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C O M P O U N D S & A D V A N C E D S I L I C O N

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RFMD and Anadigics expanding manufacturing in China

Toronto becomes second city to join LED City initiative

Philips sells Ommic as it exits GaAs • Red LED makers expand
Glasgow's XanIC funded for MHEMT foundry • MANTECH report

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GaAs industry back in equilibrium

CS MANTECH 2007 evidenced much optimism about GaAs market growth (despite glitches with Motorola's handset business), as well as progress in GaN HEMT performance and reliability.

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COMPOUNDS & ADVANCED SILICON

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p7 Groundbreaking for Anadigics' new 6" GaAs wafer fab in Kunshan, China.



p30 Osram Opto Semiconductors has more than doubled the peak brightness of its Ostar Headlamp LED from 250 lumens to 620 lumens.



p32 Luminus Devices' new HQ in Billerica, MA, USA, which houses expanded engineering, assembly and test facilities for its PhlatLight LEDs.



Cover: Toronto's CN Tower, showing alternating colors after the conversion of its floodlighting to LEDs. Toronto is the first Canadian city — and only the second anywhere — to join Raleigh, NC, USA in the 'LED City' initiative, aiming to install LED lighting city-wide throughout its infrastructure. p25

GaAs RFIC and LED expansions gain pace

While the two biggest RFIC suppliers RF Micro Devices and Skyworks both suffered a second quarter-on-quarter revenue drop in Q2/2007 due to main customer Motorola losing handset market share, other major suppliers including Triquint and Anadigics, as well as fabless suppliers such as Hittite, continued their growth (see next issue for a detailed round-up). Also, both RFMD and Skyworks are expecting strong recoveries in Q3/2007.

Such general RFIC revenue growth is being driven partly by unit growth in cell-phone handset sales (which has driven GaAs supply and demand back into balance over the last year or so, raising fab capacity utilization from 50% to 75%) and partly by the rise in GaAs dollar content in the more highly integrated RF front-end modules in multi-mode, multi-band handsets (as outlined by Triquint's CEO Ralph Quinsey in his invited talk at May's CS MANTECH conference — see report, page 40 — as well as by semi-insulating GaAs substrate market data from Strategy Analytics on page 5).

The confidence in the sustainability of ongoing growth prospects is manifested by Anadigics breaking ground (in early July) for its second 6" GaAs wafer fab (see page 7) and by RFMD expanding its RF transmit module assembly capacity (specifically, enabling it to start production of its more highly integrated Polaris 3 quad-band EDGE RF solution, which commands about three times the dollar content of existing EDGE cellular front-ends — see page 6). Significantly, both these expansions by US firms are in China (in the case of RFMD, at its existing Beijing assembly plant; in the case of Anadigics, in a development zone in Kunshan).

Also expanding are LED chip manufacturers, including for AlInGaP-based red-spectrum LEDs (for use in not only cell phones but also LCD backlighting). This is evidenced by rising orders for mass-production MOCVD reactors, particularly in Asia (see page 19), which in first-half 2007 represented over 85% of Aixtron's revenues. In addition, after announcing an expansion of its red/yellow LED chip production last December, SDK is now accelerating the expansion (announced in February) of its GaN-based blue LED production capacity (page 26). Also, Cree has launched a blue version of its XLamp XR-E LED that is 70% brighter than its previous blue power LEDs (page 24).

Cree has also boosted the luminous output of its cool-white XLamp LED to a minimum of 100 lumens (at a drive current of 350mA), while Lumileds has likewise boosted its Luxeon Rebel cool-white LEDs to 100lm (pages 27–28). Lumileds reckons that its new Thin Film Flip Chip (TFFC) technology should progress from a luminous efficacy of 80lm/W to 100lm/W in the coming year and 150lm/W long-term. (Nichia should launch 150lm/W white LEDs by end-2007, but based on its small-chip prototypes demonstrated last December, which yielded just 9.4lm from a drive current of 20mA.)

Such progress in performance, as well as in production economies of scale, are making LED lighting no longer just a niche application, as demonstrated by Toronto's decision to become the second 'LED City' (after Raleigh, NC, USA), aiming to install LED lighting throughout its infrastructure (page 25).

Mark Telford

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

Regular issues contain:

- 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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GaN laser market to double annually through to 2011

The market for GaN-based laser diodes will grow at a compounded average annual growth rate (CAAGR) of 103% through to 2011, according to the report 'Gallium Nitride Laser Diodes: Markets and Applications 2006-2011' from market research firm Strategy Analytics' GaAs and Compound Semiconductor Technologies (GaAs) service. The consumer-based optical data storage market will dominate all other applications, driven by adoption in games consoles, PCs and home theatre. The latter will become dominant as the two competing formats Blu-Ray and HD-DVD finally gain mass market acceptance, reckons Strategy Analytics.

Strategy Analytics also predicts a significant shift in the market by 2011 as the demand from gaming consoles, using low-cost, low-power GaN laser diodes, is supplanted by a significant rise in the recordable versions of Blu-ray and HD-DVD players, using higher cost, higher-power laser diodes.

"The 'format war' between Blu-ray and HD-DVD in the home is still there to be won. It will be dictated by the price of players/recorders and the choice of available titles," says Stephen Entwistle, VP of the Strategy Analytics Strategic Technologies Practice. "Since both formats essentially use the same technology, the GaN laser diode manufacturers will be the winners regardless of which technology loses the format war."

"Early development of the GaN laser diode market was hindered by low manufacturing yields and a lack of competition, compounded by Nichia's strong IP position," says Asif Anwar, director of the GaAs service. "Continuing advances in substrates and growth technology removed many of the IP issues." This is allowing traditionally strong manufacturers of consumer laser diodes such as Sharp and Sony to enter the market and compete with the incumbents and with each other, reducing overall costs and driving the emergence of the volume merchant market, Anwar adds.

Sapphire substrate suppliers to lose GaN laser diode market

Strategy Analytics predicts that, over the next five years, manufacturers of GaN laser diodes will move away from sapphire substrates to nitride substrates in order to enhance performance and yield and to avoid the potential intellectual property pitfalls associated with device production on foreign substrates.

While the move will not affect sapphire substrate suppliers such as Rubicon and Kyocera materially in a significant way, the trend is one that these companies should follow closely, advises the market research firm, as it also has potential ramifications for future trends in the production of light-emitting diodes.

Seven years before LEDs penetrate home lighting

Solid-state LED lighting (SSL) had zero penetration in the illumination market as of the beginning of 2007, but the SSL market will grow 21% through 2011, forecasts analyst firm Strategy Analytics in its report 'Solid State Lighting Market 2006-2011'. However, most demand will come from niche lighting applications, such as architectural, task lighting, medical and off-grid lighting applications, rather than from the residential lighting market.

The global lighting market will increase at a compound annual average growth rate (CAAGR) of 4% through 2011, with SSL technologies penetrating no more 3% of the residential lighting market by 2011. Significant implementation in residential and consumer markets is not expected until 2014 or 2015.

"Environmental concerns are making an impression on consumers who are beginning to look for environmentally beneficial lighting products. They will buy only when products reach the right price point," said Stephen Entwistle, VP of the Strategy Analytics Strategic Technologies Practice. "The long and slow adoption of energy-saving compact fluorescent (CFL) light bulbs must be acknowledged when making optimistic forecasts for the solid-state lighting market."

"In addition to the commercial challenges, there are also technical challenges that need to be overcome. One such obstacle is the ability to guarantee consistent quality of the white light over the life of the lamp," adds Asif Anwar, director of Strategy Analytics' GaAs and Compound Semiconductor Technologies (GaAs) service. "In the near term, emerging demand from other markets, such as automotive, aviation and medical, will help spur development in the general illumination market."

www.strategyanalytics.net

Handset unit sales to grow at 4% annually through to 2012

Global handset sales will grow 12% in 2007 and 8% in 2008, and exhibit a five-year compound annual growth rate (CAGR) of 4% through 2012, according to the report 'Global Handset Sales Historical & Forecasts, 2002-2012' from Strategy Analytics, which covers sales for 17 protocols in 6 regions and 73 countries worldwide.

UMTS sales will exceed 167 million units in 2007, and will grow at a healthy 35% five-year CAGR through 2012, according to the report.

Replacement rates will continue to grow through 2009, peaking at just over 32 months (37%) that year, says Strategy Analytics. Emerging markets will account for 45% of global sales in 2008.

● By the end of 2007, 2.5bn people will be using cellular services, running 3.2bn subscriptions collectively, according to the report 'Worldwide Cellular User Forecasts, 2007-2012' by Strategy Analytics.

By 2011, half of the world's population will have at least one mobile phone. However, 2007 will be the last year of double-digit service revenue growth, as saturation points in many markets are reached and average revenues continue to slip, says the report.

While 2G and 2.5G GSM systems will dominate and still account for half of global cellular users in 2012, WCDMA will emerge as the largest platform for revenue creation by 2011, reckons Strategy Analytics.

www.strategyanalytics.net

Handset power amplifier and filter module suppliers set to consolidate

The base of suppliers of front-end power amplifier (PA) and filter modules for handsets will undergo consolidation over the next six years, with perhaps only six firms remaining, argues market research firm Strategy Analytics in its report 'Will Consolidation of Handset FEM Suppliers Imitate Infrastructure RF Subsystems?'. The report's author, Chris Taylor, director of Strategy Analytics' RF & Wireless Component service, compares the situation to the one that faced suppliers of power amplifier and filter subsystems for cellular base-stations a few years ago. "Increased competition and higher product development costs pushed gross margins to record

lows in 2001, triggering a wave of mergers and acquisitions," he elaborates. "Today only two significant suppliers remain: Powerwave and Andrew."

Taylor adds, "In handsets, suppliers of power amplifiers and front-end modules have developed a variety of technologies to segment the market and maintain share. However, competition and the dominance of two customers (Nokia and Motorola) continue to put pressure on suppliers, several of which have recently dropped out of the market. The good news is that profits should improve somewhat as the number of suppliers declines," Taylor concludes.

SI GaAs substrate demand to grow at 6% through 2011

The market for semi-insulating (SI) GaAs bulk substrates will grow at a compound annual average growth rate (CAGR) of 6% through to 2011, forecasts market research firm Strategy Analytics in the report 'Markets for Semi-insulating GaAs Substrates: 2006-2011'.

Volume growth will be driven mainly by increasing GaAs content in cellular handsets and Wi-Fi radios, with millimeter-wave, CATV, DBS and fiber-optic markets also adding to demand, says the report.

In 2006, demand grew by 29% year-on-year. In particular, Freiburger Compound Materials grew about 41% and took the number one position from Sumitomo Electric Industries.

"With major GaAs fabs running at full capacity throughout the industry, the GaAs bulk substrate suppliers were in a strong position in 2006," said Asif Anwar, director of Strategy Analytics' GaAs service.

"However, the strong demand has also increased raw material costs. We estimate that gallium costs have risen by almost 120% over the past two years," adds Anwar. Rising raw material costs will put pressure on bulk substrate supplier profitability.

Also, "Overall demand will be counterbalanced by process technology trends toward integration and smaller die sizes which, at first glance, is a negative for bulk substrate suppliers," says Stephen Entwistle, VP of the Strategy Analytics Strategic Technologies Practice. "Ultimately, however, these trends will ensure that GaAs device manufacturers offer added value to their end-customers, securing future demand for GaAs substrates."

www.strategyanalytics.net

RFMD expands its Beijing assembly facility's capabilities

RF Micro Devices Inc of Greensboro, NC, USA has announced a 200,000ft² expansion at its facility in Beijing, China, including increased assembly capacity and new capabilities to support its new Polaris 3 RF solution (ramping up production this quarter).

The increased capacity will roughly double assembly capabilities for RFMD's transmit modules. Capacity of wire bond and test capabilities will be expanded this quarter, with full capacity available by November. Also, new capabilities will include flip-chip packaging technology and RFMD's internal RF shielding technology. The firm is also developing proprietary RF test platforms internally, as well as working in conjunction with third-party suppliers for transceiver module testing.

On completion, RFMD expects the expansion and new technologies to streamline its supply chain, speed time to market, and cut manufacturing and inventory-carrying costs.



Artist's impression of RFMD's Beijing plant, with the extension on the right.

"Our Beijing expansion reflects our commitment to support our customers with operational scale, technological innovation and an industry-leading cost structure," says CEO Bob Bruggeworth.

"We are introducing new enabling technologies that support our market leadership in cellular front ends and position RFMD to deliver more highly integrated RF solutions that reduce overall costs and increase

our dollar content in cellular phones. Our patent-pending self-shielding technology, in particular, reduces the volume required for RF solutions by 30–50% and provides RF components that are not sensitive to board placement."

RFMD expects the Beijing expansion to positively impact its ability to meet demand for Polaris 3 as it ramps in the coming months.

www.rfmd.com

RFMD begins production of Polaris 3 Total Radio

To support customer orders, RFMD has started volume production of Polaris 3 Total Radio (a fully integrated quad-band EDGE RF system solution with high levels of RF functionality). Commercial shipments are expected to begin in the September quarter, and production volumes are forecast to grow sequentially throughout 2008.

The start of commercial production represents "the culmination of years of technology development, as we have assembled the design, manufacturing and packaging competencies necessary to supply large production volumes of the industry's most highly integrated RF system solution", says president and CEO Bob Bruggeworth. Polaris 3 enables handset makers

to quickly and cost-effectively deploy a complete high-performance, system-in-package (SiP) solution that performs all the critical functions of the RF section of a handset in two easy-to-place modules across multiple handsets and market tiers, he adds.

Polaris solutions command about three times the dollar content of EDGE cellular front ends.

Polaris 3's highly integrated radio transceiver module incorporates a single-chip CMOS EDGE transceiver, the full crystal oscillator and all receive filter functionality.

Polaris 3 also features RFMD's front-end technology (including the power amplifier and

transmit/receive switch) as well as the firm's patent-pending integrated RF shielding technology.

When implemented, Polaris 3 eliminates the need for costly and bulky metal RF shields on the phone board while reducing component placements by about 80%, leading to savings in solution size and height, it is claimed. Polaris 3 hence reduces the RF footprint by about 50% compared to competing solutions, as well as offering handset makers the benefits of platform flexibility, ease-of-use, reduced size, low cost and high performance, RFMD claims.

RFMD also says that its Polaris solutions command about three times the dollar content of EDGE cellular front ends.

Anadigics breaks ground for 6" GaAs wafer fab in China

As part of a city-wide celebration in Kunshan in China's Jiangsu province, RFIC maker Anadigics Inc of Warren, NJ, USA has broken ground for construction of its new 6" GaAs wafer fabrication plant in the Kunshan New and Hi-Tech Industrial Development Zone (KSND), which was first announced in April.

The ceremony took place with Kunshan party secretary Guohua Zhang, mayor Aiguo Guan and vice mayor Feng-Quan Zhu as well as several government officials along with Anadigics' president and CEO Dr Bami Bastani, executive VP and chief technology officer Dr Charles Huang, and VP of worldwide human resources John Warren.

Driven by wireless and wireline broadband markets, in order to support Anadigics' anticipated growth beyond its primary wafer fabrication in Warren, NJ, the firm and KSND plan to complete construction of the new fab in first-half 2008, and to make it operational in the latter part of the year.



Groundbreaking ceremony for Anadigics' new fab.

"The addition of the commercial 6" GaAs wafer fab to the development zone not only shows our ever-growing interest in the semiconductor industry but marks a historical first for the city of Kunshan and the country of China," said Zhu.

"Our new fab in China is a very significant development for both Anadigics and the city of Kunshan," added Bastani. "Whereas the expansion will enable us to meet

our future growth needs, it also demonstrates our commitment to the communications market in China as well as the larger Asia-Pacific Region."

Anadigics said in April that it expects to invest \$10-15m in capital expenditure over two-years.

Total investment over the plant's life-time (which

could be up to 50 years) is estimated to be \$49.88m.

KSND consists of three sections within the city, involving many new and hi-tech industries including auto electronics, solar energy, robotics, and new materials. Located in Section B of the development zone, Anadigics will take on the flagship role for its compound semiconductor industry development.

www.anadigics.com

Anadigics expands wireless & broadband US sales force

Anadigics is expanding its US-based sales force by adding Duane Koonce (western regional sales manager for wireless products), David Bennett (Americas and European broadband sales director for WLAN & WiMAX Products) and Stephen Simon (broadband key customer sales director). As Anadigics continues to expand the customer base for its line of broadband and wireless products, they will aid growth by strategically creating new sale efforts, the firm says.

Koonce will be responsible for strengthening strategic relationships with key Anadigics accounts, as well as developing new opportunities

within the wireless communications market. He has over 25 years of multi-industry experience in semiconductor components and systems, along with expertise in developing and managing strategic partnerships in both broadband and wireless business segments.

Koonce's customer relationships, sound technical background and extensive experience in RF semiconductor products will enable Anadigics to increase its penetration in 2.5G, 3G and 4G wireless systems, reckons Carl Lump, senior director of Wireless Sales.

Bennett's role includes regional responsibility for business development and sales initiatives for

the broadband product line in both the Americas and Europe. He has over 12 years of experience in the semiconductor industry, including developing and implementing sales strategies with key accounts, securing design wins through all aspects of company strategy, and motivating internal teams.

Simon will focus on advancing key customer relationships for broadband products. He has 15 years of sales and marketing experience in the semiconductor marketplace, including reorganizing inside and outside sales teams, and developing key relationships with technology partners and customers.

Glasgow spin-off XanIC wins funding for MHEMT foundry

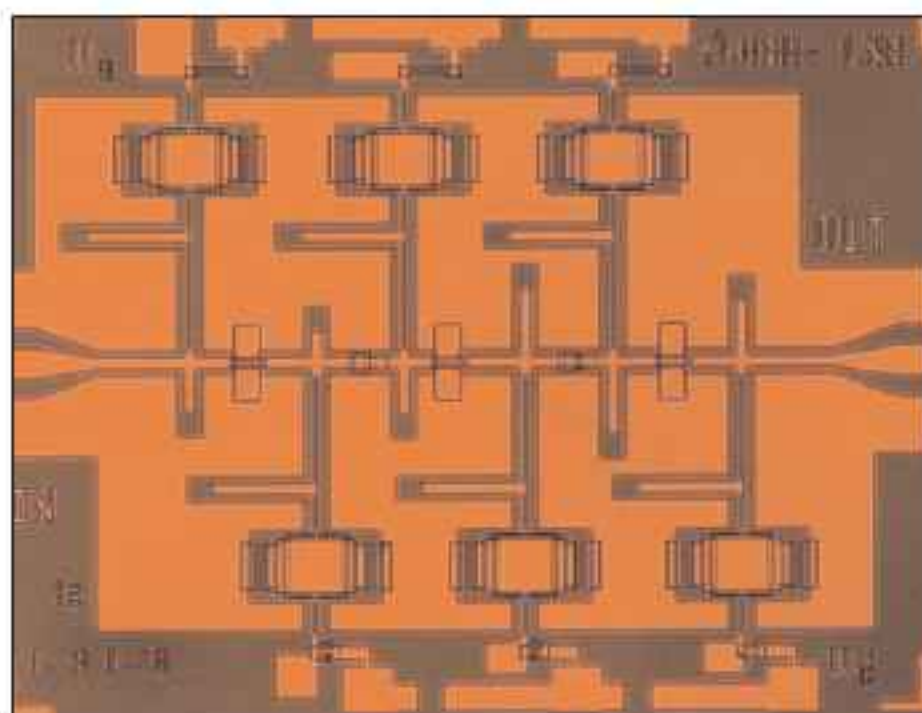
At the end of June, XanIC Ltd, which was spun off from the University of Glasgow, Scotland, UK in April, received funding of £0.4m (\$0.8m). This includes £280,000 (\$570,000) from intellectual property commercialization company IP Group plc and £120,000 (\$250,000), subject to agreed milestones being met, from the Glasgow/Strathclyde University Synergy Fund, managed by Scottish Equity Partners (SEP).

"It is particularly pleasing to be making our second investment in a Glasgow spin-out company, as we are only eight months into our 25-year partnership with the University of Glasgow [agreed last October]," says IP Group's CEO Alan Aubrey.

XanIC was set up with an exclusive license to commercialize MBE-grown 50nm-gate-length GaAs-based metamorphic HEMT technology, developed over the last 10 years by a research team led by professor Iain Thayne and Dr Khaled Elgaid of the Ultrafast Systems group in the Department of Electronic and Electrical Engineering. The technology received Scottish Enterprise Proof of Concept funding in 2001–2003 then pre-incorporation funding from the Synergy Fund. Also, this March the group was one of the five teams at the University of Glasgow (led by Thayne) that was awarded £4m (\$7.8m) from the UK government's Engineering and Physical Sciences Research Council

to develop nano-scale transistor technologies. The latest funding from Synergy and IP Group will help to get the first products to market.

Initially, prototypes and devices for sampling will be fabricated using



XanIC's 75–95GHz UF3100 chip, which is based on 50nm InP HEMT technology (now being upgraded to the latest GaAs MHEMT process).

facilities at the James Watt Nanofabrication Centre (opened in March), including large-area, high-resolution electron-beam lithography, although that strategy may change if high volumes are required.

"XanIC is representative of almost 30 years of nanotechnology research in Glasgow and, in the last 10 years, of turning some of that technology into high-performance electronic devices," says Steve Beaumont, vice principal (research & enterprise). "We are delighted that this research is now finding a route to the marketplace, which now demands the high performance Glasgow's technology can deliver," he adds.

Industry demand continues to grow for systems operating at higher speeds, and existing technologies are reaching their physical limits of

performance. XanIC's technology overcomes these limitations, it is claimed, allowing the production of high-frequency components that are crucial to next-generation applications in imaging, sensing, communications, homeland security and safety systems such as enhanced airport security scanners (i.e. millimeter-wave imagers, which can detect a wide range of materials, including plastics, that conventional x-ray scanners are unable to detect), as well as aircraft landing systems, smart buildings with in-built safety features, and ultrahigh-data-rate communications links.

US supply of such components is subject to export restrictions, so XanIC aims to provide European foundry design and manufacturing of commercial MMIC components and modules operating in the 50–500GHz frequency band (ICs with operating frequencies up to 500GHz have already been demonstrated).

