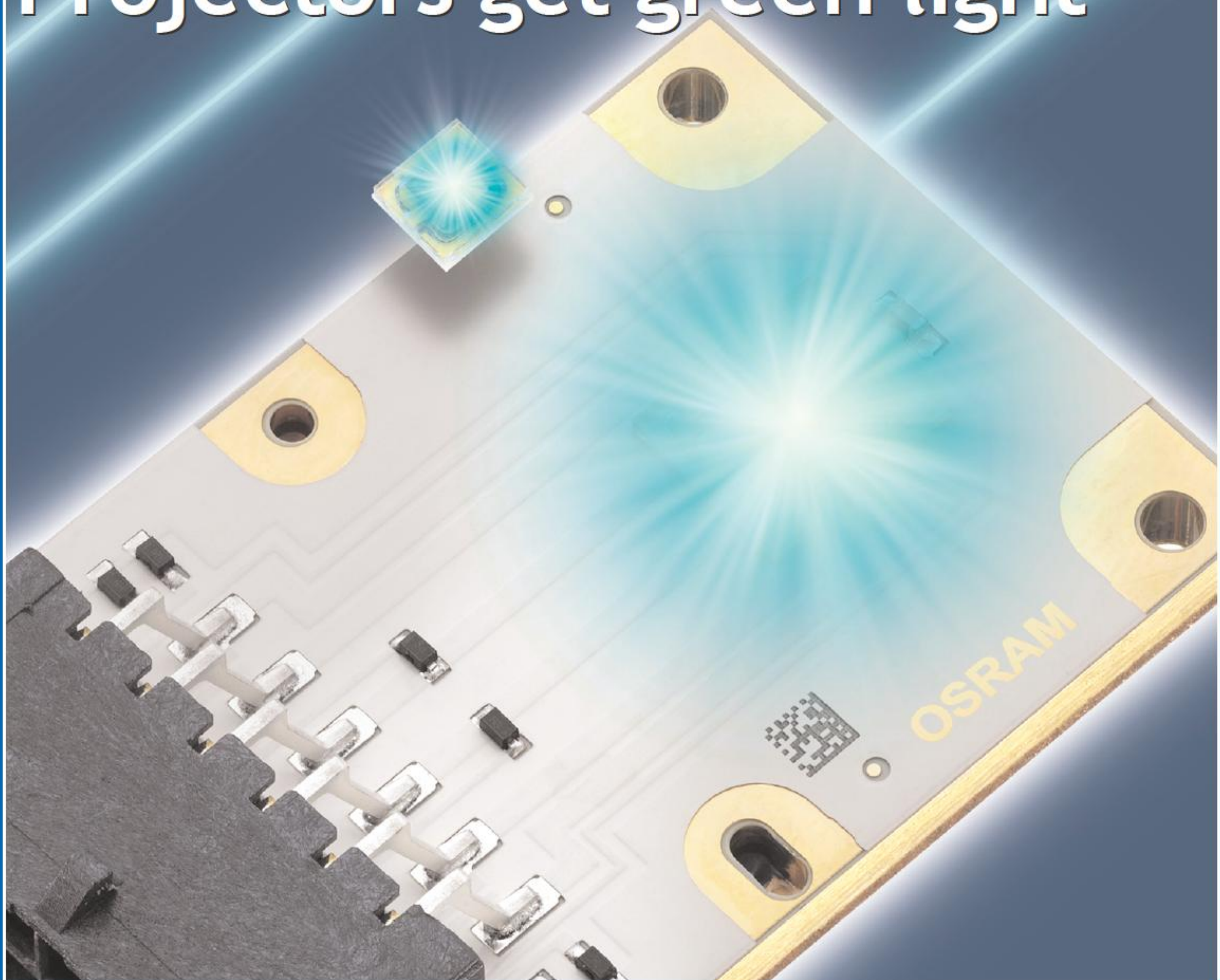


CS MANTECH & OFC reports Projectors get green light



Skyworks buys Axiom • Nichia pushes InGaN laser to 515nm
Bookham swaps New Focus for Newport's high-power laser unit

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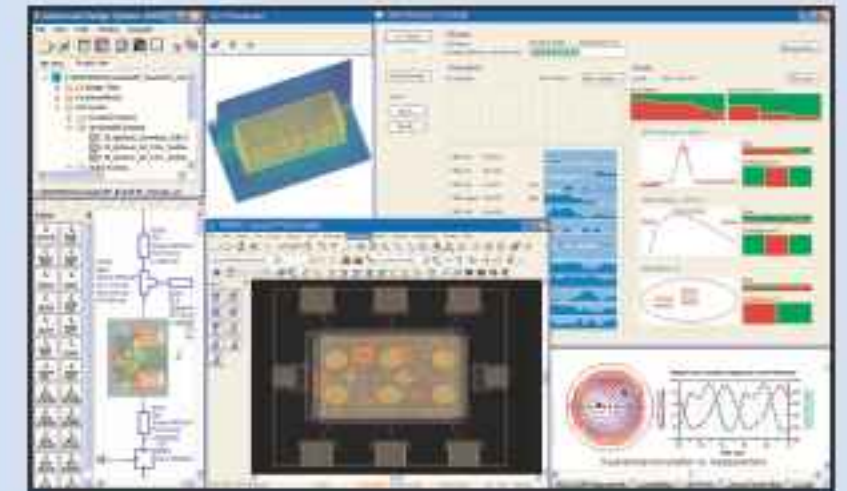
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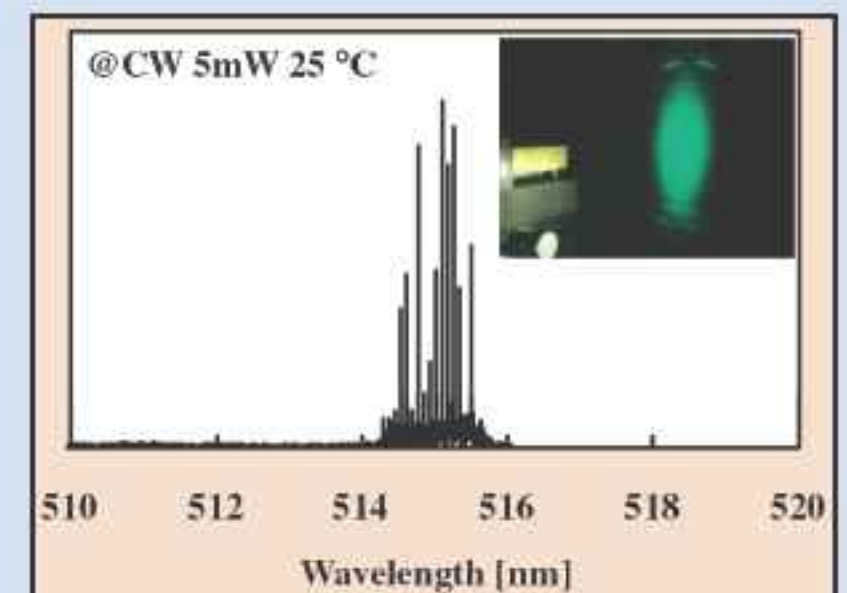
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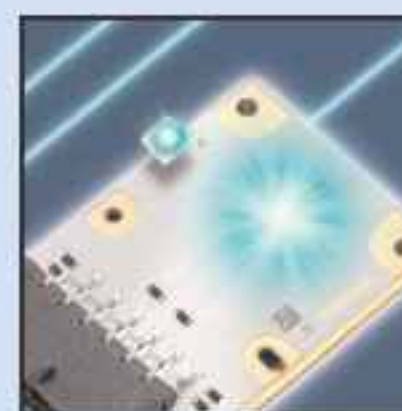
p18 Agilent's ADS 2009 Update 1, which creates nonlinear behavioral models for MMIC and RF modules using the new X-parameter Model Generator.



p36 Osram Opto's Golden DRAGON oval Plus LED, which integrates lens illuminates roads without light pollution.



p43 Output intensity vs wavelength for Nichia 'green' laser, which emits CW at 515nm from InGaN structure with an improved active MQW layer.



Cover: Osram Opto has expanded its range of LEDs for displays applications up to 300W output by launching the OSTAR Power Projection LED, available in red, blue and green colors, targeted at high-power projection applications such as home cinema and displays of 70 inches or more. **p37**

Diversification and new applications drive growth

In this issue we report from May's CS MANTECH event (this year in Tampa) which, as ever, drew the core people from the compound semiconductor manufacturing industry, focused on the RF component sector (see page 64). As expected, a reduced attendance evidenced the impact of the economic downturn since late last year. Particularly relevant therefore was market analyst Earl J Lum's assessment of the financial survivability of the main GaAs RFIC manufacturers and their suppliers. For the same reason, interest was raised by MANTECH's innovation of a session dedicated to solar cells, correlating with the aim of firms such as main GaAs RFIC maker RF Micro Devices wanting to diversify into photovoltaics, via its recent cooperative agreement with the US National Renewable Energy Laboratory (NREL).

More immediately, RFMD says that it is seeing better-than-expected demand in the June quarter, boosting fab utilization back above a more normal 75%, compared to about 25% for the March quarter (see page 10). Meanwhile, in another trend in the industry, the GaAs foundry market continues to grow and TriQuint and Taiwan's WIN Semiconductors continue to take a bigger share of that market (driving WIN to open a second 6" GaAs fab), as dual-sourcing and fabless strategies become more prominent.

Also driving the expected recovery in demand for the likes of MOCVD reactor makers Aixtron and Veeco (see pages 26–29) is the growth in LED manufacturing (particularly in Asia), stimulated by application to backlighting laptop displays and LCD TVs (launched recently by Samsung as 'LED TVs').

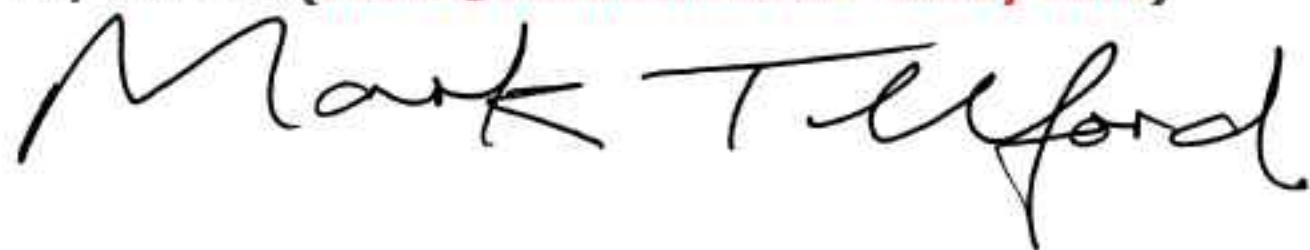
Such applications (as well as LED lighting) are cited by LED maker Cree in raising its June-quarter revenue target by 5% from its guidance given just in late April (see page 40).

Displays are also driving further development in gallium nitride-based technology for not only blue lasers but also green lasers, targeting projectors (which currently use frequency doubling in second harmonic generation lasers). In late May, Japan's blue laser pioneer Nichia reported extending the emission wavelength of its blue-green InGaN lasers beyond 500nm to 515nm (page 43), and hence further towards green wavelengths (520–570nm). However, further development is needed to reach the wavelength of about 530nm used for green in existing RGB displays.

Regarding GaN microelectronics, TriQuint has joined Raytheon in being awarded a Phase III contract for continued work on the DARPA program Wide Bandgap Semiconductors for RF Applications (WBGs-RF) and, shortly before we closed for press, TriQuint extended its corresponding contract with IQE-RF in New Jersey for GaN HEMT epiwafers.

Also shortly before closing for press, at the IEEE International Microwave Symposium (IMS 2009) in the second week of June, RFMD launched its GaN foundry business unit, demonstrating another aspect of its diversification strategy. This development will be detailed in depth in our coverage of IMS 2009 in the next issue.

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

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

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LTE to cluster in 2600MHz band

The majority of LTE (long-term evolution) deployments by wireless operators will use the 2600MHz band, creating new opportunities for terminal component vendors, says a report from Strategy Analytics. A strong tranche of deployments will also occur at sub-1000MHz frequencies, including roll-outs by prominent operators such as Verizon in the USA, eventually accounting for a third of deployments globally.

LTE offers high-speed mobile broadband up to five times faster than HSPA (high-speed packet access) at a lower cost per megabyte than 3G. Interest in LTE deployment is hence high among operators, despite the lack of a definitive answer as to what spectrum is even likely to be made available. In Western Europe, most wireless operators are focusing on the 2600MHz frequency, as this is largely clear of incumbent users and provides the greatest opportunity for swift and effective deployment.

"This drive to move swiftly toward LTE in multiple frequency bands creates opportunities for manufacturers," says Stephen Entwistle. "Verizon is looking at deploying LTE commercially at 700MHz by early 2010, which will require manufacturers of wireless data-cards, USB modems and embedded terminals to come up with new designs quickly," he adds.

"To maximize performance for LTE and provide a better match to existing 2G and 3G cell sizes, we expect operators to install upgrade equipment such as remote radio heads (RRHs) to existing infrastructure, creating demand for new RF components," says Strategy Analytics Christopher Taylor. "Multi-band RRHs may create opportunities for gallium nitride RF power transistors, which can provide high performance and efficiency in compact, light-weight modules and subsystems, particularly above 2GHz."

www.strategyanalytics.com

Q1 sees record GSM network drop

Despite a record number of 3G base-station shipments, worldwide mobile infrastructure market revenue contracted 9% year-on-year in first-quarter 2009, according to market research firm Dell'Oro Group's 'Mobility Infrastructure Quarterly Report'. However, the GSM market experienced its largest year-on-year decline as Chinese mobile operators focused on 3G network deployments.

"The three Chinese mobile operators plan to spend over \$20bn this year on rolling out the initial phases of their 3G deployments," says senior analyst Scott Siegler. "China Unicom's WCDMA deployment is shaping up to be the single largest 3G deployment in history and was the primary contributor to the most ever — 100,000 — Node B ship-

ments in the quarter," he elaborates. "With the CDMA market declining elsewhere around the world, China Telecom's spending resulted in the most CDMA base-station shipments in over four years," he adds. "As the two GSM operators — China Mobile and China Telecom — focused their spending on the rapid deployment of their 3G networks, spending on their GSM networks significantly declined. We expect this spending to accelerate in the second half of the year," Siegler forecasts.

During Q1/2009, Huawei and ZTE saw the greatest rate of growth, almost doubling their combined share of the total infrastructure market to over 20% compared to the same quarter last year, adds Dell'Oro.

www.DellOro.com

Seoul Semiconductor may challenge Lumileds as third biggest packaged LED supplier

Although full data is not yet available, the report 'World Market of Light Emitting Diodes, 2009 Edition' from IMS Research reckons that the top three packaged LED suppliers in 2008 (in terms of dollar revenue) remained the same as in 2007 when Nichia had 24% of the market, Osram Opto 10.5%, and Philips Lumileds 6.5%.

However, although these three firms have been well established as the top three for several years now, they now face strong challenges from companies in Taiwan and Korea.

"Lumileds may face competition for third spot from Seoul Semiconductor in the next few years," says analyst Jamie Fox. "For several years now, Seoul Semiconductor has grown aggressively and faster than the overall LED market, and has risen steadily through the top 10 to reach 4th spot."

Other firms in the top ten include Japan's Citizen and Toyoda Gosei, as well as Taiwan's Everlight and Kingbright, which have also seen good growth. The USA's Avago Technologies is also in the top ten by total revenue.

Other LED companies are more focused on profit margin and quality of products, or developing a portfolio with an eye on the long-term lighting market, rather than just the largest total revenues, says IMS. For example, Cree is widely considered to be one of the top four or five LED firms, but not in terms of packaged LED revenue.

In response to their confirmation as the number one supplier, a spokesman from Nichia commented that, while lower-quality products give other competitors a chance, he is increasingly seeing a demand for quality products.

www.imsresearch.com

LED market to exceed \$33bn by 2013, forecasts NextGen

In direct contrast to the bearish global economy and the resulting contraction in many product categories, demand and usage of LEDs is booming, according to the report 'LED Lighting: Solid State Lighting Applications, Technologies, and Market Opportunities' from NextGen Research (the emerging technology arm of ABI Research).

Starting in second-half 2007, LEDs have recovered from the sluggish sales and unit shipments that characterized the market from 2004 to mid-2007. LEDs — especially certain fast-emerging niche segments like high-brightness (HB) for specialized applications — have rebounded, and that resurgence will continue over the next three to five years.

As a result, the LED market will experience robust growth over the next five years, with the overall solid-state lighting (SSL) market reaching \$33bn by 2013, forecasts NextGen Research. This growth will

be fueled by increasingly powerful and energy-efficient offerings that will help businesses and consumers lower their total cost of ownership (TCO), accelerate return on investment (ROI) and be more environmentally friendly.

The illumination segment of the LED market will lead the way, with a compound annual growth rate (CAGR) of nearly 22% in 2009–2013 as cities worldwide shift their streetlights to more energy-efficient and ecologically friendly LED solutions. The display portion of the market will also shine, achieving a five-year CAGR of more than 14%.

Energized by improvements in the technology and significant extensions of product lifespans, LEDs now have powerful proponents in government agencies, municipalities, utilities and even forward-thinking private citizens, all calling for widespread acceptance and adoption of LEDs, says the market research firm.

Research analyst Laura DiDio has identified trends that have combined to make this one of the most dynamic periods in the history of LEDs. These include: bifurcation in the market between commoditized LEDs and higher-end, leading-edge applications; the speed at which LED technology is advancing; standardization and green initiatives; industry consolidation; the emergence of niche market illumination applications, and new markets for mature applications.

"The LED industry still faces challenges," cautions DiDio. "Vendors must work with legislators and industry groups to foster a smooth, orderly transition from incandescent bulbs to the more efficient LEDs," she adds. "Vendors also must provide specific product roadmaps to assist users with business continuity planning, and provide excellent after-market technical support and guidance during the transition."

www.nextgenresearch.com

Wireless comms to benefit from \$6.8bn US stimulus

The American Recovery and Reinvestment Act (ARRA, or the Stimulus Bill) will provide funding for a massive \$6.8bn worth of wireless communications upgrades and new deployments over 2009–2010, according to the report 'The 2009 Federal Stimulus Bill' from ABI Research.

The act offers a significant one-off opportunity for wireless equipment vendors, adds the market research firm. "The ARRA represents a windfall for wireless service providers as well as for satellite service providers," says vice president Stan Schatt. "It will have an enormous impact on Wi-Fi and wireless broadband vendors. It will also immediately benefit a number of specific vertical industries, including healthcare, education, homeland security, the environment, and the nation's electricity infrastructure," he adds.

In healthcare, the scope for adding wireless to the technology mix encompasses Wi-Fi-enabled mobile devices and sensors, communications systems linking health networks, telepresence, wireless LAN equipment, and Wi-Fi-enabled video surveillance systems.

In education, already a leading adopter of Wi-Fi solutions, equipment vendors are developing templated solutions in such areas as WLANs for 'learning anywhere', voice-over-Wi-Fi, and WLAN equipment and software to track students' progress for 'No Child Left Behind' record keeping.

The ARRA represents a windfall for wireless service providers as well as for satellite service providers

The Department of Homeland Security and US Customs & Border Protection are potential goldmines for wireless vendors, says ABI, because of the many agencies within them that will use ARRA funds for tactical communications equipment, infrastructure equipment, and security equipment. Even critical infrastructure construction projects such as bridges and tunnels often require wireless video surveillance systems.

"Many of the spending opportunities lie 'under the surface'," notes Schatt. "A civil engineering project which seems mainly about concrete and steel may actually benefit from a lot of wireless technology. And, because vendors can't apply for funds themselves, they are — and should be — doing everything in their power to help their customers do so," he adds.

www.abiresearch.com

Handset sales drop 8.6% in Q1 as smart-phones grow 12.7%

Mobile phone sales totalled 269.1m units in first-quarter 2009, down 8.6% on a year ago, according to the report 'Dataquest Insight: Market Share for Mobile Devices, 1Q09' from Gartner.

"There were some signs of a recovery in markets such as North America and China, but overall sales in the first quarter of 2009 registered the biggest quarter-on-quarter contraction since Gartner began monitoring the market on a quarterly basis in 2001," says Carolina Milanesi, research director for mobile devices. "This was also the first time the market contracted year over year during the first quarter, a period traditionally helped by strong seasonality in the Asia/Pacific market."

As Gartner predicted in Q4/2008, the channel intensified its efforts in Q1/2009 to reduce the levels of stock it holds, in order to minimize capital investment in response to low consumer confidence. Sales into the channel were just short of 244m units compared with sales to users of 269.1m units — a difference of 25m (up from 17m in Q4/2008), which is the biggest difference ever recorded. Channel inventory reductions will continue into Q2/2009, albeit with lower volumes, expects Gartner.

However, smart-phone sales grew 12.7% to 36.4 million units, rising from 11% of all mobile device sales a year ago to 13.5%. Growth was driven largely by touchscreen products, both in mid-tier and high-end devices, says principal analyst Roberta Cozza. "Touch for the sake of touch' was enough of a driver in the mid-tier space, but tighter integration with applications and services around music, mobile e-mail, and Internet browsing made the difference at the high end of the market," he adds.

Symbian accounted for 49.3% of smart-phone operating systems (OS) market share, down from 56.9% a year ago. Positive performance by Research In Motion (RIM) and Apple

Sales to end-users in Q1/09 (in millions).

| Firm | Q1/09 | | Q1/08 | |
|---------------|--------------|-------|--------------|-------|
| | Sales | Share | Sales | Share |
| Nokia | 97.4 | 36.2% | 115.2 | 39.1% |
| Samsung | 51.4 | 19.1% | 42.4 | 14.4% |
| LG | 26.5 | 9.9% | 23.6 | 8.0% |
| Motorola | 16.6 | 6.2% | 29.9 | 10.2% |
| Sony Ericsson | 14.5 | 5.4% | 22.1 | 7.5% |
| Others | 62.7 | 23.4% | 61.1 | 20.8% |
| Total | 269.1 | | 294.3 | |

showed that services and applications are now instrumental to smart-phones' success, says Gartner. Smart-phone OS market share has risen from 13.3% to 19.9% for RIM (maker of the Blackberry) and from 5.3% to 10.8% for Apple's iPhone.

Due to inventory reductions in markets such as Asia/Pacific and Latin America, overall handset sales for Nokia were 97.4m units, its first time below 100m since Q1/2007. Nokia continued to lead the market, but its share fell from 39.1% a year ago to 36.2%. The real impact of the market recession was on the average selling price (ASP), which fell 18% year-on-year. However, the firm managed to grow sales in the smart-phone segment by launching the Nokia 5800 in more regions.

Samsung retained second place with 51.4m sales and grew its share from 14.4% to 19.1%. It returned to double-digit profitability due to a good product mix, as sales of its Omnia, Tocco and Pixon handsets continued to benefit from strong consumer interest in touchscreen devices. The launch of the Tocco Ultra Edition late in Q1/2009 and its first Android-based product (i7500) will help it in a highly competitive second-half 2009.

LG sold 26.5m units, growing its share from 8% to 9.9% due to a strong portfolio of touchscreen, messaging and imaging devices. The new Arena device showcases a user interface that focuses on improving usability. However, LG's biggest challenge is to become competitive in the smart-phone

segment as services and applications become more important to customers, says Gartner.

Motorola experienced continued difficulties (even in its home market), but had a solid quarter with prepaid operators Boost Mobile and Tracfone. After dropping to fifth place in Q4/2008, Motorola overtook Sony Ericsson to regain fourth place. It expects iDEN handset sales to rise 50% in 2009. This

will help sustain Motorola until it revamps its portfolio in Q4/2009. Motorola has committed to Android, not only to revamp its position in second-half 2009 but to produce a long-term performance boost. However, Gartner questions how Motorola will be able to differentiate its offering when so many players will be delivering Android-based products at the same time.

Sony Ericsson sold 14.5m units, losing market share on both Q4/2008 and a year ago, driven by the recession and a weak portfolio. The product features that helped it become one of the top vendors (imaging and music) are now too common to be a differentiator. The firm is late to catch on to the popularity of touchscreen devices and has a limited smart-phone portfolio, says Gartner. While its focus on services through Play Now Arena is important, it needs to ensure its devices include the most desirable consumer applications and features.

In Q2/09, Gartner expects inventory-reduction efforts to continue (but to a lesser extent). Following Q1's better-than-expected sales to users, total sales to users for 2009 will hence remain much higher than the sell-in to the channel that many handset vendors expect, believes Milanesi. "Device vendors will focus increasingly on smart-phones, improved user interfaces and services to differentiate themselves, and fuel consumer demand." Sales to users will fall by 4% in 2009, while sell-in will fall about 10%.

www.gartner.com

PV overcapacity to drive 32% drop in market in 2009; growth to resume in 2010 at 29.2%, then 57.8% in 2011

Worldwide installations of photovoltaic (PV) systems will fall 32% from 5.2GW in 2008 to 3.5GW in 2009, forecasts market research firm iSuppli Corp. A 12% drop in average price per solar watt will lead to revenue generated by PV system installations plunging by 40.2% from \$30.5bn in 2008 to \$18.2bn.

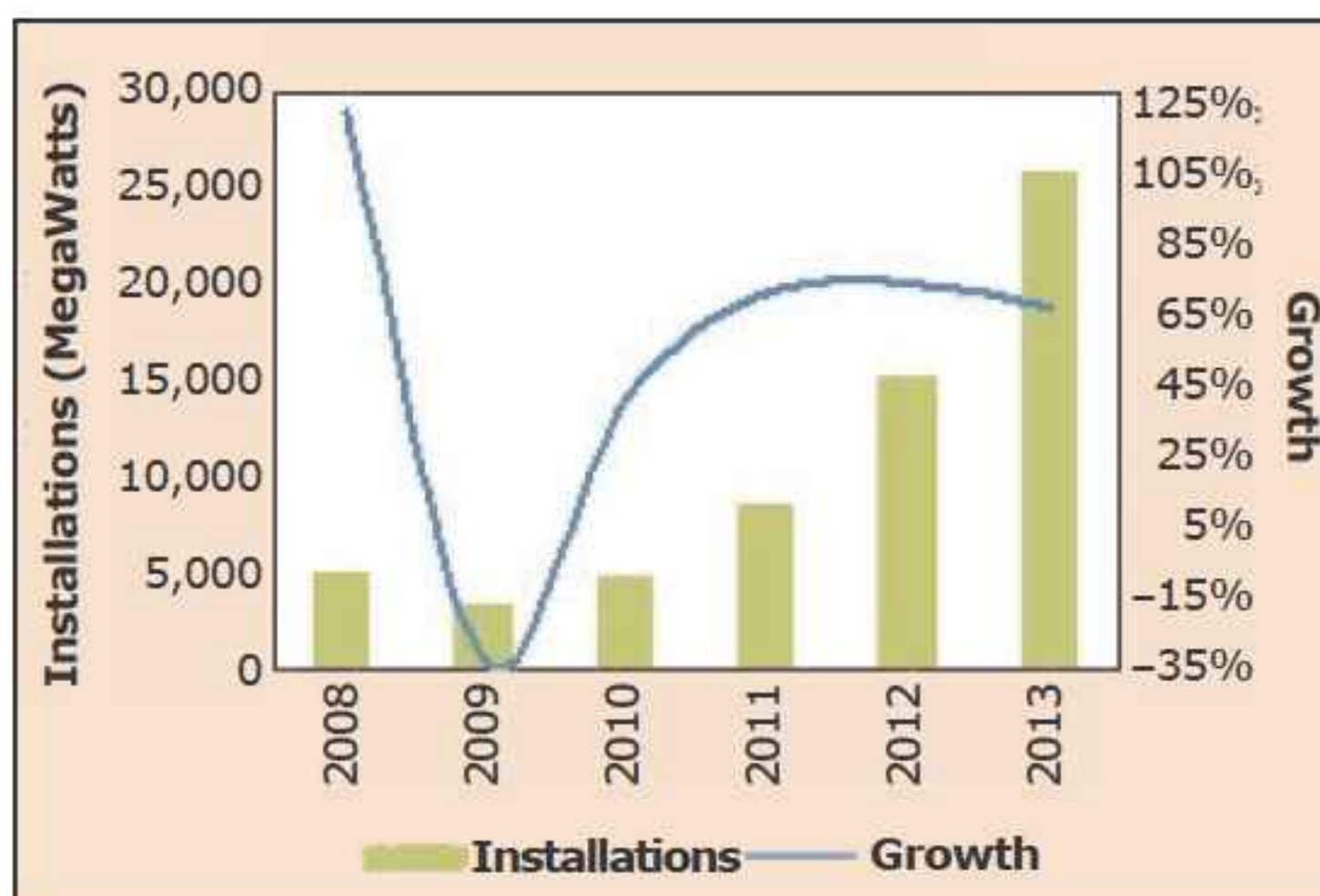
"For years, the PV industry enjoyed vigorous double-digit annual growth in the 40% range, spurring a 'wild-west' mentality among market participants," says Dr Henning Wicht, senior director and principal analyst for iSuppli.

