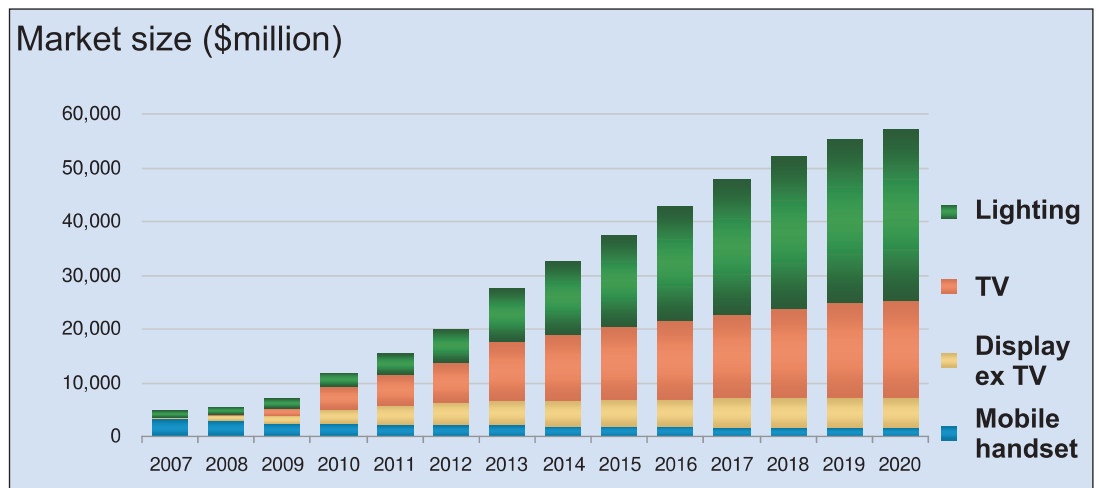


Figure 2. Morgan Stanley Research's projections for various LED markets. The expected compound annual growth rate (CAGR) for the total market is 21%, and for the lighting segment it is 31%.

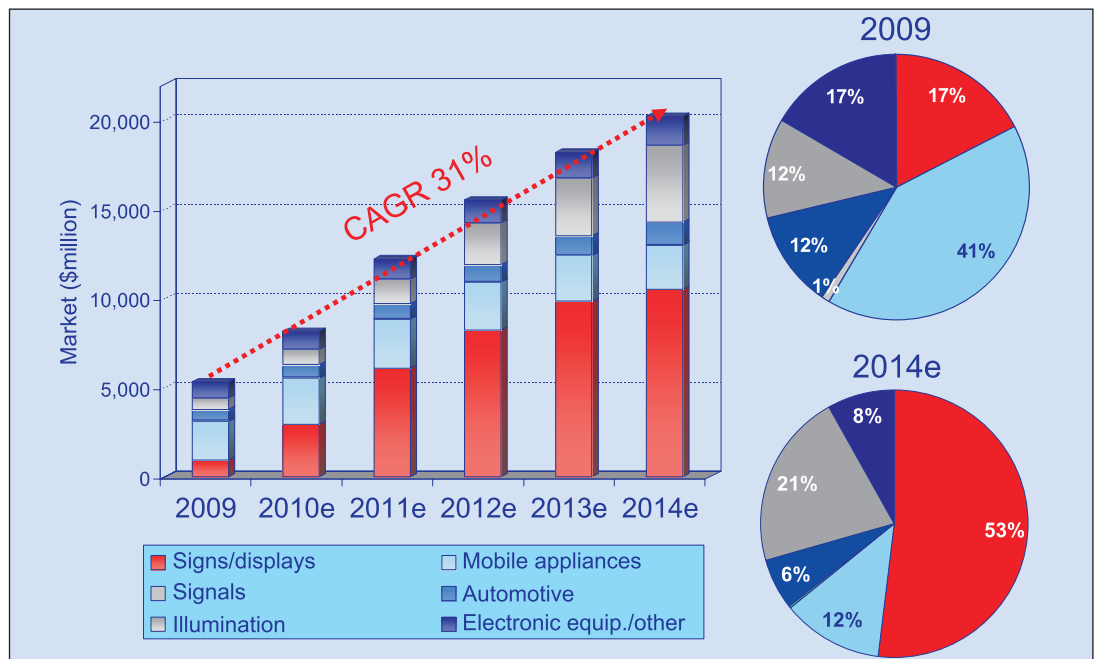


Figure 3. Strategies Unlimited February 2010 forecast for period up to 2014.