XanIC's first product will be a 94GHz low-noise amplifier (LNA), which has applications in a range of security systems where boosting the speed and quality of images is key to widespread deployment.

"There is a huge amount of commercial interest in XanIC's technology and products, which will deliver a step change in the cost and performance of next-generation security systems," claims CEO Nick Wood.

Scottish Enterprise Glasgow (supported by the European Regional Development Fund) to enable the



universities to hire CEOs for spin-offs pre-incorporation to manage them through their early stages of formation.

In July 2006 Nick Wood, a founder of UK-listed technology group Sagentia and head of technology incubation firm daVinci Ventures Ltd (as well as CEO of Glasgow spin-off Wireless bioDevices), was brought in part-time as interim CEO. This was enabled by the CEO Designate program set up in 2005 by Glasgow, Strathclyde and Caledonian universities along with

Rob Moffat, investment manager for the Synergy Fund adds, "With customer interest already growing, we look forward to seeing their revolutionary products' impact on the market."

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UCSB and IQE achieve record f_{\max} of 780GHz for an HBT

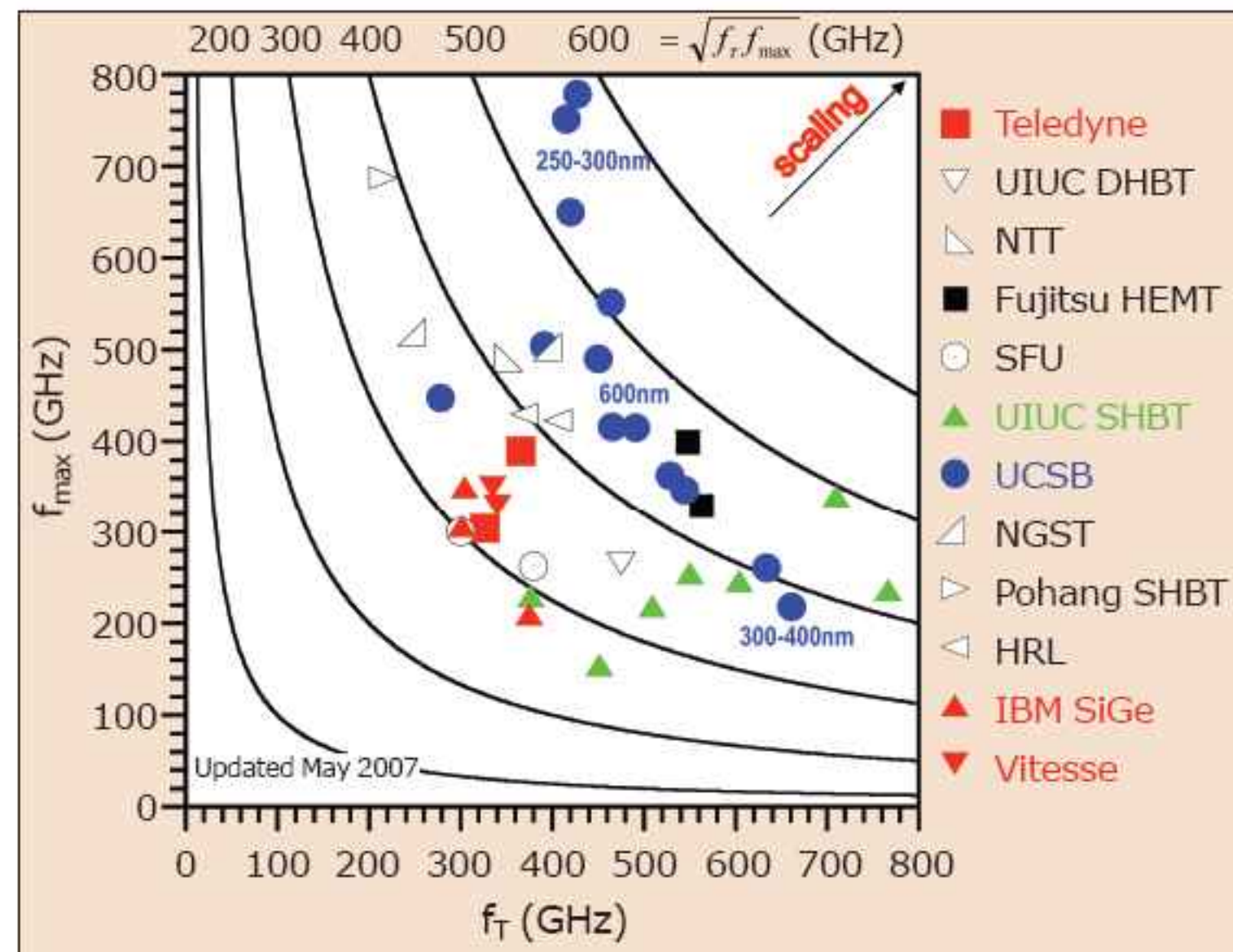
The University of California at Santa Barbara's NanoFabrication Facility has used epitaxial material grown by MBE on 3" InP wafers at wafer foundry IQE Inc in Bethlehem, PA, USA to fabricate a Type-I InP/InGaAs/InP double-heterojunction bipolar transistor (DHBT) with a record power-gain cut-off frequency (f_{\max}) of 780GHz for a mesa-structured HBT.

The team reported an f_{\max} of 755GHz at May's Indium Phosphide and Related Materials (IPRM) conference in Matsue, Japan ('Sub-300nm InGaAs/InP Type-I DHBTs with a 150nm collector, 30nm base demonstrating 755GHz f_{\max} and 416GHz f_T ', presented by UCSB's Dr Zach Griffith). However, subsequently a bias condition was found that allowed the HBT to operate at up to 780GHz f_{\max} , Griffith told Semiconductor Today.

"We have collaborated extensively with professor Rodwell's group for nearly a decade, where many record InP-DHBTs results have been demonstrated over the years," says Steve Gergar, general manager of IQE's Pennsylvania operation.

Previous records for f_{\max} were 650GHz (for an InP DHBT with a 250nm-wide emitter, reported by UCSB's E. Lind at the 64th Device Research Conference in June 2006) and 687GHz (for an InP/InGaAs SHBT, reported by Daekyu Yu et al of Pohang University of Science and Technology, South Korea and Intelligent Epitaxy Technology of Richardson, TX, USA at IEEE's International Electron Devices Meeting in December 2004).

With a simultaneous current-gain cut-off frequency (f_T) of 424GHz and a common-emitter breakdown voltage (BV_{ceo}) of 5.6V, the latest 780GHz f_{\max} UCSB device has also demonstrated a record $f_T \times BV_{\text{ceo}}$ product (for a bipolar transistor) of



UCSB's DHBT (top), with record f_{\max} and $f_T \times BV_{\text{ceo}}$ product.

2.39THz V. (N.B. GaN HEMT devices have higher $f_T \times BV_{\text{ceo}}$ products.) The previous record for this figure of merit was 2.30THz V (with $f_T=384\text{GHz}$; $BV_{\text{ceo}}=6\text{V}$) from a Type-II InP DHBT with a 15nm-thick GaAsSb base and an InP collector (Liu et al of Canada's Simon Fraser University, IEEE Transactions on Electron Devices, vol. 53, no.3, March 2006, p559).

Last December, Milton Feng's group at the University of Illinois at Urbana-Champaign reported an InGaAs-collector InP-SHBT with a simultaneous 845GHz f_T and 263GHz f_{\max} when cooled to -55°C , or 765GHz f_T with 227GHz f_{\max} at room temperature. However, a common-emitter breakdown voltage of 1.65V gave an $f_T \times BV_{\text{ceo}}$ product of just 1.26THz V.

UCSB's latest 780GHz f_{\max} devices use a graded base-collector junction (with a 150nm-thick InP collector containing an InGaAs/InAlAs superlattice grade to eliminate the conduction-band discontinuity between the InP and the 30nm-thick highly doped InGaAs base region). However, using i-line lithography,

the base spreading resistance beneath the emitter and increased radial heat flow from the narrower junction, significant increases to f_{\max} and reductions in device thermal resistance are observed.

Most of UCSB's InP HBT current effort is now focused on the 125nm and 62.5nm emitter-width nodes, Griffith told Semiconductor Today. According to a roadmap presented by UCSB's professor Mark Rodwell at both IPRM 2007 and the IEEE MTT-S International Microwave Symposium (IMS 2007) in Hawaii in early June, these should yield f_{\max} values of 1.3THz and 1.5THz, respectively, with simultaneous f_T values of 730GHz and 1THz. However, work on these 125nm and 62.5nm 'generation 4' and 'generation 5' devices is still in its infancy, adds Griffith.

● The UCSB/IQE work is supported by program N0001-40-4-10071 of the US Office of Naval Research (ONR), as well as the SWIFT program and the TFAST program N66001-02-C-8080 of the US Defense Advanced Research Projects Agency (DARPA).

www.ucsb.edu

www.iqep.com

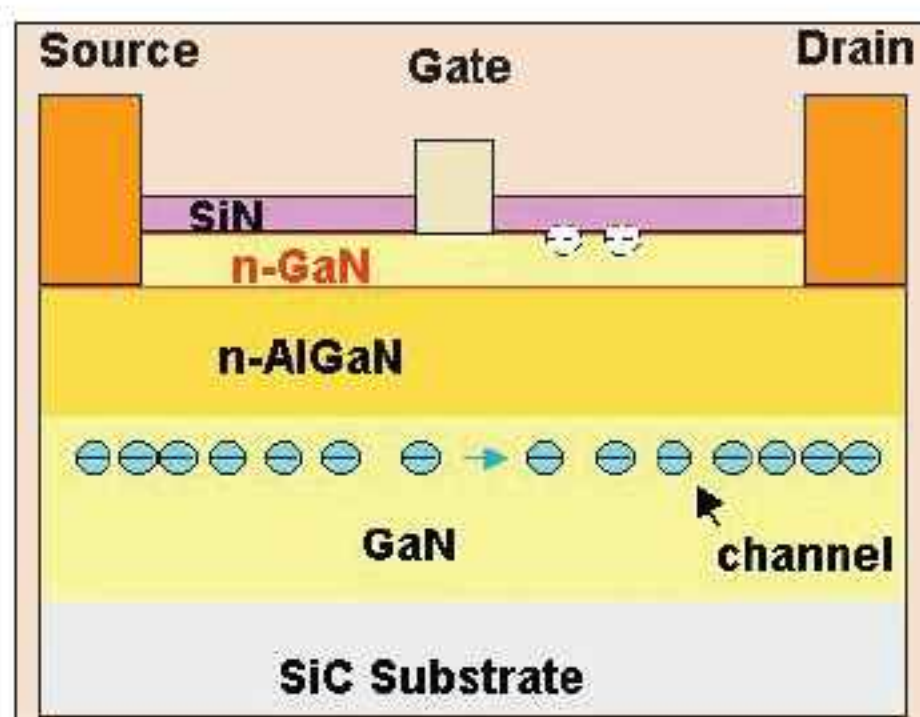
the lateral width of the emitter junctions have been scaled from the 500–600nm of the previous 'generation 2' InP HBTs to the 250–300nm of 'generation 3', while maintaining similar collector-to-emitter area ratios. Because of the subsequent reduction of

GaN HEMT to last for 1m hours

At June's IEEE MTT-S International Microwave Symposium (IMS 2007) in Hawaii, Fujitsu Laboratories Ltd of Kawasaki, Japan reported that it had developed new manufacturing technology that enables high-power GaN-based HEMTs to operate with long-term high reliability at channel temperatures as high as 200°C for a record of more than 1 million hours (a lifespan of more than 100 years) with a drain voltage of 50V under high-temperature (above 300°C) pinch-off testing conditions (the most severe reliability test).

Fujitsu claims this is the world's first result in which such a long lifespan has been achieved under pinch-off conditions with such a harsh testing factor as a 50V drain; the previous record was at a maximum of 28V.

As wireless communication data rates continue to increase, power consumption in base-stations (e.g. for mobile phones) is also increas-



GaN HEMT structure, showing cap layer and surface traps.

ing. GaN HEMTs promise lower power consumption for high-power amplifiers in next-generation high-speed wireless communication systems. However, for GaN HEMTs to be used as high-power, high-voltage-endurance devices, they must maintain high reliability (a long lifespan), as it is anticipated that they must withstand harsh usage conditions, including high

temperatures and high drain voltages.

In long-term reliability testing, Fujitsu found that in GaN HEMTs a correlation exists between gate leakage current and reliability, and that the increase of gate leakage current depends on crystal quality and the structure of the GaN HEMT (which Fujitsu grows on SiC substrates), says the firm. This led the company to use its proprietary n-type GaN cap layer (surface layer) to improve the crystal quality and optimize the layer structure, reducing the electric field in the GaN HEMT structure through fewer surface traps (see Figure).

Fujitsu says it will target the new GaN HEMT technology at high-speed wireless communications, for applications such as satellite communication (VSATs), cellular base-stations, and WiMAX base-stations.

www.fujitsu.com

Nitronex appoints QA manager and director of marketing

After recruiting a director of RF product development and a supply chain manager in May, Nitronex of Durham, NC, USA, which manufactures GaN-on-Si RF power transistors for the commercial wireless infrastructure, broadband and military markets, has added further key staff as it ramps up production.

Frank A. Palmieri has been recruited as quality manager at the firm's manufacturing and R&D facility.

Palmieri has more than 25 years of industry experience in operations and quality assurance, specializing in ISO 9000 certification.

Before joining Nitronex, he was the quality manager at AVX, responsible for quality assurance for passive components. He was also the operations and quality manager of the team that launched AVX's manufacturing plant in Juarez, Mexico, where he oversaw its ISO 9000 certification. More recently, he also helped other AVX facilities around the world to



Frank A. Palmieri and Ray Crampton.

gain ISO 9000 certification.

"Adding an experienced industry veteran like Frank Palmieri underscores the transition at Nitronex from being a great engineering company to one that will also be a solid link in the supply chain. Frank adds a new perspective and ushers in a fresh outlook for Nitronex," said Bruce Cochran, VP of operations.

Nitronex has also appointed Ray Crampton as director of marketing. He brings more than 10 years of industry experience spanning RFIC amplifier design, and technical and

marketing management. "As the industry shifts to a new generation of high-efficiency, wide-bandwidth power amplifiers using GaN transistors, the addition of Crampton enables us to accelerate our product definition and development activities," says Chris Rauh, VP sales & marketing. "Ray will also lead our applications team, which is a critical function in supporting our customers throughout the product life cycle."

Before joining Nitronex, Crampton was strategic marketing and systems engineering manager for Texas Instruments' Linear Regulators product line. Previously, he held positions at Sirenza Microdevices including product line manager, engineering manager and senior RFIC design engineer. Crampton also served as RFIC design engineer and engineering manager at ITT GaAs TEK and senior RFIC design engineer at M/A-COM.

www.nitronex.com

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Axiom expands into new HQ

Axiom Microdevices Inc of Irvine, CA, USA, which supplies the only fully integrated complementary metal oxide semiconductor power amplifiers (CMOS PA) for mobile handsets, has relocated and expanded its headquarters into a new office in the Irvine Business Center.

"Our relocation is not simply about moving into a larger space; it is the culmination of a succession of events that confirms the market viability of Axiom Microdevices' technology and business models," says CEO Brett Butler.

In February, Axiom completed full type approval testing for compliance with GSM specifications and performance requirements for its AX502 CMOS PA (designed into a cellular handset) and raised \$25m in third-round funding (to ramp production of first-generation CMOS PAs and to develop the product roadmap).



Axiom's new headquarters.

In March the firm appointed a VP of operations. In May, the AX502 received an American Electronics Association (AeA) High Tech Innovation Award. In late June, Axiom shipped its one millionth AX502.

"From the company's inception, through three rounds of funding and customer wins, we are doing what many have said could never be done: delivering a CMOS PA as a viable alternative to GaAs," says Butler. "Our technology enables handset manufacturers to take advantage of the industry's investments in mainstream CMOS processes and provides for better long-term integration by removing the need for specialty process technologies."

Switching the PA to CMOS moves the last non-CMOS portion of the RF block to a standard silicon process, which improves supply continuity and opens the door for future integration, says Axiom. The AX502 single-chip CMOS PA also improves quality by reducing the number of potential failures associated with more complex implementations.

www.axiom-micro.com

SiGe makes ex-Motorola president Shlapak chairman

SiGe Semiconductor Inc of Ottawa, Canada, which supplies RFICs and front-end modules for wireless systems, has appointed Fred Shlapak as its new chairman, expanding its board of directors to seven members.

"He brings over three decades of leadership and operational experience coupled with deep knowledge of the semiconductor industry," says CEO Sohail Khan. Shlapak was president and CEO of Motorola's Semiconductor Products Sector when he retired in 2004 after 33 years with the firm. He led its Canadian semiconductor operations, then its European Semiconductor Group. He is also on the boards of AMCC, Gennum and Tundra Semiconductor.

"His perspective will be invaluable as we continue to grow our market share in RF components, says Khan. "We're in an exciting period as we leverage our experience in GPS and WiFi to penetrate emerging opportunities for fixed and mobile WiMax."



Shlapak (left) and Gammel (right).

SiGe provides components for WLAN, GPS and Bluetooth devices (e.g. mobile phones, PDAs, laptops, wireless data equipment and GPS).

SiGe has also appointed Peter L. Gammel as CTO, responsible for generating technology and product roadmaps and identifying new applications. He will also work closely with external partners, internal engineering and marketing groups to exploit capabilities in wireless consumer electronics markets.

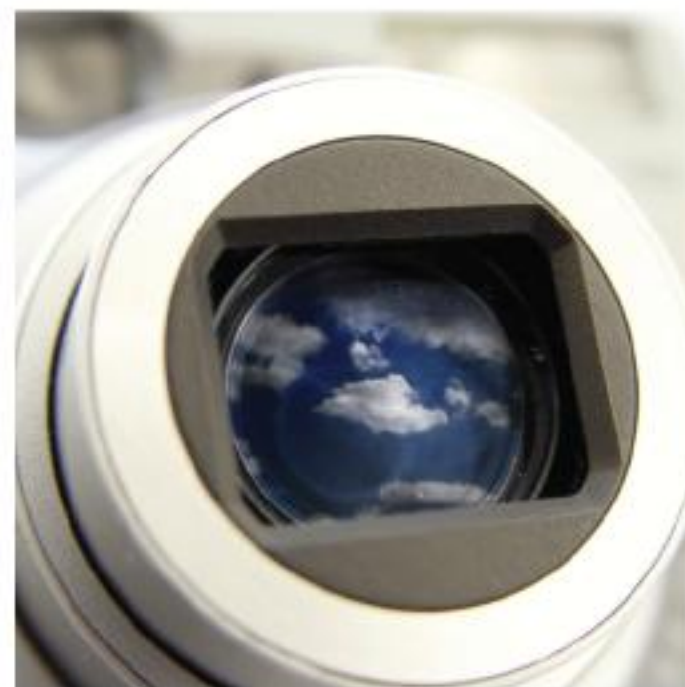
"Gammel will play a leading role in the long-term direction of the corpo-

ration," says Khan. "As an industry veteran with a proven track record, he will be a valuable representative at technical forums and engagements. His strong ties with academia will help us in our university collaboration as well as our efforts to attract and retain the top talent."

As well as having a PhD in physics from Cornell University, Gammel has 20 years of experience in new product and funding development, intellectual property investment, and team building and management. His technical expertise covers single-electron devices, superconducting devices, MEMS and RF acoustic wave devices.

Prior to joining SiGe, Gammel was VP engineering at a venture-backed start-up firm. Previous positions include CTO of AdvanceNanotech Inc and Agere Systems' analog products business unit, and research director at Bell Labs (Alcatel-Lucent).

www.sige.com



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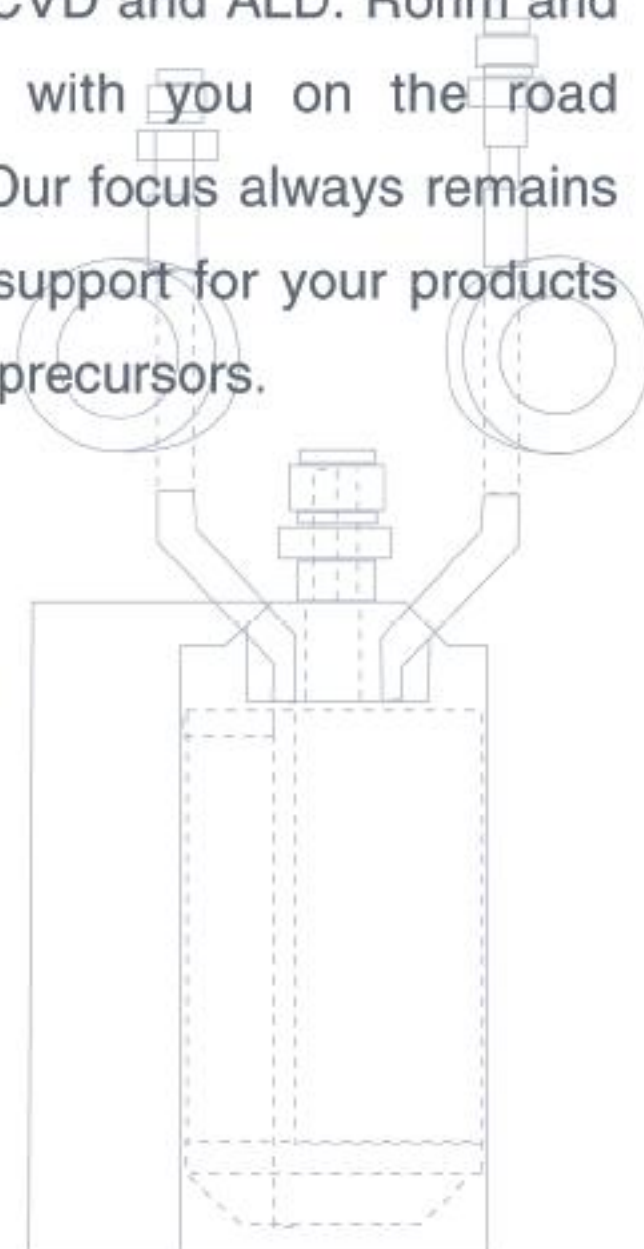
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IN BRIEF

NIEC to launch SiC Schottky diodes in Japan using chips made by Cree

Cree Inc of Durham, NC, USA has reached an agreement for its silicon carbide chips to be used by the silicon-based power semiconductor manufacturer Nihon Inter Electronics Corp (NIEC) of Hadano City, Japan in a line of SiC-based Schottky power rectifier diodes to be introduced in Japan.