"An ever-rising flood of market participants attempted to capitalize on this growth, all hoping to claim a 10% share of market revenue by throwing more production capacity into the market," he adds. "This overproduction situation, along with a decline in demand, will lead to the sharp, unprecedented fall in PV industry revenue in 2009."

However, the PV market downturn in 2009, like the PC shakeout of the mid-1980s, is likely to change the current market paradigm and could actually have a positive outcome for the solar industry, cutting down on industry excesses and leading to a more mature and orderly supply chain when growth returns in 2010 and beyond, believes the firm.

"The number of new suppliers entering and competing in the PV supply chain will decelerate and the rate of new capacity additions will slow, bringing a better balance between supply and demand in the future," says Wicht.

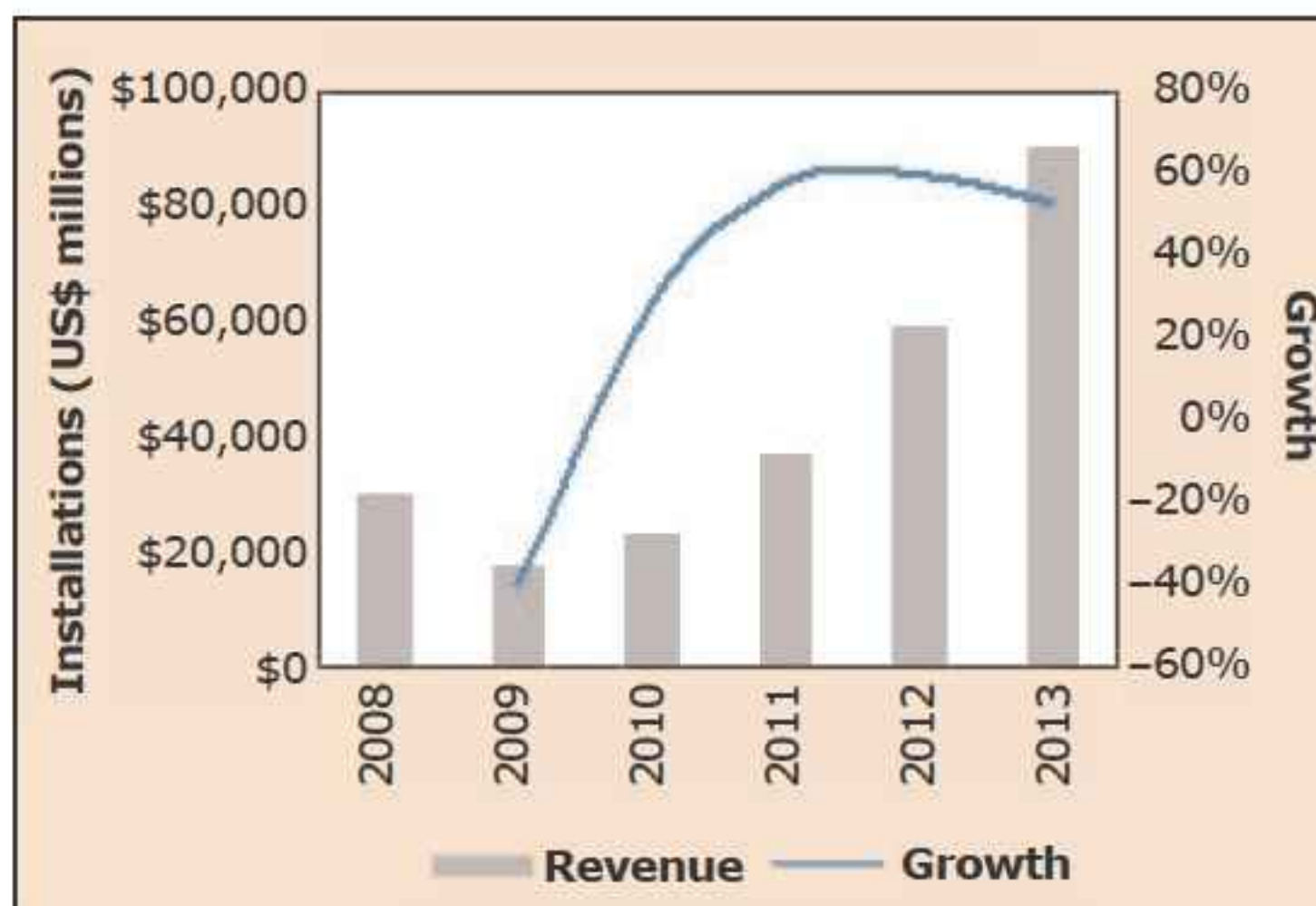
The single event most responsible for the 2009 PV market slowdown was a sharp decline in expected PV installations in Spain. In 2008, Spain accounted for 50% of worldwide installations. An artificial demand surge had been created as the time approached when the country's feed-in-tariff rate was set to drop and a new cap of 500MW loomed



PV system installations and growth rate in MegaWatts.

for projects qualifying for the above-market tariff. This set a well-defined deadline for growth in the Spanish market in 2009 and 2010.

While the Spanish situation is spurring a surge in excess inventory and falling prices for solar cells and systems, this will not stimulate sufficient demand to compensate for the lost sales in 2009, says iSuppli. Even new and upgraded incentives for solar installations from nations including the USA and Japan—and attractive investment conditions in France, Italy, the Czech Republic, Greece and other countries—cannot compensate for the Spanish whiplash in 2009. The impact will continue into 2010, restraining global revenue growth to 29.2%.



PV system installations and growth rate in dollar revenue. www.isuppli.com

Beyond Spain, the PV market has been hit by the credit crunch. "Power production investors and commercial entities are at least partially dependent upon debt financing," Wicht notes. "Starting in the first quarter of 2009, many large and medium solar-installation

projects went on hold as they awaited a thaw in bank credit flows."

After 2010, the fundamental drivers of PV demand will reassert themselves, bringing a 57.8% increase in revenue in 2011 and similar growth rates in 2012 and 2013.

"PV remains attractive because it continues to demonstrate a favorable return on investment (RoI)," Wicht says. "Government incentives in the form of above-market feed-in-tariffs and tax breaks will remain in place, making the RoI equations viable through 2012," he adds. "Cost reductions will lead to attractive RoI and payback periods even without governmental help after 2012."

Also, lower system prices will open up new markets by lowering incentives and subvention costs. The lower the PV system prices are, the lower the incentives will have to be. Developing regions will be the big beneficiaries of these lower prices and thus will grow faster than the global average, Wicht forecasts.

Bulk GaN substrates to expand from blue lasers to LED lighting and power electronics applications

The market for bulk and free-standing gallium nitride (GaN) substrates is currently driven mostly by blue laser-diode production and related applications in high-density data storage (in particular, strong demand for Blu-ray players and game stations), according to the report 'Bulk GaN 09' from Yole Developpement.

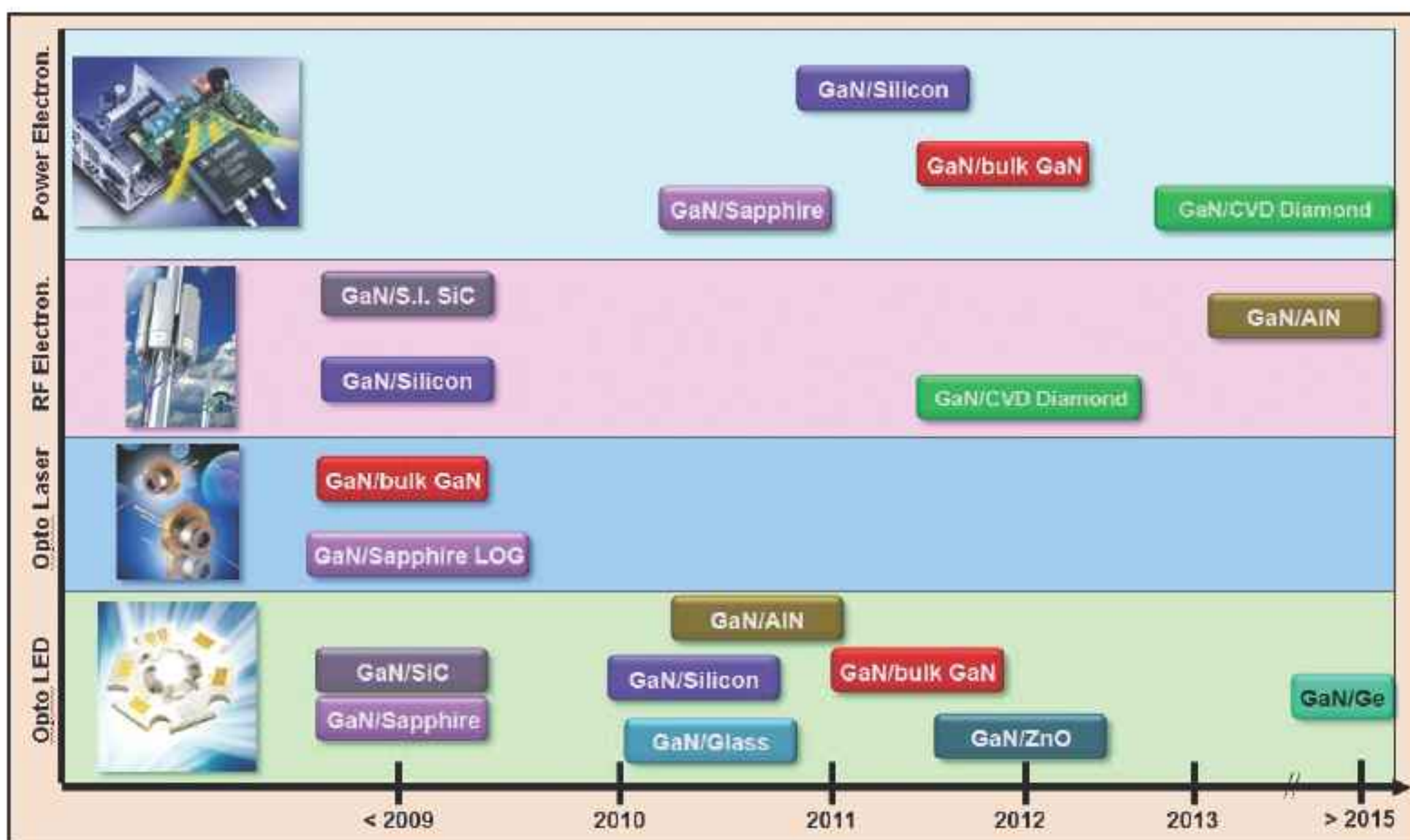
The market is currently centered essentially on free-standing GaN material. However, the shortage of this product has to be compensated for by the use of home-made epitaxial liftoff (ELO) GaN-on-sapphire substrates. Yole estimates that about 28% of laser diodes were made on ELO-GaN in 2008.

This percentage will decrease a little but will remain significant in 2012.

However, starting in 2011 or most likely 2012, a portion of bulk GaN production will be used to make ultra-high-brightness (UHB) LEDs, forecasts Yole. "That will only be possible with a sharp drop in bulk-GaN prices," says project manager Philippe Roussel. The critical price threshold for a 2" LED-grade substrate needs to be below \$1500 to act as leverage for a takeoff of the LED market, he reckons.

The years 2012 and 2013 will see the launch of new high-power devices based on bulk GaN. But again, this is strongly dependent on the pricing of bulk GaN, which will have to compete with alternative 4" and future 6" silicon carbide (SiC) and GaN-on-silicon technology.

Asia currently dominates the GaN substrate market, but the European Union and the USA are credible challengers, says Yole. The main producer of free-standing GaN remains Sumitomo, mostly supplying Nichia and Sony for laser production. However, other challengers such as Hitachi Cable (now sampling



Bulk or free-standing GaN substrate mass-market introduction by application.

3" wafers) and Mitsubishi Chemical are gaining more of a presence.

In Europe, Lumilog of Vallauris, France (acquired by Saint-Gobain group in April 2008) is fine-tuning its product lineup for LED illumination, while Ammono and TopGaN Ltd (both of Warsaw, Poland) are improving their strong expertise in low-dislocation-density crystals. The US, including Kyma Technologies Inc of Raleigh, NC, Inlustra Technologies Inc of Santa Barbara, CA

and Oxford Instruments-TDI of Silver Spring, MD, is focused mainly on non-polar or semi-polar material.

Production of 2" substrates could reach 100,000 units by 2010, leading to a \$240m market for both free-standing and ELO GaN, reckons Yole. Beyond 2013, demand for bulk GaN in LED lighting applications will grow rapidly, dominating the GaN substrate market in terms of volume by 2015, the firm concludes.

www.yole.fr



Sensitivity to dislocation density in active layer for various nitride devices.

Merchant substrate market for GaN to be \$470m in 2013

Over the past 15 years, the availability of high-quality sapphire and silicon carbide (SiC) substrates has enabled the rapid growth of the gallium nitride device market (mainly high-brightness LEDs) to \$4.6bn in 2008. However, increasing demand for blue-violet laser diodes, UV LEDs and high-power, high-frequency electronic devices will provide significant market opportunities for advanced substrates such as gallium nitride and aluminum nitride, according to the report 'Substrates for GaN-Based Devices: Performance Comparisons and Market Assessment 2009' from Strategies Unlimited.

These substrates will be needed to provide the lattice matching and

thermal characteristics necessary to produce high-performance devices at high yields, says the market research firm. At the same time, demand for higher device manufacturing throughput and lower costs will push sapphire and SiC diameters from 2 inches to 3 inches and 4 inches, and ultimately to 6 inches, it adds.

As the market expands, a number of firms are in a position to provide such substrates, including larger, established companies such as Sumitomo Electric, Cree and Samsung Corning, as well as smaller technology-focused startups such as Crystal IS, Kyma, and TopGaN. The effort to develop advanced substrates, as well as to improve

conventional substrate properties, is worldwide in scope and includes 80 companies and 65 universities and research centers, reckons Strategies Unlimited.

Based on the forecast demand for high-brightness LEDs, blue-violet laser diodes, and high-power, high-frequency electronic devices, the merchant market for substrates for gallium nitride devices (excluding captive producers such as Cree) is forecast to grow from \$280m in 2008 to \$470m in 2013. In particular, advanced substrates such as gallium nitride and aluminum nitride will comprise more than 40% of the market in 2013, predicts Strategies Unlimited.

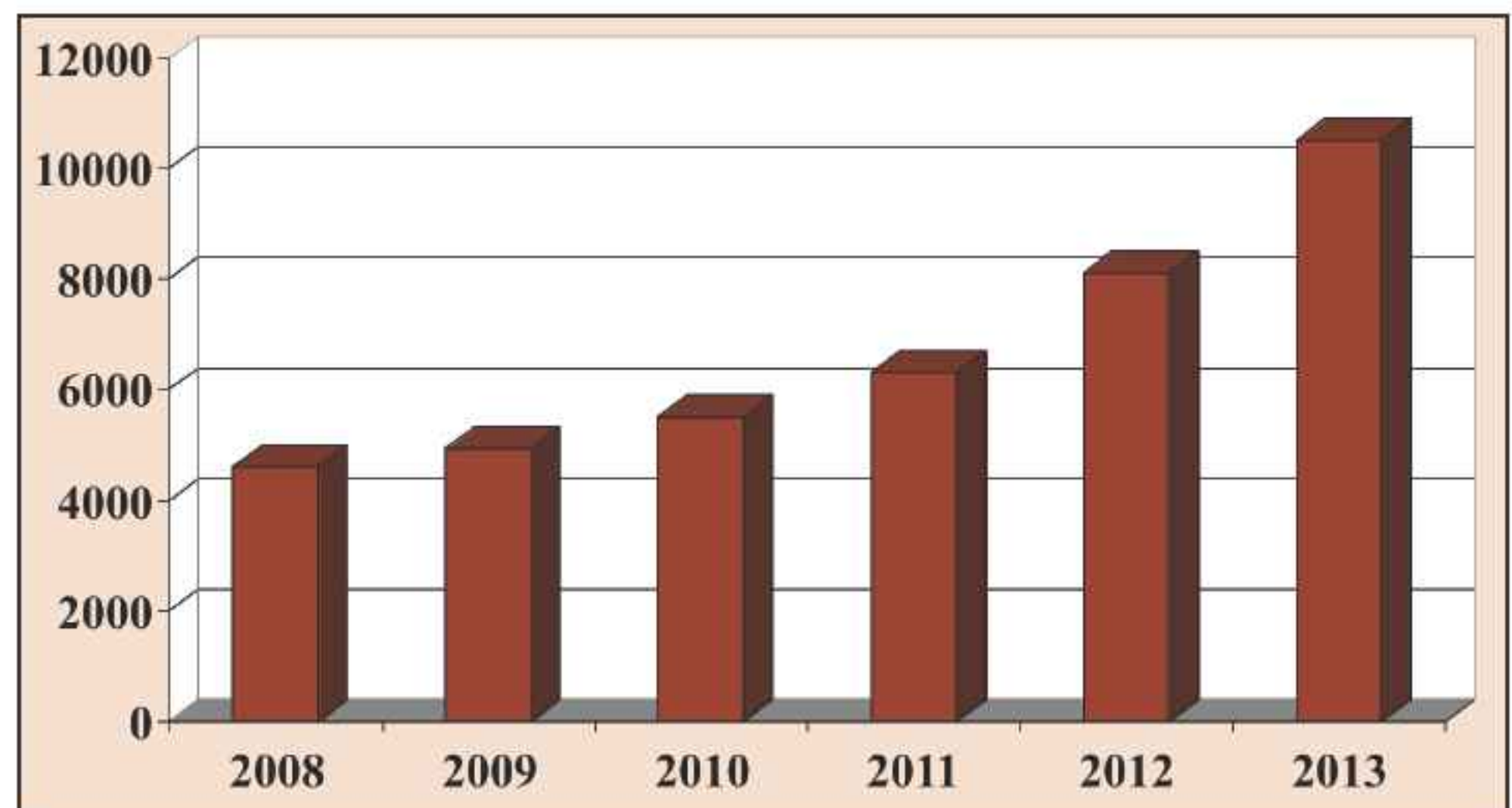
<http://su.pennnet.com>

White HB-LEDs to overtake RGB multichip LEDs by 2013

Market consumption of packaged high-brightness LEDs (HB-LEDs) was nearly \$4.6bn in 2008 and will grow to \$10.5bn in 2013, according to a new report by market research firm ElectroniCast Consultants.

The use of white HB-LEDs is forecasted to grow six-fold, at an average annual rate of 43.5% over 2008-2013. Meanwhile, the use of red-green-blue (RGB) multiple-chip HB-LEDs will remain strong, although the growth rate will be flat over the forecast period, says Stephen Montgomery, president of Asia Pacific at ElectroniCast Consultants and director of the LED project group. "White LEDs are taking market share from the RGB multichip segment, and we see white LEDs almost taking the relative market leadership by 2013," he adds.

Market consumption of HB-LEDs used in signals (most notably traffic signals and pedestrian signal/controls) is forecasted to grow a dramatic average annual growth rate of 46.7% over 2008-2013. "The HB-LED signal market segment includes both retrofitting applications and new fixture deploy-



Forecast global consumption of HB-LEDs (in \$m), 2008-2013.

ments," says Montgomery. "Additionally, incentives based on 'going-green' or 'green-tech' initiatives are increasing the use of HB-LEDs in the signal segment," he adds. "Other dynamics include the safety of pedestrian and vehicle traffic, since the LEDs are a proven and reliable technology. LEDs are a good choice in this sector because, as in all applications, the low-energy consumption models drive the LED markets."

www.electronicast.com

● HB-LEDs to grow from 55% to 60% of signage & professional display LED market

Of the more than \$1.1bn of packaged LEDs consumed in signage & professional displays in 2008, high-brightness LEDs comprised 55% and will grow 60% in 2013, forecasts ElectroniCast.

"LED-based signage and displays enable real-time message delivery, which is critical for public emergency announcements and other useful information," says Montgomery.

RFMD seeing better-than-expected orders

At the Barclays Capital Wireless And Wireline Conference in New York in late May, RFMD's president & CEO Bob Bruggeworth said that its fiscal first-quarter 2010 (ending 27 June) is seeing better-than-expected demand. Fab utilization is over 75% (up from the March quarter's 25%).

Also, new, higher-margin products are comprising a growing proportion of revenue. Gross margin is hence trending above plan.

Capital expenditure was about \$4m in the March quarter, and should be \$3–5m in the June quarter. So, free cash flow (net cash provided by operating activities minus property and equipment expenditures) is on track for \$80–120m in fiscal 2010. RFMD expects to cut its net debt.

Also, at the RBC Capital Markets Technology, Communications and Media Conference in San Francisco, on 9 June, chief financial officer Dean Priddy said that RFMD achieved non-GAAP profitability in the first two months of fiscal Q1, and the cash, cash equivalents and short-term investments balance are ahead of plan, increasing by more than \$15m. With order activity remaining solid, September-quarter visibility continues to improve.

RFMD launches hybrid modules for CATV and fiber-deep architectures

RF Micro Devices has expanded its broadband transmission portfolio by releasing samples and pre-production quantities of two new products, in industry-standard SOT115J packages, for current- and next-generation cable TV infrastructure applications.

The D10040300GTH hybrid power doubler amplifier module is designed for CATV infrastructure applications including line amplification and hybrid fiber coaxial (HFC) optical nodes. It operates from 40MHz to 1GHz while typically maintaining 30dB or better gain across the entire frequency range (an industry first for available power doublers, it is claimed). The new module also helps cable operators to upgrade existing distribution networks to 1GHz and enables bandwidth-intensive services such as high-speed data, voice and HDTV. Operators can also exploit the device's linearity to reduce the number of amplifiers in the network, RFMD says.

The OS10040320PW is a 1GHz hybrid high-dynamic-range optical receiver module designed for use in HFC optical nodes and deep fiber network installations. It contains a single-mode optical input suitable

for wavelengths from 1290nm to 1600nm, a terminal for monitoring the PIN diode current, and an electrical output with an impedance of 75Ω. The equivalent input noise current (EINC) performance is just 5pA per root Hertz (typical performance), helping cable operators to implement 'fiber deep' solutions as they upgrade to 1GHz networks. Specifically, by enabling the optical node portion of HFC networks to be placed deeper into CATV networks, the OS10040320PW minimizes requirements for more costly erbium-doped fiber amplifiers (EDFAs), RFMD claims.

Maximum current consumption at 24V is 440mA for the D10040300GTH and 260mA for the OS10040320PW.

"As multiple system operators (MSOs) continue to upgrade their CATV infrastructure to 1GHz and implement fiber deep programs, these new products help to lower overall upgrade costs and enhance system performance," says Alastair Upton, general manager of RFMD's Broadband Components business unit.

RFMD expects initial shipments to start in the September quarter.

www.rfmd.com

WIN opens fab B

On 1 May, WIN Semiconductors opened its second 6" GaAs wafer fab (Fab B). Co-located in the Hwaya Technology Park, its capacity of 5000 wafers per month (wpm) will add to Fab A's capacity of 7000 wpm, offering cost-effective synergy in operations, the firm says.

Fab B has been opened to meet accelerating demand in an industry driven by continued efficiency-based outsourcing and consolidation, WIN says.

"We have also purchased the land for Fab C located in the same technology park," adds Bob Donahue, executive VP of sales & marketing.

www.winfoundry.com

TriQuint, WIN grow foundry share

TriQuint Semiconductor of Hillsboro, OR, USA and Taiwan's WIN Semiconductors grew their collective share of the GaAs foundry market from 67% in 2007 to 77% in 2008, according to Strategy Analytics.

TriQuint retained top spot in 2008, benefiting from commercial opportunities and engagement in the US defense and aerospace industries. WIN is much the largest pure-play GaAs foundry, and only one percentage point behind TriQuint in overall market share in 2008.

Strategy Analytics reckons the GaAs foundry market grew 27% year-on-year in 2008 to \$311m. "The market for GaAs foundry serv-

ices will continue to grow as dual-sourcing and fabless strategies become more prominent in the GaAs industry," forecasts Asif Anwar of Strategy Analytics.

"Start-up companies and research institutes targeting niche and emerging markets may be finding that the tape-out costs of 'cheap silicon' are too expensive in the current downturn," notes Stephen Entwistle, VP of Strategy Analytics' Strategic Technologies Practice.

"This offers an additional opportunity for GaAs foundries to leverage the lower costs and higher performance capabilities offered by GaAs."

www.strategyanalytics.com

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China's ZTE signs \$50m deal

TriQuint Semiconductor says that it has signed a framework agreement with Chinese wireless communication system equipment maker ZTE Corp. Under the deal, ZTE will procure TriQuint components — including but not limited to CDMA, GSM, and WCDMA ASICs — to the value of no less than \$50m in 2009.

The agreement was formalized on 28 April at the US-China Business Signing Ceremony: 'Partnering for Sustainable Economic Growth' in Chicago, IL, witnessed by vice minister Ma Xiuhong and consul general Huang Ping. The event, aggregating \$5.7bn of US-China business through 28 contracts, was organized by the China Chamber of Commerce for Import & Export of Machinery and Electronic Products.

"Not only does this agreement strengthen the relationship of the two companies, but our innovations will bring high-quality voice, data, and video communications to people everywhere," stated TriQuint president & CEO Ralph Quinsey.

www.triquint.com

TriQuint wins TechAmerica Oregon's System/Hardware 'Company of the Year' award

As part of the Technology Awards program of TechAmerica Oregon (formerly the Oregon Council of AeA) at the Portland Art Museum late last week, RF product maker and foundry services provider TriQuint Semiconductor Inc of Hillsboro, OR, USA received the 2009 System/Hardware 'Company of the Year' award in recognition of its accomplishments, leadership and commitment to the community and industry.

"A thriving high-tech community and the jobs it creates contribute to the overall health of our economy," said Phillip J. Bond, president of Washington DC-based TechAmerica, which was formed last year through the merger of AeA (formerly the American Electronics Association), the Cyber Security Industry Alliance (CSIA), the Information Technology Association of America (ITAA) and the Government Electronics & Information Technology Association (GEIA). "Oregon's high-technology

industry is dynamic, diverse and growing... TriQuint is a key player in the region's technology industry. We all benefit from their focus on innovation to advance global communications," Bond added.

"We are honored to have been chosen for this award amongst so many respected and successful local companies," said TriQuint's president & CEO Ralph Quinsey as he accepted the award on behalf of the firm.

Quinsey was also formally recognized as TechAmerica Oregon's 2009 Technology Executive of the Year (announced in February), on the basis of his leadership shown in TriQuint, the greater Oregon community and the technology industry. Quinsey was chosen by a collection of the program's previous Technology Executive of the Year and Lifetime Achievement Award recipients who make up the selection committee.

www.oregontechawards.com

Texas 4" fab accredited by DoD as Category 1A 'Trusted Foundry'

RF product maker TriQuint Semiconductor Inc of Hillsboro, OR, USA has been accredited by the US Department of Defense (DoD) as a Category 1A 'Trusted Foundry' for its 100mm (4-inch) gallium arsenide facilities in Richardson, TX, USA. Accreditation expands TriQuint's GaAs circuit fabrication capabilities by including classified programs; a Category 1A designation is the highest awarded by the DoD.