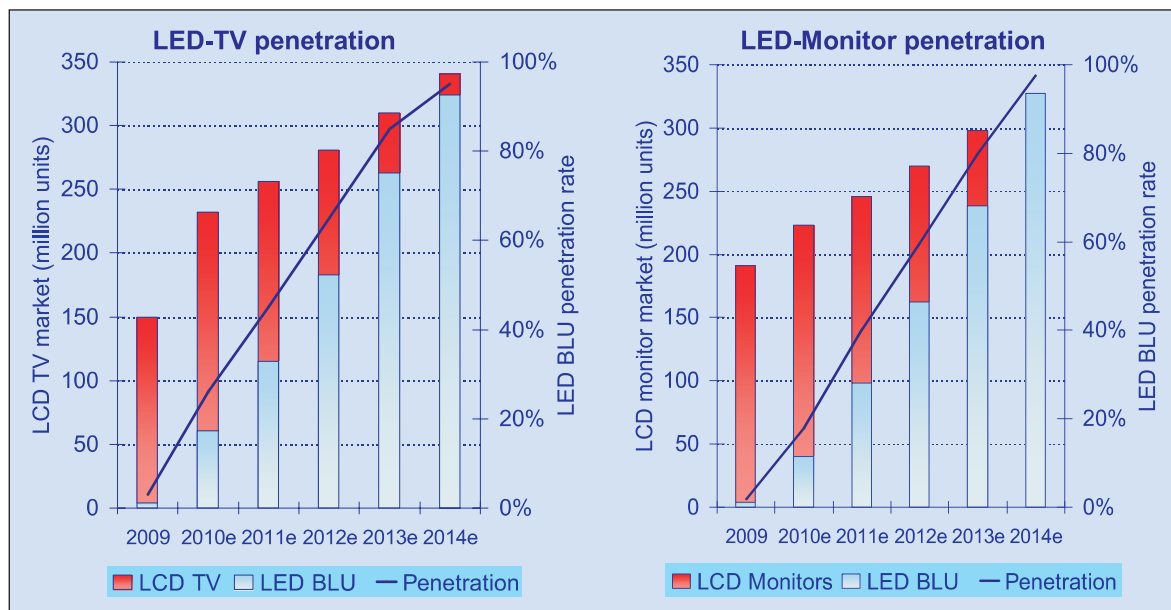


Figure 4. LED backlighting unit (BLU) market forecasts based on data from Aixtron and Display Search, Q2/2010.

tural lighting, and for TV/monitor LCD display back-light units (BLUs).

Much of the recent increase in LED demand has been associated with an expected switch from cold-cathode fluorescents (CCFL) to LED BLUs (Figure 4). Advantages of LED power LCD displays can include greater dynamic contrast, compactness (thinner screens), wider color gamut (especially with RGB lighting), less pollution on disposal, and lower power consumption.

BLU production seems to be the motivation of a number of the Chinese companies setting up LED facilities. One of these, Elec-Tech, is a supplier of household electronics (e.g. TVs) to the Wal-Mart retail giant in the USA.

Some market research firms (e.g. TrendForce) comment that there is a large degree of over-optimism in China for LED prospects. Some companies in China are entering the arena blindly without an accurate idea of the market or their place in it.

The great increase in Chinese MOCVD capacity is likely to suffer from a lack of qualified personnel, particularly at the R&D end of product introduction. This will have impacts on product quality, volume, yield, competitiveness, etc.

There also seem to be wide discrepancies in the market research estimates (Figure 5) — TrendForce sees there being plans for 1200 systems, with 300 coming in 2010; IMS Research says that 300 systems were installed in Q2/2010 and that there are expectations for more than 4000 systems to ship over the 2010–2013 timeframe, giving an increase in LED capacity of more than 300% over 2009–2014.