"Our market is showing growing demand for the far greater efficiency and performance offered by silicon carbide-based diodes, which enables reduced energy consumption in applications for home appliances including air conditioner and automotive invertors," says NIEC president Masao Ishii.

Specifically, Cree says that, compared with traditional silicon-based diodes, its SiC-based rectifiers can:

- simplify power factor correction (PFC) boost design by eliminating the need for snubbers and reducing component count;
- reduce power losses, leading to cooler operating temperatures;
- produce significantly less electromagnetic interference (EMI).

"Our agreement with NIEC will allow us access to their extensive marketing and sales channels in Japan, and is consistent with our current strategy to create a more global sales and marketing presence," says John Palmour, Cree's executive VP for advanced devices.

"We are excited about the potential impact our two companies can make on the Japanese market by combining our strengths," he adds.

www.cree.com
www.niec.co.jp

Norstel & ETRI/AIST co-developing SiC

Substrate and epiwafer supplier Norstel AB of Norrköping, Sweden and the Energy Technology Research Institute (ETRI) of the National Institute of Advanced Industrial Science and Technology (AIST) in Tsukuba, Japan have signed a strategic collaboration agreement to jointly develop single-crystal growth processes for large-diameter high-quality and cost-effective high-volume SiC manufacturing for semiconductor applications.

Norstel was founded in February 2005 as a spin-off from silicon wafer manufacturer Okmetic Oyj which has, since 1995, developed and patented the high-temperature chemical vapor deposition (HTCVD) method for growing SiC single-crystal ingots. Norstel is currently ramping up its manufacturing operations in its new facility (opened last August). Under the supervision

of Dr Alexandre Ellison, the HTCVD method has yielded very high-purity wafers, the firm claims.

Under Dr Shin-ichi Nishizawa, over the past seven years AIST has developed growth techniques based on the sublimation method, with impressive results for material quality up to 4" in diameter. In April, Nishizawa joined AIST's ETRI.

The main aim of the collaboration is to study SiC crystal growth based on HTCVD to optimize crystal quality and manufacturability. "This agreement brings together a breadth of SiC expertise without parallel in the industry," claims Norstel's CEO Iain Jackson. "We are thrilled to have someone of Dr Nishizawa's experience co-operating with Norstel as we look to next-generation SiC manufacturing technology".

www.norstel.com

<http://unit.aist.go.jp/energy>

Norstel appoints CEO and chairman

To strengthen its management team, Norstel has appointed a new CEO and a new chairman of the board as it ramps up its SiC output.

The CEO is Iain Jackson, a graduate of the University of Cambridge and a 25-year veteran of the semiconductor industry. Jackson has a long career at application-specific integrated circuit (ASIC) developer LSI Logic, with management positions in strategic planning, wafer fab operations, quality and reliability, marketing and design engineering.

The previous CEO and founder, Dr Asko Vehanen, has been made a director and will remain as a full-time member of the management team, with global responsibility for all customer relationships and collaboration with strategic partners.

Norstel's new chairman, Hasse Johansson, founded Mecel AB (which became part of Delphi Delco Electronics Systems in 1990) and was director of Advanced Engineering Europe from 1995, business director of Mobile Multimedia Europe from 1999, engineering director of Delphi Delco Electronics Systems Europe from 2000, then managing director. Since 2001, he has been group VP R&D for transport vehicle maker Scania.

Jörgen Bladh (general partner with Northzone Ventures) steps down as chairman but remains on the board. "As the Norstel facility develops from research and early-stage manufacturing into a full production facility, appointing seasoned industry veterans will give Norstel the momentum it needs to accelerate its growth," Bladh says.

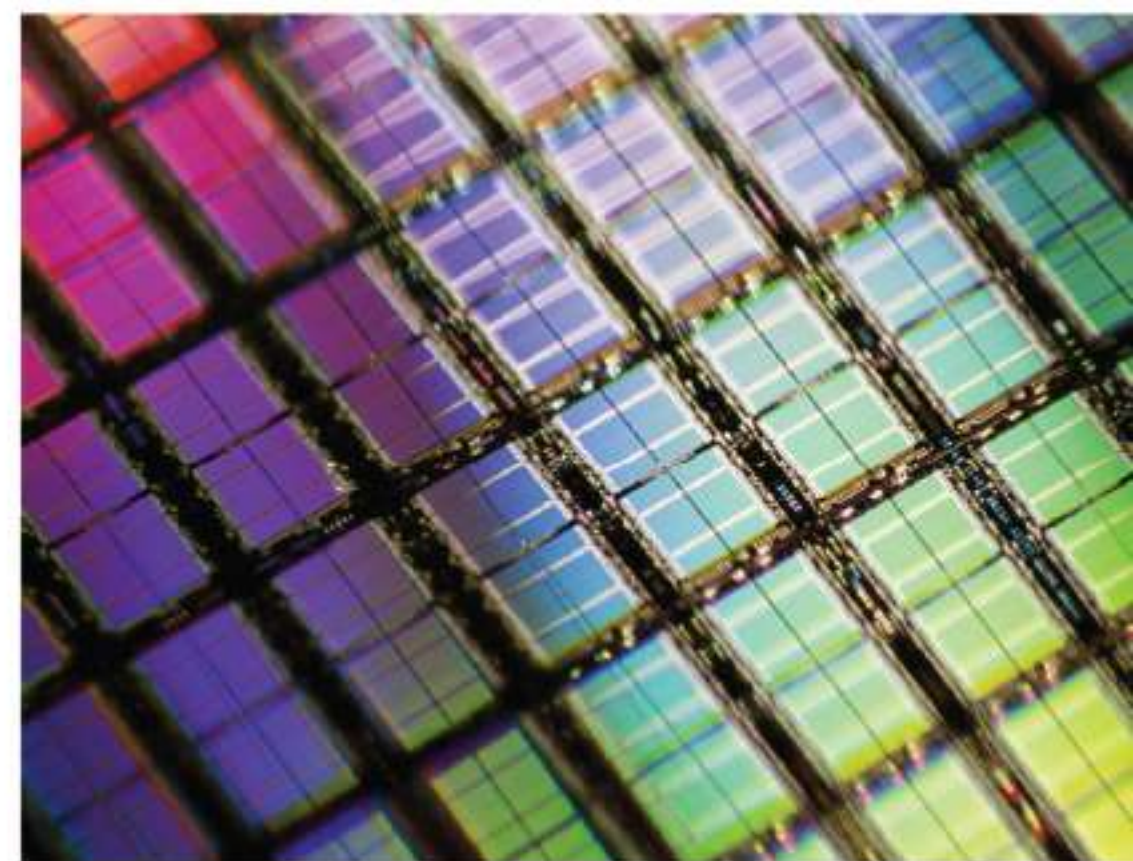


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IQE's revenues move ahead of forecasts in first-half 2007, driven by wireless PA and Asia-Pacific related acquisitions

In a trading update, substrate and epiwafer supplier IQE plc of Cardiff, UK says that the flat start in January and February has been followed by monthly revenues increasing through the rest of first-half 2007 (as expected on issuing preliminary results at the end of March). IQE now expects first-half revenues to be slightly above the market forecasts of £22.5m (and up greatly from £14.6m for first-half 2006).

Epiwafer foundries MBE Technology Pte Ltd of Singapore and IQE RF LLC of Somerset, NJ, USA (formally Emcore's Electronic Materials & Device division), both acquired in second-half 2006, have integrated well and performed ahead of expectations, IQE says. By gaining exposure to the wireless power amplifier market through IQE RF, and to Asia Pacific markets through MBE Technology, IQE's product and customer

reach has been enhanced, the firm reckons, especially in the global wireless communications market (now 75% of overall revenue).

Fixed costs remained flat during first-half 2007, and operating margins are slightly ahead of analysts' forecasts. As a result of the IQE Group's strong operational gearing, earnings before interest, taxes, depreciation and amortization (EBITDA) should be substantially higher than analysts' current forecast of broadly breakeven, despite the continued and increasing weakness of the dollar against sterling. The group is cash-positive and has also put in place £5m of overdraft facilities to ensure that working capital needs do not constrain growth.

"As a result of the acquisitions made during 2006 and strong focus on the rapidly growing wireless communications marketplace, IQE

has started to deliver on its strategy and expected financial benefits," claims CEO Drew Nelson. "Demand for our products is being fuelled by both the growth in wireless volumes (mobile phones, Wi-Fi, WiMAX, GPS, direct broadcast TV and Bluetooth) and, significantly, the continued trend to higher-speed, feature-rich devices," he adds. "Recent upgrades to the overall handset market for both 2007 and 2008, the major portion being for high-end replacement phones, bodes well for strongly increasing demand for GaAs-based power amplifier and switch products."

IQE's board is confident that current strong market conditions and the group's strategy will yield continued growth, concludes Nelson.

IQE will announce the half-year results formally on 22 August.

www.iqep.com

IQE's CEO opens research campus at Sheffield University

In June, The University of Sheffield's £30m North Campus (the UK's largest dedicated centre for multi-disciplinary research and high-technology businesses) was officially opened by Dr Drew Nelson, an alumnus of the Department of Electronic and Electrical Engineering and CEO and president of epiwafer foundry IQE plc of Cardiff, Wales, UK.

"This multi-disciplinary centre is an important development for both the university and the whole region, creating an environment which allows industry to engage with university research," said Nelson.

The site includes the Kroto Research Institute; Kroto Innovation Centre; Nanoscience & Technology Centre (home to the EPSRC National Centre for III-V Technologies, directed by professors Peter Houston and Maurice Skolnick and Europe's largest university research centre dedicated to III-V compound semiconductors); and Sorby Nano Investigation Centre.

The opening followed the Kroto Research Symposium (with Department of Chemistry alumnus Sir

Harry Kroto, the 1996 Nobel Prize winner for co-discovering fullerenes).

www.shef.ac.uk/northcampus

Lifetime achievement award for Nelson

In recognition of the growth of the industry in Wales, IQE's CEO Drew Nelson (who is also chairman of the Welsh Electronics Forum) received a lifetime achievement award at June's S2K event in Cardiff (relocated this year after several years in Edinburgh).

The Welsh technology and semiconductor industry employs about 27,000 people and comprises over 500 firms. Conference organiser the UK's Joint Equipment and Materials Initiative (JEMI), supported by the Welsh Electronic Forum and Welsh Assembly Government, is working to return the event to Wales in 2008.

"Nelson has made a huge impact on the industry, not only via his



Nelson (right) receives award.

own companies but through his dedicated support for the Welsh Electronics Forum," said S2K chairman Mike Smyth. "Drew has been a fantastic supporter of the Forum for many years," added Dr Chris Young, chief executive of the Welsh Electronics Forum.

Philips sells Ommic as it exits GaAs

At the end of June, Royal Philips Electronics of Amsterdam, the Netherlands sold its controlling stake in Ommic SAS of Limeil-Brévannes, near Paris, France (part of its Corporate Investments portfolio) in a management-assisted buy-out led by new investor Financière Victoire SAS. The value of the transaction was not disclosed.

Ommic was formed in January 2000 from Philips Microwave Limeil (PML) to focus on III-V activities. The firm has about 75 staff, and offers GaAs- and InP-based MOCVD-based foundry services, including epitaxial growth, process development, wafer processing, and monolithic microwave integrated circuit (MMIC) design, for applications such as wireless

telecoms infrastructure, fiber-optic networks and automotive mobile TV.

Ommic's technologies include: short-gate-length enhancement-depletion (E/D)-mode pseudomorphic high-electron-mobility transistors (pHEMTs), power pHEMTs, general-purpose metamorphic HEMTs (MHEMTs), low-noise MHEMTs, E-mode MHEMT, short-gate-length high-indium-content MHEMTs on GaAs substrates, and double heterojunction bipolar transistors (DHBTs) on InP substrates for frequencies from 500MHz to 150GHz and from low Mb/s to 80Gb/s.

The sale of Ommic represents another step that Philips is taking to focus on its Healthcare, Lifestyle and Technology activities.

www.ommic.com

Capo to head Wafer World's business development

Wafer World Inc of West Palm Beach, FL, USA has appointed Donald J. Capo as head of business development. "We forecast to expand sales to \$10-20m worldwide in the near future," says CEO and owner Sean Quinn. An 11-year old privately held firm, Wafer World provides GaAs reclaim, as well as wafer products including GaN, InP, ZnO and Ge.

Capo previously headed the US office in Boynton Beach, FL of Singapore-based epiwafer foundry MBE Technology Pte Ltd (bought by IQE at the end of 2006). During his 25 years in the compound semiconductor industry, he has also held executive management posts at Freiburger Compound Materials, QED, and Unilever.

www.waferworld.com

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SAFC Hitech's 5-year MOCVD & ALD materials roadmap

At July's Semicon West show, the SAFC Hitech business segment of SAFC of St Louis, MO, USA detailed its new five-year chemical roadmap for MOCVD and atomic layer deposition on silicon substrates.

ALD and MOCVD precursors are made at SAFC Hitech's ex-Epichem plant in Bromborough, UK. Though traditionally used for compound semiconductors, MOCVD is increasingly applicable to new materials in advanced silicon chips.

Hitech's silicon roadmap adheres to the International Technology Roadmap for Semiconductors (ITRS) and maps a materials development program for various device layers (high-k dielectrics in memory and logic devices, additional functional memory architectures, electrodes in DRAM or gate stacks, barrier layers, wiring, and low-k dielectrics).

"As the silicon semiconductor industry moves from the 65nm node through 45nm, 32nm and beyond, demands on the electrophysics of

the device require the development of new enabling chemistries," says SAFC Hitech's president Barry Leese. "The semiconductor market is entering an 'age of chemistry' where continual materials evolution will be vital to enable future technology nodes. SAFC Hitech is positioning itself at the forefront of this material development with a number of advanced materials in production."

"Silicon oxides and other 'traditional' materials have long been used as pre-metal dielectrics," says Dr Peter Heys, director of R&D. "We are already employing oxides and binary oxides such as aluminum oxides, hafnium oxides, hafnium silicates and zirconium oxides and complex rare-earth oxides in our production processes. These metal oxides have a very high-k value and will continue to be widely exploited in the next couple of years if the industry stays on course with Moore's Law [where the number of transistors on an IC doubles about every 24 months]."

In the course of the new roadmap, SAFC Hitech will launch more complex high-k oxides, such as hafnium zirconium based layers, which offer greater flexibility, adds Heys, as they can be doped with other materials like silicon, nitrogen, aluminum, lanthanum and yttrium to meet individual customer needs for a particular device design. Beyond that, R&D of, e.g., lanthanide and strontium chemistries, binary metals and complex metal oxides or iterations of oxides should yield the k values 50+ needed for future technology nodes (compared with just 3.9 for silicon dioxide).

Materials that will be key in high-k dielectrics are those with the proper physical chemical characteristics and the required deposition capabilities for all device architectures, says Leese. "These materials will possess the appropriate electrical properties and must be offered at an acceptable cost," he adds.

www.safchitech.com

Integrating chemical supply into process development

Citing the growing importance of chemicals in semiconductor making, chemical maker Sigma-Aldrich's custom manufacturing and services arm SAFC (which has 1600 staff and sales in 2006 of nearly \$500m, making it one of the world's 10 largest fine chemical firms) has unveiled the new identity of its SAFC Hitech brand (one of its four operating segments, comprising 12% of sales), offering a 'total supply chain partner capability' with global sales and local service.

In February SAFC spent \$60m to acquire chemical supplier Epichem Group Ltd of Bromborough, UK (now SAFC Hitech's headquarters, with Barry Leese, co-founder of Epichem in 1983, as president).

"We acquired Epichem because of their unique understanding of advanced chemistries for silicon and compound semiconductor markets," said SAFC president Frank Wicks.

This extends SAFC's understanding of manufacturing production-scale high-purity chemicals, its global supply chain infrastructure and financial strength, he adds. The combination offers access to chemicals expertise, close collaboration on the development of new materials and process integration schemes, and the ability to quickly scale-up to volume production, accelerating technology progression and time-to-market, Wicks claims.

The role of chemistry in semiconductor manufacturing is evolving as the industry strives to keep pace with Moore's Law, says SAFC. The need for increased performance and smaller design rules brings greater complexity in device manufacturing, especially on the gate level, where molecular chemistry is applied. Original equipment manufacturers (OEMs), chemical companies and integrated device manufacturers

(IDMs) will need to interface directly with each other to develop the optimum chemistries, process technologies and integration schemes for particular applications.

"As we continue to find innovative materials for next-generation technology nodes, the need for greater collaboration between process engineers, tool makers and chemical companies becomes critical," says Leese. "What we will experience moving forward is an increased commitment to a turnkey approach through increasing levels of cooperation," he adds, as SAFC transitions from supplying raw materials through third-party suppliers (via Sigma-Aldrich's catalog of 120,000 chemicals) to dealing with OEMs and IDMs directly (guiding them through the entire supply chain and production process, from R&D through pilot production to commercialization and materials disposal).

Bell Labs' MBE pioneer Cho receives US National Medal of Technology

Alfred Y. Cho, adjunct VP of semiconductor research at Alcatel-Lucent's Bell Labs, has received the 2005 US National Medal of Technology (the highest honor awarded by a US President for technological innovation) for his contributions to the invention of molecular beam epitaxy and his continuing work to refine it into a commercial process. This is the eighth time that Bell Labs and its scientists have received the award.

"Al's invention makes it possible to produce materials that cannot be duplicated by nature or fabricated using any other known technique," said Jeong Kim, Alcatel-Lucent's Bell Labs president. "MBE is used today not only for everyday applications but is also critical for advanced research, done by Alcatel-Lucent's research teams and other research laboratories, into areas as diverse as topological quantum computing,

multilayer crystal growth, and radically new devices such as high-speed transistors, microwave devices, laser diodes and detectors.

Holder of B.S., M.S. and Ph.D. degrees in electrical engineering from the University of Illinois, Cho has been at Bell Labs for 39 years (since 1968). He is a member of the US National Academy of Sciences and National Academy of Engineering, and he is a Fellow of the American Physical Society, the Institute of Electrical and Electronics Engineers, and the American Academy of Arts and Sciences.

www.alcatel-lucent.com



Bell Labs' Al Cho.

Riber reactor shipments slip

For first-half 2007, MBE reactor maker Riber of Bezons, France has reported sales down 67% on €7.3m a year ago (when three reactors were sold) to just €2.4m (in components and accessories). This is due to delivery of several machines slipping into second-half 2007, for either technical or contractual reasons.

Order backlog at the end of June was €11.2m (including 11 research reactors), down 16% on €13.5m a year ago.

However, including an order for an MBE 6000 production system in late July (to be delivered by end 2007, for the manufacture of devices for portable electronics products), second-half sales are currently €12.2m.

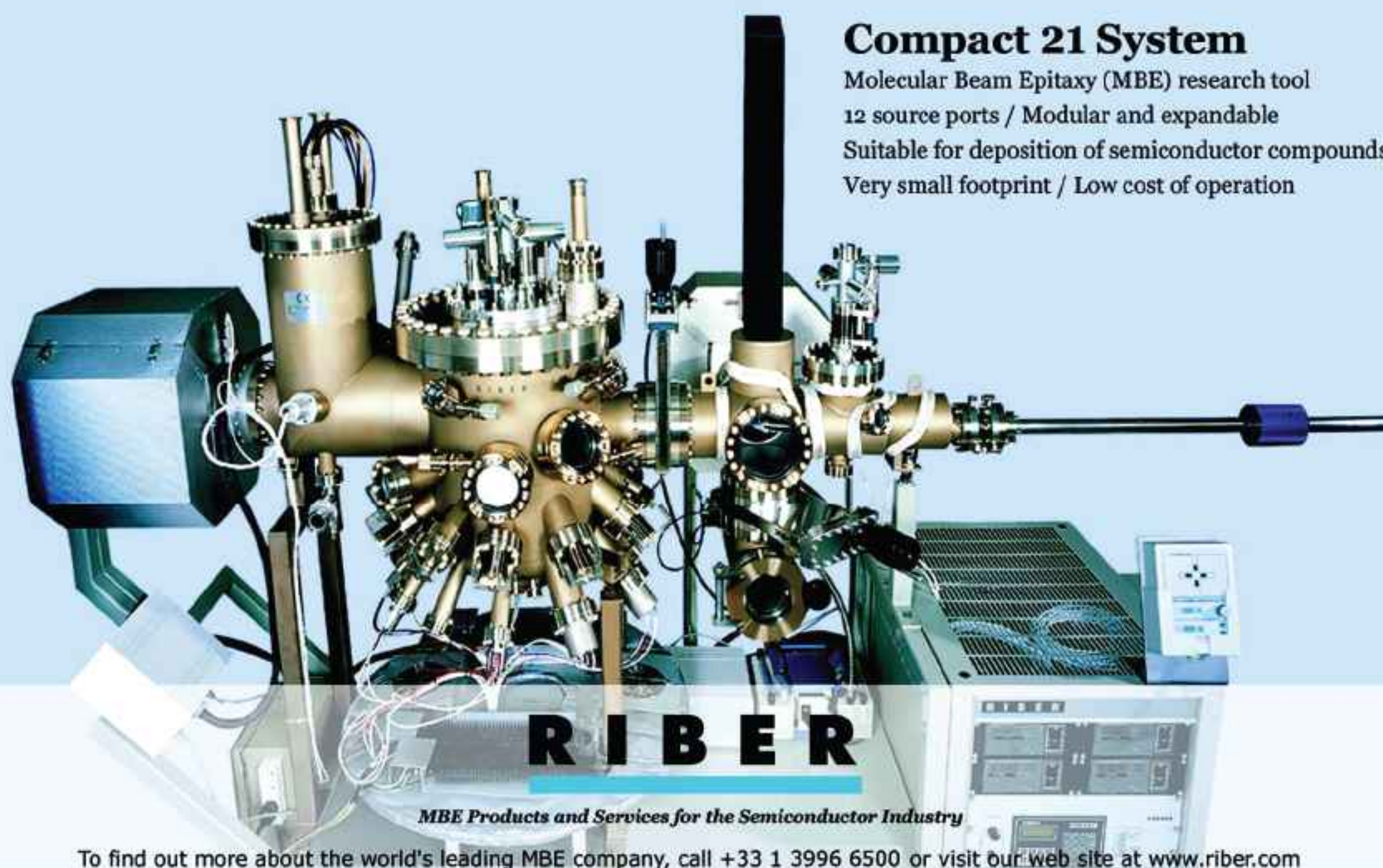
For full-year 2007, Riber forecasts total sales of €17-19m.