Accreditation certifies that TriQuint processes meet stringent product control and secure handling standards during all stages of circuit fabrication. Accreditation also creates an avenue for increased high-security monolithic microwave integrated circuit

(MMIC) business, according to Dr Gailon Brehm, TriQuint's director of defense & aerospace product marketing.

"TriQuint's foundry has become one of a very elite group of trusted manufacturers that can fabricate both classified and unclassified circuits for critical DoD programs," says Brehm. "This creates an opportunity for new business at TriQuint with government programs that only work with 'trusted' foundries," he adds. "Accreditation builds on our heritage as a leading provider of high-power, high-frequency devices for defense and aerospace systems."

Accreditation through the Trusted Access Program Office (TAPO) and the DoD's Defense Microelectronics

Activity (DMEA) requires following stringent policies and procedures regarding 'chain of custody' during manufacturing. These processes and TriQuint's ability to fully satisfy the requirements are safeguards against supply chain interruption, modification or tampering with devices as well as unauthorized reverse engineering, says the firm.

TriQuint's 150mm commercial wafer fabrication takes place at its headquarters in Hillsboro, OR. The 100mm GaAs wafer fabrication plant in Texas also serves commercial customers. The firm is recognized by market research firm Strategy Analytics as the world's largest commercial GaAs foundry manufacturer.

www.triquint.com/foundry

AWR adds TriQuint's devices to Microwave Office software

AWR Corp of El Segundo, CA, USA, which supplies high-frequency electronic design automation (EDA) products, says that users of its Microwave Office design software now have access to XML library data for a broad array of microwave amplifiers from Hillsboro, OR-based TriQuint Semiconductor Inc's design center in San Jose, CA (formerly WJ Communications, until its acquisition in May 2008). The devices include packaged gain-blocks, field-effect transistors (FETs), and heterojunction bipolar transistor (HBT) amplifiers.

The library provides measurement-based models and footprints used for printed circuit board (PCB) and module layouts. It is available to users of AWR's Microwave Office software through the XML library link accessible from the software. While most of the library is targeted at small-signal simulation, a variety of nonlinear models are available for the AP60x Series high-voltage HBT amplifiers. The data sheet for each TriQuint device can be viewed by clicking the 'Vendor Help' button from within the Microwave Office

parameter dialog box for the device, which connects the user directly to TriQuint's website.

"Integrating TriQuint's component models into the Microwave Office XML libraries will enable RF engineers to design their end solutions in an easier and faster manner," says Tuan Nguyen, product marketing manager for TriQuint's Network business unit.

"AWR's simulation software helps RF design and applications engineers quickly generate circuit designs while meeting performance and schedule requirements."

The Microwave Office XML parts allow designers to incorporate commercially available devices

Integrating TriQuint's component models into the Microwave Office XML libraries will enable RF engineers to design their end solutions in an easier and faster manner

directly into their designs by providing a schematic symbol and simulation model as well as by relating the data to a part number and package footprint suitable for a production layout and assembly drawing. AWR says that XML components have added value because the models themselves are created and provided by TriQuint, which ensures that the model is accurate and represents TriQuint's concept of how the part should function.

The new XML parts increase both the volume and quality of AWR's rapidly growing vendor parts. The library is available from the AWR website, and other vendors can add and modify parts within the firm's vendor program, as TriQuint has done. XML parts can be targeted for native Microwave Office circuit simulation, enabling designers to take advantage of AWR's linear and nonlinear frequency-domain simulation, including APLAC and HSPICE, as well as system simulation using Visual System Simulator (VSS) software.

www.awrcorp.com

TriQuint selects Synopsys' TCAD Sentaurus to speed development

Synopsys Inc of Mountain View, CA, USA, which provides software and IP for semiconductor design, verification and manufacturing, says that TriQuint Semiconductor of Hillsboro, OR, USA has adopted its TCAD Sentaurus device simulation software to support its R&D of high-frequency and high-power devices targeting mobile handsets, 3G and 4G base-stations, Wi-Fi, WiMAX, and defense and aerospace applications.

Synopsys says that TCAD Sentaurus' accurate modeling and other advanced capabilities enable

TriQuint to speed up the development of devices including heterojunction field-effect transistors (HFETs) and heterojunction bipolar transistors (HBTs). It accomplishes this by supporting wafer experiments with detailed simulations of the electrical and thermal behavior of the devices. "TCAD Sentaurus helps us tailor and optimize the design of these transistors to specific applications," says Otto Berger, TriQuint's director Advanced Technology.

The TCAD Sentaurus product family comprises two- and three-

dimensional process and device simulation tools used for exploring and optimizing silicon and compound semiconductor technologies.

"We've seen a rising interest in the application of our simulation tools to the design of these devices as companies continue to push against the envelope of high-frequency and high-efficiency to meet stringent wireless requirements," says Howard Ko, senior VP & general manager of Synopsys' Silicon Engineering Group.

www.synopsys.com

IN BRIEF

M/A-COM appoints ex-president as CEO

M/A-COM Technology Solutions Inc of Lowell, MA, USA, which provides microwave and RF design solutions and products, has appointed Joseph G. Thomas (formerly the firm's president) as CEO. Thomas has been with the firm for 35 years, serving in a number of senior management positions. He has led growth teams addressing multiple markets, ranging from consumer entertainment to strategic defense applications.



Joseph G. Thomas.

Prior to joining the firm, he received a Bachelor's Degree in Electrical Engineering from the University of Massachusetts in 1973 and was an engineering manager with Micro Dynamics of Woburn, MA, USA.

M/A-COM Technology Solutions has also appointed Conrad Gagnon as chief financial officer. Gagnon has been with the firm for more than 25 years, serving in leadership roles in finance, sales and marketing, acquisitions, new ventures and portfolio management. "He has played a pivotal role in shaping our finance organization and contributing to our strategic planning efforts," says Thomas.

Prior to joining the company, Gagnon was cost and budget manager at Ingersoll-Rand. He gained a Bachelor of Science degree in accounting and computer science from Boston College in 1976. He is also a certified public accountant.

www.macomtech.com

Anadigics awarded four US patents for power amplifiers

Anadigics Inc of Warren, NJ, USA has been granted four new US patents for advances in the design and development of radio frequency (RF) power amplifier (PA) technology.

The new patents include numbers: ●7459974, a system and method for distortion cancellation in amplifiers; ●7400873, a method and system for image rejection by using post-mixer I/Q equalization; ●7385447, a power amplifier with curve-fitting pre-distorter; and ●7443236, a CDMA power amplifier design for low and high power modes.

A highlight is that the new CDMA PA design improves handset efficiency at low power levels without compromising efficiency at high power levels. This is particularly beneficial to designers of CDMA and WCDMA handsets, because the devices are mostly used in low-power modes.

Anadigics says that, before its High-Efficiency-at-Low-Power (HELP) family of products, a typical PA used for handsets could be internally optimized only at maximum rated power. This produced

very poor efficiency at the low power levels where the handset spends most of its time. HELP power amplifier products for CDMA and WCDMA use mode switching to achieve optimized DC power consumption over a range of output powers, reducing average battery current consumption by as much as 75% compared to earlier PA designs, it is reckoned.

The new CDMA PA design improves handset efficiency at low power levels without compromising efficiency at high power levels

“Patent awards acknowledge the tremendous RF expertise of our design engineers, which ultimately translate into high performance and better-value products,” says Ron Michels, senior VP, chief technology and strategy officer. www.anadigics.com/company/patents

Anadigics wins China Telecommunication Technology Innovation Award

Anadigics says that its AWT6221 HELP3 WCDMA dual-band power amplifier (PA) has won the 'Excellent Achievement Award' in the Wireless Communication Technology & Solution category of the China Telecommunication Technology Innovation Award. Anadigics is the only RF provider to be recognized in this category.

The award is approved by the China Industry and Information Technology Ministry and was introduced in 2006 to encourage the development of innovative information and telecommunication products in China. The awards are considered to be the most influential honors presented by

the Chinese government for technology innovation.

Anadigics says that the AWT6221 reduces average current consumption by 75% and increases talk-time by up to 25%. The firm claims that, through selectable bias modes, its HELP3 PAs achieve optimal efficiency across the low-range and mid-range output power levels. The AWT6221's intelligent bias circuit reduces current consumption to 8mA at low power levels. Through the integration of two independent PA chains, it delivers uncompromised performance in both frequency bands and conserves printed-circuit board area, the firm adds.

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IN BRIEF

Skyworks ranked 15th in Boston Globe list of public firms in Massachusetts

Skyworks Solutions Inc of Woburn, MA, USA has ranked 15th in the Boston Globe's annual list of top-performing public companies based in Massachusetts.

Now in its 21st year, the Globe 100 ranks Massachusetts-based public companies whose stock is publicly traded on the NASDAQ, New York Stock Exchange, or American Stock Exchange equity markets, based on financial data from the four quarters ending nearest to 31 December 2008.

To be eligible, a company must be traded publicly for the whole of 2008 on the New York Stock Exchange, the NASDAQ or the American Stock Exchange, and have reported a positive net income for both 2007 and 2008. (For the December-quarter 2008, Skyworks reported net income of \$22m, despite the dramatic downturn in markets during that quarter.) Companies are ranked on four criteria: return on average equity, one-year percentage change in revenue, one-year percentage change in profit margin, and 2008 revenue.

"These companies represent the resilience of Massachusetts business, navigating difficult waters and surviving the ebbs and flows of an unstable economy and stock market," says Shirley Leung, business editor of the Boston Globe.

"Our strong financial performance is a reflection of our talented workforce whose hard work and dedication are driving Skyworks to be a uniquely diversified analog semiconductor company," adds president & CEO David J. Aldrich.

www.skyworksin.com

Skyworks acquires CMOS PA supplier Axiom

Skyworks Solutions Inc of Woburn, MA, USA, which manufactures linear products, power amplifiers, front-end modules and radio solutions for handset and infrastructure equipment, has announced its acquisition of fabless semiconductor company Axiom Microdevices Inc of Irvine, CA, which designs and supplies silicon CMOS-based power amplifiers (CMOS PA) and other RF semiconductor devices for GSM/GPRS-based cellular handsets. Skyworks says that Axiom is the world's only volume supplier of CMOS-based PAs for mobile phones.

Axiom says that its patented technology enables conventional CMOS to be used to realize Watt-level RF power amplifiers without the requirement for a module package, providing unique benefits in terms of reduced design complexity and bill of materials. Use of a standard high-volume CMOS process and a simple leadframe package also ensures security of supply. Axiom has been shipping high-volume production of its AX502 device to customers in Europe and Asia since the beginning of 2007. Last December, it expanded its product range with the AX508, which features improved performance and a smaller footprint.

"The acquisition of Axiom complements our existing GaAs capabilities, bolsters our fundamental intellectual property portfolio and augments our design expertise," says Skyworks' president & CEO David J. Aldrich. "Today Skyworks is the leading supplier of both GaAs and silicon front-end solutions for cellular and smart-phone applications. With the addition of Axiom's patent and product design portfolio, we can further our industry leadership position," he reckons.

"At the same time, this acquisition supports our existing product roadmaps in adjacent linear products markets, such as low-power smart grid networks and wireless meter reading, where we maintain a first-mover advantage," Aldrich adds. "At a higher level, this transaction is another important step towards realizing our vision of enabling mobile connectivity in handsets and across a set of highly diverse analog markets."

Terms of the acquisition were not disclosed, but will have no significant impact to operating expenses, Skyworks says. Accordingly, the firm expects the transaction to be earnings per share neutral in fiscal 2009 and accretive thereafter.

www.axiom-micro.com

Skyworks secures Samsung design wins for over 10 multimode handset platforms

Mobile phone maker Samsung is using Skyworks Solutions' EDGE front-end solutions to power a variety of new handsets including the S5230 mobile phone, which is one of several new full touch-screen offerings recently launched in European markets.

In addition, Skyworks is supporting the Samsung S3310, an ultra-thin quad-band GSM/EDGE candy bar mobile phone capable of global roaming.

Samsung is enhancing its position as a leading player in the hugely popular touch-screen mobile market, says Liam K. Griffin, Skyworks' senior VP of sales & marketing. "We look forward to further strengthening our partnership with Samsung as they add to their portfolio of innovative platforms that combine all essential multimedia functionality into a single device."

www.samsung.com



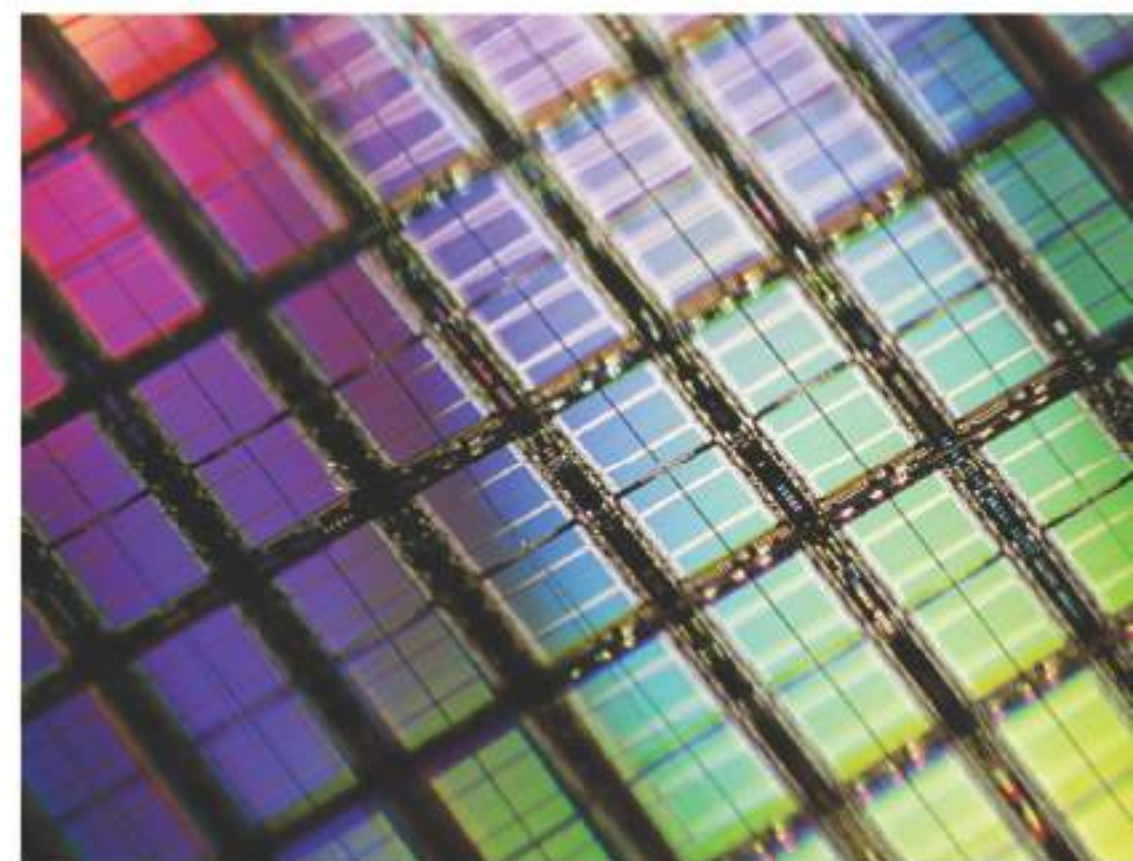
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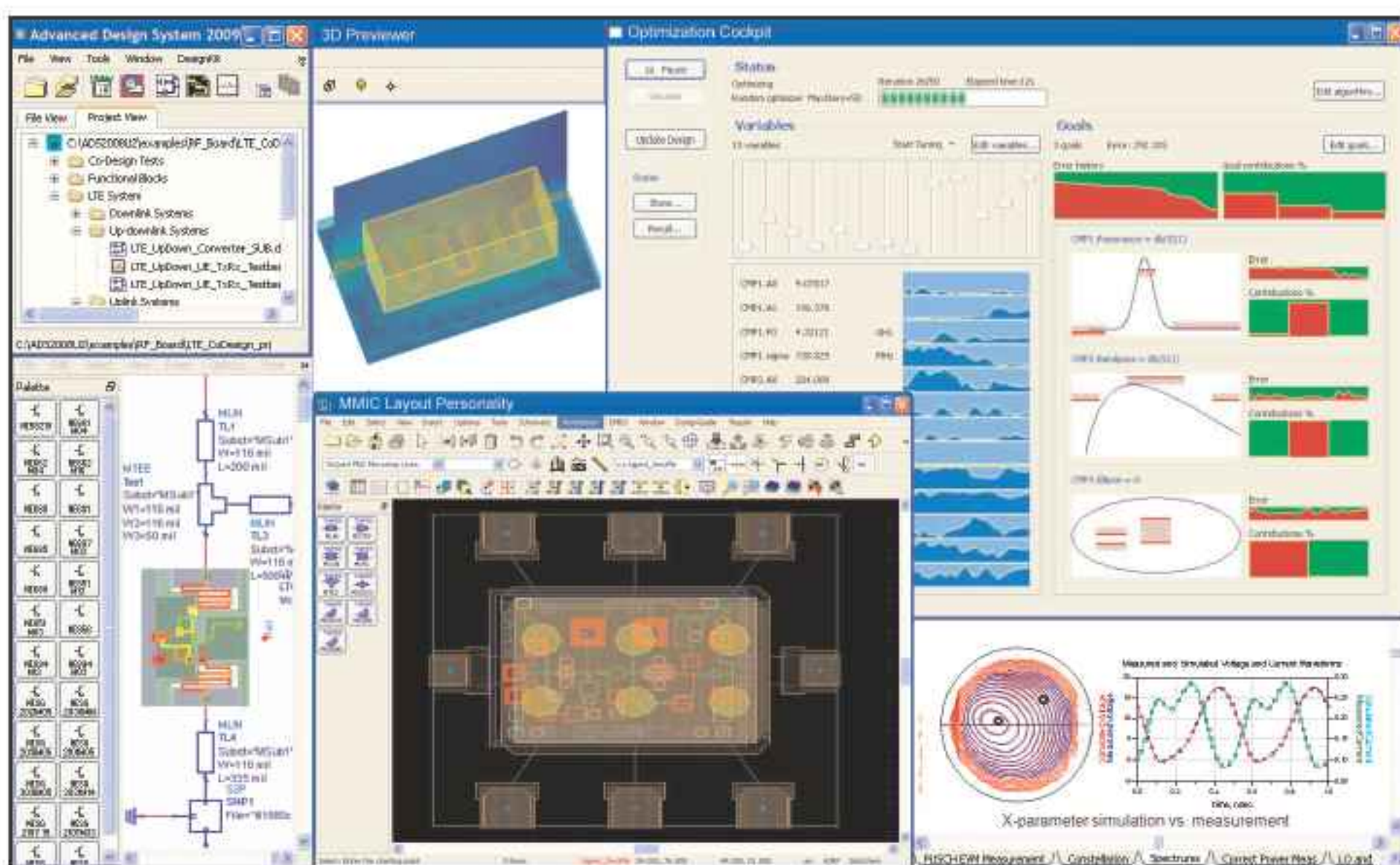
Front-to-back solution for MMIC and RF module design

Agilent Technologies Inc of Santa Clara, CA, USA has launched Advanced Design System (ADS) 2009 Update 1, which it claims to be the industry's first complete, front-to-back solution for monolithic microwave integrated circuit (MMIC) and RF module design. The release integrates 3D electromagnetic (EM) analysis, wireless standards-based design verification libraries, X-parameter simulation, and statistical design and yield optimization. ADS 2009 Update 1 enables designers to stay within the design and simulation platform of choice for their entire design cycle and eliminates the need for separate, time-consuming point tools.

"This release represents a big jump in efficiency for MMIC and RF module designers," claims How-Siang Yap, product marketing manager with Agilent's EEs of EDA division. "Designers clearly prefer a single design flow, without the stops and starts associated with point tools. ADS 2009 Update 1 provides a single, superior flow where our customers can do more analysis while spending less money on design tools."

Features include.

- integrated planar and 3D EM simulation and analysis that allows designers to account for EM effects from packages and interconnects without any import or export of data or models (saving time and making the overall design process more efficient and accurate);
- an X-parameter simulation model generator that delivers fast, drop-in usable and accurate nonlinear behavioral models (eliminating the need for datasheets of specification-based characterization parameters and the laborious measurements typically required for accurate designs); and
- easy-to-use statistical and yield Optimization Cockpit that allows designers to interactively modify settings in real time during the optimization (resulting in better, faster designs).



ADS 2009 Update 1 creates nonlinear behavioral models with the new X-parameter Model Generator.

ADS 2009 Update 1 also includes other enhancements for MMIC design, including:

- an MMIC layout personality, allowing one-click access to commonly used MMIC layout functions for ease-of-use and increased engineering productivity;
- access to ADS layout functions from foundry-endorsed process design kit (PDK) components for faster, error-free MMIC/system-in-package (SIP) layout and design synchronization with the schematic; and
- Mentor Calibre Layout-Vs-Schematic (LVS) integration in the MMIC/SIP design flow, ensuring error-free layout connectivity before hardware fabrication.

In addition, Agilent has recently established a new R&D team specifically focused on enhancing PDKs to take advantage of the MMIC/SIP front-to-back design flow in ADS2009 Update Release 1.

"Our partnership with key MMIC foundries and their customers ensures that all criteria required for full PDK endorsement within ADS is met," says Steve Chen, Advanced Design System R&D manager with Agilent's EEs of EDA division.

"The partnerships allow the ADS EDA platform to completely support the MMIC front-to-back flow signoff

with Mentor's Calibre or Cadence's Assura verification tools, which are required by many foundries and customers," he adds.

ADS 2009 Update 1 also integrates with Cadence and Mentor backend verification tools, enabling the import of Design Rule Check results from Cadence Assura, Mentor Calibre or Triquint MailDRC for viewing and correcting within the ADS layout environment.

Agilent's Advanced Design System (ADS) is an electronic design automation software system that offers complete design integration for products such as cellular phones, wireless networking and GPS, radar and satellite communications systems, and high-speed digital serial links. ADS supports system and RF design engineers developing all types of RF designs, from simple to the most complex, from RF/microwave modules to integrated MMICs for communications and aerospace/defense applications.

ADS 2009 Update 1 will be available in September, with prices starting at about \$21,000. It is also available in time-based bundles, starting at about \$8000 per year.

www.agilent.com/find/eesof-ads2009-update1

Agilent offers PDKs for Jazz's 0.18µm SiGe BiCMOS

Agilent Technologies has announced the availability of two process design kits (PDKs) for the 0.18µm SiGe BiCMOS process offerings of Jazz Semiconductor that can be used with Agilent's Advanced Design System 2009 EDA software. The PDKs accelerate time-to-market for the development of ICs used in automotive collision avoidance, high-data-rate networks, emerging HDTV wireless standards and other high-speed applications. Agilent and Jazz demonstrated the PDKs at the IEEE's International Microwave Symposium (IMS 2009) in Boston, MA, USA (7-12 June).

The Jazz SBC18HA and SBC18H2 PDKs are the result of collaboration between Jazz and Agilent to offer an accurate and productive work environment for the industry's latest silicon germanium monolithic microwave integrated circuit (SiGe MMIC) design solutions. The SBC18HA and SBC18H2 have

been widely accepted in many high-frequency applications, including 24GHz and 77GHz collision avoidance radar, 60GHz wireless local-area network (WLAN) HDTV, wireless base-station back-haul, and a host of optical applications, including transimpedance amplifiers (TIAs), laser drivers, SerDes (serializer/deserializer), and CDRs (clock and data recovery).

"Our collaboration with Jazz is in response to the strong market demand from our mutual customers for a fast and efficient RFIC design flow," says Avery Chung, foundry program manager of Agilent's EESof EDA division. "With these new SiGe PDKs in ADS 2009, customers will be able to design high-performance ICs operating up to 60GHz and higher. They can use the breadth of capability ADS provides, including design for manufacturing toolsets and Momentum, the industry-leading 3D planar EM simulator".

"These PDKs offer design teams a smooth transition from GaAs-based high-frequency product design to silicon-based product design by using the same Agilent ADS design environment now available with Jazz's high-performance SiGe technology," says Jazz senior VP & general manager Marco Racanelli. "Jazz partnered with Agilent to speed time-to-market for our customers who are targeting applications up to and beyond 60 to 77GHz in our SiGe technology," he adds.

Both PDKs are certified by Jazz and Agilent to take advantage of ADS 2009, which contains new features that support IC, package and RF board co-design. Agilent says that the software helps to cut hardware integration turns by revealing unexpected component interactions upfront that cause integration failures downstream. The new PDKs should ship in late June.

www.agilent.com/find/eesof

'Radar on Chip for Cars' project formed by German car makers and suppliers to promote safety technology

BMW Forschung und Technik GmbH, Continental AG, Daimler AG, Infineon Technologies AG and Robert Bosch GmbH have formed the 'Radar on Chip for Cars' (RoCC) project, involving joint research that aims to increase driving safety by making highly reliable radar systems available in all vehicle classes.

The three-year project has a budget of more than €17m, supported by a financial grant of €8.3m from the German Federal Ministry of Education and Research (BMBF) as part of the ITK2020 support program focusing on 'Innovation Alliance in Automotive Electronics'. The government's high-tech strategy promotes efforts made to reduce the number of traffic accidents, in this case by helping to introduce innovative safety solutions into the compact and small-vehicle classes as quickly as possible.

The five firms (coordinated by Infineon) aim to co-develop highly integrated, cost-optimized automotive radar sensor systems operating at 76-81GHz for both long range (up to 250m) and short range (5cm-20m). Additional participants from academia include German universities in Bochum, Bremen, Erlangen-Nuremberg, Stuttgart and Ulm, the Technical University in Munich, and the University of Applied Sciences in Ulm.

A previous BMBF-supported project, KOKON (vehicle high-frequency electronics) laid the foundations for automotive radar sensor technology and provides a technological lead of at least two years for Germany, it is claimed. Results led to the market introduction by Infineon of the first silicon germanium (SiGe)-based radar chip family for 77GHz (RASIC) and its use by Bosch in the first

silicon-based electronics solution for an automotive 77GHz radar system (LRR3). Using Infineon's SiGe ICs, Continental also developed the first demonstrator of a short-range radar system at 79GHz.

Existing short-range automotive radar sensors use ultra-wideband technology at 24GHz. However, this frequency is licensed in Europe only until 2013. So, RoCC aims to convert the system to the 79GHz range already released by the EU, and deliver systems that use such higher-frequency sensors at a cost not exceeding that of 24GHz systems.

Infineon says this presents a significant challenge to semiconductor technology, sensor design and in-vehicle integration that can only be tackled by a joint research project involving key firms in the automotive industry and their suppliers.

www.infineon.com

Teledyne wins \$18.8m DARPA contract for THz electronics

Teledyne Technologies Inc of Thousand Oaks, CA, USA says that its subsidiary Teledyne Scientific & Imaging LLC (TS&I) has been awarded a contract from the Microsystems Technology Office of the US Defense Advanced Research Project Agency (DARPA) to develop terahertz electronics devices and integrated circuits.

Under DARPA's Terahertz Electronics (THz) program, TS&I will pursue advances in transistor technology, circuit design and circuit packaging to demonstrate receiver and transmitter blocks operating at frequencies greater than 1THz.

The initial Phase 1 contract is valued at \$8.3m over a 24 month period. If all contract phases proceed, the total contract value would be \$18.8m for work performed through 2014.

Circuits will be designed and fabricated using TS&I's indium phosphide (InP) heterojunction bipolar transistor (HBT) technology. Transistor bandwidths will be extended to THz frequencies by scaling transistor dimensions to less than 100nm and implementing innovative fabrication processes, says Teledyne. A silicon micro-machining process will also be developed for forming batch-manufactured waveguide blocks for circuit integration.