TrendForce adds that historical experience suggests that the number of actual systems will be less than those planned.

According to IMS, Aixtron and Veeco are increasing capacity to meet demand — targeting about 150 and 120 systems per quarter by the end of the year, respectively. Aixtron has about 60% market share and Veeco about 37%, worldwide. Aixtron leads in Taiwan and China, while Veeco is dominant in South Korea. Veeco puts its own market share at more than 40% 'and growing'.

The firm claims a bookings market share for Q2/2010 of 52%, while in revenue terms market share is around 30% in Q1, but increases to 42% in Q2. The company says that it sells to more than 80% of the world's LED makers. It has doubled its 2009 customer list and plans to ship to more than 35 manufacturers this year. Key Veeco customers include Osram, Bridgelux, Lumileds, Seoul Optodevice, and Sanan.

Aixtron points out that it has maintained a 60–70% market share over the period 2002–2009 (based on figures from VLSI Research and Gartner Dataquest). The only other significant MOCVD tool producer (~10%) over this period was Taiyo Nippon Sanso. Other companies have either fallen by the wayside or been acquired, such as Emcore by Veeco. Although Applied Materials is researching LED MOCVD production equipment with US government money (see May issue of Semiconductor Today, page 110), it does not yet have commercial tools available.

Sales highlights

Both Aixtron and Veeco have made a string of press announcements of sales in China since the beginning of the year.

Veeco has an impressive list of Chinese clients. Since January 2010, the company has announced sales destined for production at facilities owned by the firms Tsinghua Tongfang, Elec-Tech, Shanghai Epilight, Invenlux, Neo-Neon, and Sanan. Other Veeco sales announcements this year are in Taiwan (Arima, Epistar, Genesis Photonics) and Korea (Seoul Optodevice).

However, even some of the 'non-Chinese' sales are destined for installation at facilities in China. For example, Arima Optoelectronics is to install most of its new Veeco systems in Shanxi Province, northern China. ▶

▶ The Taiwanese firm has an agreement with the local government to form a new joint venture to manufacture LEDs for backlight applications.

Arima also has plans in Wujiang, Jiangsu Province, where some 10 MOCVD systems are expected to be installed by the end of the year, 10 more by mid-2011, and perhaps 150 over the next five years. Arima plans to convert an existing facility that it owns in Wujiang.

Veeco is making in-roads into Aixtron's dominance in China: Veeco is termed Tsinghua Tongfang's 'primary MOCVD supplier' for a new production facility in Nantong to be completed by the end of the year. The initial systems of a 'large' multi-tool order have been booked. The Chinese company evaluated the Veeco TurboDisc K465i MOCVD system at its R&D facility in Beijing.

Describing the system's benefits in terms of cost of ownership (CoO) and productivity, Tsinghua Tongfang vice president Wang Lianghai reports: "We have an aggressive plan to ramp production of LEDs primarily to address backlighting demand for TVs, and Veeco's technology, tool performance and customer support best matched our needs."

Elec-Tech has given Veeco its 'tool of choice' label for two new LED facilities in Wuhu and Yangzhou. As with Tsinghua Tongfang, initial systems from a large multi-tool purchase order from Elec-Tech's LED subsidiary Elec-Tech Optoelectronic Technology (Wuhu) have been booked.

"Our board of directors has approved our plan to purchase 130 MOCVD tools to ramp production capacity at our two LED factories," reports Elec-Tech's chairman Tony Wang. "Our goal is to become one of the top three LED companies by output and sales revenue in China within two years, focusing primarily on the general lighting and BLU market, but on other applications as well," he adds.

Wang also describes Veeco as his firm's "preferred and primary supplier for the vast majority of the 130 MOCVD systems", citing low CoO and high productivity as leading factors in the decision.