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IN BRIEF

Hydrogen purifiers for GaN LED makers

Johnson Matthey Gas Purification Technology (GPT) group of West Chester, PA, USA has sold two more bulk hydrogen purifiers to China:

- a GPT-30 bulk purifier (capable of 22.5Nm³/hr flow) to GaN LED epiwafer and chip maker Shanghai Blue Light Technology of Zhangjiang Hi-tech Park (spun off from Peking University in 2000 as Shanghai Beida Blue Light); and
- a GPT-20 bulk purifier (capable of 15Nm³/hr flow) to LED epiwafer maker HC Semitek of Wuhan University Science Park.

The purifiers have been sold via Johnson Matthey's distributor Gentech International (responsible for sales, training and service in China). "China's compound semiconductor market is one of the fastest growing in Asia," says Sean Peng, Asian sales manager of gas purification. "We anticipate significant sales growth."

"We have already sold a number of purifiers in the Pacific Rim and expect sales to grow in other Asian countries as well," Peng adds. GPT has sites in Japan, South Korea, Singapore, Taiwan, China and Hong Kong.

www.pureguard.net

Power+Energy Inc of Ivyland, PA, USA has shipped three PE9375S hydrogen purifiers (capable of 22.5m³/hr flow) to a 'leading manufacturer of high-performance LED devices'.

The PE9375S is a part of P+E's new-generation PE9000S series (launched last September), which offers greater capacity in a single, compact system (with models for flow rates of 1.8–40m³/hr).

The systems have a palladium alloy membrane assembly that incorporates a patented design co-developed via Department of Defense contracts.

www.powerandenergy.com

BOC Edwards launches exhaust abatement system for MOCVD

BOC Edwards of Crawley, UK, which supplies vacuum, abatement, and chemical management equipment, has launched the Spectra-G, a large-scale, combustion-based exhaust abatement system capable of treating all exhaust gases generated by MOCVD production tools (including all nitride-based applications). The system is specifically designed as a high-performance, cost-effective and environmentally friendly solution for processes that include high flows of hydrogen and ammonia. Two models are available: the SG800 and SG3000.

A six-inlet head (similar to that introduced on the Helios range — see June issue, page 18) and high flow capacity allow it to handle exhaust for multiple process tools. The high flow capacity allows it to process exhausts from up to six tools simultaneously. Dedicated inlets for each tool keep exhaust streams separated until they are introduced into the combustor.

Fuel cost is minimized due to the system's use of the exhaust gas itself as the primary fuel source. Careful management of the combustion

process minimizes the formation of undesirable NO_x, says BOC Edwards. High-velocity air flow transports heat and combustion products out of the system, eliminating the need for water and treatment facilities. Oxide particles can be removed from the air stream by filtering or a central scrubber.

"The Spectra-G exhaust abatement system is an innovative solution for handling the hydrogen and ammonia-laden MOCVD exhausts from GaN tools," says product marketing manager Mike Czerniak. "We've experienced a fairly spectacular entry into the market," he claims. "We have sold multiple systems to one of the world's leading LED manufacturers, and this has been followed with additional sales to a leading manufacturer in Asia."

www.bocedwards.com



BOC Edwards re-brands as Edwards

At July's Semicon West trade show in San Francisco, CA, USA, BOC Edwards announced its re-branding as Edwards. This follows the sale of the firm by The Linde Group in May to private equity firm CCMP Capital.

Founded by F.D. Edwards in 1919, Edwards High Vacuum International was acquired by The BOC Group in 1968, and became BOC Edwards in 1997. The BOC Group was acquired by The Linde Group in September 2006.

Edwards employs about 4000 staff globally. "With the support of our new owners, CCMP Capital, we intend to invest in growing Edwards as a newly independent

privately owned company, offering greater responsiveness and flexibility to surpass our customers expectations," said Edwards' CEO Nigel Hunton.

At Semicon West, Edwards showcased several new vacuum and abatement systems.

The Atlas range of high-flow combustion abatement solutions offers reduced operating costs and enhanced flexibility. Atlas systems meet the need for solutions to three process-related abatement problems: increased flow rates, greenhouse gas destruction and increased numbers of waste streams from next-generation processes.

Solid-source deposition systems launched for nanowire production

First Nano, a division of CVD Equipment Corp of Ronkonkoma, NY, USA, has launched its ET2000-SS and ET3000-SS solid-source deposition systems, designed for producing semiconducting nanowires.

First Nano claims that solid sources such as gallium and zinc powders are less expensive and safer alternatives to conventional metal-organic sources used by the current MOCVD method for manufacturing LEDs.

So far, GaN and ZnO nanowire LEDs and lasers have been possible only on a research scale. A major issue for producing larger samples has been controlling the temperature of the solid source (Zn or Ga) and the sample temperature uniformity.

The typical process for depositing nanowires is vapor-solid (VS) or vapor-liquid-solid (VLS) CVD. For ZnO, the source is heated to

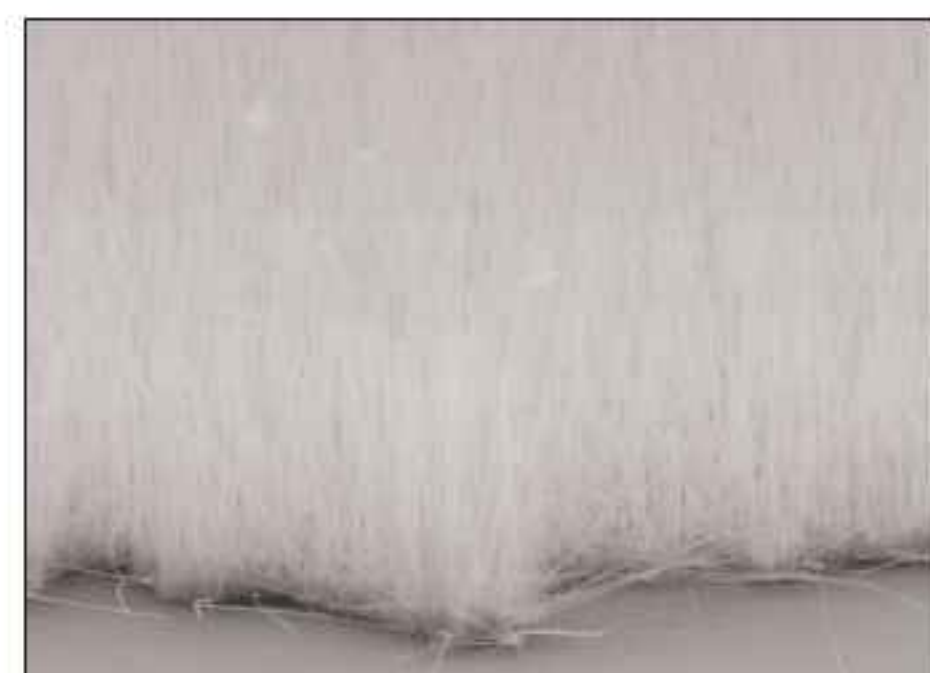
about 900°C to vaporize the source powders and the sample is placed in the chamber where the temperature drops to about 800°C. In most systems this leaves a non-uniform area for the substrate, and hence a very narrow process area in which the sample can be placed.

First Nano's solid-source deposition systems are designed to accommodate the VS and VLS methods of nanowire deposition. The new design provides better temperature control of the source material and substrate temperature uniformity by providing distinct temperature zones and separate closed-loop temperature control systems. This, along greater capacity of the new systems, represents the first step in bringing these materials to full production levels, claims First Nano.

www.firstnano.com



First Nano's new ET3000-SS system.



Vertical zinc oxide nanowires grown on a 2" sapphire wafer using a solid-source CVD deposition system.

Red LED manufacturers expanding production capacity

Aixtron of Aachen, Germany says it is seeing signs of strong AlInGaP LED market activity after receiving orders for mass-production MOCVD reactors from several manufacturers of red-spectrum high-brightness LEDs, mainly in Asia.

Changelight starts production

Founded in just February 2006, Changelight Co Ltd of Xiamen, China has started production of red LEDs after installation in late 2006 of its first two AIX 2600G3 multiwafer planetary reactors (in 49x2" and 12x4" configurations).

"Only two weeks after installation we took over the reactors and started mass production of red LEDs yielding 120mcd," says professor Wang Xiangwu, VP technology. "This is already a commercial-quality product within our target specification."

"Changelight managed to ramp up full LED manufacturing within less than one year from its foundation," says president Deng Dian Ming.

"We look forward to a further expansion of our capacity for LEDs with the third MOCVD system [another AIX 2600G3, delivered in Q2/2007], which is now ready for operation," adds Ming.

Lumileds orders reactor

Philips Lumileds of San Jose, CA, USA has ordered an AIX 2600G3 IC planetary reactor. The multi-wafer system will produce AlInGaP-based red-emitting HB-LEDs.

This latest order demonstrates the success of the long-time relationship between the two firms, says Aixtron.

Arima expands production

Arima Optoelectronics Corp of Taoyuan, Taiwan has ordered an AIX 2600G3 system in 49x2"-wafer configuration to boost production of AlGaInP red, yellow and yellow/green ultra-high brightness (UHB) LEDs. Arima operates multiple Aixtron planetary reactors, including three 49x2"-wafer AIX 2600G3 reactors ordered last September.



● Arima orders AIX 2800G4 HT for GaN-based UHB-LEDs

Arima has also ordered an Aixtron AIX 2800G4 HT MOCVD system, with an integral Yield-Plus Package, for developing and mass producing GaN-based UHB LEDs.

The AIX 2800G4 HT (pictured above) is Aixtron's latest reactor for GaN materials, for which its capacity (42 x 2" wafers) is the highest available on the market, it is claimed.

"Without this level of capability we could not continue to meet the market need for competitively priced high-brightness LEDs," says Arima president Dr P J Wang.

www.aixtron.com

LED maker Tekcore adds wafer scribes

High-brightness LED epiwafer and chip maker Tekcore Co Ltd of Nantou, Taiwan has installed two IX-210 ChromaDice wafer scribing systems and an IX-260 ChromaLift LLO (LED Lift-Off) system from J P Sercel Associates (JPSA) of Manchester, NH, USA. Founded in 2000, Tekcore provides epiwafers for applications including lighting, displays, backlights and automotive. Its products include blue, green and UV (370–530nm) HB-LEDs (while expanding into red, yellow, and orange LEDs).

JPSA's IX-210 ChromaDice is a UV laser workstation equipped with a DPSS laser; it is a Class 1 industrial-grade system designed for high-volume wafer singulation. The UV laser process is a fast, low-stress, vibration-free method of singulation that minimizes chip breakage after cutting, with kerfs as narrow as 2.5µm. ChromaDice systems feature air bearing stages that provide higher speed and acceleration in addition to greater travel for up to 300mm wafers. A patented beam delivery system allows front-side scribing in sapphire-based LEDs, resulting in lower light loss compared to conventional back-side scribing, up to 20% more die per wafer, and a high throughput of 12 wafers per hour, the firm claims.

JPSA's IX-260 ChromaLift LLO uses proprietary UV excimer-based laser technology which homogenizes the beam profile and fires it through the back of a sapphire wafer to de-bond the LED device, prior to transferring it to a substrate for packaging onto a heat sink and/or optical reflector, reducing the time and cost of LED fabrication. LED lift-off also enables the growth of vertical-design LED devices, which provide the highest light output, says JPSA.

www.jpسالaser.com

www.tekcore.com.tw

NWR launches higher-throughput LED wafer-scribing systems

New Wave Research Inc (NWR) of Fremont, CA, USA has launched the AccuScribe 2112 and 2150 high-speed LED wafer-scribing systems, which have a throughput of 12–14 wafers per hour (compared to 10wph of the existing AccuScribe AS2000FX launched in July 2006) as well as a rugged and customizable platform optimized for demanding 24/7 production-line environments.

The platform provides 4" wafer support capability and is easily customized. Backside alignment allows scribing from the backside of wafers when opaque materials preclude topside alignment and scribing.

Features for enhancing work efficiency include a highly accurate, repeatable and reliable X-Y stage, user-selectable energy output with stability feedback loop, and advanced debris removal system.

High-speed performance is

achieved via high-efficiency, high-stability, UV DPSS laser technology and NWR's optical and image-processing technologies. Performance-enhancing features include a patented wafer edge detection system that enables scribing of partial or broken wafers, increasing yields.

The semi-automated 2112 features automated alignment, positioning, and focus. The fully automated 2150 adds automated loading/unloading of wafers from/to cassettes.

"Automation will significantly reduce man hours, minimize human error and boost overall process uniformity," says product manager Pete Manautou. "Moreover, there's very little operator training or specialized skill necessary — users just program-in their scribing parameters."

www.new-wave.com

ESI acquiring NWR for LED wafer scribing

In early July, Electro Scientific Industries Inc of Portland, OR, USA agreed to acquire NWR for \$36m (about equal to its annual revenue).

Founded in 1944, ESI supplies photonics and laser systems for precision fine-tuning of microelectronics device features in high-volume manufacturing.

"ESI's acquisition of NWR accelerates our mutual growth strategies by leveraging our combined core competencies into adjacent markets," says ESI's president and CEO Nick Konidaris.

Founded in 1990, NWR has 150 staff and provides laser-based applications, with an extensive installed base and direct presence in the USA, Europe, and Asia. Its products are used for sapphire wafer scribing, flat-panel display repair and semiconductor failure analysis. NWR also produces laser ablation and other tools for industrial and scientific applications, as

well as laser-micromachining tools for drilling, etching, and scribing a wide variety of materials.

"NWR will give us entry into the sapphire wafer scribing market through their Accuscribe systems," says Konidaris. "Together our strong research and development talent pool will provide us with centers of excellence in Portland, Montana, and Silicon Valley to help accelerate the development of new tools for both companies."

ESI will enhance NWR's products by providing scientific, engineering, and system-design capabilities, says NWR's CEO and co-founder Pei Hsien Fang (who becomes VP, in charge of the New Wave Research Division). "This alliance will also greatly benefit our customers by giving them access to a larger range of cutting-edge products in addition to an expanded support network."

www.esi.com

BluGlass hires commercial manager

BluGlass Ltd of Sydney, Australia (spun off from Macquarie University, New South Wales in mid-2005) has appointed Giles Bourne (a specialist in developing offshore business opportunities for Australian corporations) as commercial manager.

Bourne's main focus will be on developing revenue opportunities in the LED lighting industry and the establishment of sales and marketing structures to seek direct markets for niche LED products.

His role will support the commercialization of BluGlass' low-cost LED technology, manufactured using the firm's remote plasma CVD (RPCVD) process for low-temperature deposition of gallium nitride onto glass substrates (rather than conventional MOCVD on sapphire).

"We are now at the stage of technology development where we can begin to develop strategic commercial alliances with key industry players," says CEO David Jordan.

"That will include deals to licence our LED technology to international manufacturers and also to investigate niche technology markets like specialized high-quality nitride layers, RF and power electronic devices."

Bourne joins BluGlass from being a director at Grafton Capital Partners, advising clients on breaking into markets in the Asia Pacific region. Previously, he worked with polymer substrate technology provider Securrency (a joint venture between the Reserve Bank of Australia and Innovia Films). Bourne holds an MBA from the Macquarie Graduate School of Management, Sydney.

Bourne will have a secondary focus to assist Jordan in managing the firm's investor relations.

www.bluglass.com.au



Giles Bourne.

Ocean hires VP of research & technology

Optical sensing and spectroscopy product maker Ocean Optics of Dunedin, FL, USA has appointed Jason M. Eichenholz (formerly Newport's director of strategic marketing) as VP of research and technology.

Eichenholz will focus on collaborative projects in industry and academia, and develop products and applications for the firm's line of miniature fiber-optic spectrometers, optical sensors, sampling accessories, light sources, fibers, probes, thin films and optics.

Eichenholz has over 15 years of laser and photonics research and product development experience. A member of SPIE and IEEE-LEOS, he chairs the OSA Laser Science and Engineering Technical Group and is a member of the OSA Science and Engineering Council.

www.OceanOptics.com

Production solutions for HB LEDs

Systems and processes with industry-leading batch capability

Oxford Instruments' process tools offer industry-leading production solutions for HB LEDs; high throughput and high yield with excellent in-wafer, wafer-to-wafer and run-to-run uniformity.

Substrate preparation

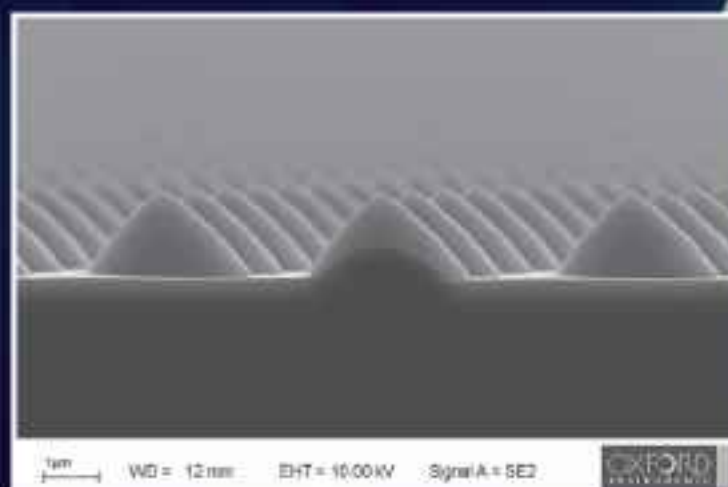
Sapphire, SiC, GaN etching
20 x 2" up to 4 x 4"

GaN, AlGaN, AlGaInP and related materials etching

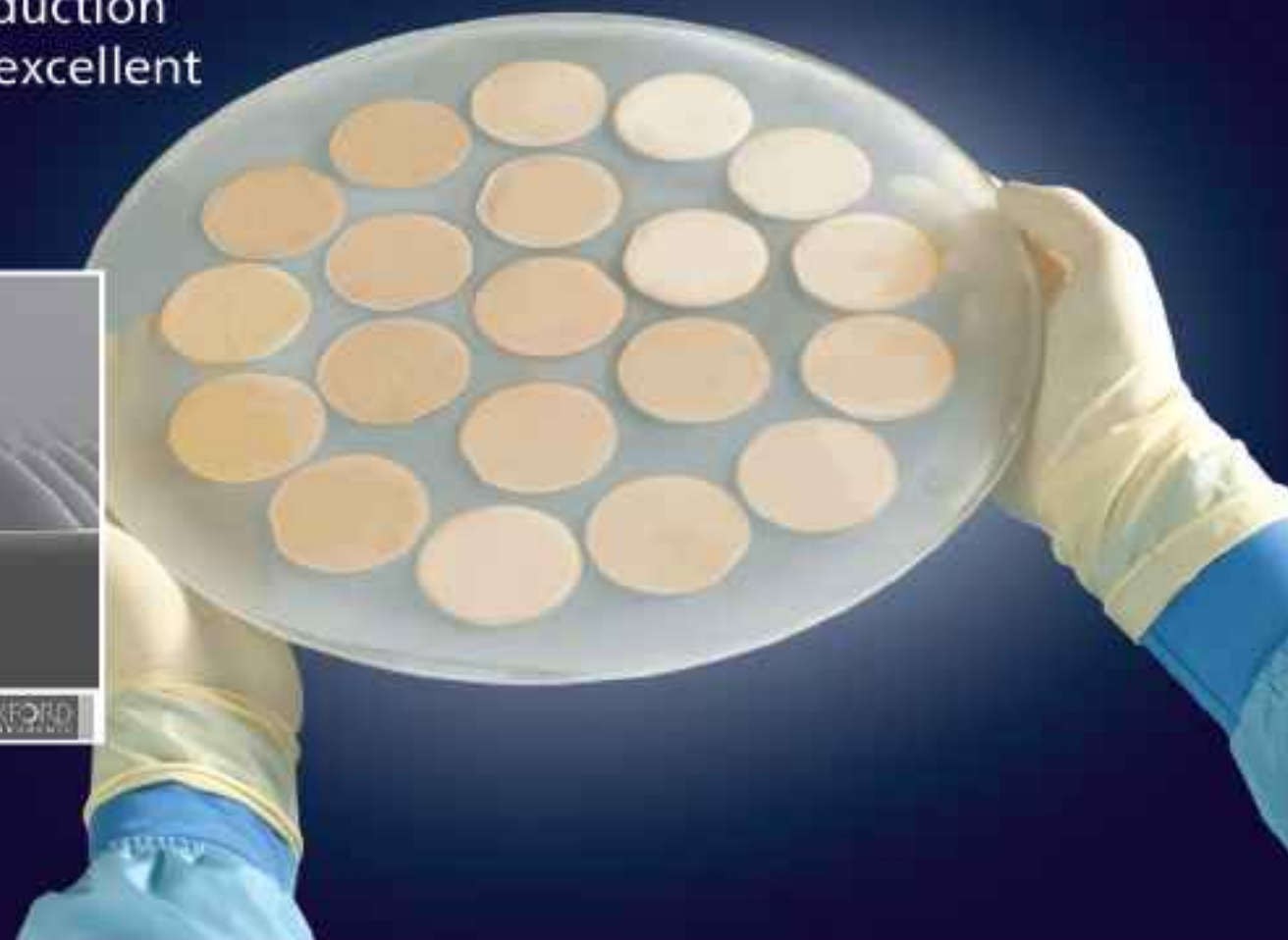
20 x 2" up to 4 x 4" (GaN, AlGaN)
10 x 2" up to 3 X 4" (AlGaInP)

Hard mask and passivation

SiO₂ and SiN_x deposition and etch
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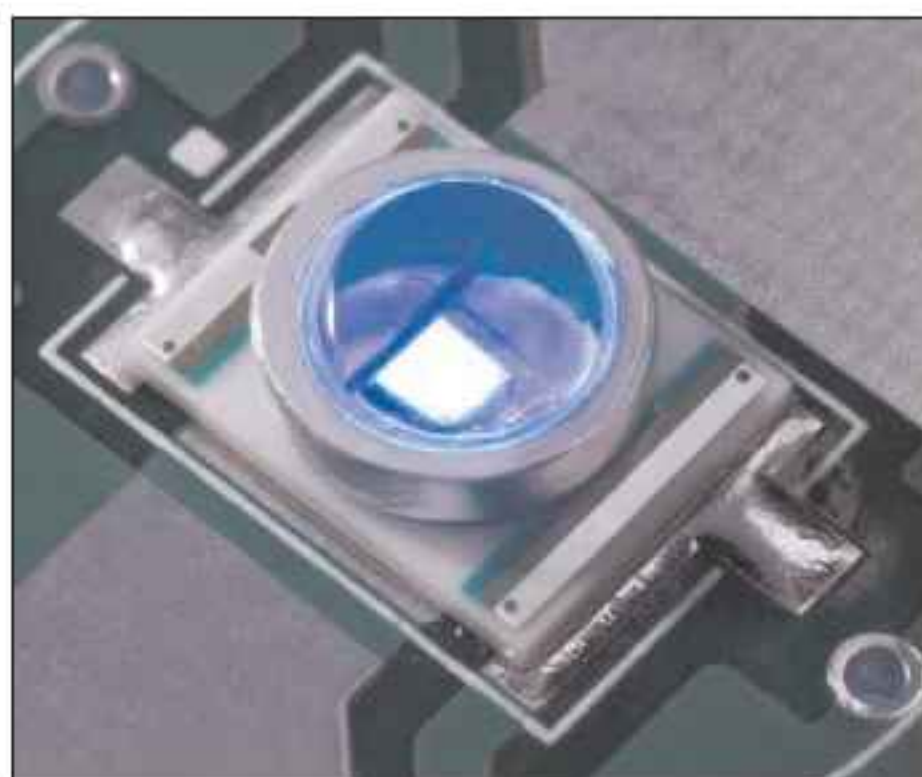


Cree's new blue XR-E LEDs 70% brighter than power LEDs

LED maker Cree Inc of Durham, NC, USA has launched blue XLamp XR-E LEDs, which are 70% brighter than its previous blue power LEDs, producing maximum luminous flux of 42lm at 350mA.