For the purposes of the program, TS&I says that it has put together a team consisting of the leading research groups from NASA's Jet Propulsion Laboratory, University of California at Santa Barbara, University of California at San Diego and Raytheon Integrated Defense Systems. The suite of technologies developed under the program should benefit a large class of radio frequency (RF) and mixed-signal circuits for Department of Defense applications, it concludes.

www.teledyne.com

Raytheon wins \$54m contract to retrofit Navy aircraft with AESA radar

Defense contractor Raytheon Company of Waltham, MA, USA has been awarded a \$54m US Navy contract by the Naval Air Systems Command of Patuxent River, MD to retrofit APG-79 active electronically scanned array (AESA) radars into lots 26-29 of the F/A-18E/F Super Hornet block II aircraft. The APG-79 radars use transmit/receive (TR) modules incorporating GaAs MMICs made at Raytheon's foundry in Andover, MA.

The AESA units will replace the APG-73 radars currently installed in the aircraft, ensuring that pilots and aircrews are equipped with the most advanced technology available.

"Raytheon's reliable, high-performance radar systems provide

an affordable means for fleets to optimize fighter capabilities," says Tom Kennedy, VP for Tactical Airborne Systems. "The added reliability and maintainability of the APG-79 result in lower life-cycle costs and enhanced capabilities for the Navy."

Raytheon has delivered 134 AESA radars to the US Navy for the Super Hornet and EA-18G Growler aircraft. With this latest contract, orders for the retrofit of the 133 block II F/A-18s now total 38.

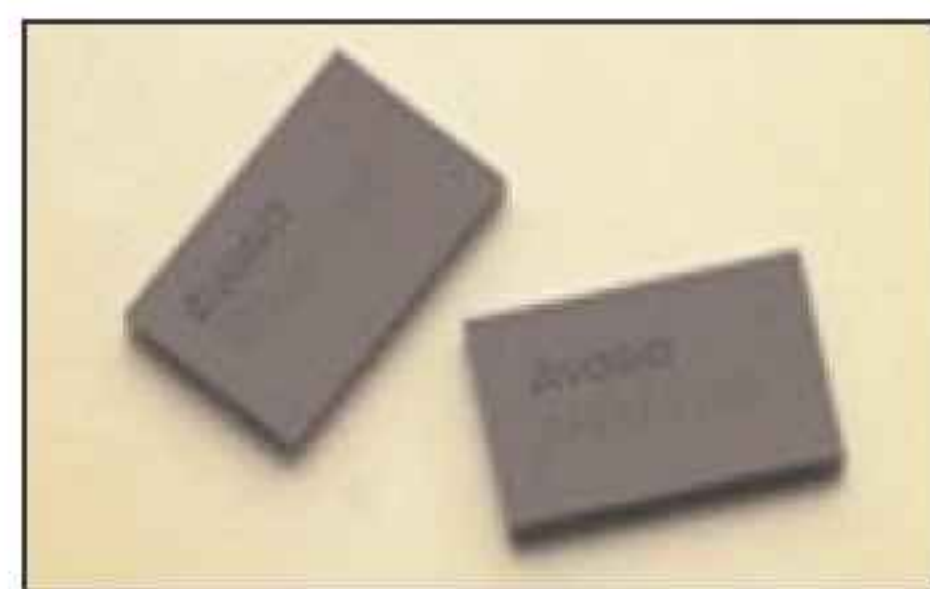
Work on the retrofit program will be performed in Forest, MS; Dallas, TX; El Segundo, CA; and Andover, MA, and should be completed in December 2010.

www.raytheon.com

Avago launches CDMA cell-band and PCS FEMs for mobile handsets

Avago Technologies of San Jose, CA, USA has introduced two new front-end modules (FEMs) that incorporate a power amplifier (PA), duplexer, band-pass filter and coupler in a 4mm x 7mm x 1.1mm SMT package to improve efficiency and extend talk time in mobile handsets.

The AFEM-775x series includes Avago's CoolPAM and film bulk acoustic resonator (FBAR) technologies, which improve performance in CDMA cell-band and dual-band handsets, wireless PDAs and wireless data cards, says the firm. The fully matched FEMs (which are CDMA 2000 1xRTT capable) are designed to minimize power consumption with three power modes: high power (>15dBm), mid power (>8dBm), and bypass (with very low quiescent current). Also, the CoolPAM-V technology incorporated in the modules does not require a DC-DC converter, helping to save cost and space in handset designs. The PA is based on InGaP HBT technology.



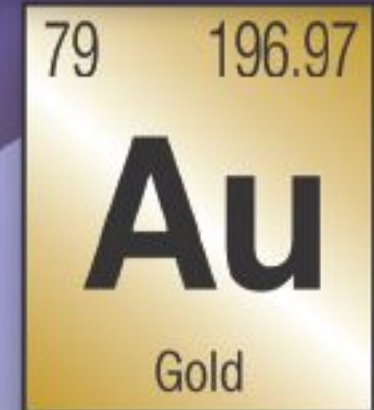
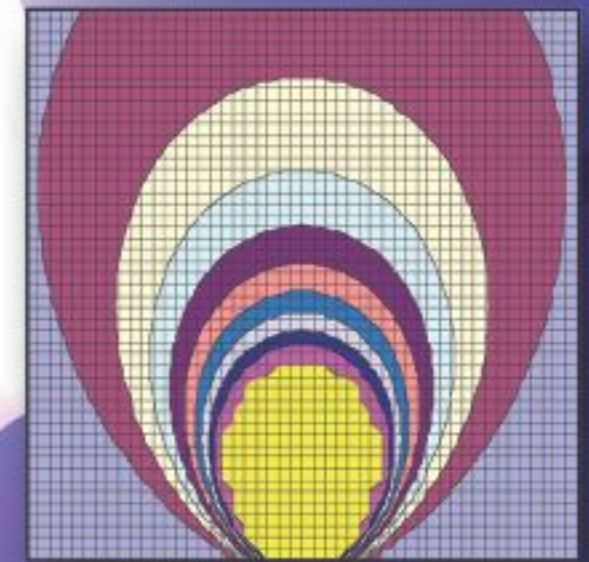
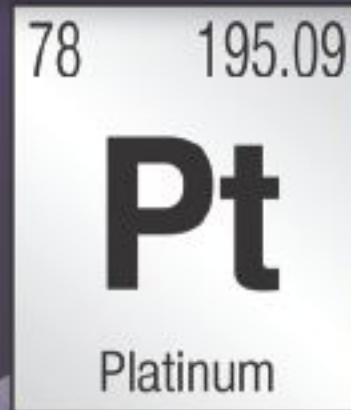
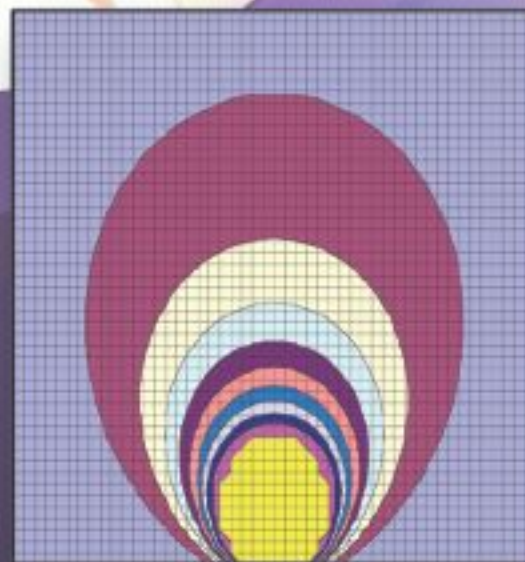
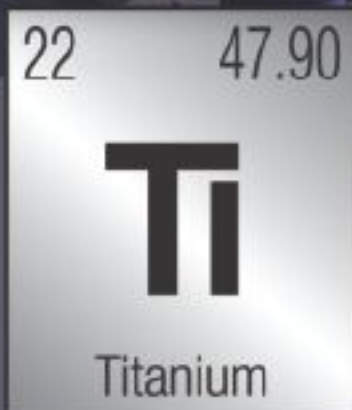
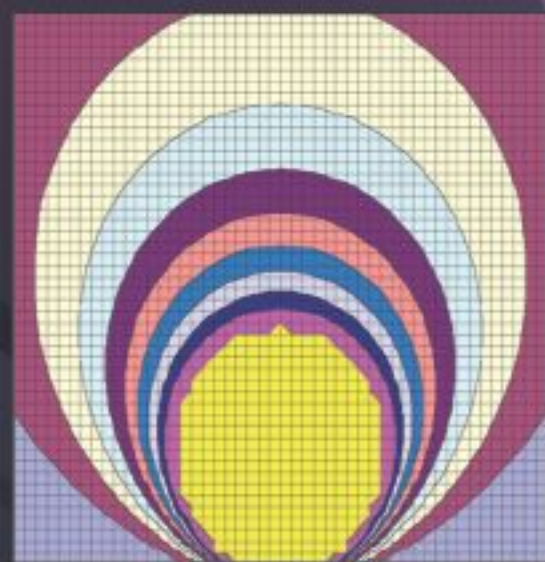
Avago's AFEM-775x series FEMs.

The operating frequencies are: Tx=824-894MHz, Rx=869-894MHz (AFEM-7750); Tx=1850-1910MHz, Rx=1930-1990MHz (AFEM-7758).

The AFEM-7758 is an FBAR-based duplexer that provides low insertion and what is claimed to be outstanding isolation to minimize Tx leakage in both Rx and Tx bands over a wide temperature range. It also improves handset receiver sensitivity and single tone desensitization performance. Furthermore, optimized matching between the PA and duplexer eliminates the need for a bulky and costly isolator.

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ARL contracts TriQuint to lead \$16.5m Phase III of WBGS DARPA program

RF device maker and foundry services provider TriQuint Semiconductor Inc of Hillsboro, OR, USA has been contracted by the US Army Research Laboratory (ARL) in Adelphi, MD to lead the two-year \$16.5m Phase III of the R&D program Wide Bandgap Semiconductors for RF Applications (WBGS-RF). Funded by the US Defense Advanced Research Projects Agency (DARPA), the WBGS-RF program is designed to develop new high-power, high-efficiency wideband amplifiers based on gallium nitride (GaN) for defense applications.

TriQuint has undertaken GaN R&D for both defense and civilian applications since 1999. In addition to its military design and manufacturing work, TriQuint has released GaN amplifiers for wireless communications networks and other applications, along with offering commercial GaN foundry services since last year.

The Phase III contract was awarded on the basis of TriQuint surpassing goals including improved power density, efficiency and ruggedness for GaN high-

electron-mobility transistor (HEMT) devices as part of its focus on the wideband element of the WBGS-RF program's \$15.8m Phase II, which began in 2005. The other two elements focused on X-band frequencies (Raytheon/Cree) and Q-band frequencies (Northrop Grumman). Already, in late March, Raytheon was awarded a \$23.9m, 38-month Phase III contract from DARPA and the US Missile Defense Agency (MDA) to continue work on the WBGS program, with the aim of demonstrating the capabilities of GaN to improve the performance of missile defense radars.

"In Phase II, we developed a high-performance, reliable gallium nitride process with excellent reproducibility and high yield," says Cathy Lee, TriQuint's Phase III program manager. "Since the program began we have achieved key milestones including 48V operation and superb high-frequency performance."

Phase III now seeks to extend device reliability for 48V operation while increasing operational lifetime

and extending performance to cover the high end of contracted frequency ranges.

Key Phase III program tasks include material optimization as well as device and monolithic microwave integrated circuit (MMIC) development. TriQuint says that the contract emphasizes reliability, yield, uniformity and reproducibility. The program also includes a MMIC validation process.

TriQuint is the prime Phase III contractor and is teamed with defense contractors Lockheed-Martin and BAE Systems, as well as IQE-RF in Somerset, NJ (a subsidiary of epi-wafer foundry IQE plc of Cardiff, UK). II-VI Inc remains the program's primary supplier of high-quality silicon carbide (SiC) substrates. University partners Dr Michael Shur of Rensselaer Polytechnic Institute (RPI) in Troy, NY and Dr Jesus del Alamo of the Massachusetts Institute of Technology (MIT) continue their roles in device physics, reliability and modeling.

www.darpa.mil/MTO/programs/wbgsrf

Cree strikes GaN HEMT supply deal with Korea's RFHIC

Cree Inc of Durham, NC, USA has signed an agreement to supply gallium nitride on silicon carbide (GaN-on-SiC) high-electron-mobility transistors (HEMTs) to RFHIC Corp of Suwon, Korea for its GaN HEMT amplifier product families.

In addition, Cree and RFHIC have entered into a market development agreement to facilitate deeper market penetration of GaN HEMT solutions by leveraging Cree's expertise in GaN transistor production on SiC substrates and its monolithic microwave integrated circuit (MMIC) foundry capability with what is claimed to be RFHIC's leading position in innovative packaging, amplifier integration and volume assembly capabilities.

"This important relationship is designed to allow both Cree and RFHIC to expand their market presence and accelerate the insertion of GaN HEMT technology into a number of key, volume applications," says Dr Cengiz Balkas, VP & general manager of Cree's Power and RF business unit.

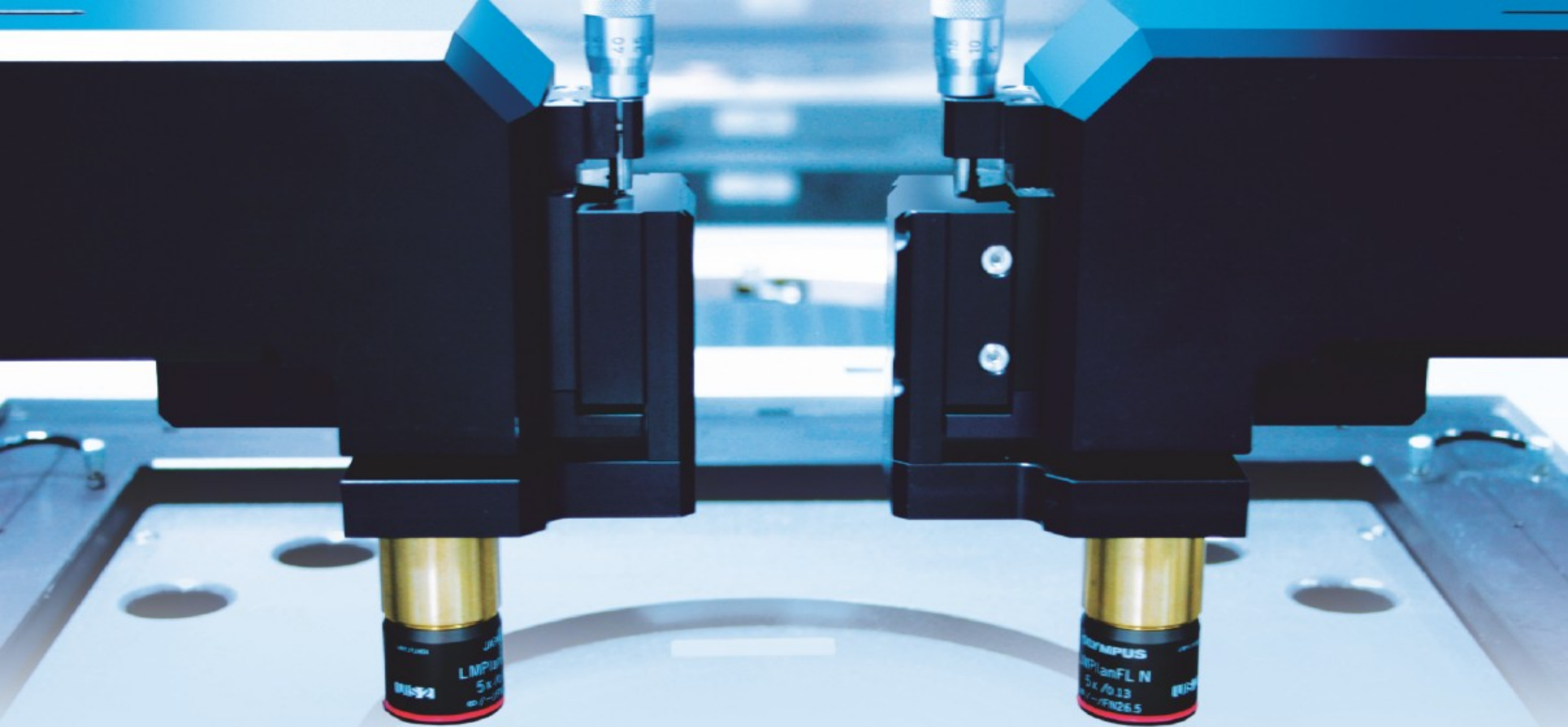
"The combination of Cree's and RFHIC's core strengths can accelerate GaN HEMT market penetration in cellular infrastructure, two-way communication, CATV amplifier, and a variety of other emerging market segments," says Jim Milligan, Cree's director of RF and microwave products. "It provides a wide range of options in hardware integration

levels to best address customer needs," he adds.

"Cree's GaN-on-SiC HEMT process is the most mature GaN HEMT process in the market," comments RFHIC's chief technology officer Dr Samuel Cho. "We initially pursued a GaN-on-Si HEMT approach but converted our product line and future direction to Cree's GaN-on-SiC HEMT technology, based on its superior thermal and electrical characteristics as well as its outstanding robustness and reliability," he adds. "RFHIC aims to offer cost-effective, GaN HEMT amplifier solutions to the market."

www.rfhic.com

www.cree.com



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AmberWave adds EVG tools for engineering LED substrates

Wafer bonding and lithography equipment maker EV Group (EVG) of St. Florian, Austria says that an EVG520IS wafer bonding system and an EVG810LT low-temperature plasma activation system have been installed at AmberWave Systems in Salem, NH, USA, which will use them to manufacture engineered substrate products, with the aim of increasing the efficiency of high-brightness LEDs (HB-LEDs) while reducing overall cost.

AmberWave is a strategic new customer, solidifying EVG's presence in the burgeoning LED market. "AmberWave's technology is focused on some key growth segments,"

says Steven Dwyer, VP & general manager, EV Group North America. "Emerging markets such as GaN-based LEDs require new unique solutions to bring down rising manufacturing costs," he adds.

"This is a great opportunity for EV Group to further expand our presence in the LED market and access new growth opportunities."

EVG says that AmberWave replaced competitive tools with the new systems, including a custom-designed solution comprising a custom-engineered bond head that provides high-temperature (650°C) and high-force (60kN) bonding capabilities.

Other decision criteria for the order included EVG's willingness to explore novel tool configurations to meet the unique challenges associated with the target class of materials.

Specifically, the systems will be instrumental to AmberWave's layer transfer of GaN materials onto poly AlN, allowing it to make more cost-effective LED-, blue laser- and GaN-based power amplifier products.

"These systems will allow us to quickly ramp up our manufacturing capacity and make our products more cost effective," says AmberWave's VP business development, Wade Sheen.

www.amberwave.com

Scottish opto foundry CSTG secures \$6m refinance deal

Compound Semiconductor Technologies Global Ltd (CSTG) of Glasgow, UK, which was formed in 1998 by the universities of Strathclyde and Glasgow together with Scottish Enterprise and claims to be the only 'pure play' foundry supplier of III-V optoelectronics wafers and chips, has agreed a \$6m finance deal consisting of \$3.4m of new investment and restructuring long-term debt.

The funds were secured through private equity fund European Digital Partners (EDP), Scottish Enterprise's co-investment fund, and the Scottish Government's Regional Selective

Assistance (RSA) scheme.

The funding will allow the firm to expand its capabilities through the purchase of new equipment and technology, and go towards further development of the firm's device process platforms for the defense, medical, industrial and communications markets. CSTG will also develop its quality of service to its OEM and fabless client base worldwide.

"Building on a solid performance over a number of years, we've had an incredibly successful few quarters of trading and this additional funding will enable us to expand our capa-

bilities and enhance our service offering," says CEO Neil Martin. "In addition it will allow our R&D team to develop platforms for our developing markets, including faster compound semiconductor laser products for broadband access devices," he adds.

"The ability to buy new equipment will allow us to provide more complex devices with enhanced quality and services, enabling us to widen our market access," says Martin. "This investment will allow us to strengthen our position of being a volume supplier of complex quality products."

www.compoundsemi.co.uk

UK funds IQE and CSTG for next-gen broadband access laser R&D

The UK government's Technology Strategy Board (TSB) has awarded £1m to epiwafer foundry IQE plc of Cardiff, UK and chip foundry partner CSTG to fund initial research including three feasibility studies in a parallel approach to look at co-developing low-cost AlInGaAs-based diode lasers for uncooled, extended-reach fiber-to-the-home (FTTH) applications, targeting broadband Internet access technology at up to 10Gb/s.

"We are looking to solve the para-

dox of producing diode sources with telecoms-grade quality with consumer-grade pricing for this last link of access to the home," says project lead Dr Wyn Meredith of IQE. "We are already seeing unprecedented growth in InP-based epitaxial products driven by FTTH deployment in Asia, and we are preparing to address next-generation network expansion with high-value-add foundry products," he adds.

"We are enabling a new breed of component vendors who have been

quick to adopt the foundry model, and are proving far more agile and resilient than their vertically integrated competitors in the current market conditions... Involvement in this programme will result in rapid introduction of standardized foundry epitaxial- and fabrication-level laser diode solutions which will have proven performance in terms of transmission speed and optical power output, compatible with larger (4") wafer formats."

www.iqep.com

Nyrstar buys SRA's mid-Tennessee mine complex

European-based Nyrstar NV, a supplier of zinc, lead and other valuable metals, has acquired the Mid-Tennessee Zinc Corp (MTZ) mine complex for nearly \$10m from mining company Strategic Resource Acquisition Corp (SRA) of Toronto, Canada, which had been planning to recover germanium and gallium from the zinc residue.

MTZ acquired the complex in 2006. It includes facilities at three sites within about 10 miles of each other: Elmwood, Gordonsville and Cumberland. Ore is processed into zinc concentrate at Gordonsville, about 100 miles from a smelter and refinery owned by Nyrstar in Clarksville, TN.

Over 18 months, SRA invested \$150m to revive the former zinc and germanium complex, which had been operated continuously from 1975 to 2003. Production restarted in April 2008. Once in full production, it was expected to be the largest zinc producer in the USA. A resource statement in October indicated ore

reserves of about 30 million tons containing 1 million tons of zinc at an average ore grade of 3% zinc.

Last July, SRA also said that a preliminary assessment had affirmed the economic viability of a proposed plant at MTZ to recover germanium and gallium from the concentrate, and that it was proceeding with the permitting, laboratory testing of the recovery process, and planning a pilot plant (for completion by Q1/09).

However, cash costs per pound of payable zinc were subsequently well above prevailing commodity prices and, helped by the credit crunch, the project was declared uneconomic. In October, SRA began a temporary care and maintenance program to keep the mining assets in ready condition while it pursued funding and strategic alternatives to allow restart when prices improved.

However, after failing to file its audited financial statements for the fiscal year (to end September) by the end of 2008 and failing to make

interest payments on loans, in mid-January SRA and its MTZ subsidiary filed for Chapter 11 bankruptcy protection. SRA listed assets of \$1m and debt of \$100m; MTZ listed assets of \$50,000 and debt of \$50m.

Nyrstar aims to continue the care and maintenance program for the near future, but will review opportunities to recommence operations "as soon as commercially feasible".

Once operations are restarted, the MTZ complex should remain a key source of zinc for its smelter in Clarksville (originally built to treat concentrate from MTZ), providing close to 50% of its requirements.

"Acquisition of the mine complex provides us with an opportunity to capture a number of important synergies that should support a long-term sustainable future for Clarksville, in addition to capturing the value contained in the germanium- and gallium-rich concentrate," says Nyrstar's CEO Roland Junck.

www.nyrstar.com

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Veeco's revenues fall 43% after pause in bookings

For first-quarter 2009, Veeco Instruments Inc of Plainview, NY, USA reported revenue of \$62.8m, down 39% on \$102.3m a year ago and 43% on \$110.3m last quarter. "First quarter results were in line with guidance [of \$60-70m] in an extremely challenging market environment," says CEO John R. Peeler.

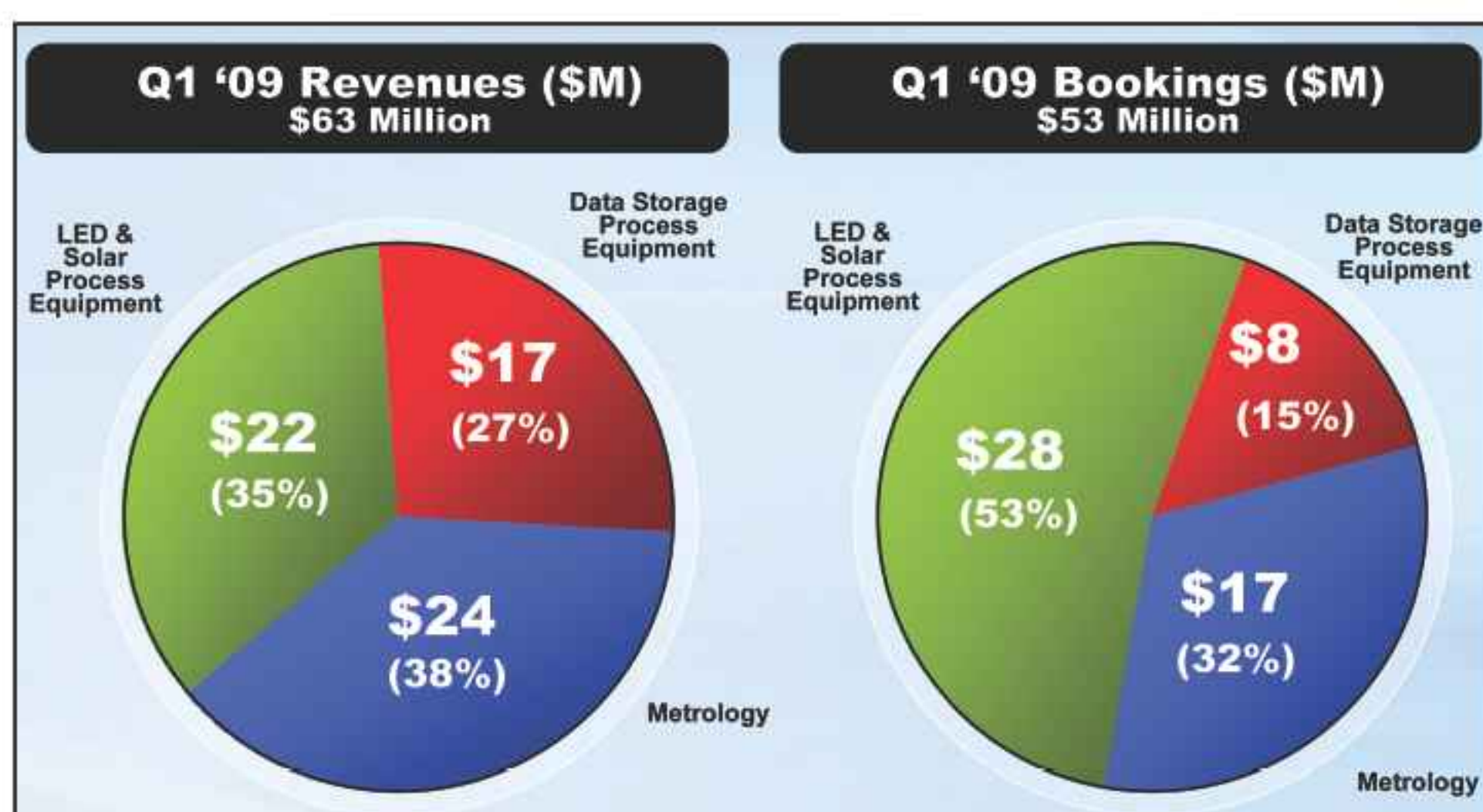
LED & Solar process equipment contributed 35% of revenue (\$22.2m, down 42% on \$38m last quarter and 47% on \$42.1m a year ago due to the high-brightness LED industry absorbing the significant number of MOCVD systems bought in the last two years).

Metrology contributed 38% (\$24m, down 15% on \$28m last quarter and 34% on \$36m a year ago).

Data Storage process equipment contributed 27% (\$16.9m, down 62% on \$45m last quarter and 30% on \$24.1m a year ago due to customers freezing their capital equipment spending).