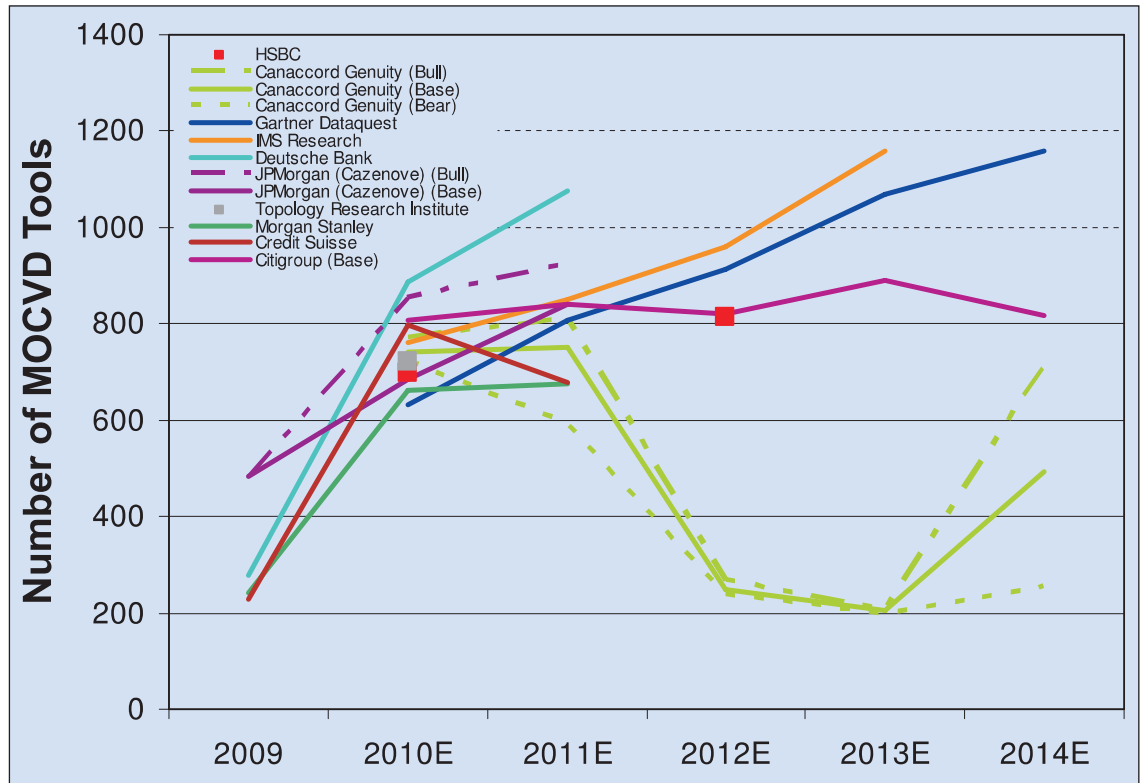


Figure 5. MOCVD market forecasts from HSBC, Canaccord Genuity, Gartner Dataquest, IMS Research, Deutsche Bank, JPMorgan, Topology Research Institute, Morgan Stanley, Credit Suisse, and Citigroup.

Aixtron has also made announcements about its recent sales in China, including: Long De Xin (LDX), Neo-Neon International, Epilight Technology, Yangzhou Longyao, Sanan Optoelectronics, Hangzhou Silan Microelectronics, Xi An ZoomView, Yangzhou Zhongke Semiconductor Lighting Center, Jiang Su Can Yang, Changelight, and Lattice Power.

Elsewhere sales have been made to Philips Lumileds Lighting Company (USA), INCOTEX Group (Bulgaria), Visual Photonics Epitaxy (VPEC, Taiwan), Tekcore (Taiwan), and Epistar (Taiwan).

To fund its expansion, Neo-Neon has recently raised TWD2.06bn (\$64m) on the Taiwan stock market, allowing the firm in Q4/2009 to order ten Aixtron CRIUS 31x2-inch configuration deposition systems for GaN ultra-high brightness (UHB) blue/green LED production. The systems are due for delivery in Q3-Q4 this year, and will be installed in a five-story facility in Guangdong.