The blue XR-E is the latest release in Cree's XLamp XR-E family, which includes warm- and cool-white LEDs.

"The release of our award-winning XR-E LED in blue is the next step in our mission to be the first LED sup-



Cree's new blue XLamp XR-E LED.

plier to offer a full color range of lighting-class LEDs," says Norbert Hiller, VP and general manager for lighting LEDs.

"The new blue XR-E LEDs offer lighting designers increased flexibility for their designs," adds Hiller. "They can now choose to use fewer LEDs to lower the overall design cost, or use the same number of LEDs to achieve greater light output."

www.cree.com/xlamp

XLamp LEDs warm up Croatian Riviera

Cree has also announced that its XLamp XR-E LEDs are now being used to illuminate the Riviera waterfront in Croatia with warm-white light. For this high-visibility location, outdoor-lighting manufacturer Schröder custom-designed the street-light.

Schröder's LED walkway luminaire incorporates 180 high-power, warm-white XR-E LEDs, each producing up to 124lm at 3000K.

"LEDs provide directional lighting, which requires extreme precision in orientation when they are used for urban



Schröder's warm-white LED streetlights (incorporating XLamp XR-E LEDs) along the Croatian Riviera waterfront. LEDs provide precise directional lighting, suiting urban applications.

lighting," said Luc Coppers, engineering manager of Uitrustig

Schröder Belgium, a member of the Schröder group. "This was the challenge Schröder's designers and engineers took on in creating unique fixtures that are both beautiful and functionally optimized for this waterfront promenade. The Cree XLamp XR-E is the only warm white power LED with the performance characteristics that meet the brightness, color stability and uniformity requirements of this installation. Together we have created a stunning evening social destination."

www.schreder.com

Cree's XLamp LEDs designed into camping lanterns

Cree's XLamp XR-E and XR-C power LEDs (launched in February) are being designed into all of the LED-lighting products of The Coleman Company Inc of Wichita, KS, USA, a manufacturer of outdoor equipment and lighting products (including lanterns, flashlights etc).

"Coleman has decided to convert all LED-based products to the Cree XLamp LED due to Cree's advanced technology, common package size

within the entire XLamp LED family and excellent support," says Traci Willing, Coleman's product manager for battery lighting. Coleman is rolling out Cree LED-based

Coleman's Pack-Away LED lantern.



lanterns, headlamps, flashlights, spotlights and specialty Exponent products. (Coleman's web-site currently offers Exponent 4AA Pack-Away lanterns that incorporate 3 Watt K2 Luxeon LEDs from Philips Lumileds.)

"Campers and outdoor enthusiasts worldwide can now join the LED lighting revolution," adds Norbert Hiller, Cree's VP and general manager for lighting LEDs.

www.coleman.com

Toronto joins LED City initiative

Toronto is to be the first Canadian city to join Raleigh, NC, USA in the 'LED City' initiative, aiming to install LED lighting city-wide throughout its infrastructure, according to an announcement by the Toronto Association of Business Improvement Areas (TABIA) through its 'greenTbiz' energy conservation and environmental program.

The LED City program was launched in February by City of Raleigh officials in conjunction with LED maker Cree Inc of Durham, NC. It aims to create a community of cities committed to the evaluation, deployment and promotion of LED lighting in city infrastructure applications. Member cities will share their experiences with LED lighting trials and deployment to foster the creation and adoption of best practices for LED lighting. In turn, the collaboration is expected to increase awareness of LED lighting solutions and accelerate the deployment of LED lighting.

TABIA says it will evaluate, deploy and promote the use of LEDs across multiple lighting applications. In the coming months, LEDs will appear throughout parks, parking garages and in architectural lighting.

TABIA adds that, over the past four years, Toronto has been a center for LED consumer education and an



Toronto's floodlit CN Tower.

early adopter of LED lighting, demonstrating the advantages of LEDs to residents and businesses.

In partnership with the local electricity utility, an exchange program has enabled consumers to swap their old incandescent holiday lights for new LED holiday lights (with TABIA participating in developing the ENERGY STAR qualification for LED holiday lights). A complete turnkey retail store installation has replaced halogen MR16 track lighting with MR16 LED retrofit products. Also, LED streetlights have been installed in the city's Exhibition Place. Meanwhile, Toronto has already converted the CN Tower lighting to LED lighting (cutting its lighting energy consumption by 60%). Other current and planned LED projects include

solar-powered LED lights in a park and LED lighting in a public parking garage.

Just converting Toronto's 160,000 streetlights to LEDs should save about \$6m a year in electricity costs, while reducing greenhouse gas emissions by over 18,000 tonnes, it is estimated.

The commitment to the LED City initiative shows support for the Canadian legislative agenda focused on energy efficiency, claims TABIA, as well as Toronto's participation in the William J. Clinton Foundation's Climate Initiative to accelerate greenhouse-gas emissions reductions and slow global warming.

"LED lighting enables cities such as Raleigh and Toronto to save energy, preserve the environment and save our taxpayers money," adds Raleigh's mayor Charles Meeker.

"Toronto and Raleigh understand how important it is to set the pace for a new generation of energy-conscious citizens and government leaders," says Cree's chairman and CEO Chuck Swoboda. "LED technology is clearly making progress towards widespread adoption for government, commercial and residential applications."

www.toronto-bia.com

www.ledcity.org

www.cree.com

BridgeLux appoints Lumileds' Mark Swoboda as CEO

BridgeLux of Sunnyvale, CA, USA, which was founded in 2003 and manufactures ITO/InGaN-based LED chips for solid-state lighting, has appointed Mark Swoboda (brother of Cree CEO Chuck Swoboda) as its new CEO. Dr Robert C. Walker (CEO since July 2005) continues on the board and as a member of the senior management team, leading strategic business development initiatives.

Swoboda joins after 8 years at Philips Lumileds Lighting Company, where he was most recently execu-

tive VP, leading the sales, marketing, applications, and custom product development teams. Previously, Swoboda spent 17 years with the Hewlett-Packard Semiconductor Products Group in sales, marketing, and channel management positions.

"Mark brings with him an incredible portfolio of development, market and branding experience that will be key to positioning the company for its next phase of growth," says Walker. "With lighting-class LED products having reached volume production,

Mark's vision will enable BridgeLux to brand itself as a key supplier to companies pursuing some of the most exciting emerging markets."

"BridgeLux has assembled one of the strongest R&D teams in the industry, and has shown great results with its technology," said Swoboda. "It's an exciting prospect to lead a team of this calibre into a market that is so ripe for explosive growth and at the same time is simply important for the world."

www.bridgelux.com

SDK boosting monthly blue LED chip capacity to 200m by June

After receiving orders for its GaN-based blue LEDs this year at a rate far exceeding its original expectations, chemical manufacturer Showa Denko K.K. (SDK) of Tokyo, Japan has decided to invest JPY5bn to expand production capacity of GaN-based blue LED chips at its Chiba site ahead of schedule, to 200 million units per month by June 2008. This is in addition to its ongoing expansion (announced in February) from 30 million to 100 million units per month by the end of 2007 (see April issue, page 29). Capacity is currently 60 million units per month.

While GaN-based blue LEDs are currently used in mobile phones

and displays, demand is expected to grow at an annual rate of nearly 20% in the next five years, due mainly to the development of applications such as LCD backlighting, says SDK.

To produce blue LED chips, SDK is using its new Hybrid PPD process, which combines the conventional metal organic chemical vapor deposition process and SDK's proprietary plasma-assisted physical deposition (PPD) process for growing nitride-based semiconductor crystals.

The new process technology enables the use of high-quality 4-inch epitaxial wafers (which is not possible with the conventional MOCVD process, the firm claims).

SDK therefore aims to improve product quality and strengthen its competitive position, while achieving high-brightness emission.

Under the ongoing 'Passion Project' medium-term consolidated business plan, SDK is aggressively expanding its ultrabright LED business, centering on GaN-based blue/green LEDs and AlGaInP-based red/orange/yellow/yellowish green LEDs. SDK is positioning the business as one of its 'new growth driver' businesses, allocating resources correspondingly. SDK is planning to increase annual sales of its ultrabright LED chips to JPY20bn by 2008.

www.sdk.co.jp

Avago launches 1W warm-white Moonstone power LED

Avago Technologies of San Jose, CA, USA has added a 1W warm-white LED (with color temperatures of 2600–4000K) to its family of Moonstone power LEDs, which already includes 1W Moonstone LEDs in blue, green and cool-white colors.

Available in one of the industry's thinnest packages (8.5mm wide by 15.85mm long by just 3.3mm high), the ASMT-MY00 LED provides a robust and reliable package that provides high-brightness illumination and easy installation, and is suited to solid-state lighting applications that require ultra-high-brightness LEDs, such as decorative lights, garden lights, task and reading lights, architectural, accent and marker lights.

The ASMT-MY00 high-brightness surface-mount package, which feature a smooth radiation pattern and 110° viewing angle, has been developed to withstand high operating temperatures and driving currents. An exposed pad design

provides low thermal resistance (10C/W) between the LED chip junction and printed circuit board to minimize temperature rise and help assure long-term device reliability. Heat transfer from the package to the motherboard via the exposed pad design enables the LED to be driven at a forward current of

350mA and deliver up to 56lm. Typical total luminous flux is 50lm.

With its low profile design (suited to applications where height is a constraint), the ASMT-MY00 can be easily soldered using conventional surface mount (SMT) techniques to minimize production costs.

www.avagotech.com/led

Avago has also launched the HLMP-CYxx series of high-brightness InGaN-based warm-white through-hole (TH) LEDs as a light-bulb replacement in solid-state lighting and illumination applications. The color temperature range is 2500–4600K, the typical color rendering Index (CRI) is 70, and the typical optical efficacy is 33lm/W.

The HLMP-CYxx series has been designed to provide a cost-effective, high-brightness LED that offers the flexibility of multiple 5mm round package options. The T-1 3/4 high-intensity white



Avago's HLMP-CYxx series LEDs.

LED lamps are untinted and non-diffused, and incorporate precise optics that produce well-defined spatial radiation patterns at specific viewing angles of 15, 23, 30 and 50° in several packaging options (targeting designers of retail and commercial display lighting, as well as street and portable lighting applications).

Cree boosts cool-white XLamp to 100lm minimum

Cree Inc of Durham, NC, USA has launched what it claims are the first LEDs commercially available in volume production with a minimum luminous flux of 100lm at a drive current of 350mA.

Over the past year and a half, XLamp LED performance has improved by 100%, the firm claims. Compared with its previous generation, the latest product — available in cool-white color temperatures of 5000–10,000K — can deliver either 25% greater brightness with improved efficacy, or up to 55% greater brightness at the same efficacy. Also, the new LEDs retain the same footprint as the earlier version, so they can be used as replacements without the need for design changes.

"The availability of such high-performance devices should certainly accelerate the conversion of the

lighting market to solid-state sources," comments Robert Steele, director of the optoelectronics practice at market research firm Strategies Unlimited.

"This is an announcement of volume availability, not an R&D result or availability of a few parts," says Norbert Hiller, Cree's VP and general manager for lighting LEDs. "These LEDs can enable lighting manufactures to create fixtures using fewer LEDs than before, thereby lowering initial product cost and reducing energy consumption," he adds.

This is an announcement of volume availability, not an R&D result or availability of a few parts

www.cree.com

Nichia to start mass production of 150lm/W white LEDs by end 2007

At early June's fourth annual euroLED 2007 event in Birmingham, UK, Dr Nico Vogelaar, marketing manager of Nichia Europe B.V., outlined Japanese LED maker Nichia's white LED roadmap, confirming that it is aiming to start mass production of white high-brightness LEDs with a luminous efficacy of 150lm/W by the end of 2007 (two years ahead of Nichia's original schedule for commercial release in 2009).

The products are based on the laboratory demonstration 150lm/W LEDs announced last December, which have a color temperature of 4600K. This exceeds the luminous fluxes for a halogen lamp

(20lm/W), a compact fluorescent lamp (45lm/W), a conventional fluorescent lamp and a metal halide lamp (both 90lm/W), and even a high-pressure sodium lamp (132lm/W).

However, the LEDs have small chips that operate at a low drive current of 20mA, yielding a luminous flux of just 9.4lm. Larger chips driven by higher currents of 350mA and up to 1A are less efficient but produce significantly more lumens. For example, larger chips introduced commercially by Cree and Lumileds have lumen outputs as high as 100lm per chip.

www.nichia.com

Some gems need a little extra help to sparkle



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Lumileds boosts Rebel to 100lm at 350mA via TFFC technology

Philips Lumileds Lighting Company of San Jose, CA, USA has extended its Luxeon Rebel family of cool-white LEDs (launched in March) to new products with minimum luminous fluxes of 90 and 100lm at 350mA (claimed to be the brightest, most efficient power LED light sources available). The new LEDs join the existing 70 and 80lm products. Rebel has already sold over 1 million units (making it the fastest growing product line for lighting applications in Lumileds' history).

Each Luxeon Rebel LED with a luminance of over 70lm incorporates the firm's newly introduced Thin Film Flip Chip (TFFC) technology. The TFFC process involves laser removal of the sapphire substrate and roughening of the chip's light-emitting surface to improve light output efficiency, delivering as much as 17% more light output than competing thin-film chip architectures, Lumileds claims.

"White Luxeon LEDs with TFFC are capable of delivering more than 80lm/W at 350mA," says Frank Steranka, executive VP of research and development. "TFFC technology allows us to maximize the light-emitting area and minimize thermal resistance, resulting in brighter and more efficient LEDs.

Such attributes are required for applications in general lighting, automotive lighting, displays, and projection."

The brighter and more robust TFFC chip technology has been implemented previously in Lumileds' Luxeon Flash LED products (which are targeted at cell-phone applications), but not in the firm's mainstream product range until now, according to marketing director Steve Landau.

"Luxeon Rebel has the most detailed reliability information. Design confidence is critical too and therefore we provide useful minimum performance data as opposed to 'typical' or 'up to' output numbers that aren't useful in the design process," adds Eastley.

"Customers sampling the minimum 90lm and minimum 100lm parts over the last few months are convinced that Luxeon Rebel's performance will enable new product opportunities; and we are certain that these parts will deliver substantial new design activity," says product manager David Eastley. "Luxeon Rebel has been extremely well received by the lighting com-



Lumileds' Luxeon Rebel LED.

munity because of its small size, performance and value it delivers," he claims.

The new Luxeon Rebel minimum 90 and 100lm parts are available from via Future Lighting Solutions

(a division of Future Electronics, the world's third largest electronic components distributor).

● Lumileds reckons that its TFFC technology should lead to 100lm/W and higher white power-LEDs in the coming year and, in the longer term, achieve performance levels of 150lm/W and above.

"The TFFC architecture is a prerequisite for additional innovations from Philips Lumileds' Advanced Labs group, some of which were used to achieve our record 115lm/W performance earlier this year," says Steranka.

"We will continue to move technologies from our Advanced Labs group into R&D and Manufacturing," he adds. "This process provides for a continuum of performance improvements in the chip, phosphor, and packaging areas."

www.futurelightingsolutions.com/100
www.philipslumileds.com

Philips buys LED lighting system maker Color Kinetics

Royal Philips Electronics is acquiring the outstanding shares of LED lighting systems maker Color Kinetics Inc of Boston, Mass, USA for \$791m (€592m).

The merged company, headquartered in Burlington, MA, USA, will operate under the name Philips Solid-State Lighting Solutions. Philips' and Color Kinetics' LED fixtures and Color Kinetics' OEM modules will be ultimately co-

branded Philips/Color Kinetics.

The transaction is expected to close in the second half of 2007 (subject to the terms and conditions of the merger agreement and to the approval of Color Kinetics' shareholders, as well as to customary regulatory clearance).

Philips already has a strong position in the solid-state lighting (SSL) market. Philips secured full ownership of Lumileds in 2005,

and also recently acquired solid-state lighting module maker TIR Systems.

"This acquisition uniquely positions Philips as a major player in the fast-growing SSL business with technology, expertise and intellectual property in all parts of the value chain of integrated LED-based lighting solutions," said Theo van Deursen, CEO of Philips' Lighting division.

ITC's US exclusion order comes into force on Epistar's LEDs

The US International Trade Commission's exclusion order has come into force barring importation into the USA of the AlGaInP-based MB, GB and OMA LEDs and the next-generation MB II, GB II and OMA II LEDs of Epistar Corp of Hsinchu, Taiwan, as well as packaged lamps containing the LEDs and boards consisting primarily of arrays of such lamps. This follows the end of a 60-day period of US Presidential review after the ITC's final determination on 9 May that the LEDs infringe US Patent no. 5,008,718 owned by Philips Lumileds Lighting Co LLC of San Jose, CA, USA.

As a result of the exclusion order, Lumileds says it is notifying LED chip packagers, downstream customers and distributors of the following:

1. The manufacture, use, sale, offer for sale, or importation into the USA of Epistar's metal-bond (MB), glue-bond (GB) and omni-directional mirror adhesion (OMA) LEDs or products incorporating those LEDs is an infringement of Lumileds' patent rights.

2. Unlicensed manufacturers should not rely on indemnity agreements to excuse their infringement. A promise by a manufacturer to 'indemnify' its customer against legal action will not prevent Lumileds from asserting its patents and seeking damages directly from that customer. Likewise, indemnification will have no effect on exclusion of the infringing products by customs officials.

3. Companies that use, import, or sell unlicensed infringing products, even unknowingly, are direct infringers of the patent.

4. During the ITC investigation, Epistar was required to disclose all of its available AlInGaP LED products and its 'next generation' products, and these were all found to infringe the 5,008,718 patent. Given the broad scope and critical importance of this patent to making commercially viable AlInGaP LEDs, Lumileds does not believe that Epistar will be able to suddenly devise a non-infringing alternative after having been unable to do so for the last decade or more.

Lumileds says that buyers have several other options for sourcing AlInGaP LED products, including working through chip packagers, such as Avago, or distributors (such as Lastertech, Marubeni, Promate and Future Electronics) that offer products licensed under its patents.

Lumileds also has a pending action in the US District Court for the Northern District of California, in which it is asserting its patent rights against Epistar's OMA, MB, and GB products and seeking both damages and an injunction.

● On 19 July, after Epistar filed an appeal, the US Court of Appeals for the Federal Circuit (CAFC) temporarily stayed enforcement of the exclusion order for up to 30 days.

The CAFC has also granted its request for an expedited response from the ITC. "We understand the CAFC rarely grants such a stay and are cautiously optimistic that the court will also grant a permanent stay while Epistar's appeal is litigated," says Lee.

www.lumileds.com

Epistar launches Phoenix and Aquarius AlGaInP LEDs

Epistar has since responded to the exclusion order coming into force by announcing its new Phoenix and Aquarius lines of ultra-bright AlGaInP LEDs (designed so that they are not subject to the ITC's exclusion order, it is claimed).

"Epistar has always been committed to ensuring that its customers can buy its products with confidence," says president B.J. Lee. "In light of the ITC's ruling we accelerated our development program and are now manufacturing the Phoenix and Aquarius products in volume. Those products remove entirely the feature Lumileds claims is the basis for its patent, and also

provide significantly improved performance over the previous [MB, OMA and GB] designs," he claims.

In light of developments, Epistar is urging LED packagers, downstream customers and distributors to be aware of the following:

1. Epistar is working with the Department of Homeland Security - US Customs and Border Protection to assure that customers importing, selling or using Phoenix and Aquarius products will not be subject to the exclusion order. Epistar expects a favorable determination soon.

2. Epistar is confident that Lumileds has no basis to claim that those products infringe its patent.

3. The ITC's decision that the OMA, GB and MB product designs infringe Lumileds' patent is not binding on any US court that would decide whether the sale or use of those products infringes. Epistar still believes that the ITC's decision is contrary to the facts and the law, and is confident that the US Court of Appeals for the Federal Circuit will reverse it. "In the meantime, we can offer our customers these new, improved and clearly non-infringing products [Phoenix and Aquarius]," says Lee.
4. Epistar has assured customers that it will stand behind their decisions to purchase Epistar products.