"We have moved swiftly to restructure Veeco in light of the very challenging start to 2009, and saw the initial impact of these cost-reduction actions in the first quarter," says Peeler. "We are on-track with cost-reduction plans, including increased outsourcing, manufacturing consolidation, materials cost management and workforce reductions," says Peeler.

Previously, in Q4/2008, Veeco initiated a restructuring program that included cutting staffing by 24%, from 1318 at the end of September 2008 to under 1000 by the end of 2009 (reaching 1091, or 17%, at the end of Q1/2009). The cut is being achieved by simplifying Veeco's organizational structure, involving centralizing the firm's supply chain and operations, consolidating business units, increasing outsourced manufacturing (to lower expenses and improve the variable cost structure), and cutting the number of manufacturing sites from eight to four. In particular, Veeco aims to fully outsource MOCVD system manufacturing in Somerset, NJ by



Veeco's Q1/2009 revenues and bookings, showing shift to solar business.

Q4/09 (compared to outsourcing about 60% of the product line as of a year ago). It also aims to move the CIGS (copper indium gallium diselenide) web-coater plant in Lowell, MA (formerly Mill Lane Engineering, acquired last May) to outsourced manufacturing (while retaining a focus on prototypes).

These efforts have already yielded declines in manufacturing overhead, service and operating expenses of over 20% since Q3/2008. In particular, operating spending has been cut from \$38m in Q4/2008 to \$33m in Q1/2009.

Including \$4.4m in restructuring charges and a \$1.5m inventory write-off in the Data Storage segment (from discontinuing certain products), operating loss was \$18.9m, compared to \$77.1m last quarter (which included charges of \$80.1m, mainly an asset impairment associated with the Data Storage and AFM businesses) and operating income of \$0.2m a year ago.

Gross margin has fallen from 41.7% a year ago and 39.5% last quarter to just 34.9%. In particular, LED and solar process equipment gross margins have fallen from 41% a year ago and 35% last quarter to

just 29.2%, due mainly to the significant drop in sales volume, especially in MOCVD products.

Earnings before interest, taxes and amortization (EBITA) was a loss of \$9.7m, compared to EBITA of +\$6.2m last quarter and +\$6.9m a year ago. Veeco's cash balance has fallen from \$103.8m to a still healthy \$93m after a \$9.6m earn-out was paid for the Mill Lane acquisition.

Due to the extremely weak business conditions in all business segments (leading to \$1.8m of order cancellations), orders in Q1/2009 were \$53m (down 40% on \$88.5m last quarter and 51% on \$109.3m a year ago). Backlog hence shrank by \$11.9m to \$135.3m. LED & Solar contributed 53% of orders (\$28.5m, down 26% on \$38.7m a year ago and 35% on \$44m last quarter). One bright spot is that, despite the difficult economic circumstances, Veeco continues to build its solar business, booking a large, multi-system order from Korea's Daiyang Metals (which is building a 50MW CIGS PV power plant, ramping to 200MW in the next few years) plus orders for thermal sources from several European CIGS manufacturers. Data Storage orders contributed just 15% of orders (\$7.8m, down 44% on \$14m last quarter and 81% on \$40.6m a year ago to a record low level) as customers con-

tinue their capital spending freeze. Metrology contributed 32% (\$17m, down 45% from \$31m both sequentially and year-on-year, due to weakness in all end markets including semiconductor, data storage, scientific research and industry).

Beginning in second-quarter 2009, Veeco is therefore implementing further cost-cutting actions, consisting mainly of temporary salary reductions, reductions in bonuses and profit sharing, and plant shut-downs. This, combined with those already underway, should reduce manufacturing overhead, service and operating expenses by about \$40m in 2009, compared to last year. The goal is to achieve EBITDA breakeven on quarterly revenue of less than \$80m by Q3/2009, and to return to profitability by Q4.

"While we remain extremely cautious about business conditions, we see early signs of improvement," says Peeler. This includes improved equipment utilization rates (particularly for LED manufacturing), increased quoting activity across

three business segments (especially to a large number of potential CIGS customers), and no significant additional push-outs (of MOCVD orders for LED manufacturing), he adds. Second-quarter orders should improve from the trough levels of the first quarter, he believes.

For Q2/2009, Veeco expects revenue of \$60–70m and gross margin of 33–35%, excluding expected charges of \$2.7–3.2m related to restructuring activities. However, it expects operating spending to be steady at \$32–33m and operating loss to be cut to \$13–18.1m. This compares with Veeco's model of operating spend-

ing of \$34–35m on revenue of \$80m for a breakeven quarter.

"We remain confident that Veeco will emerge from the present downturn with leading-edge technology, a solid balance sheet and a leaner, more cost-effective organizational structure," says Peeler. "Despite the near-term pause in customer spending, we continue to invest heavily in R&D to remain aligned with technology roadmaps across our three businesses," he adds.

Veeco expects strong multi-year LED industry growth tied to further adoption for applications such as TVs and laptops, driving purchases of MOCVD tools. In Solar, Veeco is actively quoting its FastFlex systems for flexible CIGS thin-film PVs and has just introduced its new FastLine system for CIGS PVs on glass substrates. Veeco now believes that it is the only firm offering production-scale solutions for CIGS manufacturing on glass using thermal evaporation sources for the CIGS absorber layer.

www.veeco.com

Veeco expects strong multi-year LED industry growth tied to further adoption for applications such as TVs and laptops, driving purchases of MOCVD tools

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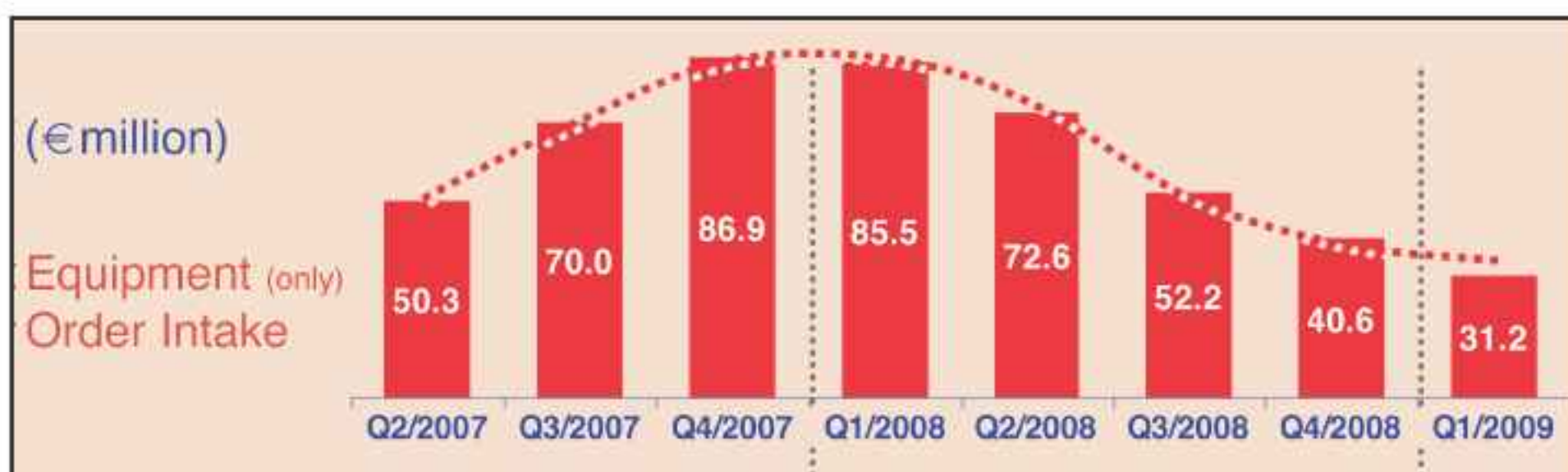
Aixtron sales fall 44%, but LEDs to drive pick up in orders

Affected by the global recession and the current difficult market environment, for first-quarter 2009 deposition equipment maker Aixtron AG of Herzogenrath, Germany has reported revenue down 26% on €62.6m a year ago and 44% on €82.3m last quarter to just €46.2m.

However, the year-on-year decline was largely due to silicon-related revenue falling 98% to just €0.2m. Despite the current market environment, compound semiconductor equipment was down only 12% year-on-year to €41.9m (91% of total revenue). Spare part & service (the other 9%) was also lower due to customers reducing inventories. Asia fell from 87% of revenue last quarter to 68%, due mainly to inventory reduction being particularly evident in Asia. In terms of applications, 68% of systems are now used to manufacture LEDs (e.g. for backlighting laptops, monitors, TVs and other devices).

Despite the drop in revenue, gross margin has risen from 39% a year ago and 43% last quarter to 45%. This is due mainly to a stronger US dollar rate, a more favorable revenue mix (with a higher percentage of final customer system acceptances in the quarter), and benefits from Aixtron's flexible operating-cost model (outsourcing about 90% of manufacturing while retaining most key final assembly & test work internally).

Operating income (EBIT) was €7.6m, an operating margin of 16% (up from 14% a year ago and 9% last quarter). However, this included €3.8m from two one-off events: €1.3m from the sale of the firm's former headquarters in Aachen, and €2.5m from a compensation payment for a cancelled MOCVD system order by a customer that decided to outsource LEDs manufacturing rather than making its own. Without these, EBIT would have been €3.8m, an operating margin of 8%. Net profit of €5.5m was down from €5.9m a year ago but up on €4.1m last quarter.



Equipment order intake over last 24 months, forecasting a low in Q1/2009.

Boosted by cash inflow of €6.7m from the sale of the headquarters, free cash flow of €10.4m was much improved on last quarter's -€2.9m (but still down on €12.9m a year ago). Cash and cash equivalents at the end of March remained a healthy €81.6m, down just 7% on a year ago and up 16% on last quarter.

After falling throughout 2008, equipment order intake is down 64% on €85.5m a year ago and 23% on last quarter's €40.6m to what is forecast to be a low of €31.2m. Of this, 98% was for compound semiconductor equipment (€30.6m, down 60% year-on-year). Silicon system order intake was just €0.6m, as the persistently negative memory market environment was again worsened by the global credit crisis and recession.

Order backlog at the end of March was €100.7m (including just 7% for silicon). This was down 36% on €157.3m a year ago but just 4% on last quarter's €105m. Aixtron expects about €96m of that backlog to be converted into revenues by the end of 2009 (including €89m of compound semiconductor systems).

"Whilst we are still looking for firm evidence of a sustainable recovery, we are now having some more positive dialogue with our customers that is leading us towards a sense of cautious optimism," says president & CEO Paul Hyland. "We seem to have reached the point in Q1 where inventory levels need to be replenished," he adds, citing some customer equipment utilization rates rising from 20% to 80% since mid-Q1.

Another plus is the increased interest from customers not necessarily buying systems due to short-

term demand but because investing in LED production is a timely strategic development. Aixtron believes that its flexible manufacturing model will allow it to ramp up production rapidly if strategic investors need systems quickly and as demand rises.

Aixtron hence believes that in 2009 it can deliver revenue of €200-220m and an EBIT margin of 10-11%.

Aixtron maintains that the medium- to long-term fundamentals for the LED industry remain strong, especially as new customers emerge. Despite the current weak demand for consumer electronics, laptop LED backlighting will almost certainly grow from 10% penetration last year to close to 100% in the next 3-4 years, while the adoption of LEDs in TVs has accelerated in recent quarters, it adds.

Also, LED streetlights and other energy-efficient and environmentally friendly lighting applications are starting to appear on the market, supported by national and regional government stimulus programs. "The medium- to long-term prospects for our business are better than at any time in the last six to seven years," believes Hyland. Correspondingly, Aixtron's increase in R&D spending reflects its focus on new product development programs. "The world economy will eventually recover and, when it does, it will almost certainly be technology-led... We intend to be prepared and able to take full advantage of the opportunities that will emerge once a real recovery takes hold," adds Hyland.

www.aixtron.com

CIOMP orders MOCVD systems for GaN LEDs and AlInGaP red lasers

Aixtron says it has received an order from China's CIOMP (Changchun Institute of Optics, Fine Mechanics & Physics, within the Chinese Academy of Sciences) for two MOCVD reactors: an AIX 200/4 and an AIX 200/4 RF-S (delivered in Q2/2009) for the development of ultra-high-brightness (UHB) GaN-based LEDs and AlInGaP-based red diode lasers.

"China has made a strategic commitment to advanced optoelectronic devices and UHB LEDs and red laser diodes in particular," says Song Hang, professor & executive director of Key Laboratory of Excited State Processes, Chinese Academy of Sciences. "We have formulated a plan to introduce two new advanced MOCVD tools to our new state of the art facilities via a contract with

Aixtron AG. They have demonstrated that their overall package of process know-how, technical excellence and support will ensure we have a quick and straightforward commissioning of the new tools in the coming months," he adds.

"Aixtron's AIX 200/4 will become our principal R&D system and I am confident that it will be the best match to our specific laser fabrication development requirements," says professor Wang Lijun, who will be responsible for the diode laser AlInGaP-based system. "It has attractive new features which, together with the implemented design innovations, will, I believe, optimize the uptime and yield for AlInGaP epitaxial layer deposition," he adds.

www.ciomp.ac.cn

LED maker HuaLei places Aixtron's largest MOCVD order from China

Aixtron says that HuaLei Optoelectronic Ltd of Hunan Province, China has issued a purchase contract for multiple CRIUS MOCVD systems for the production of high-brightness LEDs (for shipment in Q2-Q4/09), representing its largest ever single order for MOCVD systems from China. Part of this has been recorded as order intake in Q1/2009.

HuaLei Optoelectronic was founded in late June 2008. Major shareholders are Hunan Province Zixing coke electric joint stock limited partnership, Hunan ZiXing Mining Group LLC, and Taiwan Junchen Technology Co Ltd.

"Our investor and parent company is very keen to shift away from reliance on heavy industry and move into high-tech," says HuaLei Optoelectronic's president Daqing He. "We have therefore conducted in-depth investigations on the worldwide LED market; entering [the] high-brightness LED business is

our strategic target, for which we have decided to work closely with Aixtron, as the strongest partner, to enable HuaLei to achieve our goals quickly and efficiently," he adds.

"We will exploit the technical expertise of international partners targeting a fast entry into the LED market in order to be ready for the market upturn," says Dr Bastian Marheineke, Aixtron's VP sales.

"HuaLei's investment is very timely and representative for a China on the rise," he adds. "Our company has had a strong presence in China for many years; Aixtron was the first company to install a commercial MOCVD reactor there, and since then we have enjoyed excellent relations with the leading institutes and companies," Marheineke claims. The new order reflects the enthusiasm in China for investing in new technology opportunities, he concludes.

www.ledcz.com/en

IN BRIEF

Aixtron and SemiLEDs fabricate blue LEDs on 6" sapphire

A collaboration between Aixtron AG of Herzogenrath, Germany and SemiLEDs of Boise, ID, USA has resulted in the fabrication of GaN-based blue LED chips on 6" sapphire wafers for what is claimed to be the first time. The process is sufficiently close to production compatibility that SemiLEDs should soon be able to use the larger wafer size.

The 6" sapphire wafer process is based on MOCVD and a series of follow-on device fabrication steps through to final test. Specifically, the LED structure was deposited on a 1000µm-thick 6" sapphire substrate using an AIX 2800G4 HT MOCVD reactor in 6x6" configuration.

"Brightness and efficiency are encouraging, even though we are only a small step away from our existing and mature 4" sapphire process," says SemiLEDs' president & COO Dr Chuong Tran. "Judging from the uniformity of the 18,000 1mm x1mm vertical LED on metal alloy chips from one single wafer, we can clearly see the yield advantage of this larger-wafer MOCVD process," he adds. "One of the contributing factors to yield enhancement is the significantly reduced edge area compared to the area equivalent of nine 2" wafers."

Aixtron Greater China general manager Dr Christian Geng adds: "I expect that once, the price of a 6" substrate becomes competitive, many of our customers will convert their AIX 2800G4 HT systems from 42x2" to 6x6" configuration, since it merely requires the exchange of the so-called satellite disks."

www.semileds.com

www.aixtron.com

Aviza agrees asset sale and files for Chapter 11 after bank calls in debt

According to a filing with the Securities and Exchange Commission (SEC), on 20 May United Commercial Bank sent etch and deposition equipment maker Aviza Technology Inc of Scotts Valley, CA, USA a demand to pay an outstanding debt of \$29.5m. Aviza was in default of an April 2007 loan and security agreement that had already been amended twice last September/October. Subsequently, on 9 June, Aviza and its subsidiaries Aviza Inc and Trikon Technologies Inc filed a voluntary petition under Chapter 11 of the US Bankruptcy Code in order to better manage its operations through a restructuring process.

Previously, in late April, Aviza said that, after the resignation from its board of directors of Richard Neely Jr (designated as its 'audit committee financial expert'), it was not in compliance with Nasdaq's audit committee composition requirements, since only two members of its audit committee remained.

Then, on 11 May, the firm missed the SEC financial report filing deadline for its fiscal second-quarter (ended 27 March). On 14 May Nasdaq gave it 60 days to submit a plan to regain compliance with the obligation to file periodic reports. If Nasdaq accepted the plan, Aviza would be granted an extension of up to 180 days from the filing's due date (until 9 November). Otherwise, it would be threatened with delisting.

Aviza has been hard hit by the recession's effect on the DRAM memory chip market. Already, to decrease its overall dependence on the DRAM market, it had been downsizing its programs, products and spending related to trench capacitor technology for DRAMs, involving ceasing development of large batch thermal systems. Meanwhile, in April last year, Aviza announced a restructuring of its product strategy, served markets and internal opera-

tions to refocus on growth market segments with its single-wafer products, including its core strengths in atomic layer deposition (ALD) technology for the sub-45nm nodes, and PVD and etch technologies for the 3D-IC, MEMS and III-Vs markets.

Nevertheless, at the end of this April, Aviza lowered its fiscal Q2 revenue guidance from \$13-18m to \$9.5-11m (less than half of last quarter's revenue of \$25.2m and a third of \$30.2m a year ago). It also raised its forecast for adjusted net loss from \$1-5m to \$5-6m (excluding restructuring charges of \$9-10m), compared to last quarter's adjusted net income of \$4.9m.

When Aviza gave its initial guidance in early February, it said that fiscal Q2 would be challenging, as the firm continued to face an unpredictable environment for orders and weakness in customer demand. It added that it would continue to institute shut-down days at varying times and locations. US staff were required to take off one Friday every two weeks (amounting to a pay cut of about 10%) while similar cuts took place internationally. Board members and senior management also accepted a 20% cut in fees and salaries. Previously, Aviza cut 18% of its staff and contractors last year and about 90-110 more in the December quarter. Of 380-400 staff, about 100 are based in Scotts Valley, with the rest at its manufacturing plant in Wales, UK and support facilities in the UK, Germany, France, Taiwan, China, Japan, Korea, Singapore and Malaysia. Aviza has been trying to sell its headquarters in Scotts Valley for some time.

In early January this year, Aviza said that, to preserve financial resources, it had engaged Needham & Company LLC to help in pursuing financial and strategic options (including either merging with

another company, selling its assets, or liquidating or dissolving the firm through bankruptcy proceedings).

Prior to the Chapter 11 filing, Aviza executed a non-binding letter of intent to sell certain of its assets and businesses to Japan's Sumitomo Precision Products Co Ltd (SPP), which is the parent company of plasma etch and deposition equipment supplier Surface Technology Systems plc (STS) of Newport, Wales, UK. Through the bankruptcy proceedings, the firm intends to pursue its proposed strategic transaction with SPP and effect other significant asset sales. During this process, it expects to continue essential operations, including product support, service and warranty programs. As well as the headquarters in Scotts Valley, Aviza has manufacturing, R&D, sales and customer support facilities in the UK (also in Newport, Wales), Germany, France, Taiwan, China, Japan, Korea, Singapore and Malaysia.

"We have been working hard to find a buyer that would best leverage our products and provide ongoing support to our customers," says president & CEO Jerry Cutini. "Through this voluntary bankruptcy process, we can continue to operate our business and pursue an orderly transition to SPP with minimal impact on our customers and employees," he adds.

Most recently, as a result of the Chapter 11 filing, on 10 June Nasdaq notified Aviza that it will suspend trading of its common stock at the opening of business on 19 June and file a Form 25-NSE with the US Securities and Exchange Commission removing it from listing and registration on the Nasdaq Stock Market. Aviza says that it does not intend to request a hearing before the Nasdaq Listing Qualifications Panel to appeal delisting.

www.aviza.com

Tegal France founded as Tegal's European hub and DRIE product development center

Tegal Corp of Petaluma, CA, USA, which makes plasma etch and deposition equipment for fabricating MEMS, power ICs and opto-electronic devices, has established the subsidiary Tegal France, with offices in the Haute Savoie capital of Annecy.

The move completes the transition associated with last September's acquisition of the deep reactive ion etching (DRIE) products and related intellectual property for 3D packaging and MEMS devices from France-based Alcatel Micro Machining Systems (AMMS) and Alcatel Lucent.

With staff composed of engineers from the former AMMS operation and led by general manager/R&D director Nicolas Launay (former R&D director at AMMS in Annecy), Tegal France constitutes Tegal's European hub and the center of its advanced DRIE product development

initiatives. Launay reports to Tegal's CEO Thomas Mika.

The AMMS acquisition boosts Tegal's technology portfolio and provides new opportunities in the MEMS and power device markets, where Tegal is well entrenched. It also provides access to large and fast-growing

new markets such as through-silicon vias (TSVs) for 3D IC packaging. Joint development programs (JDPs) and consortium programs in which AMMS was actively involved continue under Tegal's ownership.

"It makes excellent business sense to focus our development activities in this European location," says Mika. "Through the former

JDPs and consortium programs continue under Tegal's ownership

AMMS team, we already enjoy an entrenched position with close proximity to key customers and access to technology talent from premier universities," he adds. "We are very pleased to formalize the new R&D infrastructure, where we will continue to innovate advanced DRIE solutions."

The new R&D infrastructure provides the resources to broaden the application reach of the DRIE technology and expand its served markets, says Launay.

"With our many combined years of etch technology development and process expertise within both the Tegal and the AMMS product families, we believe we can offer powerful new solutions to leading semiconductor manufacturers, especially those working on new-generation 3D packaging applications," he adds.

www.Tegal.com

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IN BRIEF

Korean RPCVD license for BLK

BluGlass has outlined the material, terms and conditions of an exclusive sales & marketing license agreement (for an initial period of two years) with Korean LED firm BLK Co Ltd, which was formed last year by CNT International to speed commercialization of BluGlass' RPCVD technology in the Korean market. This marks the first step towards a full customer agreement for BluGlass.

The agreement also outlines BLK's acquisition of a BluGlass BLG-150 deposition tool. BLK plans to establish an RPCVD pilot manufacturing plant in Gwangju Technology Park (the centre of Korea's LED industry) as it aims to use BluGlass' technology to produce GaN-based LEDs in order to gain access to Korea's major LED makers.

Gwangju is officially designated South Korea's 'LED Valley', and 70 LED firms are said to be setting up shop in the district. BluGlass reckons that this will involve significant spending on manufacturing capabilities, including the purchase of new deposition tools and equipment for new fabrication plants.

BluGlass says that it is furthering negotiations to establish a joint development agreement whereby BLK will participate in the final optimization of the RPCVD technology to speed to introduction to the mainstream market.

"BLK has an experienced management and technology team that will complement the existing capabilities of BluGlass," says BluGlass' CEO Giles Bourne. "With the establishment of an RPCVD manufacturing plant in the centre of the new LED development of Korea, we are looking forward to great ongoing collaboration with BLK," he adds.

BluGlass to expand RPCVD from LEDs to nitride-based solar cells

BluGlass Ltd, which was spun off from Australia's Macquarie University in 2005, says that it intends to expand the market potential of its remote plasma chemical vapor deposition (RPCVD) manufacturing technology to thin-film solar cells incorporating group III-nitride materials. The firm currently develops and commercializes RPCVD for depositing thin films such as gallium nitride (GaN) and indium gallium nitride (InGaN) in the production of LEDs.

BluGlass says that, although there are many materials from which solar cells can be developed, group III nitride semiconductors have many advantages over current materials. This is due to the alloy InGaN having a direct energy bandgap with wide tunability, giving the potential to convert almost the full spectrum of sunlight (infrared, visible and ultraviolet radiation) to electrical current. Such properties hence allow more energy from the solar spectrum to be captured efficiently by a solar cell and converted to electrical power. If successful, InGaN solar cells promise to be long lasting, relatively inexpensive and highly efficient, reckons BluGlass.

To date, solar cells have been capable of a maximum efficiency of 41.1% (and only using advanced laboratory technologies). In contrast, most commercial solar cells are retailed at efficiencies of 5-28%, due to the fact that commonly used materials have either a high or an indirect energy bandgap, limiting their potential. Research has established that InGaN solar cells could produce efficiencies of more than 50% [Jani et al. Applied Physics Letters 91, 132117-3 (2007)]. If this could be achieved in practice, then it would represent the biggest ever breakthrough in solar cell efficiency.

BluGlass says that RPCVD has advantages over existing commercial

processes, including being more environmentally sensitive and having significant low cost potential. Also, being a low-temperature process, it is suited to the growth of InGaN: during the growth process, the alloy's fragile bonds crack at high temperature, leading to poor-quality material. A low-temperature process would hence allow indium-rich InGaN layers to be grown. Currently, the standard nitride growth process of metal-organic chemical vapor deposition (MOCVD) relies on extreme temperatures of more than 1000°C to achieve the active nitrogen species. In contrast, BluGlass' process extracts the active nitrogen directly from a nitrogen plasma source, which allows low-temperature growth to be achieved.

InGaN also has superior resistance to energy radiation and high-temperature tolerance. Hence nitride solar cells could maintain high performance under extreme conditions, including space applications such as powering satellites and space probes. Furthermore, the inherent scalability of the RPCVD process (which has been demonstrated by growing GaN for LED applications) is another potential benefit of the process over existing manufacturing methods, reckons BluGlass' CEO Giles Bourne.

Following recent research on InGaN, BluGlass aims to develop a prototype high-efficiency solar cell for industrial testing. It has already designed a solar cell structure that has been grown using MOCVD and fabricated into a device at BluGlass. This cell will be used as a benchmark for subsequent development work carried out on the RPCVD process.