Neo-Neon has also ordered one Veeco TurboDisc K465i as part of a LED manufacturing capacity ramp at a factory in Jiangmen. Neo-Neon's chief technology officer Dr Jurgen Yeh reports that his company plans to expand LED wafer output seven-fold over the next three years. The company specializes in flexible LED-based 'Neon-like' light replacements and has recently begun making LED streetlights.

Epilight made a 'phase 5' purchase of four CRIUS 31x2 inch Aixtron tools. These are being commissioned at the company's Shanghai facility in Q3 2010. ▶

► Financial performance

In Q2, Veeco reported record revenues of \$253m (up 250% on the previous year and 53% better than Q1). The firm shipped 81 MOCVD systems. MOCVD equipment is sold by Veeco's LED & Solar division, which made bookings of \$260m out of \$347m across the firm, including its other divisions Data Storage and Metrology.

Veeco recently agreed to sell its Metrology (scanning probe microscopy and optical) businesses to Bruker in a \$229m deal expected to close in Q4. Veeco's aim is to focus on its LED & Solar and Data Storage businesses.

CEO John R. Peeler commented on his firm's Q2 results: "We received \$251m in MOCVD orders, with customer wins in all regions, including the USA, Europe, Taiwan, Japan and Korea, and experienced accelerating demand from LED companies expanding facilities in China."

Veeco expects strong order quoting patterns, both from China's domestic companies and from Korean and Taiwanese customers that are partnering with Chinese entities.

The company has plans to ship 100 MOCVD tools in Q3 and to increase its capacity to 120 in Q4. It has a variable-cost, outsourced manufacturing strategy that allows it to 'flex' actual MOCVD shipments up or down each quarter, depending on specific customer demand and delivery requirements. In the present case, Veeco is able to 'dramatically increase' MOCVD production.

Veeco estimates sales opportunities for several hundred MOCVD units and more than \$500m in subsidies for the 2010–2011 timeframe. Customers anticipate continued investment into 2012, Veeco reports.

For Aixtron, Q2 revenues were €191.8m (~\$260m, €1 = \$1.35), up 258% on the previous year and 24% on the previous quarter. The company sees the high system demand being fuelled mainly by high-brightness LED backlighting and lighting applications.

Equipment orders were €168.5m in Q1 and €175.4m in Q2. Some 8% of the LED system orders in first-half 2010 were for new-generation systems, launched in Q1.

Aixtron's president/CEO Paul Hyland commented on the Q2 results: "It seems clear to me that a combination of the positive volume and performance effect the backlighting applications have had on LED industry yields and efficiencies and the sustained government subsidies we are now seeing, are creating tangible momentum in the development of solid-state lighting applications." He added: "The macro perspective is that the industry is clearly moving from a technical niche market to a more sustainable and larger commodity market, and this development is already having a corresponding effect on the expectations of customers who are demanding better performing products with better cost of ownership, which in turn is driving shorter product cycles and, for us, increased R&D investments." ■

MOCVD equipment suppliers' growth strategies

Veeco has two main pieces of MOCVD equipment that it is selling into the Chinese market: K465i and E475 for nitride and arsenide/phosphide deposition, respectively.

The TurboDisc K465i GaN MOCVD system was based on Veeco's 'production-proven' high-throughput K465 platform. The K465i aims to provide wavelength uniformity, run-to-run repeatability, and high yield (90% in 5nm bin, 2mm edge exclusion).

K465i incorporates new 'Uniform FlowFlange' technology to deliver alternating flows of alkyl and hydride evenly across the wafer carrier, improving uniformity and repeatability. In-situ process monitoring combines deflectometry, reflectometry and temperature measurements during growth runs.

The system can handle wafer diameters up to 8 inches. A simplified tool design allows easier tuning for fast production qualification, and fast recovery of the system after maintenance. Higher system availability results from less need to maintain the system.

The TurboDisc E475 As/P MOCVD system is engineered for high-volume production of red, orange and yellow HB-LEDs. The system can also produce laser diodes, transistors (pHEMTs, HBTs) and III-V solar cells for concentrator systems. (There is also a new K475 As/P system aimed at high-efficiency solar cell production.)