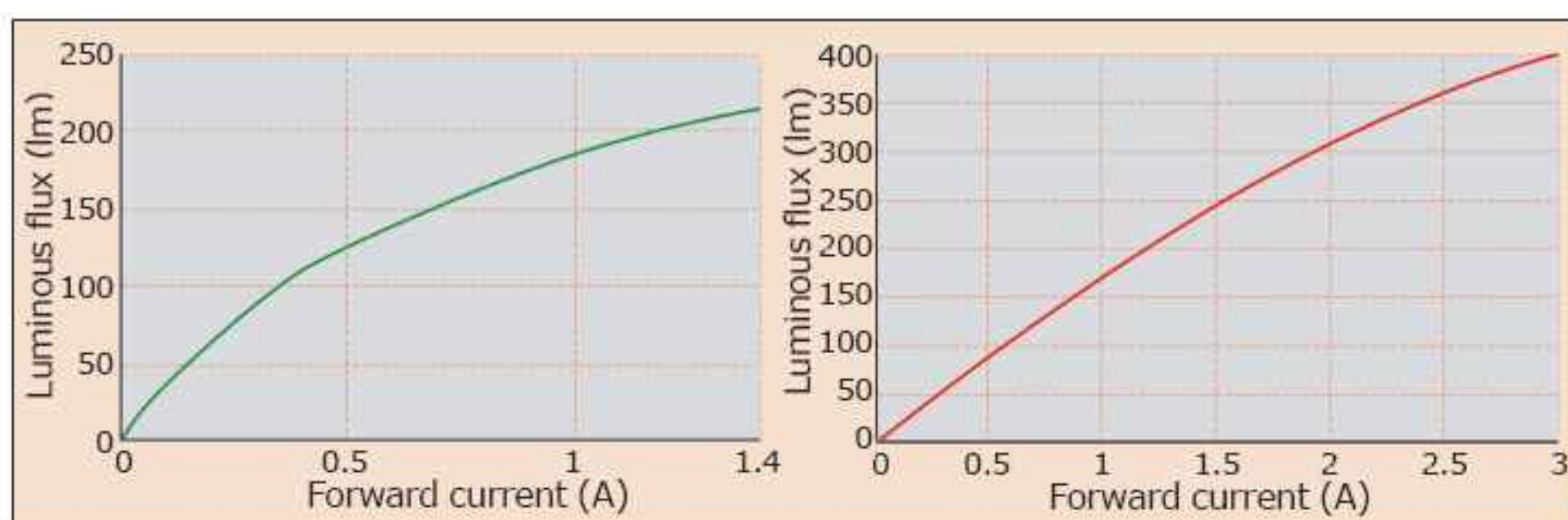
Osram demonstrates brighter red and green LED chips

Osram Opto Semiconductors says that its new low-current, high-power 1mm², green LED chip (emitting at a wavelength of 527nm) has achieved a brightness exceeding 180lm under laboratory conditions from an operating current of 1A (compared to 100lm for Osram's existing green Platinum Dragon LED chip). The new chip achieves maximum luminous efficiency at 100–350mA, and can produce 100lm from 350mA — a power consumption of just 1.4W (giving a luminous efficacy of 72lm/W).

Osram credits the increase in output brightness and efficiency to using the latest evolution of its ThinGaN InGaN-on-sapphire epitaxial process technology as well as an improved chip design.

The new high-intensity green chip will be used in Osram Opto's Dragon and Ostar LEDs, and suits LCD backlighting applications. Fewer LEDs are needed to provide a specified brightness level over large display diagonals. Also, due to the small power consumption, less demand is placed on display cooling.

Also, using its latest InGaAlP thin-film technology Osram Opto says it has demonstrated a 1mm² red LED chip (emitting at a wavelength of



Luminous flux (lumens) vs drive current for (left) green and (right) red LEDs.

615nm) with a record brightness of over 300lm under laboratory conditions from an operating current of 2A and a power consumption of 6W (a high luminous efficacy of 52lm/W). This compares with Osram's existing red Platinum Dragon LEDs, which have an output of 96lm for power consumption of 2.5W (a luminous efficacy of 38lm/W).

"We have achieved this enormous increase in brightness above all by designing the new chips to handle higher currents," says development engineer Dr Ralph Wirth. "This has resulted from optimizing the series resistors."

In addition, because of the red chip's thin-film technology and scalable, smaller chip surfaces, the same number of LEDs can be used as in previous applications while

yielding greater luminance.

Designed mainly for projection applications, the chips will be used in Osram's Dragon and Ostar LEDs. For Ostar Projection, the new chip offers greater luminance than its predecessor, allowing optimum light injection into external optical systems, says Osram Opto. As a pure surface emitter in Ostar LEDs, the red chip should achieve higher system outputs in an efficient package.

The new chip's higher current-handling capacity and high brightness also suit exterior automobile lighting (where high luminance and efficient output is in increased demand).

For both the new green chips and the new red chips, the first LEDs are expected to enter volume production by third-quarter 2008.

www.osram-os.com

Peak brightness of Ostar Headlamp LED doubled to 620 lumen

Osram Opto says it has further developed its Ostar Headlamp LED (which has been certified according to the automotive standard), more than doubling its peak brightness from 250lm to 620lm at an operating current of 700mA (with power consumption of 12W). The typical brightness is 500lm. Initial samples are available now. Volume production will start at the end of 2008.

The Ostar Headlamp LED does not have a lens. Its five closely packed chips are connected in series and produce light with a color temperature of 6000K. However, in future Osram reckons



Osram's boosted Ostar Headlamp LED.

that three or four Ostars will be enough to produce the 1000lm required for headlights.

The brightness has been achieved due to a combination of measures. Osram says that the Ostar

Headlamp makes use of the features that gave its Ostar Lighting LED product family a significant boost in brightness (to 1000lm). For example, the package has been designed to minimize reflections. Also, an improved converter and advances in thin-film technology have further improved luminous efficacy.

Like all LEDs with thin-film chips, says Osram, the Ostar Headlamp offers a high luminance that is further enhanced by the closely packed chips. The LED can also be combined with small optics, takes up little space, and offers design flexibility.

Osram breaks ground on Malaysia chip fab

Germany's Osram Opto Semiconductors GmbH (the world's second biggest LED maker, and the biggest in Europe) has broken ground on construction of its new LED chip fabrication plant in Bayan Lepas, Penang, Malaysia (announced in May) in a joint ceremony performed by CEO Dr Rüdiger Müller and Tan Sri Dr Koh Tsu Koon, chief minister of Penang.

With total investment ultimately "in the high double figures of millions of euros" and a floor area of more than 30,000m² to serve the booming LED market, Osram Opto expects the new LED chip fab to be open by spring 2009 and to be the most advanced in the world.

The Penang fab will manufacture nitride-based LED chips, complementing Osram Opto's existing LED chip fab at its headquarters in Regensburg, Germany (which is also being expanded simultaneously, to be completed by the end of 2007).

Also, the capacity of the existing LED assembly line in Penang (which started operation in 1972) is being increased by more than 50%. This will lead to the creation of over 800 new jobs in the long term, bringing the total to more than 3000 (making Osram one of the largest employers in the northern region of Malaysia).

"Today marks the beginning of a new era in more than 30 years of cooperation between Osram and Penang," said Müller. "We are delighted to be further



Osram Opto Semiconductors Penang's managing director Werner Gelner; Osram Opto CEO Rüdiger Müller; chief minister Koh Tsu Koon; and Herbert Jess, German ambassador to Malaysia (from left to right).

strengthening our partnership today at this groundbreaking ceremony and to be embarking on a new chapter," he added. "In constructing this LED chip factory here in Penang, Osram is for the first time exporting central strategic technology know-how to another market outside its home country of Germany. This is only possible because our many years of cooperation have meant that we have the utmost trust in the quality, motivation and skills of the local workforce and authorities."

Müller concludes, "Regensburg will continue to be our main site, where we will concentrate our know-how and benefit from having our research and development facilities so close to our production line."

www.osram-os.com



Model of Osram Opto's new LED chip fab in Penang.

Patent dispute settled as Citizen licenses white LED IP

Munich-based Osram GmbH and its LED making subsidiary Osram Opto Semiconductors GmbH of Regensburg, Germany have signed a license agreement that covers the use of its intellectual property concerning phosphor light conversion technology in the white LED products of Citizen Electronics Co Ltd of Tokyo, Japan.

The agreement settles patent lawsuits that Osram Opto Semiconductors filed against Citizen (in both the Dusseldorf Regional Court in Germany in May 2005 and the US District Court in Wilmington, Delaware in November 2006) for violation of Osram's white LED intellectual property rights (whereby white light is produced by converting blue light using a yellow converter).

Citizen manufactures white LEDs using technology licensed from Nichia, under an agreement (the very first signed by Nichia) dating back to early 2002. Later in 2002, Nichia and Osram Opto signed a cross-licensing agreement, allowing the companies access to each other's technology. However, this does not allow third-party access.

Citizen is now granted the right against payment to use Osram IP in white LEDs of all sizes, in all output categories and for all application areas (e.g. the automobile sector or displays and keypads).

"We are pleased that this agreement signals the end of a dispute and that another renowned LED manufacturer in Citizen Electronics has recognized the importance of our intellectual property," say Osram Opto's CEO Dr Rüdiger Müller and Osram GmbH's general counsel Gerd Pokorny.

Further to the license agreement, Osram and Citizen are also exploring possibilities for cooperation.

www.c-e.co.jp

Luminus moves HQ & expands manufacturing operations

LED maker Luminus Devices Inc has moved its headquarters to an expanded facility at the Technology Park business campus in Billerica, MA, USA housing its engineering, assembly and test operations, as well as its corporate offices.

This follows receipt in mid-June of a \$2.5m development loan from the Massachusetts Development Finance Agency's Emerging Technology Fund (ETF). The funds are allotted for capital and leasehold improvements and aim to help create new jobs over the next five years. The firm's semiconductor foundry will remain its 30,000ft² manufacturing facility in Woburn, MA.

The new building will house the firm's expanding manufacturing operations to help meet increased demand for its PhlatLight (Photonic Lattice) LED-based solid-state light sources, and will accommodate its growing staff of scientists, engineers and manufacturing personnel.

Luminus will initially use 45,000ft² of the building.

Luminus was founded in 2002 by chief technology officer Alexei Erchak on the basis of research at Massachusetts Institute of Technology. "We are encouraged by the State's support of our business and we are pleased to be giving back to the local economy by maintaining our Massachusetts roots and continuing to create new jobs," says CEO Udi Meirav.

"The loan from MassDevelopment will help continue the expansion of our manufacturing operations and contribute to the mass commercialization of our PhlatLight products," he adds. "A larger facility for Luminus has been long overdue, with the growth of our company and the need to ramp up production of our existing products for our consumer electronics customer base and as we enter into new applications. The



Luminus' new headquarters in Billerica, MA and (inset) the PhlatLight LED.

new facility will be essential as we enter our next phase of growth. We will continue to operate in Massachusetts and believe Billerica is an ideal environment for a rapidly expanding company like Luminus, thanks to excellent infrastructure and a fantastic workforce in and around our new hometown."

Luminus' PhlatLight products have been adopted by consumer electronics manufacturers. PhlatLight LED technology is the light source in Samsung Electronics' new line of Slim LED DLP TVs, which all use PhlatLight illumination products in place of the hazardous mercury lamps found in traditional projection TVs. PhlatLight technology is

also in commercial use in projection TVs from NuVision, as well as in a compact new pocket projector from LG Electronics.

This, as well as its more recent expansion into new applications, has driven a stream of new personnel recruitments.

Luminus has created 175 local jobs over the last four years and says it will continue to

expand its workforce throughout the term of the development loan agreement, aiming to create a further 300 jobs.

Further growth is expected to come from new applications including backlights for LCD TV, video projectors, avionics displays, and LED-based lighting systems.

● Poised to capitalize on the rapidly growing LCD TV market, during the Society for Information Display's SID 2007 international symposium and exhibition in Long Beach, CA in late May, Luminus, in partnership with Global Lighting Technologies (GLT), demonstrated a 52-inch prototype of its PhlatLight-based backlight unit for LCD TVs. The

co-developed back-lighting unit needs only 10 PhlatLight chipsets for illumination, compared to many thousands using conventional LEDs. Also at the show, Luminus was awarded SID's 2007 Display Component of the Year Silver Award (the industry's highest honor) for its PhlatLight LED technology.



Cleanroom in Luminus' new assembly & test facilities. www.luminus.com

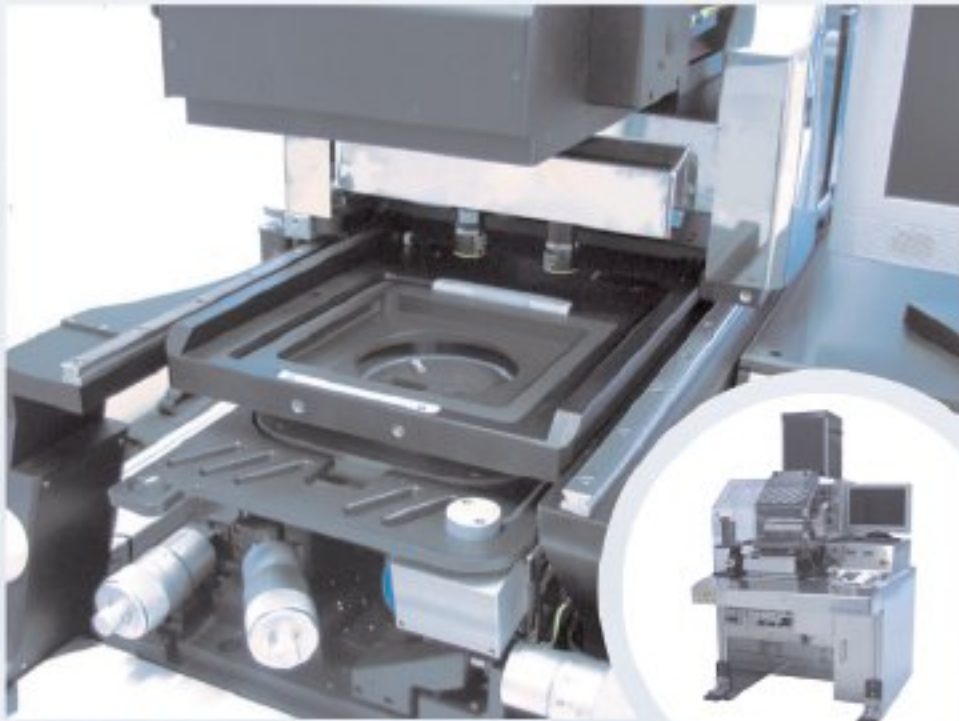
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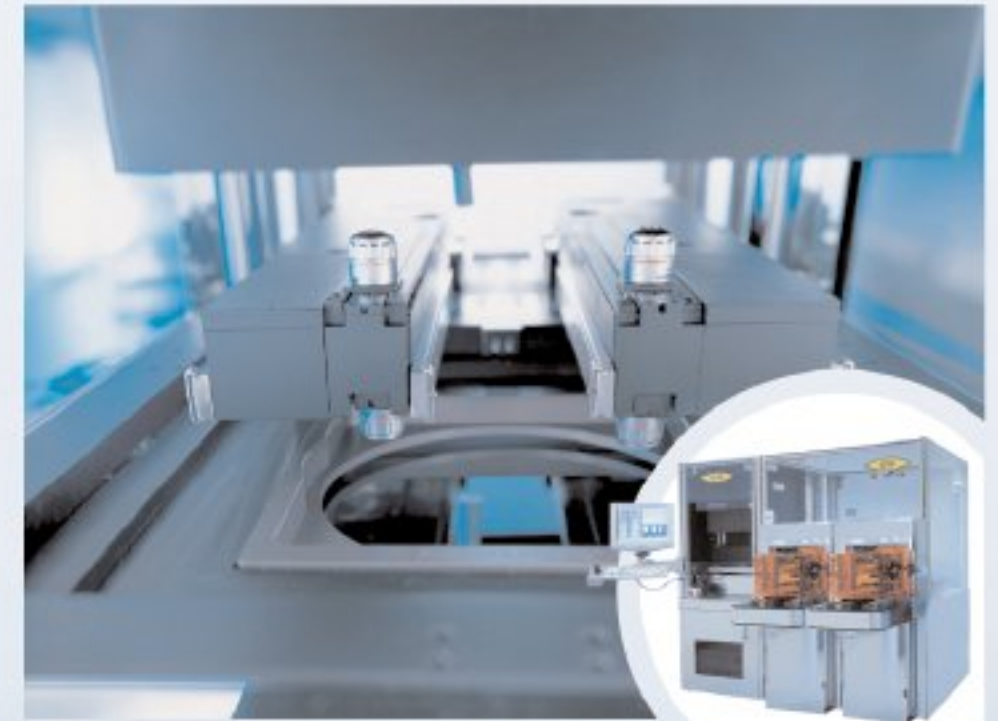
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Optium hit by drop in sales of high-end 300-pin products

For its fiscal Q4/2007 (to end July) Optium Corp of Horsham, PA, USA, which makes optical subsystems for core-to-the-edge applications in telecoms and cable TV networks, expects revenue of \$26.0–26.5m (down 23–25% from the previous quarter's \$34.5m), on the basis of preliminary financial information.

Optium also expected a net loss, driven by lower-than-expected revenue, lower-than-expected shipments of higher-margin products, and under-absorption of manufacturing overhead and potential provisions for inventory reserves.

"Our long-term view of demand for our products and market share with our customers continues to be strong, but certain timing issues with some of our customers significantly impacted our performance this quarter," says chairman and CEO Eitan Gertel.

The most significant factor affecting revenue was a decline in sales of high-end 300-pin products to Optium's historical two largest telecoms customers (first experienced in Q3, but more pronounced than

expected in Q4). This was mainly as a result of the timing of certain projects at the carrier level.

Optium's four top 10% or greater end customers for fiscal 2007 were Scientific Atlanta/Cisco, Ericsson, Alcatel Lucent and Tellabs. Another factor was later-than-expected integration of Optium products by its previously announced new cable TV customer, which caused a partial delay of shipments.

However, Optium expects demand recovery for its high-end 300-pin 10Gb/s products during fiscal Q1/2008. "Demand for network bandwidth and agility driven by growth in video and telecom applications will be the fundamental drivers of our business. We believe we are well positioned to take advantage of these trends," says Gertel. "Key customer indications and our market observations point to strong long-term demand for 10Gb/s and 40Gb/s telecoms products," he adds. "We made our first commercial shipments of both long-haul and client-side 40Gb/s transceivers in the fourth quarter

and initial customer demand for these products appears strong."

In addition, Q4 revenues from reconfigurable optical add/drop multiplexers (ROADMs) more than doubled from Q3. "We believe our ROADM product line is continuing to gain momentum with demand building for fiscal 2008," says Gertel. "In cable TV, we are in the early stages of growth with our new customer after making initial commercial shipments in the fourth quarter." This development, combined with expected positive long-term cable TV market trends, is projected to be an important part of Optium's long-term growth.

"Based on customer forecasts and discussions, we are cautiously optimistic that the timing issues that impacted us in the fourth quarter are abating and that continued momentum in other areas of our business should translate to future growth," says Gertel.

Optium expects to report its full fourth-quarter and fiscal 2007 results in mid-September.

www.optium.com

Finisar receives Nasdaq notice for last fiscal year

Fiber-optic component and subsystem maker Finisar Corp of Sunnyvale, CA, USA has received another staff determination notice from The Nasdaq Stock Market stating that it is not in compliance with its Marketplace Rule 4310(c)(14) because it did not timely file its annual report on Form 10-K for the fiscal year to end-April, and that its common stock is subject to delisting.

On 29 June, Finisar filed a Form 12b-25 with the Securities and Exchange Commission reporting that it had delayed filing Form 10-K until 'as soon as practicable' after the completion of a review of its historical stock option grant practices being conducted by an audit committee of its board of directors.

Finisar had previously received staff determination notices for failing

to file its quarterly reports on Form 10-Q for the quarters to end-October 2006 and end-January 2007. Following the original notice, Finisar requested a hearing before the Nasdaq Listing Qualifications Panel, held on 15 February, when Finisar requested continued listing of its stock pending completion of the review, the preparation of restated financial statements (if required), and the filing of the October 10-Q. Finisar supplemented its request to cover the delayed filing of the January 10-Q.

On 4 April the panel issued a decision granting Finisar extensions to 11 June to file its October 10-Q (plus any required financial restatements) and to 3 July to file its January 10-Q. Finisar appealed the decision to the Nasdaq Listing and Hearing Review

Council, requesting that it stay the decision, and any future panel decisions to delist Finisar, pending appeal, and grant Finisar an extension to come into compliance with its reporting obligations until at least the end of August. The council has since called for review and stayed the panel's decision, and has requested that Finisar make an additional submission for its consideration by 10 August. It will then review the matter on the basis of the written record.

As a result of the latest staff determination notice, Finisar now says that it intends to supplement its previous submission to Nasdaq to include the Form 10-K in its pending request for additional time to make the required filings.

www.finisar.com

Avanex acquires Essex CCPD to expand transmission portfolio

Optical communications component and module maker Avanex Corp of Fremont, CA, USA has acquired the assets relating to the 10Gbit/s 300-pin MSA transponder and XFP MSA transceiver businesses of the Melbourne, FL-based Commercial Communication Products Division (CCPD) of Essex Corp (based in Columbia, MD, USA, and a subsidiary of Northrop Grumman's Mission Systems sector since January).

CCPD is a design team focused on developing pluggable transceivers and tunable transponders. Avanex says that the acquisition accelerates its time-to-market in expanding its presence in the telecom transmission module market (which is estimated to grow to about \$1.0bn by 2009, according to a recent study by Ovum RHK).

Avanex expects that it will have the acquired products integrated

into its product portfolio and ready for general availability by the end of this year.

"This acquisition reinforces our commitment to investing in key telecommunication optical technologies to provide our telecom customers with compelling and differentiated solutions," says Avanex's president, chairman and CEO Jo Major.

www.avanex.com

Advanced Photonix wins contract for missile program

Advanced Photonix Inc of Ann Arbor, MI, USA, which is a vertically integrated designer and manufacturer of photodetectors, subsystems, and terahertz systems, has received a two-year, \$2.6m contract from a 'leading military contractor' that supplies missile tracking and imaging systems for tube-launched, optically tracked, wire-guided (TOW) missile platforms (a crew-portable, vehicle-mounted, heavy anti-armor

weapon system consisting of a launcher and one of five versions of the TOW missile). The missile is primarily used in anti-tank warfare.