While solar applications present a natural progression (as RPCVD technology is so well suited to such applications), Bourne stresses that LEDs remain the primary focus of BluGlass' business.

www.bluglass.com.au

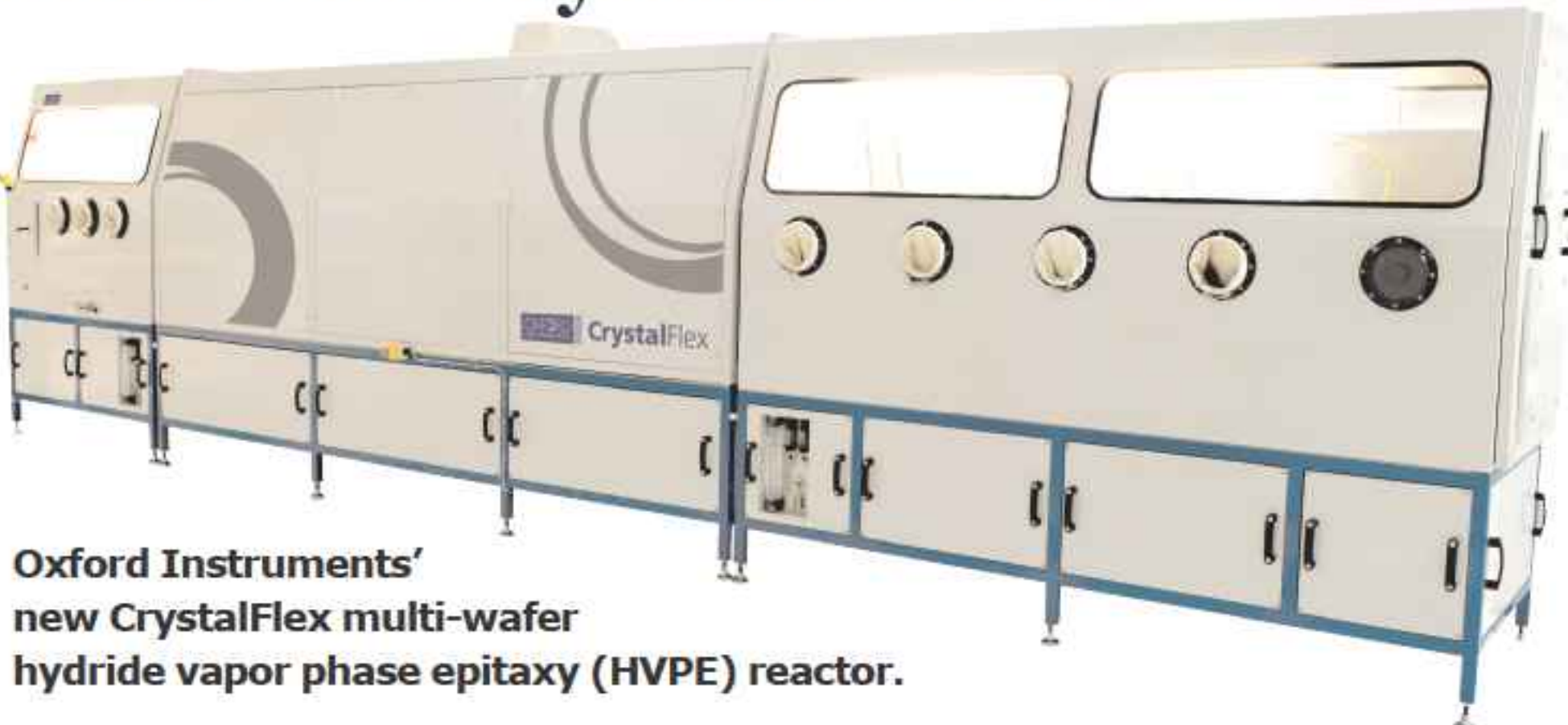
Oxford Instruments launches CrystalFlex HVPE reactor

UK-based Oxford Instruments has launched the CrystalFlex multi-wafer hydride vapor phase epitaxy (HVPE) reactor.

CrystalFlex is claimed to provide superb epitaxial growth control and offer a cost-effective route for the production of high-quality, crack-free epitaxial single-crystal compound semiconductor materials including GaN, AlGaIn and AlN.

The equipment is designed for R&D or full-scale production of Group III nitrides, with the focus on process stability, reproducibility, and optimal source materials usage. The flexible reactor configuration enables end users to grow a variety of Group III nitrides with various thicknesses, the firm says.

"This product launch is a natural progression for Oxford Instruments," says general manager Bernard Scanlan. In April 2008, Oxford Instruments acquired Technologies and Devices International Inc (TDI) of Silver Spring, MD, USA, which had



Oxford Instruments' new CrystalFlex multi-wafer hydride vapor phase epitaxy (HVPE) reactor.

been developing HVPE processes and techniques for the production of Group III nitrides since being founded by Vladimir Dmitriev in 1997. "Our acquisition in 2008 of TDI and its highly qualified team of research scientists, together with Oxford Instruments development scientists and top-level technological expertise, provide a unique platform from which to develop this reactor," he adds. "Its flexibility means that it is capable of both R&D and full-scale production."

The new reactor complements Oxford Instruments Plasma Technology's existing range of processes specifically designed to serve the high-brightness LED (HB-LED) market. Oxford Instruments has supplied etch and deposition technology to the HB-LED industry for more than 10 years. With the addition of the CrystalFlex HVPE growth system, another key point on the HB-LED production chain is addressed, says the firm.

www.oxford-instruments.com

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China's largest LED maker Sanan and Crystal IS to co-develop commercial UV-C LEDs

Crystal IS Inc of Green Island, NY, USA, which makes UV LEDs based on aluminum nitride (AlN) substrate technology, and Sanan Optoelectronics Co Ltd of Xiamen, China have signed a memorandum of understanding (MOU) for a joint development program that aims to establish pilot manufacturing of LEDs operating in the UV-C part of the electromagnetic spectrum.

As China's largest manufacturer of full-color LEDs, Sanan designs, manufactures and distributes full-color ultra-high-brightness (UHB) LEDs, epitaxial wafers, photodiode detectors and compound semiconductor solar cells, with an annual throughput of 550,000 epi-wafers and 16bn LEDs. During the term of the MOU, both

parties intend to negotiate a long-term business agreement covering high-volume manufacturing, marketing and sales.

"Working with an experienced and dynamic company like Sanan Optoelectronics will significantly speed up the market introduction of UV-C LEDs," says Crystal IS' CEO Steven Berger. "Leveraging Sanan Optoelectronics' unique expertise in processing and packaging will allow us to focus on making the precision substrates required for efficient UV-C LEDs."

"The opportunity to partner with Crystal IS on a new LED technology will help Sanan Optoelectronics maintain its leadership position," says Sanan Optoelectronics' CEO Simon Lin.

"We expect downstream integrators of UV-based products will welcome an established supply train for this new product," he adds.

The UV-C LEDs will operate at the optimal germicidal wavelength, and are suited to use in water and air sterilization products. Initial applications will include portable and residential point-of-use systems such as cleantech alternatives to bottled water and in-home counter-top systems.

The technology roadmap also includes industrial and municipal applications, where long-lasting, energy-efficient LEDs can replace existing mercury-based light sources.

www.crystal-is.com

www.sanan-e.com/en

LED stage lighting

PR Lighting Ltd of Guangzhou, China has chosen Golden DRAGON LEDs from Osram Opto Semiconductors GmbH of Regensburg, Germany for its XLED 590 intelligent wash light.

Osram is highlighting its portfolio of LEDs (including OSTAR SMT, Diamond DRAGON and Golden DRAGON Plus LEDs — exhibited at the China PALM Expo for professional audio light music technology in Beijing at the end of May).

"We wanted to offer a high-brightness, long-lifetime solution that meets the needs of the high-power stage lighting market," says PR Lighting's Steve Tulk chief engineer. "This XLED 590 with Osram's LED is the brightest intelligent wash light in the market," he claims. Light output is greater than a conventional 1200W wash light. PR Lighting exhibited more than 20 Diamond DRAGON RGB LED-based wash lights at the China PALM Expo.

www.pr-lighting.com

UV LEDs yield deeper-color antioxidant-rich plants

Plant physiologists led by Steve Britz of the US Department of Agriculture (USDA) in Beltsville, MD have developed a method using ultraviolet LEDs to create darker, redder lettuce with more nutritional value than iceberg lettuce, for example, since darker colors in leafy vegetables such as spinach are often signs of antioxidants, which are thought to have a variety of health benefits.

The researchers say that the dark red tinges on a leaf of red leaf lettuce are created when the sun's ultraviolet rays strike the plant, which creates UV-absorbing polyphenolic compounds in the outer layer of cells. Some of these compounds are red, and help to block the UV radiation, which can mutate plant DNA and damage the photosynthesis process.

To create red leaf lettuce plants enriched with antioxidant compounds, Britz exposed them to about 10mW/m² of UVB light

(a component of natural sunlight) from low-power LEDs. After 43 hours of exposure, the lettuce plants were noticeably redder than other plants that only saw white light.

"We've been pleasantly surprised to see how effective the LEDs are, and are now testing how much exposure is required, and whether the light should be pulsed or continuous," said Britz.

The USDA research was presented at the recent 2009 Conference on Lasers and Electro Optics/International Quantum Electronics Conference (CLEO/IQEC) in Baltimore, MD, USA (31 May to 5 June).

www.usda.gov

Automated nanoimprint litho system for high-volume LED manufacturing

Obducat AB of Malmö, Sweden, which supplies systems based on nanoimprint and electron-beam lithography, is launching the first model from its Sindre platform. The Sindre400 is claimed to be the first fully automated lithography system for high-volume manufacturing of LEDs. The first commercial system has been ordered by Taiwan-based LED maker Luxtatek. With its first truly industrial platform, Obducat says that it has laid the foundation for the development of future mass-production systems.

The result of eight years of R&D, and based on models installed in customer plants and in use in industrial manufacturing conditions since February 2006, the Sindre400 has been optimized and enhanced to operate 24/7, the firm says.

Now that the basic technology is in place, in the longer-term the Sindre platform also provides opportunities with other manufac-



**Sindre400
nanoimprint
lithography system**

turers, reckons Obducat, since it can be adapted and customer-specified. It can also serve as the basis for systems designed for optoelectronics and solar photovoltaic manufacturing, the firm adds.

www.obducat.com

Azzurro appoints VP Operations

Epiwafer foundry Azzurro Semiconductors AG of Magdeburg, Germany, which provides GaN on large-diameter (50–150mm) substrates (including silicon) for LED, high-voltage and high-frequency applications, has recruited Dr Markus Sickmüller as VP Operations.

In more than 15 years in the semiconductor industry, Sickmüller has held various engineering and executive functions worldwide. Before joining Azzurro, Sickmüller was senior director Production at Qimonda Taiwan, assigned to Inotera Memories Inc as part of their top management team. As VP Front-end Technology he was responsible for technology synchronization and technology transfer between various sites worldwide as well as having overall technical responsibility for the global front-end manufacturing sites of Infineon

Memory Products.

He also held management positions in Assembly & Test in Germany as manager of the backend facility in Dresden and as worldwide Test Cluster Manager located in Malaysia.

Sickmüller is returning to the area of his academic background of optoelectronics, which he studied at the Technical University of Braunschweig and completed with his doctorate at the University of Ulm.

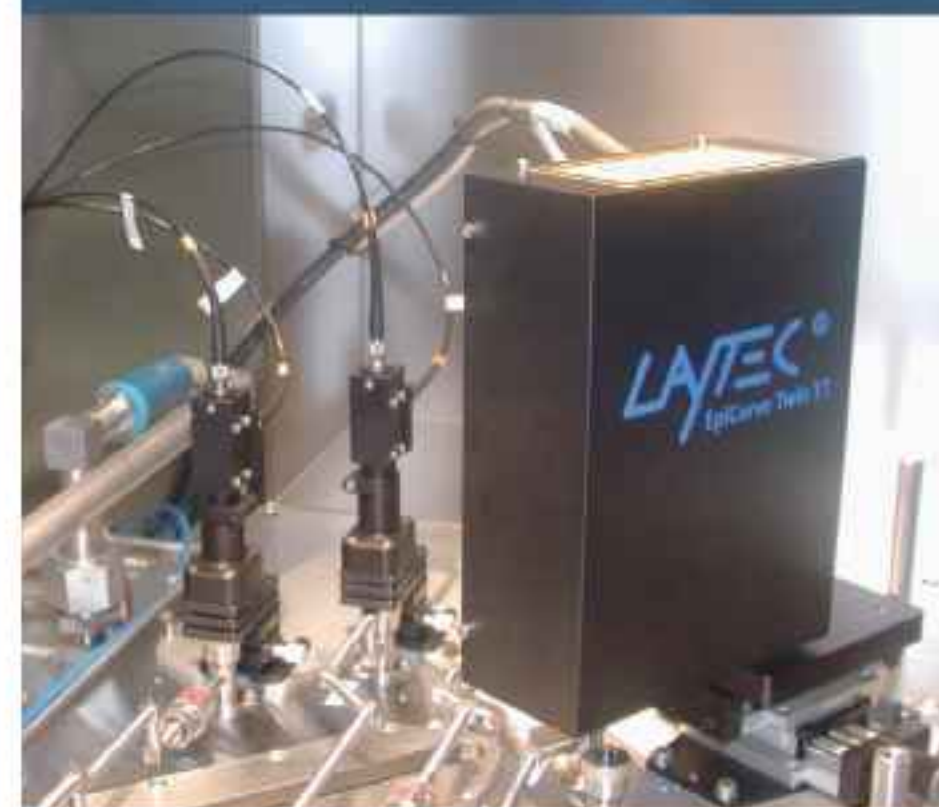
"Markus' experience in running large-volume 200mm and 300mm production facilities is precisely what Azzurro requires on its expansion path — enabling large-area GaN wafers for LED and high-voltage products," says CEO Erwin Wolf.

www.azzurro-semiconductors.com



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Osram introduces Golden DRAGON oval Plus LED with integrated lens for accurate street lighting

Osram Opto Semiconductors has introduced the Golden DRAGON oval Plus LED which, due to its integrated lens, provides an homogenous oval radiation pattern (suitable for energy-efficient street and tunnel lighting) without the need for secondary optics.

With its oval beam characteristics (80° vertical, 120° horizontal), the Golden DRAGON oval Plus directs light precisely onto the area to be illuminated (with no upward stray light), minimizing light pollution.

Since different streets require different lighting solutions, the LED is available in various white tones, with an efficiency of 90lm/W in cold white (a colour temperature of 6500K) and 80lm/W in neutral white (5000K). The warm-white ver-



The Golden DRAGON oval Plus LED's integrated lens provides energy-efficient light to brighten roadways without light pollution.

This new light source also makes it easier to upgrade current systems to more efficient street lighting with LED technology

sion, with a colour temperature of 2700–4500K, suits lighting where a warm and welcoming atmosphere is required. At 4500K it has an efficiency of 65lm/W.

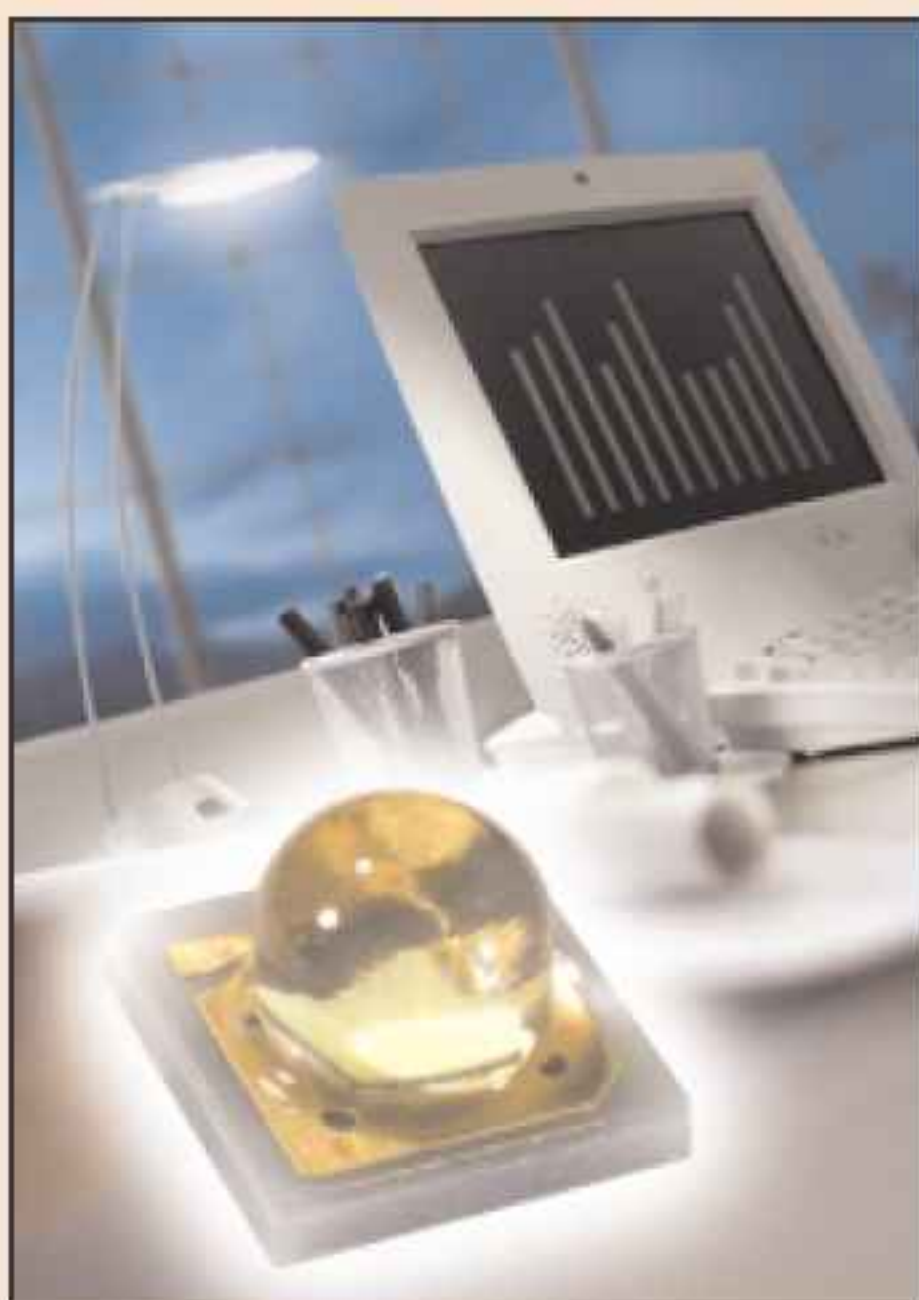
"Our new 'street-lighting LED' combines various lighting benefits in one innovative package," says Dr Markus Klein, head of SSL Product Development. "It is highly efficient, and has a long lifetime due to its silicone lens. Additionally, it offers good visibility at night because the LEDs can be arranged in the system to distribute the light accurately, delivering light where it is most needed," he adds. "This new light source also makes it easier to upgrade current systems to more efficient street lighting with LED technology."

1 Watt ultra-white LED launched for general solid-state lighting

The 1 Watt-class ultra-white OSOLON SSL LED has been launched by Osram Opto Semiconductors GmbH of Regensburg, Germany, available in a package that measures just 3mm x 3mm.

Osram Opto says that its properties provide the basis for high application efficiency due to its high luminous efficacy (typically 100lm/W) even at high current, as well as its simplified thermal management, high reliability and a beam angle of 80° (suited to the injection of light into external lenses). The light emission meets the requirements for use in general lighting, including use as a replacement for halogen lamps in spotlights, desk lights, reading lights and ceiling floodlights (as well as retrofit applications), says Osram Opto.

"Its ability to handle high currents efficiently enables our customers to create particularly energy-



Osram Opto's OSOLON SSL LED.

efficient and cost-saving lighting solutions," says SSL marketing manager Dr Gunnar Moos. "Its low thermal resistance of 7K/W simpli-

fies thermal management," he adds. If particularly strong light is needed, several light sources can be combined in a cluster. In addition to ultra-white (5700–6500K), the LED will be available this summer in neutral-white and warm-white color temperatures (ranging from 2700K to 4500K).

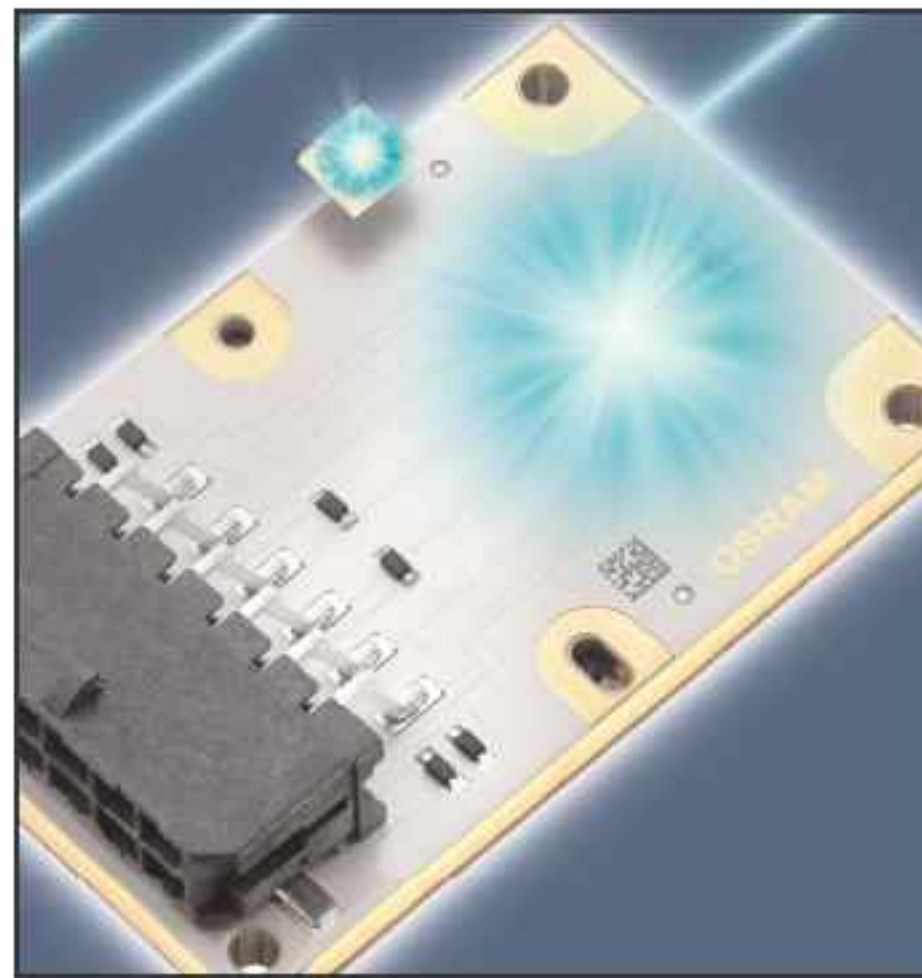
At an operating current of 350mA, the OSOLON SSL achieves a typical brightness of 110lm in ultra-white (5700 and 6500K), with a maximum possible luminous flux of 130lm at present. At an operating current of 350mA and a color temperature of 3000K, it achieves a typical efficiency of 75lm/W and a brightness of 85lm. Also, brightness is 155lm at an operating current of 700mA (warm white). Applications that demand high lighting levels can therefore be achieved using fewer LEDs, says the firm.

www.osram-os.com

Projection LED power range extended across 1W to 300W

Osram Opto Semiconductors has expanded its portfolio for the projection market with two new LEDs at the low and high ends of the performance range: OSTAR Compact (designed for small, efficient pico-projector systems in cell phones, PDAs and MP4 players) and OSTAR Power Projection (targeted at high-power projection applications such as home cinema systems with displays of 70 inches and more). Osram says that its LED portfolio now provides full coverage of the projection system range from 1W all the way up to 300W.

For small applications at the lower end of the performance range and available in red, blue, green and white, the OSTAR Compact measures just 3.9mm x 3.6mm and is a cost-effective component, particularly for pico projectors for small mobile devices. Manufacturers wanting very compact units can use a double-chip version that contains a red chip and a blue chip in one LED, saving space compared with



OSTAR Power Projection LED.

the usual configuration of three individual LEDs (red, blue, green). As an SMT component, it can be easily integrated into standard manufacturing processes. Integrated ESD protection diodes guard against electrostatic effects.

Having low thermal resistance and operable at a current up to 36A, the OSTAR Power Projection LED delivers typical brightness values of

2700lm in red and 3500lm in green and an optical output of 13W in blue. While the OSTAR Power Projection's dimensions of 45mm x 25mm seem large for a standard LED, the thermal resistance is only 0.77K/W. The LED suits all types of cooling (including water cooling). Since the junction temperature is the same for all colors (125°C), a uniform cooling system can be used.

"LEDs will one day become the standard for all projection applications, including high-end applications," believes Wolfgang Schnabel, marketing manager LED Projection. "We are well positioned for this swift migration of LEDs into projection applications and offer several OSTAR LED versions, namely Compact (up to 25W), SMT (10–40W), Projection (25–70W) and Power Projection (90–150W), to cover numerous applications — from cost-effective pico projectors to home cinema equipment as well as mobile projection systems for mid-range applications," he adds.

Smallest multi-chip RGB LED targets high-res full-color video screens

Osram Opto Semiconductors has developed the smallest member of its RGB Multi ChipLED family, bringing what it claims is a new dimension of high-definition picture quality to large full-color video screens.

The RGB Multi ChipLED's package measures 1.6mm x 1.6mm and just 0.9mm high, so a pixel spacing of only 2mm is possible and many pixels can be accommodated in a very small area: less than 10m² is sufficient to display pictures in HDTV quality and accommodate more than 2 million pixels. A 2.5m x 4.0m (98" x 157") display that is 10m (394") in diagonal can achieve a system luminance of 1500–2500cd/m², corresponding to about ten times the luminance of a conventional LED-backlit TFT LCD screen.

All this enables high-resolution full-color video screens (e.g. in TV



1.6mm x 1.6mm RGB Multi ChipLED for high-resolution video screens.

studios, conference rooms, trade fairs and concert halls) to offer

brilliant colors and high contrast from all viewing angles, helped by the LED being housed in a black package that reflects hardly any ambient light, the firm says.

Also, due to specially developed encapsulation material, perfect color mixing in the package itself means that color appearance remains constant across the entire viewing angle, and pictures appear vibrant even viewed off-axis. The LED's beam angle is $\pm 60^\circ$.

If the RGB-LED is operated with a current of 20mA, the individual red, blue and green chips (made using Osram's ThinFilm and ThinGaN technology) produce typical luminous intensities of 250mcd (red), 350mcd (green) and 70mcd (blue). Typical efficiency of this luminous intensity is 4cd/W, corresponding to a luminous efficacy of 12lm/W.

www.osram-os.com

Court rejects Epistar appeal vs ITC ruling on Lumileds patent

...but lifts import ban on downstream third-party products

On 22 May, the US Court of Appeals for the Federal Circuit issued a ruling that rejected the appeal by Epistar Corp (Taiwan's biggest LED chip maker) concerning the Washington DC-based International Trade Commission's interpretation of the claims in US Patent 5,008,718, which is owned by Philips Lumileds Lighting Co of San Jose, CA, USA (the world's biggest maker of power LEDs used in cars, cameras and general lighting).

In May 2008, the ITC determined that Epistar's AlGaInP-based omnidirectional mirror adhesion (OMA), metal-bonded (MB) and glue-bonded (GB) LEDs (and next-generation OMA II, MB II and GB II LEDs), as well as other, third-party products (packaged lamps containing the LEDs and boards consisting primarily of arrays of such packaged lamps), infringe patent 5,008,718, concerning Lumileds' invention of a transparent semiconductor window layer within the chip structure that laterally spreads current away from the metal contact, yielding brighter light emission (used in Lumileds' AlInGaP LEDs since the early 1990).

In September, the appeal court denied Epistar's request to stay enforcement of the ITC's limited exclusion order (which came into effect last July) prohibiting import of the LED products into the USA.

The appeal court has now confirmed the ITC's ruling that Epistar infringes the patent, says Lumileds.

The appeal court also upheld the ITC's decision that "Epistar (as a successor to UEC) may not contest validity of the '718 patent with respect to the UEC products that it inherited in the merger" between Epistar and UEC (in 2005).

However, the court overturned the ITC's ruling that Epistar could not

contest validity of the patent with respect to other products made by third parties (i.e. Epistar's customers), when none were named as respondents in the patent lawsuit.

Lumileds says that a change in the law after the ITC's decision called into question its long-standing practice of issuing limited exclusion orders that bar importation into the USA of downstream products manufactured by third parties not named in the case. The appeal court has therefore vacated the LEO and remanded the case back to the ITC for further proceedings.

Lumileds had earlier filed a petition with the ITC requesting that the LEO be converted into a general exclusion order that, even after recent changes in the law, would still bar importation of the downstream products.

Epistar claims that the appeal court's decision now opens the way for it to invalidate the 5,008,718 patent (which, in any case, is due to expire on 18 December).

The firm says that it has notified the US Customs and Border Protection of the appeal court's decision and order vacating the LEO.

Epistar adds that it now aims to proceed with its action against Lumileds in the US District Court for the Northern District of California for breaching the terms of an agreement between Epistar and Lumileds in July 2004 to settle a dispute over whether certain OMA

products infringed Lumileds' patent, whereby Lumileds agreed not to sue Epistar for infringement based on the OMA products and granted a license to Epistar to make, sell, use, offer to sell and import AlGaInP absorbing-substrate LEDs. However, during last year's ITC investigation, Lumileds alleged that Epistar's OMA products infringed the patent. Epistar's complaint to the appeal court therefore claimed that the assertion of the patent against the OMA LED products was a violation of the terms of the 2004 settlement agreement.