Aixtron is selling two types of production MOCVD machine for LED production — the Planetary and Close Coupled Showerhead reactors.

The Planetary reactor was developed by Philips and is under exclusive license to Aixtron. It is able to handle substrates up to 8 inches. For the lower temperatures (~850°C) needed for arsenide/phosphide materials, the heating is via infrared. The higher temperatures for nitride deposition (1200–1300°C) are achieved using induction. The precursors are delivered in a horizontal laminar flow onto substrates on a rotating carrier, allowing the Planetary reactor to create precise heterojunctions at the monolayer level.

The Close Coupled Showerhead (CCS) system introduces the reagents into the reactor through a water-cooled showerhead surface over the entire area of deposition. The showerhead system is placed near the substrates and the reagents are injected onto the substrates from a multitude of separate small tubes.

The latest CRIUS II CCS system for nitride material growth allows 55 2-inch substrates to be processed at one time for high-volume production. The rotating susceptor that carries the substrates is resistively heated. The temperature profile can be adjusted for uniformity, since the heating is divided into zones.

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6 Deposition equipment


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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,
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Tel: +1 408 943 6900

Fax: +1 408 428 9600

www.semi.org

Yole Développement

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5–9 October 2010

**CEATEC JAPAN 2010:
Combined Exhibition of Advanced
Technologies)**

Makuhari Messe, Tokyo, Japan

E-mail: contact@ceatec.com

www.ceatec.com

10–15 October 2010

**218th Electrochemical Society (ECS)
Meeting**

Riviera Hotel, Las Vegas, NV, USA

E-mail: meetings@electrochem.org

www.electrochem.org/meetings/biannual/218/218.htm

19–21 October 2010

SEMICON Europa 2010

Dresden, Germany

E-mail: ktorres@semi.org

www.semiconeuropa.org

20–22 October 2010

**3rd International Workshop on
Concentrating Photovoltaic Power Plants:
Optical Design and Grid Connection**

Bremerhaven, Germany

E-mail: workshop@concentrating-pv.org

www.concentrating-pv.org

26–28 October 2010

**PV Taiwan 2010 (Taiwan International
Photovoltaic Forum and Exhibition)**

Taipei, Taiwan

E-mail: pv@taitra.org.tw

www.pvtaiwan.com

27–29 October 2010

**ILOPE 2010:
15th International Lasers, Optoelectronics
and Photonics Trade Show**

Beijing, China

E-mail: lishu@ciec.com.cn

www.ilope-expo.com

31 October – 4 November 2010

**43rd International Symposium on
Microelectronics (IMAPS 2010 – Research
Triangle)**

Raleigh Convention Center - Research Triangle, NC, USA

E-mail: bschieman@imaps.org

www.imaps.org/imaps2010

3–4 November 2010

Photonex 10

The International Centre, Telford, UK

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www.photonex.org

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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>

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/2nd-international-conference-on-pv-module-recycling.html

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 PV POWER EXPO 2011

Shanghai New International Expo Center (SNIEC), China

E-mail: teresa.wen@sneec.org.cn

www.sneec.org.cn/indexe.asp

1–4 March 2011

LED CHINA 2011

China Import and Export Fair Pazhou Complex, Area B, Guangzhou, China

E-mail: led-trust@ubm.com

www.LEDChina-gz.com

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

16th European Molecular Beam Epitaxy Workshop (Euro-MBE 2011)

Alpe d'Huez, France

E-mail: embe2011@grenoble.cnrs.fr

<http://embe2011.neel.cnrs.fr>

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

16 – 21 April 2011

54th Society of Vacuum Coaters Annual Technical Conference (2011 SVC TechCon)

Chicago, IL, USA

E-mail: svcinform@svc.org

www.svc.org

25–29 April 2011

SPIE Defense, Security, and Sensing 2011

Orlando World Center Marriott Resort and Convention Center, FL, USA

Abstract deadline: 11 October 2010

E-mail: customerservice@spie.org

http://spie.org/defense-security.xml?WT.mc_id=RCal-DSSW

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