For over ten years, the firm has been supplying military contractors with photodetector assemblies used in the guidance systems of various modules of the TOW missile: the Improved Target Acquisition System (ITAS), the Improved Bradley Acquisition System (IBAS),

and the TOW Visual Module.

Last month Advanced Photonix completed its new 5000ft² micro-fabrication facility for optoelectronic devices, consolidating its silicon photodiode operations in Camarillo, CA and Dodgeville, WI into one centralized facility at its InGaAs and InP optical receiver manufacturing subsidiary Picometrix LLC in Ann Arbor (see June issue, page 35).

www.advancedphotonix.com

Losses cut as Advanced Photonix forecasts 15–25% growth in fiscal '08

Advanced Photonix has reported net sales for full-year fiscal 2007 (to end March) of \$23.6m (level with fiscal 2006), including fiscal Q4/2007 net sales of \$6.2m (down from \$6.8m a year ago).

Telecoms revenue rose 87% year-on-year from \$2.7m to \$5.9m and medical revenues rose 11% to \$2.5m. However, industrial sensing/non-destructive testing (NDT) revenues fell 3% to \$10.0m, military/aerospace revenues fell 12% to \$5.2m (due to a long-standing military contract that reached end-of-life status and unexpected delays in other follow-on contracts), and homeland security revenues fell from \$1.9m to

just \$73,000 (due to a delay of Terahertz development contracts, mainly from the Transportation Security Administration).

However, net loss has been cut year-on-year from \$5.3m to \$4.6m for full-year fiscal 2007, including from \$2.5m to \$1.3m for fiscal Q4. This is despite \$720,000 in expenses rising due to consolidating the firm's wafer fabrication into just one plant in Ann Arbor.

For full-year 2007, gross profit rose 18.6% to \$10.9m due to increased sales of higher-gross-margin products for the telecoms and medical markets (with overall gross margin rising from 39% of sales to 46%).

Advanced Photonix says it continues to expect quarter-to-quarter fluctuations in consolidated revenue for fiscal 2008 due to fluctuations in customer delivery schedules, which are beyond its control. However, "With the launch of our new T-Ray 4000 system, the opening of our new wafer fabrication facility in Ann Arbor and the ongoing expansion of our HSOR product offerings and active customer base, we are looking forward to a very solid year of growth and progress on a number of fronts in fiscal 2008," says chairman and CEO Richard Kurtz. The firm expects its fiscal 2008 revenues to rise 15-25% year-on-year.

Emcore sales rise but terrestrial solar R&D costs increase losses

Component and subsystem maker Emcore Corp of Albuquerque, NM, USA has reported revenue for its fiscal second-quarter 2007 (to end March) of \$39.7m (up 10% on \$36.1m a year ago from continuing operations and up 3% from \$38.5m the prior quarter), as the firm reported in brief at the end of April.

Fiber Optics revenue was \$26.2m (up from \$25.9m a year ago and \$25.3m the prior quarter). Despite revenue in the digital fiber-optics sector dipping due to customer inventory management, Emcore is seeing a sustained significant rise in demand for CATV products (expected to continue throughout fiscal 2007).

Photovoltaics revenue was \$13.4m (up only slightly from \$13.2m the prior quarter, but up as much as 30% from \$10.3m a year ago).

Excluding a one-time \$1.2m inventory charge associated with certain legacy products in the digital fiber-optics sector, gross profit was \$8.1m (up on \$7.9m a year ago from continuing operations and

\$6.4m the prior quarter). After falling from 22% a year ago, gross margin has recovered from 16% last quarter to over 20%. Fiber Optics gross margin has continued to fall, from 25% a year ago and 22% last quarter to 20% (due to unabsorbed fixed overhead as a result of reduced digital fiber-optics revenue). However, Photovoltaics gross margin was 20%, up from 14% a year ago and 7% the prior quarter due to increased revenue and favorable product mix.

Operating loss has risen from \$7.9m a year ago to \$9.3m. Also, this excludes \$2.3m of professional fees incurred from the firm's review of its historical stock option grants and about \$2.5m of development costs for the new terrestrial solar power division. Emcore expects to complete the second generation of its solar power concentrator system in the September quarter and to transfer system development to production in the December quarter.

Cash reserves fell by \$9.9m during the quarter to \$77.1m, mainly

due to the fees from its review of stock option grants, legal costs of the firm's patent infringement lawsuits against Optium Corp, and various increases in net working capital requirements.

Emcore expects a much stronger fiscal second half year, based on increased strength in CATV and Broadband product lines. "This quarter, revenues from our datacom and telecom sectors are returning to business levels of last year and we continue to see strength in our photovoltaics business for both the satellite and terrestrial markets," says CEO Reuben F. Richards Jr. Emcore forecasts revenue for fiscal Q3 (to end June) of more than \$44m (up 11% sequentially) and for fiscal Q4 (to end September) of \$46-47m. The firm has also raised its guidance for fiscal 2007 revenue to \$170m.

"We expect corresponding improvement in profitability to reach EPS [earning per share] in mid-2008," adds Richards.

www.emcore.com

Bookham appoints new CEO; Bordui remains chairman

Optical component, module and subsystem maker Bookham Inc has appointed Alain Couder as president and CEO, based at its headquarters in San Jose, CA, USA. He is also expected to be elected to the firm's board of directors. Couder succeeds Dr Peter Bordui (acting president and CEO since Giorgio Anania left in February), who continues as chairman.

"Couder is a highly qualified international executive with a well-established record of success," says Bordui. "We believe he's a great fit for our organization and we expect his contributions will be invaluable in serving our customers."

"I am joining Bookham at a time when, having achieved significant technological success, the company is poised to achieve profitable growth in a market eager for ever increasing bandwidth," says Couder. "I plan to leverage the company's position in the communication market to increase shareholder value."

Couder was most recently president and CEO of database solutions



CEO Alain Couder.

provider Solid Information Technology Inc. Previously, he was president and CEO of Confluent Software Inc and IP Dynamics Inc, and chairman and CEO of Packard Bell NEC Inc. Couder has also been chief operating officer for Agilent Technologies and Groupe Bull. Earlier in his career, Couder held general and technology management positions at Hewlett Packard and IBM. He has also served as an advisor for Sofinnova Ventures, a venture capital firm.

Couder holds a Master's degree in electrical engineering from École Supérieure d'Électricité in Paris.

www.bookham.com



The 2007 Compound Semiconductor IC Symposium

We cordially invite you to the 2007 Compound Semiconductor IC Symposium being held October 14 – 17 in beautiful Portland, Oregon. The high-performance wireless and high-speed digital communications markets are thriving due to impressive strides in new materials and devices, greater integration levels, novel circuit implementations, and ever-changing systems partitions. Over the last 29 years the Compound Semiconductor IC Symposium (CSICS — formerly named the GaAs IC Symposium) has been and continues to be the preeminent international forum in which advances in semiconductor circuit and device technology are presented, debated, and discussed. The scope of the Symposium encompasses devices and circuits in GaAs, SiGe, InP, GaN, and InSb as well as targeting the fields of RF/mm-wave CMOS and high-speed digital CMOS to provide a truly comprehensive conference. This is the ideal forum for presentation of the latest results in high-speed digital, analog, microwave/millimeter-wave, mixed-mode, and optoelectronic integrated circuits.

This year's 2007 CSIC Symposium consists of a full 3-day technical program, 2 short courses, a primer course, and a technology exhibition. The technical program consists of approximately 60 high-quality state-of-the-art technical papers, 4 panel sessions, 2 Short Courses on 'Compound Semiconductor Devices and Integrated Circuits for Millimeter Wave Imaging' and 'Compound Semiconductor Power Amplifiers' and an Industry Exhibit. The Symposium will also be offering the popular annual introductory level Primer Course on 'Basics of Compound Semiconductor ICs'. This year the Symposium will feature approximately 15 invited papers on a wide range of important topics encompassing device engineering to circuit application using advanced compound and other related semiconductor technologies. In addition, the Symposium will continue the tradition of including important 'late breaking news' papers.

The technology exhibition will be held on Monday and Tuesday. The exhibition will feature informative and interesting displays with corporate representatives on hand. The list of exhibitors can be found in the CSICS advance program which will be published and distributed in late June.

To complement the Symposium, there are several social events which include the Sunday Evening CSICS Opening Reception, the Monday CSICS Exhibition Opening Reception, the CSICS Tuesday evening Theme Party to be held at McMenamins Pub and Breweries Crystal Ballroom, and the CSICS Exhibition Luncheon on Tuesday. The Theme Party will include entertainment and a tasting of locally produced Oregon wine and beer. A breakfast will also be served on Monday, Tuesday, and Wednesday.

The 2007 IEEE CSICS will be held in Portland, Oregon in the Hilton Portland and Executive Tower located in downtown Portland. Proclaimed as North America's 'Best Big City', according to Money magazine, Portland exhibits unmatched natural beauty as well as a wealth of opportunities for leisure, sports, shopping, and outdoor activities. The conference downtown location is within easy access to the vibrant Pearl District with destination restaurants, art galleries, and shopping. While you're in Portland, be sure to enjoy the scenic beauty of the Columbia River Gorge, enjoy the hike to Multnomah Falls and the drive the Historic Columbia River Highway. Other local attractions include Mt Hood, the Willamette River, the rose gardens, the Japanese garden, the Oregon Coast, and the wine country. Portland has an excellent light rail system which can be used as transportation from the Airport to the Hilton and for getting around town.

For registration and further information, please visit the CSICS website at <http://www.csics.org>. Further questions may be addressed to the Symposium Technical Program Chair: William Peatman, Ph: +1-908-668-5000 ext. 5842, E-mail: wpeatman@anadigics.com

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Applied Materials recruits ex-Nanosolar chief scientist and CIGS PV expert Eberspacher to lead solar R&D

Process equipment maker Applied Materials Inc of Santa Clara, CA, USA says that Dr Chris Eberspacher has joined its Solar Business Group to head its advanced R&D programs. Reporting to the Solar Business Group's chief technology officer Dr Winfried Hoffmann, he will lead efforts for both silicon and non-silicon based solar materials.

Eberspacher has a doctorate degree in applied physics from Stanford University and 25 years of experience in solar development. He began his career at California-based ARCO Solar Inc (which later became Siemens Solar Industries, and now Shell Solar), where he led development teams in crystalline silicon and thin-film solar cell technologies.

Most recently, Eberspacher made pioneering contributions to nanoparticle-based thin-film copper indium gallium diselenide (CIGS) solar cell technology at Unisun of Camarillo, CA (which he founded in 1993) and then Nanosolar Inc of Palo Alto, CA, a solar start-up

focused on roll-to-roll processing of thin-film photovoltaic (PV) products, where he was chief scientist until this June.

"Applied Materials has the expertise, experience and resources necessary to provide the solar industry with the high-volume, low-cost manufacturing infrastructure needed to achieve grid-competitive solar electric power", says Eberspacher.

"We are excited to have Chris join the Applied Materials team at a time of great business and technology momentum for our group," said

"Applied has the expertise, experience and resources necessary to provide the solar industry with the high-volume, low-cost manufacturing infrastructure needed to achieve grid-competitive solar electric power"

Charlie Gay, VP and general manager of Applied's Solar Business Group. "He brings a wealth of practical experience in advanced PV technologies that will be critical to delivering next-generation nanomanufacturing innovations that will drive future solar cost reductions."

Despite its focus on silicon chip manufacturing equipment and entering the solar manufacturing equipment sector just last summer (after the \$464m acquisition of Applied Films Inc of Longmont, CO, a manufacturer of physical vapor deposition-based thin-film deposition equipment for flat-panel display manufacturing), by mid-May Applied had taken orders for \$300m of solar equipment contracts this fiscal year (to end-October), already exceeding its \$200m target. The firm is now forecasting solar contracts valued at more than \$400m this fiscal year (well on target to exceed its longer-term goal of \$450-500m by 2010).

www.appliedmaterials.com

WIN diversifies into solar cells

Taiwanese GaAs-based RFIC maker WIN Semiconductors Corp is diversifying into triple-junction solar cells on germanium wafers for terrestrial applications after ordering an AIX 2600G3 IC MOCVD reactor from Aixtron of Aachen, Germany in Q1/2007, for installation at its plant in Kuei Shan Hsiang, Taiwan.

Founded in October 1999, WIN was the world's first pure-play 6" GaAs foundry. Its technologies include 2µm and 1µm HBTs, 0.5µm pHEMT switches, 0.5µm power pHEMTs and 0.15µm pHEMTs.

WIN is one of the first Taiwanese firms to target terrestrial compound semiconductor solar cells.

www.winfoundry.com

Quantasol wins £1.35m seed funding

In June, Quantasol Ltd of Richmond, UK, which was spun off from Imperial College London, UK in July 2006, received £1.35m (\$2.7m) in seed funding, co-led by Imperial Innovations Group (the technology transfer wing of Imperial College, which has taken a 24% stake in Quantasol) and the UK-based AIM-listed investment firm Low Carbon Accelerator Ltd (LCA), which invested £480,000 for a 15.34% stake (to be raised to 25.6% with a further £320,000 investment, subject to QuantaSol achieving certain targets).

Also joining the seed investment round were Sheffield University Enterprise, the private investment fund NetScientific Ltd and Numis Securities Ltd.

The funds will be used to develop high-efficiency quantum well photovoltaic (QWPV) technology, originated by Quantasol's founders professor Keith Barnham (senior research investigator in Imperial College's Department of Physics), Dr Massimo Mazzer (senior researcher at the National Research Council of Italy), and Dr John Roberts (senior research scientist at The University of Sheffield).

The funds will also be used to prototype single-junction and tandem cells (combining both GaAs and other semiconductor materials) for use in concentrating photovoltaic (CPV) systems by three or four lead customers (targeting the utility-scale solar power generation market).

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GaAs industry back in equilibrium

The CS MANTECH 2007 conference in Austin, Texas evidenced much optimism about GaAs market growth (despite glitches with Motorola's handset business), as well as progress in GaN HEMT performance and reliability, reports **Mark Telford**.

May's 22nd annual International Conference on Compound Semiconductor Manufacturing Technology (CS MANTECH 2007) in Austin, TX, USA drew a healthy attendance of 292 delegates (or about 400, including the exhibition), including strong representations from device makers TriQuint Semiconductor, Skyworks Solutions and Northrop Grumman.

Indeed, of the total of 73 papers, TriQuint's CEO Ralph Quinsey gave the opening invited talk, 'State of the Compound Semiconductor Industry: A Focus on Communications'.

Table 1. GaAs capacities.

Firm	Wafer size	Capacity
RFMD	6"	21%
Skyworks	4"	14%
TriQuint	6"	14%
Freescale	6"	7%
Anadigics	6"	6%
Other		38%

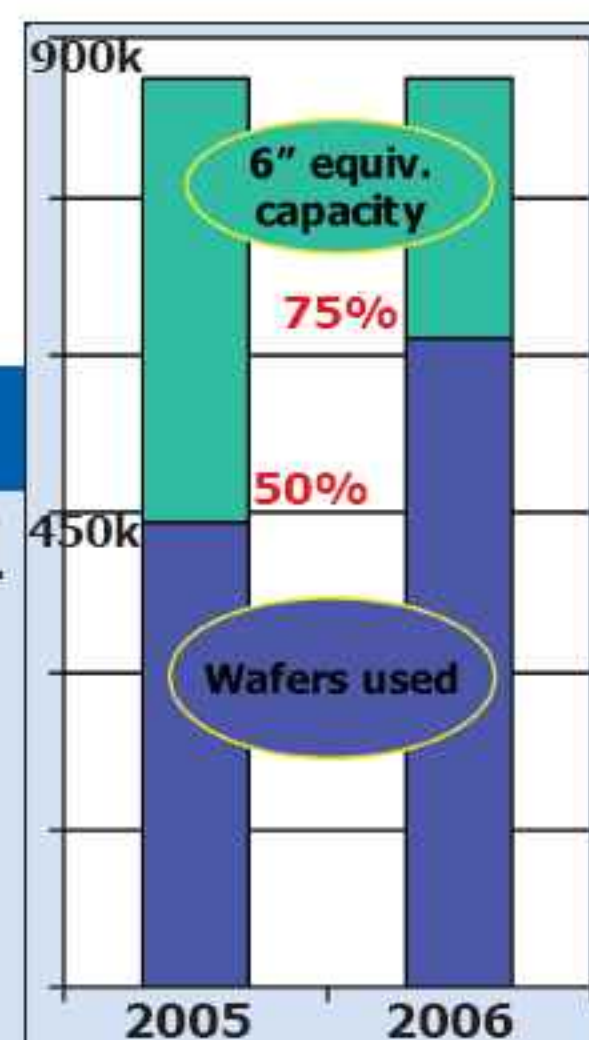


Figure 1. While GaAs manufacturing capacity stayed at 850,000 6"-equivalent wafers, 18% growth in the handset market and rising demand for GaAs ICs drove capacity utilization from 50% in 2005 to 75% in '06.

GaAs sector reaches capacity equilibrium

After the pain of 2000–2005, when commoditization and over-capacity drained value and limited investment, 2006 was a transitional year, says Quinsey, as value moved back into the compound semiconductor sector: the first year in many when GaAs IC supply and

Mid-tier suppliers squeezed as GaAs industry bifurcates

About 50% of GaAs IC capacity is now controlled by the top three suppliers (RFMD, Skyworks and TriQuint, which are each executing strategies to add capacity to their supply chain), says TriQuint's Quinsey. Mid-tier suppliers control 30%, with the remaining 20% spread across a dozen or so companies that maintain small GaAs fabrication capability for strategic reasons.

The industry is bifurcating into top-tier suppliers, where participation in the largest market (personal voice and data) will continue to drive growth and technology investment, and small niche suppliers serving unique strategic needs (typically embedded into larger vertically integrated businesses as captive units).

The 'stranded' mid-tier suppliers are feeling the pressure of either not reaching critical mass or not leveraging technology differentiation. "Mid-tier players need to either grow or be consolidated — get bigger or get out," remarks Quinsey. This may create an

Mid-tier players need to either grow or be consolidated — get bigger or get out.

environment for foundry consolidation supporting a fabless business model. It is more likely, due to the success of standards bodies reducing the ASIC nature of RF products, that mid-tier suppliers will have to choose between consolidation or integration into a vertical business to survive.

The anticipated consolidation of the industry is quietly happening, with factory shutdowns, restructuring, or combinations since early 2003 among the following companies: Suntek, GEC Marconi, Vitesse, Philips, Celeritek, Sanders, Mitsubishi, Sumitomo, WJ Communications, Filtronic, GCTC, and WIN. "Healthy consolidation of the supply chain is continuing."

Also bifurcating is cost/value versus performance. By 2010, there will be two parallel technology roadmaps, predicts Quinsey:

- high-volume, low-cost multi-technology modules (incorporating an HBT PA and a pHEMT switch) for cellular 2G, 2.5G and 3G phones as well as WLAN;
- high-performance (high-frequency and high-power) components for WiMAX base-stations, VSAT, millimetre wave and military applications (including using GaN).

demand came back into balance (indeed, in mid-2006 the GaAs sector was briefly supply constrained, he adds).

Market research firm Strategy Analytics says that the GaAs market was about \$3bn in 2006 — and is growing at a compound annual growth rate (CAGR) of 7% — with personal voice and data the highest-volume 'killer' application about 70% of the market. With 1bn units sold in 2006, cell phones remain the highest unit-volume consumer electronics device, representing an annual market of over 1bn units for components.

As cell phones have evolved down the learning curve for size, weight, cost and part count, the integration of more features, with increased performance, lower cost, and easier implementation has been the driving force for the semiconductor components, says Quinsey.

For power amplifiers (PAs) in the RF section, GaAs has proven to be the preferred technology for providing maximum battery life, starting with MESFET and migrating to HBT and pHEMT devices.

In particular, the continuing progress of GaAs down the cost learning curve has countered the threat to the GaAs market from the trade-off of performance for low cost using high-volume CMOS silicon-based technologies, with high-profile launches of CMOS PAs for the low-cost GSM/GPRS market not enjoying great success, says Quinsey. GaAs has confronted the silicon threat "at least for the foreseeable future", he reckons.

Also, although voice remains the killer application, the long-awaited commercialization of 3G, offering untethered broadband data access, should lead to the sale in 2007 of 150–170m multi-mode, multi-band handsets with more complex RF requirements. This solidifies the position of GaAs as a critical enabling RF technology, says Quinsey, since the more complex new-generation phones incorporating multi-mode (2.5G and 3G) and multi-band (800MHz to 2.6GHz) functionality multiply the usage of GaAs components per phone.

Average GaAs dollar content per phone is \$0.35–0.80 for simple standalone PAs. This rises to \$0.90–1.50 for modules (containing more RF front-end functionality), \$1.50–2.50 for EDGE phones (with modules containing multiple RF front-ends), and \$5.00–6.00 for 3G phones (incorporating EDGE and one or more WCDMA bands).