Nevertheless, Lumileds says it remains confident that any further invalidity challenges by Epistar to the 5,008,718 patent will be rejected, on the basis of rulings of US District Court judge Claudia Wilken of the Northern District of California in an earlier case against UEC granting Philips Lumileds summary judgment on multiple different validity challenges to the patent claims.

Lumileds reckons that the appeal court's confirmation of Epistar's

The appeal court has therefore vacated the LEO and remanded the case back to the ITC for further proceedings

www.philipslumileds.com

www.epistar.com.tw

www.cafc.uscourts.gov/opinions/07-1457.pdf

infringement of patent 5,008,718 paves the way for success in a further pending lawsuit against Epistar (before judge Wilken in the US District Court) asserting infringement of not only the 5,008,718 patent but also two other patents.

Lumileds claims first power LED specified for 100lm/W efficacy

In late April, Philips Lumileds of San Jose, CA, USA launched the LUXEON Rebel ES, which is claimed to be the world's first power LED specified to deliver a minimum luminous efficacy of 100lm/W. Lumileds says that, as demand for efficient lighting solutions increases, it is focusing on the performance characteristics that are most important to the lighting industry. Attention to efficacy makes it simpler to create solid-state lighting solutions that eclipse conventional solution efficiency in many applications such as outdoor and refrigeration.

"LUXEON Rebel ES meets two complementary objectives: extending the energy-saving ability of LED technology and simplifying LED product selection to make it easier for lighting designers to take advantage of those capabilities," says Steve Barlow, executive VP of sales & marketing. "Both of these features will help the industry meet its energy reduction and sustainability goals."

Lumileds says that creating energy-efficient SSL applications is easier because flux binning and forward voltage (V_f) binning selections are pre-determined to deliver 100lm/W efficacy.

With one simple selection of correlated color temperature (CCT),

lighting engineers can adopt LUXEON Rebel ES for their most efficient applications and begin reducing the energy required for many solutions.

As well as the small size, high light output, long useful life and ruggedness of LUXEON Rebel products, the ES also offers:

- a path to minimizing energy consumption and reducing carbon footprint;
- simpler LED selection to speed design and manufacturing and to lower development costs; and
- robust performance over temperature to reduce fluctuations in efficacy and light output.

These performance benefits are enabled by full implementation of Lumileds' thin-film flip chip technology and the continuous improvement of epitaxial processes.

Through these and other ongoing technology advances, the firm continues to support the lighting industry's need for brighter, more efficient, long-lasting power LEDs.

The LUXEON Rebel ES is available via Future Lighting Solutions, the exclusive provider of LUXEON power LEDs and a strategic partner dedicated to enabling luminaire manufacturers to develop solid-state lighting solutions.

www.philipslumileds.com

Lightfair sees Technical Innovation Award for Lumileds' LUXEON Rebel ES

At May's Lightfair International 2009 event in New York, Philips Lumileds' LUXEON Rebel ES was recognized with the LFI Technical Innovation Award, which honours industry innovations for lighting-related products.

This year, there were more than 200 entries, each evaluated by an independent panel of lighting professionals. LUXEON Rebel ES, which is claimed to be the first product specified to deliver a

minimum of 100 lumens per watt, was selected for its "leap forward in lighting technology".

Recent records for light output, efficacy and thermal management are direct results of the ongoing commitment to advancing solid-state lighting technology and enabling lighting solutions that are more environmentally friendly, help reduce CO₂ emissions and reduce the need for power plant expansion.

IN BRIEF

LUXEON K2 LEDs used by D-LED for museum lighting

Philips Lumileds of San Jose, CA, USA says that its LUXEON LEDs are being used by D-LED Illumination Technologies Ltd of Hod-Hasharon, Israel (a member of the LUXEON Lighting Network) in its D-Spot and Nano long-life LED luminaires embedded into walls, floors and awkward, hard-to-reach recessed spaces (where conventional light sources would be impractical) at the new Yitzhak Rabin Museum of the Yitzhak Rabin Research Center in Tel Aviv.

The aim is to create small, almost invisible light sources that do not detract from the artifacts, as well as minimizing disruption to visitors from unplanned maintenance. D-LED hence manufactured low-profile, linear luminaires to exact dimensions to fit the available space.

Each luminaire uses LUXEON K2 white LEDs driven at 700mA (spaced evenly at 27 LEDs per meter) to achieve the required light output and lumen maintenance. The project was enabled by D-LED's experience with solid-state lighting solutions, coupled with engineering expertise and support from Future Lighting Solutions (Israel).

"By using power LEDs, we were able to make backlighting luminaires that could be accommodated in very small spaces behind displays, and equally to design discreet spotlights — each using three white LUXEON LEDs — that are so small that the eye is not drawn to or distracted by them," says lighting designer Noa Lev, who implemented the interior lighting of the museum.

www.d-led.net

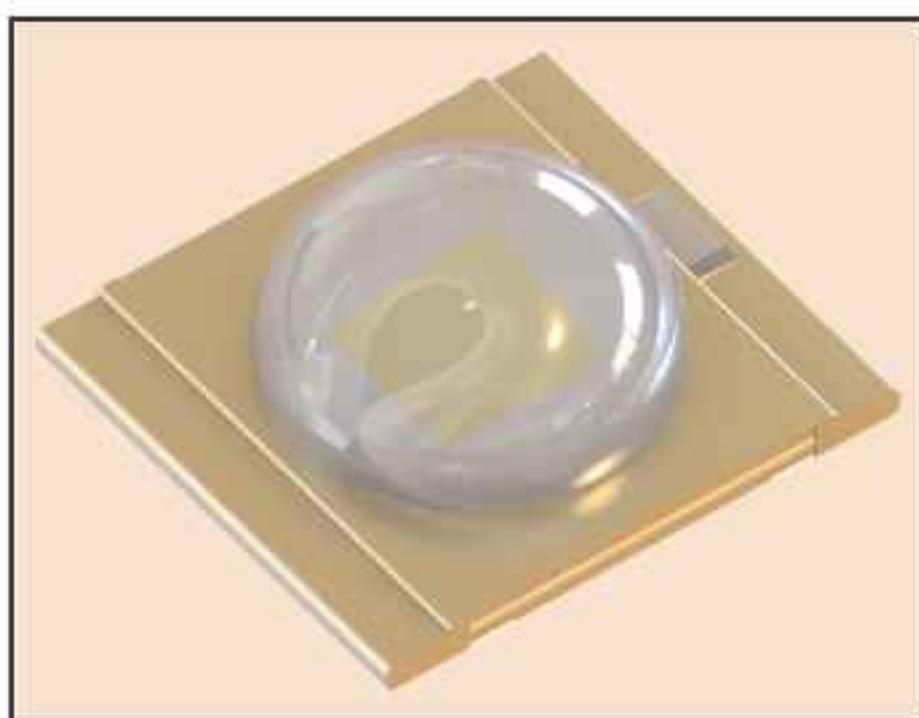
www.philipslumileds.com/solutions/In

Seoul Semiconductor launches 120 lumen per Watt white LED for general-purpose lighting

At the Lightfair International 2009 event in New York (5–7 May), Korean LED maker Seoul Semiconductor launched a 120lm/W high-efficiency, SMD-type LED for general-purpose lighting.

The firm says that, combined with its metal substrate, luminous efficiency of the patented LCW100Z1 is improved by over 20% compared to typical top-view LEDs. Enhanced heat transfer also dramatically improves efficiency. Unlike existing LED chips, the new LED delivers more than 120lm/W with an enhanced primary optic (a precision dome lens).

As an ultra-thin LED with dimensions of 3.5mm x 2.8mm x 1.6mm and a viewing angle of 120° in cool white, the LCW100Z1 delivers up to 7.8lm (at 0.06W) at a low



Seoul Semiconductor's LCW100Z1 .

current of 20mA, and 14.3lm at 40mA. The LCW100Z1 comes in three ranges of correlated color temperatures (CCTs), including pure white, warm white and natural white. Also, an optimized thermal design improves reliability, yielding the efficiency needed for both indoor and outdoor lighting, the firm says.

Pricing is comparable to similar-sized LEDs that can tolerate only half of the current, the firm claims. In contrast, in some instances, using fewer, higher-power existing devices has proven too costly and not provided an homogeneous light pattern without expensive and complex optics.

Samples have already been received by lighting appliance manufacturers worldwide. As it can immediately replace existing top-view LEDs, the LCW100Z1 is expected to be widely adopted for tube-type fluorescent lamps and surface light source lamps. It is also expected to serve as a catalyst for expanding the LED lighting market, as it allows lighting manufacturers to produce a variety of fixtures.

www.acriche.com

Cree demos LR6 LED downlight with 102lm/W efficacy

At the Lightfair International 2009 event in New York in May, Cree Inc of Durham, NC, USA demonstrated a prototype version of its LR6 LED recessed downlight that consumes just 6.5W of electricity, resulting in luminous output of 665 lumens, a fixture luminous efficacy of 102 lumens per watt, and a power factor of greater than 0.9.

The high-efficiency LR6 prototype features TrueWhite technology, resulting in a color rendering index (CRI) of 92 and a color temperature of 3500K.

"By using the latest Cree LEDs — the XLamp XP-G [also demonstrated at Lightfair International] — we were able to achieve this great efficiency," says Cree LED Lighting's chief technologist, Gerry Negley.

www.CreeLEDLighting.com

Cree raises June-quarter target by 5%, boosted by lighting and notebook PCs

LED chip, lamp and lighting fixture maker Cree Inc of Durham, NC, USA has raised its revenue target for its fiscal fourth-quarter 2009 (ending 28 June) by about 5%, from \$136–143m (announced on 21 April) to \$143–150m, due mainly to stronger LED component bookings for lighting-related applications, as well as higher LED chip bookings for notebook PC backlighting. This represents a bounceback from the March-quarter's sequential revenue decline of 11%, to \$131.1m. The new forecast for the June quarter therefore represents growth of between 4% and 14% quarter-to-quarter (and growth of between 29% and 35% from \$111.2m a year ago).

Gross margin is targeted to be at the higher end of previously targeted levels (of 36–38% non-GAAP, versus the March quarter's 36.9%).

Cree has also raised its targets for GAAP earnings from \$0.05–0.07 to

\$0.07–0.09 per diluted share and for non-GAAP earnings from \$0.13–0.15 to \$0.15–0.17 per diluted share (excluding expenses related to the amortization of acquired intangibles of \$0.03 per diluted share, and stock-based compensation expense of \$0.05 per diluted share).

"We are pleased with the strong booking trends for Q4," says chairman & CEO Chuck Swoboda. "We also remain optimistic about the growth potential for LED lighting in fiscal 2010, although there is some near-term execution risk as we ramp up production to meet these higher targets," he cautions.

Operating expenses are targeted to be about \$46m, up slightly from the March-quarter's \$44.4m.

Full results for Cree's fiscal fourth-quarter 2009 are scheduled to be reported on 11 August.

www.cree.com

Bridgelux launches Lighting Services Group to support solid-state lighting system design requirements

Lighting company and LED maker Bridgelux Inc of Sunnyvale, CA, USA has launched a Lighting Services Group to offer a range of design and support services.

As an increasing number of lamp and luminaire manufacturers transition to solid-state lighting, new system-level design opportunities are arising, says the firm. Bridgelux Lighting Services Group's charter is to support customers in developing application-specific designs both cost effectively and with reduced time-to-market.

"Rapid adoption of Bridgelux LED Arrays has opened up new opportunities for lamp and luminaire designs," says VP of business development Keith Scott. "Many customers have already incorporated our array products into new lighting products, taking advantage of the ease of use and plug-and-

play aspects of the product line," he adds. "To enable additional opportunities and further support design activities, we have developed a Lighting Services Group. This group will work with our customers on designing and developing new optical, electrical, thermal and mechanical designs to further simplify the task of adopting solid-state technology."

Bridgelux says that it now offers a full range of design and support services to help customers develop their lighting products. Core members of the group have over 15 years of experience in developing solid-state lighting systems and complementary components, including precision optics, electronics, and module designs. Through close engagement with customers, the team aims to help to accelerate market penetration of LED lighting

technology, the promise of increased energy efficiency, and enable new design possibilities for lamps and luminaires.

"With the recent market introduction of the Bridgelux LED Array product family, designed specifically for the lighting market, we now offer a unique solution for designers and manufacturers that will simplify their efforts and reduce cost," says the firm's CEO Mark Swoboda.

"The Bridgelux Lighting Services Group supports both our focus on driving sales of our LED Array products and our goal of enabling a rapid displacement of conventional lighting sources."

Bridgelux demonstrated its LED Arrays at the LIGHTFAIR International event in New York in early May.

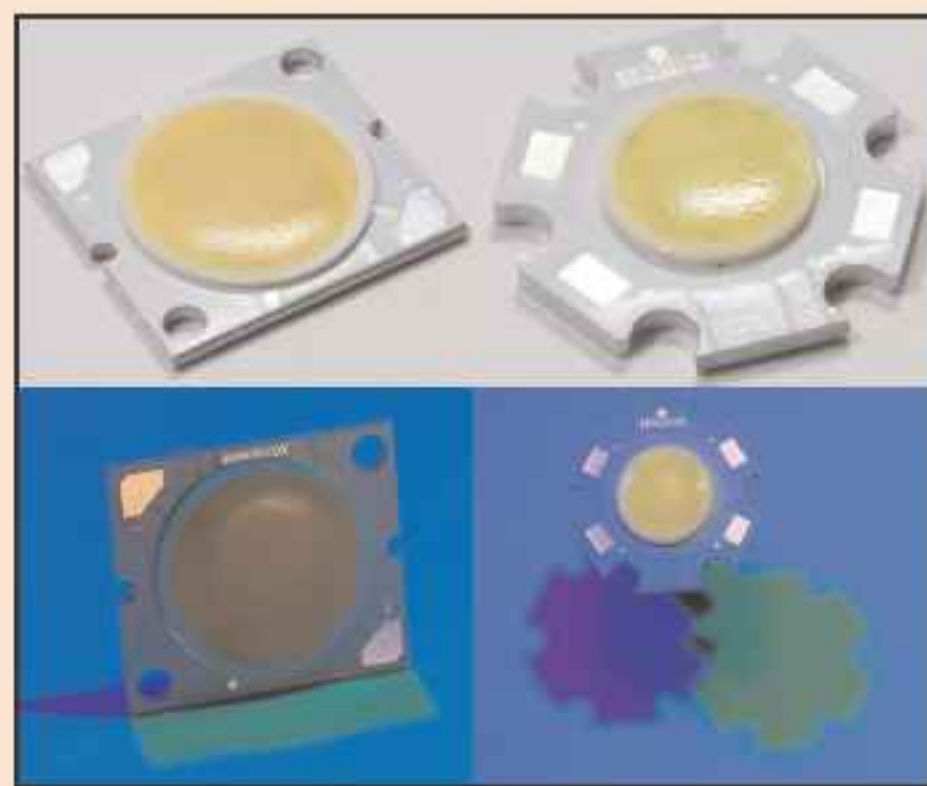
www.bridgelux.com

Bridgelux LED Arrays incorporated in IST recessed downlights

IST Lighting of Aldridge, UK has launched recessed LED downlights (the DL range) using Bridgelux LED Arrays in cool-, neutral- and warm-white colour temperatures. IST has also developed a range of high-current iDrive electronic LED drivers, optimized specifically for the LED Arrays.

"IST plans to offer a new range of cost-effective LED lighting systems based upon the innovative Bridgelux technology, not previously possible with other solid state solutions," says IST's Dr Geoff Archenhold. "In addition, IST has already committed to developing a range of LED drivers specifically suited to the Bridgelux LED Array products, enabling other fixture manufacturers to take advantage of the technology and develop innovative lighting solutions."

IST previewed the first in a range of high-current iDrive LED drivers at LIGHTFAIR International in



Bridgelux's rectangular neutral-white and warm-white (left, top & bottom) and star cool-white and neutral-white (right, top & bottom) LEDs.

New York (5-7 May), where Bridgelux also demonstrated the IST DL100 HC downlight. According to the firms, the iDrive MultiDIM-HC driver is the world's first 45W high-efficiency mains-dimmable LED driver, enabling luminaires based on Bridgelux LED Arrays to be dimmed using

standard mains dimmer switches.

"The new range of dimmable drivers from IST furthers our mutual objective to simplify design, maximize functionality and reduce system cost to accelerate widespread adoption of solid-state lighting," says VP of business development Keith Scott.

"We believe that the iDrive MultiDIM-HC driver will enable seamless adoption for end-users that wish to transition to Bridgelux LED Array technology from less efficient conventional lighting technologies," he adds.

The MultiDIM-HC offers total efficiencies in excess of 80%, high power factor correction of up to 0.95, and output DC voltages of 8-18V. It also combines up to four output currents (1.2A, 1.4A, 1.6A and 1.8A) to provide a complete solution for lighting fixture manufacturers.

www.istl.com

PhlatLight SST-90-W wins LFI Technical Innovation Award

At the LFI Innovation Awards ceremony at LightFair 2009 on 5 May, Luminus' new PhlatLight SST-90-W LED received a Technical Innovation Award, which recognizes the most significant advances in lighting technology in the past 12 months (as conferred by a judging panel of lighting professionals).

The 10W SST-90 delivers as much as 2250 lumens from a single source. "Our mission is to improve lighting through advanced LED technology for applications requiring high output," says Peter Weller, general manager of the Lighting Business at Luminus Devices.

The SST-90 is a large-chip white LED in a new SMT package that combines the benefits of high power and efficiency, enabling lighting fixture OEMs to replace conventional bulbs and multiple LED arrays with a single PhlatLight LED. This results in simplified designs, lower costs and faster time-to-market, Luminus claims.

IN BRIEF

Luminus appoints president & CEO

Luminus Devices has appointed Keith T.S. Ward as president, CEO and member of its board of directors. Udi Meirav, CEO since 2003, becomes executive vice-chairman of the board.

Prior to joining Luminus, Ward was president & chief operating officer of EYE Lighting International of North America, which he led to profitability and growth as well as expanded market share. Previously, he was general manager of General Electric Company, responsible for developing global synergy in specialty lighting products serving niche segments. Earlier positions include managing director GE Lighting of India.

Luminus launches white PhlatLight LEDs for high-output lighting

At May's Lightfair International 2009 event in New York, Luminus Devices Inc of Billerica, MA, USA demonstrated two new additions to range of white PhlatLight LEDs: the CSM-360-W and the SST-50-W.

The CSM-360-W combines large monolithic chips in a multi-chip configuration to yield a chip-on-board LED package capable of emitting 6000 lumens. As a result, fixture manufacturers are now able to target general lighting applications of 10,000 lumens and more using as few as two PhlatLight LED packages.

"The CSM-360-W has a lumen output range that provides industry-leading efficiency and delivers a new level of performance not previously realized in a single LED package," says Chad Stalker, director of product marketing & business development for Luminus Devices' Lighting Business Group. "In addition to the PhlatLight LED benefits of simplified fixture design with fewer LEDs and corresponding optics and drivers, the CSM-360-W also provides a package platform making it possible to service and upgrade the LED itself instead of replacing the whole fixture," he adds.

The CSM-360-W consists of four separate monolithic chips, each with a 3mm x 3mm light-emitting surface, closely packed in a single chip-on-board package. It produces over 3600 lumens at high efficacy and over 6000 lumens at high output.

The SST-50 white PhlatLight LED is claimed to be the first 5.5W monolithic large-chip LED in a surface-mount (SMT) package. It is designed to integrate directly with existing LED lay-outs and enable the next level of performance required by fixture designers to deliver LED-based solutions for mainstream applications in the general, architectural and portable lighting markets.



Luminus' new CSM-360-W LED, combining large monolithic chips in a multi-chip chip-on-board package.

"In a direct response to the growing needs of lighting fixture designers, the SST-50-W PhlatLight LED offers a drop-in compatible SMT LED to existing, lower-power emitters," said Stalker. "It enables lighting fixture designers and manufacturers to simplify designs by reducing the number of LEDs in the system while maintaining high performance levels," he adds. "Fixture manufacturers can easily increase light output of existing designs by a factor of two by simply replacing the current LEDs with the new, higher-output SST-50-W PhlatLight LED."

The SST-50-W's light-emitting surface is a single 5mm² monolithic chip. It produces 550 lumens at 5.5W (100lm/W at 6500K CCT) and at least 1250 lumens at its maximum rated drive current. The SST-50-W integrates with standard SMT manufacturing process and equipment. The LED is suited to applications including portable lighting and general lighting as well as architectural lighting where high performance and high efficacy in a standard package is needed.

PhlatLight LEDs are mercury-free, and provide a lifetime of 60,000 hours with lumen maintenance of greater than 70%.

Samples are available for both the SST-50 and CSM-360-W, with volume shipments starting in July.

www.luminus.com

Nichia pushes InGaN lasers nearer to green via 515nm emission

Japan's Nichia Corp has managed to coax continuous 515nm 'green' laser light out of an indium gallium nitride (InGaN) structure [Takashi Miyoshi et al, Applied Physics Express, vol.2, p062201, 2009]. The firm's researchers see possibilities for application in compact next-generation projectors, particularly in a mobile phone format. Existing projectors use direct red and blue lasers, but the green component is achieved using frequency doubling in second harmonic generation (SHG) lasers. Creating a direct green laser diode would enable smaller projectors to be produced, hopefully at lower cost.

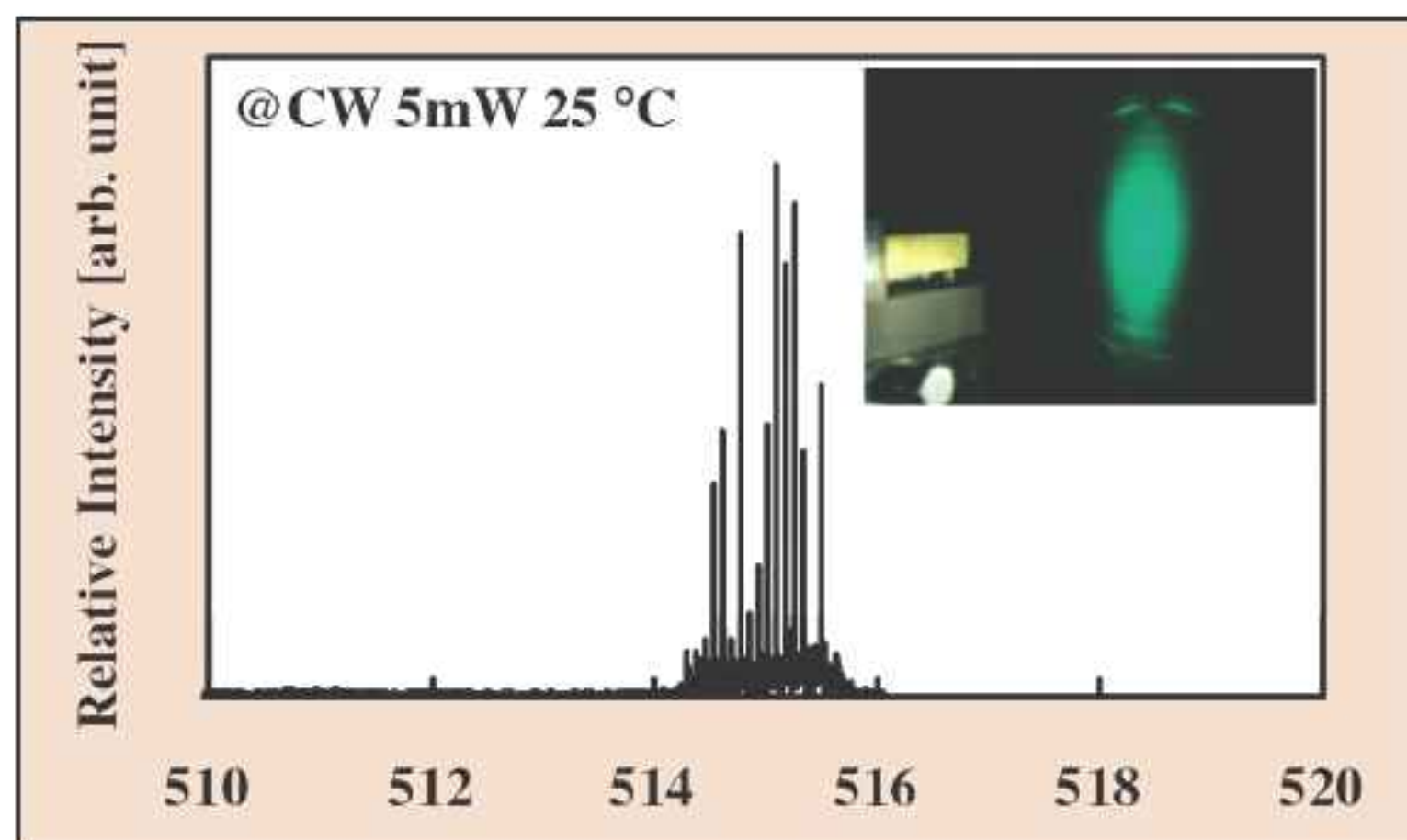
Filling the green light gap has been hard. Although lasers based on II-VI compound semiconductor materials were demonstrated in the 1990s, these devices are unreliable under the high currents that are needed to produce lasing.

Following the development of blue-violet-ultraviolet LEDs and laser diodes based on the III-nitride system, starting also in the 1990s until the present, it is natural to look to the possibility of extending the wavelength (reducing the frequency) into the green gap.

This involves narrowing the energy band gap from gallium nitride's ~3.4eV (corresponding to the ultraviolet wavelength 365nm) by introducing indium (to produce $\text{In}_x\text{Ga}_{1-x}\text{N}$).

However, to get into the green wavelength range (520–570nm) requires significant amounts of indium, and growing such layers with the required high quality is extremely difficult. Thermal stability and parasitic chemical reactions have been highlighted as particular problems in growing such layers.

The Nichia researchers used a conventional free-standing c-plane GaN substrate on which to grow their layers. Films consisting of



Laser output intensity versus wavelength (in nm).

various combinations of aluminum, indium, gallium and nitrogen (AlInGaN) were grown using metal-organic chemical vapor deposition (MOCVD). The active layer consists of InGaN multi-quantum wells (MQWs). As for most commercial laser diodes, separate confinement heterostructures (SCHs) with a lower refractive index are used to confine the emitted light within the lasing cavity.

The dimensions of the resulting laser diode ridge were $2\mu\text{m} \times 600\mu\text{m}$. Continuous wave (cw) characterization of the devices was carried out at 25°C. Below an emission wavelength of 500nm, the devices had a threshold current density of 1–2kA/cm²; this begins to increase as the amount of indium increases to the level needed to achieve a wavelength of 515nm (4.4kA/cm², corresponding to 53mA for the particular device). It is desirable for the turn-on of lasing (threshold) to be achieved at as low current as possible. The 515nm device had an output power of 5mW at an operating current of 88mA (and an operating voltage of 5.5V).

The paper also shows improved uniformity of photoluminescence compared with previous laser diodes produced by the team that operated at shorter wavelengths

regions with poor crystal quality. These non-radiating regions are not found in the new structures.

The temperature variation and lifetime characteristics were also determined. Devices rated at 510–513nm wavelength were operated cw at 25°C with automatic power control for 500 hours. This gives an estimate for the lifetime (the point when the operating current has risen by 30% over the initial current) of more than 5000 hours. Also, the increase in emission wavelength with temperature was just 0.022nm/K.

Nichia describes its latest laser diodes as 'green', presumably on the basis that, in terms of the spectral colors (violet, blue, green, yellow, orange red), 'green' is allotted the 495–570nm space. However, green is better perceived when in the range 520–570nm, while blue comes from the range 440–490nm. In between, the range 490–520nm is better described as 'blue-green'.

Rival laser manufacturers Rohm of Japan and Osram Opto Semiconductors of Regensburg, Germany have also recently produced InGaN-based LDs with wavelengths approaching 500nm.