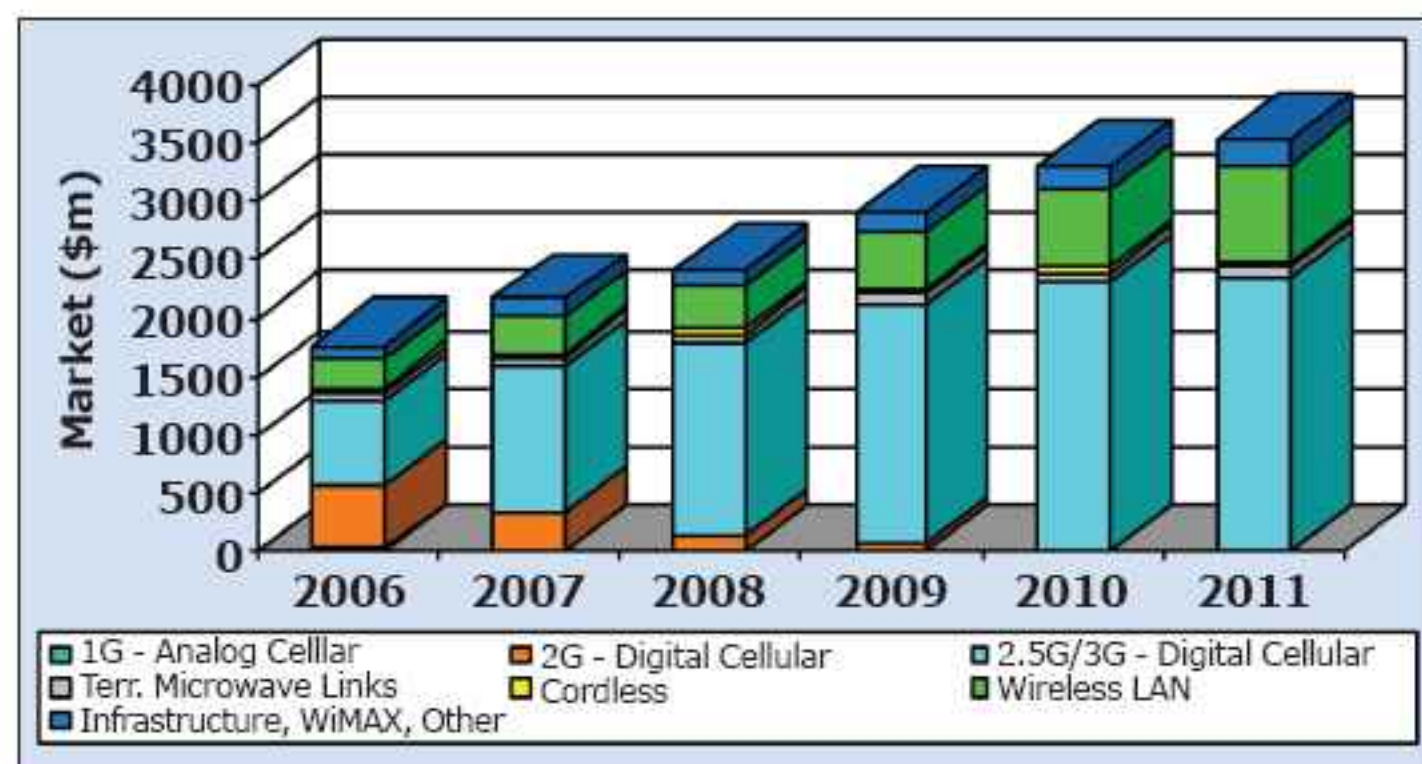


Figure 2. Wireless communications market sectors.

Likewise, for wireless LAN, a similar trend is occurring (albeit behind handsets), especially as silicon or SiGe PAs for single-band 2.4GHz WLAN have been displaced by GaAs for dual-band 2.4/5GHz WLAN: average GaAs dollar content is \$0.39 for the 802.11b specification, \$0.46 for 802.11b/g, \$0.90 for 802.11b/g/n, \$1.56 for 802.11a/b/g, and \$3.12 for 802.11a/b/g/n, with 802.11n (or MIMO, multiple-input-multiple-output, which is currently moving from development into production) containing up to three RF sections.

Meanwhile, for the more commercial wide-area broadband networks, WiMAX promises further opportunities for GaAs and, possibly, GaN technology. (Compound annual growth rates are 15% for wireless, 27% for 3G, 28% for WLAN, and 54% for WiMAX.)

Developments in GaN HEMT technology

In the session on 'Devices & Models', Ming-Yih Kao et al from TriQuint reported what it claims is the first demonstration of GaN HEMTs with state-of-the-art noise and power performance simultaneously (potentially simplifying GaN foundry process offerings).

The recessed 200µm-wide, 0.25µm-gate-length AlGaIn/GaN HEMTs, grown by MOCVD on 3" SiC wafers, has high power-added efficiency (PAE) of 62%, 57% and 41% at 10, 20 and 35GHz, respectively, and low minimum noise figures of 1.0dB and 1.4dB at 18 and 26GHz,

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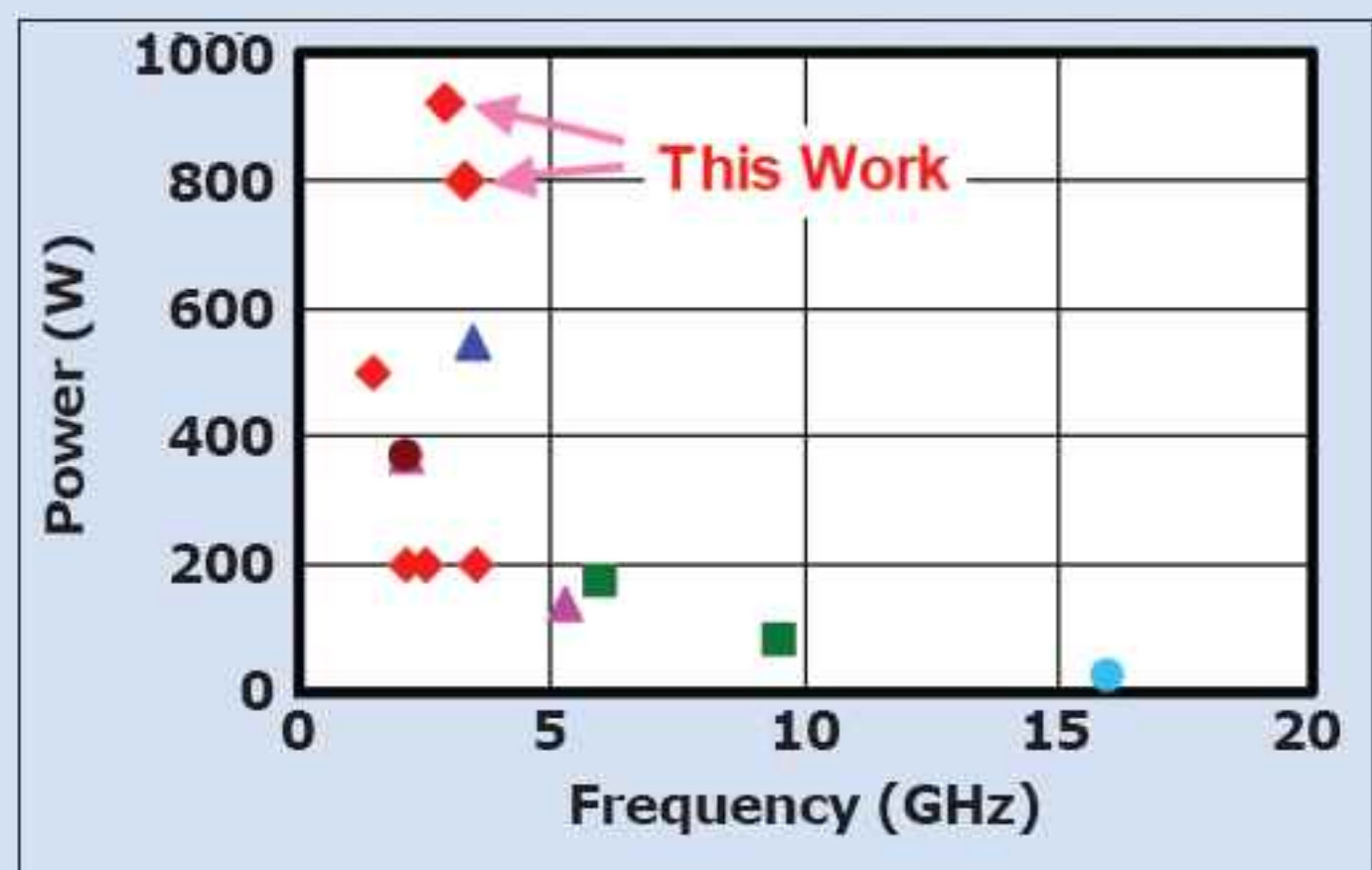
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Eudyna reports record 800W S-band transistor

In the session 'GaN & SiC Power Devices', Eizo Mitani of Japan's Eudyna Devices Inc reported a AlGaIn/GaN HEMT (grown on SiC) with what is claimed to be a record power output for an S-band transistor: peak power of 912W, together with 56.4% drain efficiency at 2.9GHz, operating at a drain bias voltage of 70V.

Operating at 65V under pulsed conditions (a duty of 10% and pulse width of 200 μ s), the device has a power output of over 800W, a high linear gain of 14dB and a high efficiency of 50% over the wide frequency range of 2.9–3.3GHz. The chip structure is the same as that used in Eudyna's standard GaN HEMT products. The results were also reported at June's IEEE MTT-S event.

The researchers had previously reported (at the June 2006 IEEE MTT-S International Microwave Symposium) a 500W AlGaIn/GaN HEMT power amplifier at 1.5GHz and demonstrated high power L-band performance. At S-band frequencies, an internally matched 550W peak-power GaN HEMT at 3.45GHz with a very short pulse of 2 μ s at a duty of 2% was reported by Cree at December's IEEE International Electron Devices Meeting.



Output powers of reported GaN HEMT devices.

For Eudyna's 800W AlGaIn/GaN HEMT, power droop and phase droop at an output power of 59.0dBm are 0.31dB and 3.9°, respectively, suiting S-band high-power applications like radar. Also, peak channel temperature is about 10°C for a pulse width of 500 μ s with 10% duty, and 110°C for a pulse width of 200 μ s with 20% duty, showing that it has sufficient thermal handling ability.

respectively, for 100, 200 and 300 μ m gate widths.

Hence, PAE, gain and noise performance are similar to those of the best reported GaAs-based pHEMT devices (the dominant technology for X- to Q-band power MMICs over the last decade), but output power densities are 4–5 times higher (potentially replacing GaAs pHEMTs or HBTs in high-power amplifiers, transmit/receive and multi-function MMICs for S- to Q-band applications).

Previously, in 2004 minimum noise figures of 0.98dB at 18GHz for 0.25 μ m GaN HEMTs were reported by University of Illinois at Urbana-Champaign's J. Lee et al (Microwave and Wireless Components Letters, Vol. 14, No. 6, p259), and in 2005 Ka-band power performance for GaN-based devices and MMICs with maximum PAEs of 50% and 45% at 10 and 30GHz, respectively, were reported by J. Moon et al of HRL Labs LLC (IEEE Electron Device Letters, Vol. 26, No. 6, p348).

AlGaIn/GaN HEMTs have achieved high voltages and current densities to obtain the required charge for power electronics, but only by relying on both piezoelectric and spontaneous polarization as well as strain (via barrier

thicknesses exceeding 160Å). This leads to short-channel effects (limiting the frequency response) for gate lengths as large as 250nm. For the higher device operating frequencies required, gate lengths of 100nm or less are desired. Gate recesses can be used to mitigate short-channel effects, but they typically rely on a timed etch and can introduce unintended effects at the interface. Another solution is to grow the barrier layer very thin.

In 2001, J Kuzmik showed that InAlN/GaN interfaces can produce a large spontaneous polarization charge due to the large conduction band offset. Lattice-matched materials such as InAlN/GaN reduce the strain and the piezoelectric contribution to the charge in the channel, reducing sensitivity to processing and growth changes, and allowing thinner barrier layers while maintaining high sheet charge densities. Last year Higashiwaki et al demonstrated 6nm InAlN layer MISHEMTs with impressive small-signal performance using a 3nm SiN layer. But even with the gate 9nm from the channel, short-channel effects are still observed.

Now, at CS MANTECH 2007, J. K. Gillespie et al of the Air Force Research Laboratory, using MOCVD material grown by Northrop Grumman Electronic Systems, have reported the first unstrained InAlN/GaN HEMT on SiC with an InAlN barrier thickness of 75Å. With a gate length of 250nm, the device demonstrated an open channel current of $I_{\max} = 861\text{mA/mm}$ and a frequency response of $f_T = 43\text{GHz}$. Power density was 2.0W/mm, and peak PAE was 29.3% at X-band frequencies. AFRL aims to optimize the growth and device design to achieve $I_{\max} > 2\text{A/mm}$ and $f_T > 120\text{GHz}$. ■

Table 2. pHEMT vs AlGaIn/GaN HEMT comparison.

Device	NF _{min} 26GHz (dB)	PAE 35GHz (%)	Gain (dB)	Power density (W/mm)
pHEMT	1.1–1.5	38–44	5.5–6	0.7–0.9 ^a
GaN HEMT	1.3–1.5	37–41	5.0–6	3.0–6.1 ^b
Comparison	Similar	Similar	Similar	4–6x

^aat 6V; ^bat 15–28V

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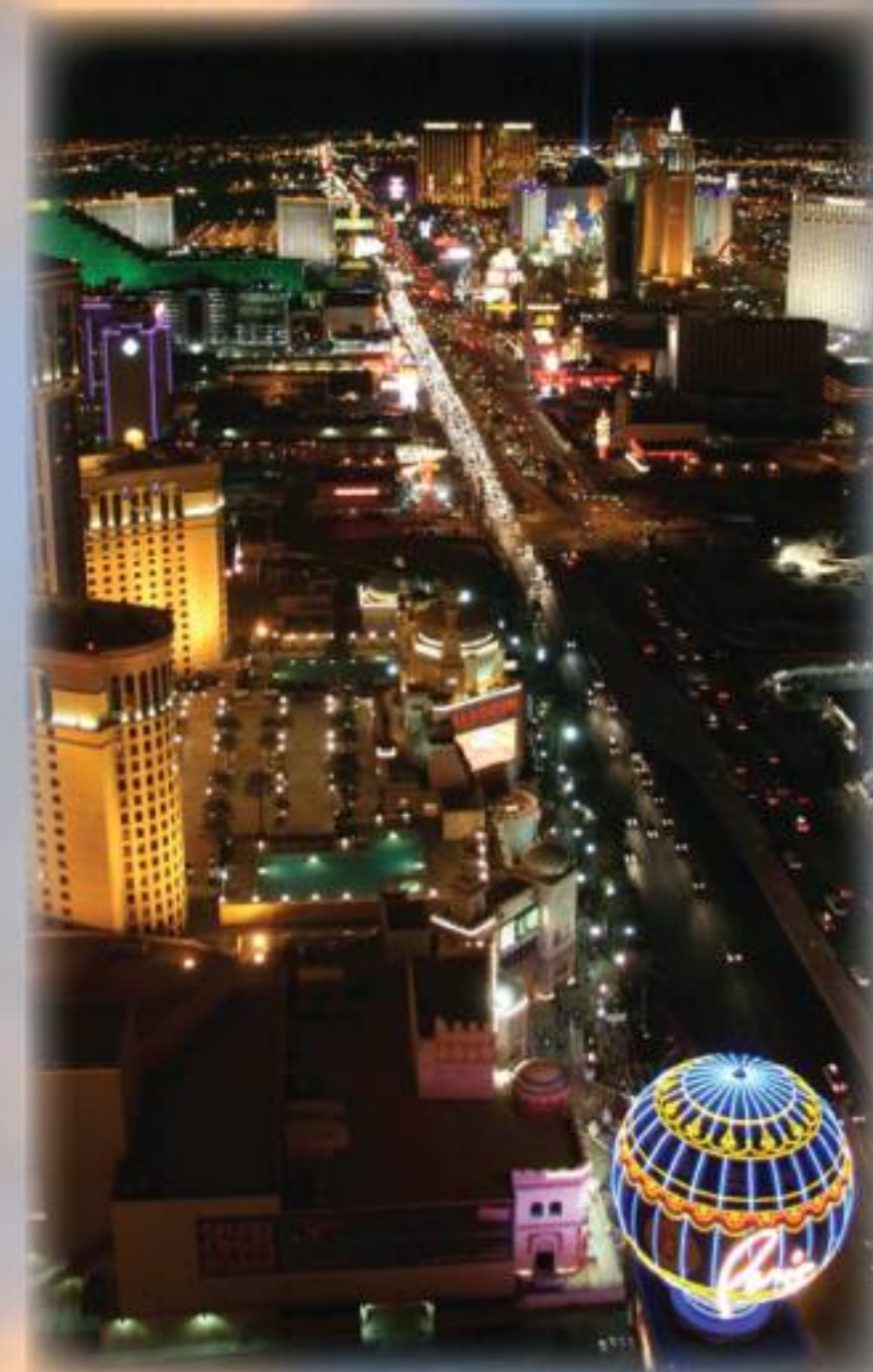
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7 Wafer processing materials

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8 Wafer processing equipment

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Fax: +43 7712 5311 4600
www.EVGroup.com

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9 Gas and liquid handling equipment

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Tel: +1 805 541 9299
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www.saesgetters.com

10 Process monitoring and control

k-Space Associates Inc
3626 W. Liberty Rd.,
Ann Arbor, MI 48103,
USA
Tel: +1 734 668 4644
Fax: +1 734 668 4663
www.k-space.com

LayTec GmbH
Helmholtzstr. 13-14, Berlin, 10587
Germany
Tel: +49 30 39 800 80 0
Fax: +49 30 3180 8237
www.laytec.de

11 Inspection equipment

Bruker AXS GmbH
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www.bruker-axs.de

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Fax: +1 510 456 2498

www.kla-tencor.com

12 Characterization equipment

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www.jawoollam.com

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www.lakeshore.com

13 Chip test equipment

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SUSS MicroTec Test Systems

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Fax: +1 802 244 7853

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14 Assembly/packaging materials

ePAK International Inc

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Fax: +1 512 231 8183

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Gel-Pak

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16 Assembly/packaging foundry

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17 Chip foundry

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United Monolithic Semiconductors

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France

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www.ums-gaas.com

18 Facility equipment

MEI, LLC

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Fax: +1 541 917 3623

www.marlerenterprises.net

19 Facility consumables

W.L. Gore & Associates

401 Airport Rd,
Elkton, MD 21921-4236,
USA

Tel: +1 410 392 4440

Fax: +1 410 506 8749

www.gore.com

20 Computer hardware & software

Ansoft Corp

4 Station Square, Suite 200,
Pittsburgh, PA 15219,
USA

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Fax: +1 412 471 9427

www.ansoft.com

21 Services

Henry Butcher International

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22 Resources

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Fax: +1 408 428 9600

www.semi.org

event calendar

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19–24 August 2007

ICFSI-11 (11th International Conference on the Formation of Semiconductor Interfaces)

Manaus, Amazonas, Brazil

E-mail: secretary@icfsi2007.com

www.icfsi2007.com

21–24 August 2007

TWHM2007 (7th Topical Workshop on Heterostructure Microelectronics)

Chiba, Japan

E-mail: twhm@aecl.ntt.co.jp

www.twhm.net

22–24 August 2007

China SSL (4th China International Forum & Exhibition on Solid State Lighting)

Shanghai, China

E-mail: lintie@china-led.net

www.sslchina.org

26–30 August 2007

Optics & Photonics (including 7th International Conference on Solid State Lighting)

San Diego, CA, USA

www.spie.org/app/conferences

26–31 August 2007

CLEO/Pacific Rim 2007 (The 7th Pacific Rim Conference on Lasers and Electro-Optics)

Convention & Exhibition Center (COEX), Seoul, Korea

E-mail: cleo@cleo-pr2007.org

www.cleo-pr2007.org

2–5 September 2007

HeTech'07 (16th European Workshop on Heterostructure Technology)

Fréjus, Var, France

E-mail: hetech07@crhea.cnrs.fr

www.crhea.cnrs.fr/hetech07

3–7 September 2007

22nd European Photovoltaic Solar Energy Conference and Exhibition

Milan, Italy

E-mail: pv.conference@wip-munich.de

<http://p12611.typo3server.info/7.0.html>

6–9 September 2007

CIOE2007 (the 9th China International Optoelectronic Exposition & Conference)

Shenzhen Convention & Exhibition Center, China

www.cioe.cn/en

9–13 September 2007

DRIP XII (12th International Conference on Defects-Recognition, Imaging and Physics in Semiconductors)

Berlin, Germany

E-mail: drip12@mbi-berlin.de

www.drip12.de

10–11 September 2007

EPIC/SPIE Europe Workshop: Manufacturing LEDs for Lighting and Displays 2007

Berlin, Germany

<http://spie.org/leds-lighting-displays.xml>

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10–14 September 2007

II–VI 2007 (13th International Conference on II–VI Compounds)

Jeju, Korea

E-mail: secretary@II-VI2007.or.kr

http://ii-vi2007.or.kr

12–14 September 2007

SEMICON Taiwan 2007

Taipei, Taiwan

E-mail: katienguyen@semi.org

www.semi.org

16–20 September 2007

ECOC 2007 (33rd European Conference and Exhibition on Optical Communication)

Berlin, Germany

E-mail: vde-conferences@vde.com

www.vde.com/Conferences_en/ECOC+2007

16–21 September 2007

ICNS-7: 7th International Conference on Nitride Semiconductors

Las Vegas, NV, USA

E-mail: raabe@tms.org

www.tms.org/Meetings/specialty/icns

17–19 September 2007

AHPSL 2007 (Applications of High Power Semiconductor Lasers)

San Diego, CA, USA

E-mail: amueller@intertechusa.com

www.intertechusa.com/conferences

23–26 September 2007

NAMBE 2007: North American Molecular Beam Epitaxy

Albuquerque, NM, USA

E-mail: motero@chtm.unm.edu

http://nambe07.chtm.unm.edu

24–27 September 2007

Solar Power 2007

Long Beach Convention Center, CA, USA

E-mail: tyager@seia.org

www.solarpowerconference.com/18/

24–28 September 2007

NUSOD-07: 7th International Conference on Numerical Simulation of Optoelectronic Devices

Newark, DE, USA

E-mail: piprek@nusod.org

www.nusod.org

1–2 October 2007

Deutscher MBE-Workshop 2007

Jülich, Germany

E-mail: g.mussler@fz-juelich.de

www.fz-juelich.de/conference/MBE2007

8–12 October 2007

European Microwave Week 2007

Munich, Germany

E-mail: vandervorst@eumwa.org

www.eumwa.org

9–11 October 2007

SEMICON Europa 2007

Stuttgart, Germany

E-mail: ktorres@semi.org

www.semi.org

11–12 October 2007

Concentrating Photovoltaic Optics and Power

Marburg, near Frankfurt, Germany

E-mail: ralf.leutz@physik.uni-marburg.de

www.concentrating-pv.org

14–17 October 2007

IEEE Compound Semiconductor IC Symposium 2007 (2007 CSIC Symposium)

Hilton Portland, Portland, OR, USA

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