Author: Mike Cooke

<http://apex.ipap.jp/link?APEX/2/062201>

(>470nm). The Nichia group explains this as being due to their improved growth of the layers, particularly of the active MQW structure. The previous structures suffered from non-radiating

GigOptix doubles revenue and halves loss year-on-year, driven by acquisitions and new products

For first-quarter 2009 (to 5 April), GigOptix Inc of Palo Alto, CA, USA, which designs optical modulators, drivers and transimpedance amplifier (TIA) ICs based on III-V materials, has reported revenue of \$4.1m. This would have slightly exceeded the \$4.4m forecast if it had not been for a product order worth \$348,000 that was completed and scheduled to ship on Saturday 4 April but, due to a customer-related shipping issue, did not leave the premises until the Monday (missing the Q1 cutoff). Nevertheless, revenue is still up 143% on \$1.7m a year ago.

The increase reflects the consolidation of GigOptix's acquisitions in 2008, including Helix Semiconductors AG of Zurich, Switzerland (which makes transimpedance amplifiers, limiting amplifiers, and VCSEL drivers) in January 2008 and Lumera Corp of Bothell, WA (which makes polymer electro-optic modulators) on 9 December (when GigOptix became a publicly traded company).

However, growth is also due partly to strong contracts with industry leaders (including US government agencies) as well as continued traction gained by the GX, HX and LX product lines. On a non-GAAP basis (as if the results of GigOptix, Helix and Lumera had been included from the beginning of 2008), Q1/2009 revenue is still up 89% on \$2.2m a year ago.

"We also excelled in product development, releasing several new products to the market, and secured new business with leading global corporations," says chairman & CEO Dr Avi Katz. New products and product line updates include the following:

- Sampling of the GX6420 43Gb/s electro-absorption modulated laser (EML) driver.
- Full volume production of the ceramic-packaged GX6155 (now being designed-in by multiple tier-one transponder makers).

- Completion of the 4- and 12-channel 10G parallel lineup and production release of the HXT/R4 family of drivers and receivers, which serve the active optical cable (AOC) market.

- Sampling of the GX6220D, a 28Gb/s electro-absorption (EA) modulator driver targeting the emerging 100GBASE-ER4 Ethernet standard for access network applications.

- Signing of a US Air Force contract worth \$2.7m over 12 months.

- Shipment of advanced engineering samples of the DP-QPSK 100G (4-channel 28Gb/s) Mach-Zehnder modulator driver to select partners.

- Initial product shipments of LX products (comprising more than 5% of Q1/2009 revenue).

"We are benefiting from measures that we put in place immediately after the merger [with Lumera] to reduce costs and increase revenues," says Katz. "Those measures, among others, included a restructuring of finance and administration, workforce reduction, and streamlining operating expenses related to the former Lumera business," he adds.

Overall operating expenses have been cut from 155% of revenue a year ago to just 92%.

"Significant operating cost-reduction measures have been deployed during 2008 and the first quarter of 2009, which have dramatically improved our margins, enhanced our cash position and the bottom line."

The increase reflects the consolidation of GigOptix's acquisitions in 2008, including Helix Semiconductors AG of Zurich, Switzerland in January 2008 and Lumera Corp of Bothell, WA on 9 December

Gross margin has risen from 39% a year ago to 58%, due partly to the increased revenue, lower product costs related to operating efficiencies, and a higher-margin product mix.

Net loss has been more than halved from \$2.1m (125% of revenue) a year ago to \$1m (25% of

GigOptix expects an increase in sales from new products and contracts as well as its move into the Military and Test & Measurement market with the rejuvenation of its broadband RF products

revenue), due mainly to the cost-containment efforts and leveraging synergies from the acquisitions.

Including a \$300,000 gain recorded in February outside normal business activities for the sale of Lumera assets (previously written down to zero book

value), cash and cash equivalents were \$4.6m as of 5 April. Also, early in second-quarter 2009, the firm paid-off and terminated its loan and security agreement with Silicon Valley Bank, and is now debt free.

"During the quarter we put in place a number of strategic initiatives in order to continue to grow as a company, organically and financially," says Katz. "We have also implemented additional meaningful cost reduction measures as of 1 April 2009, which we believe will further improve the financial performance of the company in the second quarter of 2009 and beyond," he adds.

For Q2/2009, GigOptix expects an increase in sales from new products and contracts as well as its move into the Military and Test & Measurement market with the rejuvenation of its broadband RF products.

www.gigoptix.com

Luxtera claims first commercial silicon CMOS photonics fabrication process

Fabless firm Luxtera Inc of Carlsbad, CA, USA is collaborating with Freescale Semiconductor of Austin, TX as its foundry source on what is said to be the world's first commercial silicon CMOS photonics semiconductor manufacturing process.

Luxtera was spun out of the California Institute of Technology in 2001 and received funding from venture capitalists including August Capital, New Enterprise Associates, Sevin Rosen Funds and Lux Capital. In August 2007, it launched its first product, the Blazar (the world's first CMOS photonics product, and first 40 Gigabit active optical cable). While using Freescale's prototype production line, for a number of years the firms collaborated on enhancing Freescale's silicon-on-insulator (SOI) CMOS fabrication technology to add photonic circuit capabilities to an existing 130nm electronics manufacturing process.

The new photonically enabled CMOS fabrication process enables development and manufacturing of low-cost electro-photonic integrated circuits (EPIC), bringing CMOS photonics to mainstream markets ahead of the competition, it is claimed. Silicon CMOS photonics is a key enabler of the next generation of data-networking, computer, multicore processor, and consumer electronics products, Luxtera says.

Silicon CMOS photonics enables design and manufacturing of optics and electronics on one CMOS die. The process combines standard transistors for digital and analog electronic circuitry with passive nano-photonic optical structures, as well as monolithic integration of active photonic device elements and enabling direct fiber-to-the-chip attachments. The new fabrication process allows the production of integrated single-chip transceivers for multiple applications. The CMOS photonic transceivers offer better performance, increased reliability, and reduced power consumption of

optoelectronic circuits at lower cost than traditional optical assemblies.

"Collaborating with Luxtera, we have become the first fabrication facility to enable the manufacturing of optics and electronics on a single CMOS chip and to meet the high-volume, low-cost application needs of the communication and consumer markets," says Vivek Mohindra, Freescale's senior VP of strategy & business transformation. "We are ahead of the competition by achieving the production status and shipping of commercial silicon CMOS photonics products based on this process," he claims.

"By achieving volume production status in Freescale's commercial foundry, we have now demonstrated that CMOS photonics has emerged from research and is now fully ready for mainstream commercial adoption," says Luxtera's president & CEO Greg Young. "A key element of our technology is that we enable both optical and electronic circuits on a common mainstream CMOS process, which is the industry's first," he adds. "Our silicon CMOS photonics technology platform provides us with unprecedented levels of cost, performance, power and reliability in optical systems from gigabits to terabits of data."

Luxtera is applying this process technology to deliver low-cost optoelectronic transceiver products for high-performance computing, data communications, and consumer electronics markets. The adaptation of the technology by Freescale demonstrates the flexibility to customize Luxtera's manufacturing processes to applications that have large market potential for growth, the firm says. Luxtera is also involved with projects funded by the US Defense Advanced Research Projects Agency's (DARPA) program to develop next-generation optical interconnects to produce chip-to-chip and intra-chip interconnect technology for high-performance computing systems.

www.luxtera.com

VCSEL maker VI Systems joins Optical Link

VI Systems GmbH of Berlin, Germany, a fabless developer and manufacturer of ultra-high-speed laser and photodetector chips and modules for data communications, industrial and consumer applications, is to participate in the 'Optical Link' project.

Starting on 1 July, the 24-month project is funded and managed by the Eurostars Program, a joint initiative of Eureka and the European Community. Partners include Tyco Electronics Nederland BV (in 's-Hertogenbosch, The Netherlands), LioniX BV (in Enschede, The Netherlands), the Fraunhofer IZM (in Berlin, Germany), and IHP GmbH — Innovations for High Performance Microelectronics (in Frankfurt/Oder, Germany).

The project aims to develop a new generation of ultra-high-bandwidth data communication interconnects for advanced applications including computer links such as USB 4.0 and related interfaces, PCI Express upgrades, and other vital solutions for short-reach data transfer such as future HDMI cables for audio and video signals. The partners will develop low-cost technology for optical cables by merging fast microlasers and detectors with electronic integrated circuits and photonic integrated circuits (PICs).

Originally spun-out of Germany's Technical University of Berlin and Russia's A. F. Ioffe Physico-Technical Institute in St. Petersburg, VI Systems will contribute primarily by developing ultra-high-speed single-mode vertical-cavity surface-emitting laser (VCSEL) and photodetector technologies and by performing integration services wherein its optoelectronic devices will be combined with PICs and SiGe-based BiCMOS ICs and assembled into fully packaged active optical cable.

www.v-i-systems.com

New Focus swapped for Newport's high-power laser unit

Oclaro Inc of San Jose, CA has agreed to acquire the high-power laser diode business of Newport Spectra Physics in exchange for laser and photonics components supplier Newport Corp of Irvine, CA acquiring its Advanced Photonics Solutions division's New Focus business (which makes tunable lasers, optoelectronics, high-resolution actuators, stable opto-mechanics, vacuum and ultra-clean solutions, and OEM-engineered solutions).

The two businesses are comparable in size, each with revenue of \$20–30m in the 12 months to end-March 2009. But, to reflect differences in revenues, Oclaro will also receive \$3m in cash (which should fund most related transition and integration costs). The transaction is expected to close early in the fiscal quarter ending 26 September.

"The New Focus acquisition brings a strong intellectual property position, a well-recognized brand, and a highly differentiated product portfolio to Newport," says Newport Corp's president & CEO Robert Phillippy. Of New Focus' \$30m revenue in 2008, 70% came from products that will be integrated into Newport's Photonics and Precision Technologies Division, 20% from a family of tunable and single-wavelength lasers (which will supplement Newport's Lasers Division), and 10% from subsystems for OEM applications (mainly for semiconductor manufacturing equipment).

"From a strategic perspective, we are acquiring a portfolio of high-value photonics products and systems that serve our core markets, while exiting a diode laser business that is less aligned with the focus and profit model of our Lasers Division," adds Phillippy. Most of the photonics products are currently made at Oclaro's plant in Shenzhen, China, and will be transferred to Newport's facility in Wuxi, China (roughly doubling its output). Lasers and electro-optical products currently made in San Jose will be transferred to other Newport facilities.

Oclaro was formed only in late April through a merger combining the optical components expertise of Bookham Inc of San Jose, CA with the modules and subsystems expertise of Avanex Corp of Fremont, CA to create one of the largest suppliers of optical components, modules and subsystems to the long-haul and metro optical telecoms markets.

The firm says that the transaction will allow it to expand its high-power laser diode portfolio with a deeper expertise in systems and packaging to target higher-value solutions in new markets. The Spectra Physics high-power laser diode product line is complementary to Oclaro's single-emitter and bar products and offers new growth opportunity for Oclaro in the medical and analytic, printing, and industrial markets in Japan and North America, it is reckoned. By leveraging the product line plus Oclaro's brand, chip design, technology innovation and infrastructure, the firm reckons that it is poised to become the largest merchant supplier of high-power laser diodes.

Oclaro adds that the acquisition enhances its core competences and expertise in the design and packaging of optical chips and leverages its existing global manufacturing infrastructure. Due to the process and manufacturing technology compatibility of Spectra Physics high-power laser diode products with Oclaro's manufacturing sites, it expects to cut overall costs and enhance operating efficiencies via economies of scale, with greater factory utilization.

As well as intellectual property, Oclaro acquires the operating assets of the Spectra Physics' wafer fab in Tucson, AZ (while Newport retains obligations under the facility lease). Consolidation of the fab into Oclaro's fabs in Caswell, UK and Zurich, Switzerland over the next 12 months is expected to boost wafer volumes by about 30%. Oclaro reckons that the overall high-power laser diode portfolio could yield gross margins of 40% or more, boosting gross margin for its telecom products.

The agreement includes a 4-year supply agreement whereby Oclaro will be the sole-source supplier of diodes to Newport (for incorporation into Spectra-Physics laser products) for one year, followed by majority allotment for the next three years. With no customer overlap, the acquisition should be seamless to both Oclaro and Newport customers. Both firms will provide transition-related services to the other during a 6–12 month integration period.

"Oclaro owns highly differentiated intellectual property in diode technologies and has significant design and manufacturing resources at its facilities in Caswell, UK, and Zurich, Switzerland," comments Phillippy. "We will have access to Oclaro's technology and manufacturing scale to purchase industry-leading diode lasers at very competitive price levels," he adds.

"With Oclaro as our trusted partner, Newport can focus on its own core competences as a laser systems supplier," says Dave Allen, VP & general manager of Newport's Spectra Physics Laser Division in Mountain View, CA. "We chose Oclaro specifically as our outsourcing partner due to their world-class chip design and manufacturing infrastructure. Those strengths, combined with the Spectra Physics systems understanding and packaging expertise, will create a power house in the high-power laser diode business, ideally suited as the primary supplier to Newport," he adds.

"Oclaro is executing on its strategy to become a predominant force in the fiber-optics industry," says the firm's president & CEO Alain Couder. "Through a series of strategic moves, Oclaro plans to leverage our core competences to expand our leadership position in selected markets and accelerate the pace of photonics innovation," he adds. "The high-power laser diodes business is ideally aligned with Oclaro's business model, corporate growth strategy and core competences."

www.newfocus.com

Opnext's 40Gb/s spike compensates for 10Gb/s inventory burn-off

After a drop in sales of 12% the previous quarter, for its fiscal fourth-quarter 2009 (to end March) optical module and component maker Opnext Inc of Eatontown, NJ, USA has reported sales of \$83.6m, up 15% on \$72.7m a year ago and 18.6% on \$70.5m last quarter.

In particular, sales of 40Gb/s products rose by \$34.6m to \$39.7m. However, this was due largely to the acquisition of StrataLight Communications Inc of Los Gatos, CA, USA on 9 January.

Sales of 10Gb/s and below products fell in all major product categories except XFP (down 31.3%, from \$60m to \$41.2m).

Sales of industrial and commercial products halved to \$2.7m.

Excluding \$37.8m from StrataLight, sales were \$45.8m (down 35% on last quarter's \$70.5m).

Net loss was \$118.8m, compared to \$14.5m last quarter and net income of \$0.9m a year ago. However, excluding non-cash charges and costs related to the StrataLight acquisition and stock-based compensation and class-action-related litigation expenses, non-GAAP net loss was \$18.5m.

During the quarter, cash and cash equivalents fell from \$206m to \$168.9m, due mainly to using \$26.2m for acquiring StrataLight. Cash used in operations was \$13.1m.

"During our fourth quarter, we continued to see deteriorating demand from our customers, in part due to their efforts to manage inventory levels in this difficult economic environment," says president & CEO Gilles Bouchard. "In this light, the actions announced on 1 April were designed to address our fixed cost structure and are critical to Opnext's ability to restore profitability and positive cash flow from operations."

Opnext announced plans to reduce its cost structure and operating expenses involving: a cut of about 10% in its workforce of

about 800; a 10% cut in executive salaries and directors' cash compensation; a 5% cut in salaries for other staff; the elimination of cash bonuses for fiscal 2009 and salary increases in the current fiscal year; and suspension of the firm's matching contribution to the 401(k) plan. When fully implemented by year-end, these actions are expected to contribute total annualized savings of about \$25m.

"We remain focused on cash preservation and working capital

While we foresee some rebound in 10G sales as the effects from inventory adjustments taper off, we also anticipate that 40G sales will return to more normalized levels after the spike in demand in the March quarter

management, execution of our fixed cost reductions, supply chain actions to reduce variable costs, and closure of critical design wins, while continuing to invest in future products and technologies," says Bouchard.

"We are confident we will emerge from this downturn as a stronger company, better positioned in the industry... as we address demands for greater bandwidth and higher network speeds," he adds. "We expect our June quarter [fiscal first-quarter] to reflect continued market softness," Bouchard cautions. "While we foresee some rebound in 10G sales as the effects from inventory adjustments taper off, we also anticipate that 40G sales will return to more normalized levels after the spike in demand in the March quarter following a major product transition." Overall revenue should be steady at \$80-90m.

www.opnext.com

IN BRIEF

Advanced Photonix adds ISO 9001 certification for Picometrix

Picometrix LLC of Ann Arbor, MI, USA, a subsidiary of Advanced Photonix Inc (which designs and manufactures silicon, InP- and GaAs-based photodetectors, subsystems, and terahertz instrumentation), has achieved International Standards Organization (ISO) 9001 certification of its quality systems for the design, development, manufacturing and servicing of its portfolio of high-speed optical receivers and terahertz instrumentation.

Picometrix has been supplying high-speed optical receivers since 1992, when it spun out of the University of Michigan Center for Ultrafast Optical Science. As a result, both of Advanced Photonix's manufacturing locations — in Ann Arbor, MI and Camarillo, CA — are now ISO certified.

The ISO 9001:2008 standards specify requirements in documentation, procedures and operations for a quality management system.

The standards apply uniformly to companies in any industry and of any size. Advanced Photonix says that, in achieving ISO certification, Picometrix has demonstrated its ability to consistently provide products that meet customer specification, satisfaction and applicable regulatory requirements.

"ISO registration supports our pursuit of continuous improvement and an on-going commitment to provide our customers assurance of product quality," comments Picometrix's president & general manager Robin Risser.

www.advancedphotonix.com

France's Strategic Investment Fund acquires €10m stake in 3S

In late May, 3S Photonics S.A. of Nozay, France received a capital increase of €10m (\$13.6m) through the purchase of new shares by France's Strategic Investment Fund (Fonds Stratégique d'Investissement, or FSI), which gains a representative on the firm's supervisory board.

FSI was created on the initiative of President Nicolas Sarkozy in late November amid the financial crisis, endowed with €20bn, to help stabilize small-to-medium enterprise (SME) technology and defense firms that are deemed to be strategic.

3S Photonics was founded in 1994 as Alcatel Optronics S.A. (a subsidiary of the Alcatel group) and was acquired in 2003 by Avanex Corp of Fremont, CA, USA, becoming

Avanex France S.A. In April 2007, it was bought by chairman & CEO Alexandre Krivine and entrepreneur Didier Sauvage and renamed 3S Photonics.

The firm designs and manufactures both active optical components (incorporating gallium arsenide and indium phosphide optoelectronic laser chips fabricated in-house at Nozay, France) as well as passive optical components based on fiber Bragg gratings, for use in discrete modules for high-speed telecom networks. 3S also provides foundry services using its related epitaxial and wafer processing capabilities. It employs 160 staff and reported revenues of €27.9m for fiscal 2008 (to end June 2008).

FSI will support the firm's growth strategy to develop new markets. After extending its pump laser technology from submarine to terrestrial applications, 3S aims to expand beyond telecoms markets, and has broadened its technical expertise to design a new generation of powerful seed laser modules for fiber lasers deployed in industrial systems, e.g. for micro-machining as well as microelectronics, medical and military applications. Most recently, in January, 3S launched its first product for non-telecom applications: the 1064 CHP single-mode pump laser module (with an operating wavelength range of 1050–1070nm).

www.3sphotronics.com

QPC buy-out allows continued operations

On 1 June the investor group Laser Operations LLC conducted a public sale of assets of Quintessence Photonics Corp, the operating subsidiary of high-power laser diode manufacturer QPC Lasers Inc of Sylmar, CA, USA.

This followed Laser Operations LLC on 13 May securing QPC's debt to Finisar Corp under a \$6m promissory note dated 18 September 2006.

Founded in 2000, QPC raised its first round of equity funding from Finisar in August 2001. However, last October, it defaulted by failing to make an interest payment.

Laser Operations purchased the collateral for \$750,000 (less than the amount due under the note). QPC expects to file for Chapter 7 bankruptcy protection in the near future. However, under its new ownership, the firm is continuing operations, including exhibiting at the Laser: World of Photonics 2009 show in Munich, Germany (15–18 June).

www.qpclasers.com

JDSU launches 450mW 980nm pump laser for undersea optical networks

JDSU of Milpitas, CA, USA has launched what it claims is the highest-power 980nm pump laser available for undersea optical networking. The 450mW 5100 Series pump laser will power undersea optical amplifiers that are needed to transmit fiber-optic signals along cables that span thousands of kilometers along the ocean floor, acting as trans-continental links for broadband communications.

The new pump aims to help network equipment manufacturers (NEMs) and service providers design higher-bandwidth undersea networks that can support more wavelengths or higher data rates.

The new pump laser leverages JDSU's established terrestrial pump laser package for undersea deployment. With more than 600,000 terrestrial pump devices deployed since 2000, JDSU's terrestrial pump laser platform has achieved 12 billion field hours with

a failure in time (FIT) rate of only 2.2 (the industry's lowest reported failure rate, it is claimed).

The 5100 Series also broadens JDSU's existing portfolio of undersea

The new pump laser leverages JDSU's established terrestrial pump laser package for undersea deployment

isolators and PIN detectors manufactured in Shenzhen, China. All three fiber-optic components share a common undersea manufacturing infrastructure with a low fixed cost.

Each is based on a proven terrestrial design that is also manufactured in high volumes on site, providing a stable supply chain that helps JDSU lower material costs and maintain short lead times for its customers, the firm says.

www.jdsu.com/submarine



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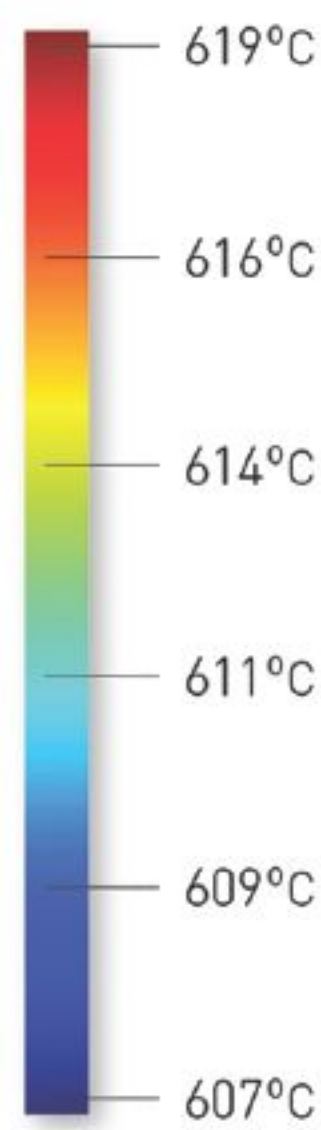
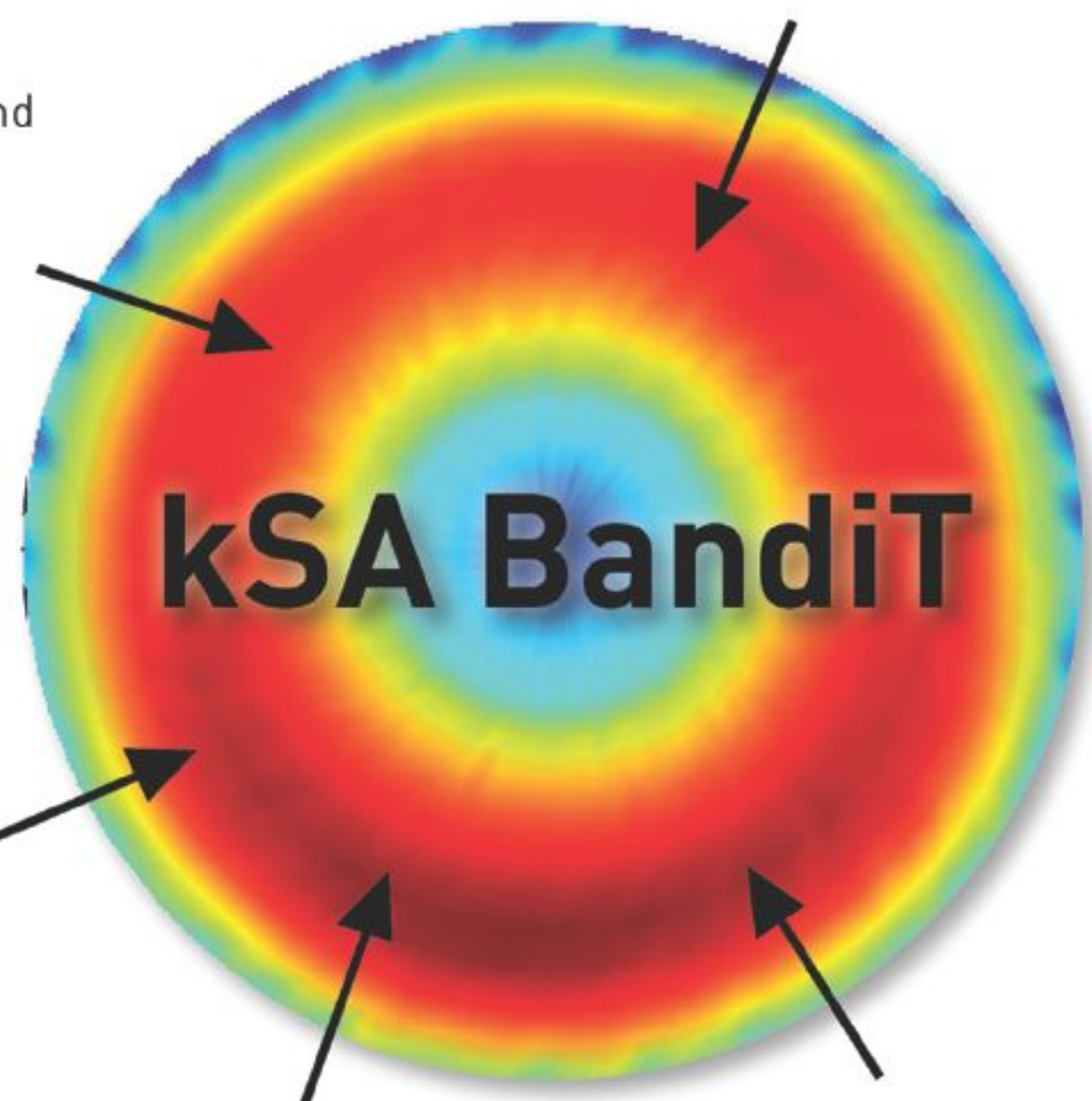
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Emcore sees late-quarter pick-up in demand

For its fiscal second-quarter 2009 (to end March), Emcore Corp of Albuquerque, NM, USA has reported revenue of \$43.3m, down 23% on \$56.3m a year ago and 20% on \$54.1m last quarter.

Fiber Optics revenue was \$28.4m (66% of the total revenue, versus 72% last quarter). This is down 28% from \$39.2m last quarter, due mainly to the economic environment producing a broad-based decline in customer demand and continued pressure on product pricing.

Photovoltaics revenue was \$14.9m (34% of total revenue, up from 28% last quarter). This is flat on last quarter, due to a decrease for concentrator photovoltaics (CPV) product lines and government service contracts negating growth for satellite solar power product lines.

Compared to 24% a year ago and -1.1% last quarter, Fiber Optics gross margin was negative 11.7%. This was due mainly to unabsorbed overhead expenses (as a result of the declining revenues), falling average selling prices, and inventory valuation write-downs of \$2.2m (magnified by efforts to monetize older-generation product inventory while transitioning to lower-cost, more competitive design platforms).

Compared to -12.8% a year ago and 13.6% last quarter, Photovoltaics gross margin was -24.7%. This was due mainly to inventory valuation write-downs of \$5.6m associated with earlier versions of CPV components and systems that have become obsolete due to the launch of newer, high-performance product platforms, plus CPV-related product warranty accruals of \$1.1m.

Excluding non-cash and other adjustments, non-GAAP net loss has risen from \$8.9m last quarter to \$14.3m.

Emcore says that, as a result of the continuation of the unfavorable

macroeconomic conditions, in combination with adverse credit market conditions, it has continued to take steps to lower costs and conserve and generate cash. In the last two quarters, Emcore has implemented measures intended to align its cost structure with lower revenues, including several reductions in staffing, the temporary furloughing of employees, salary reductions, the elimination of executive and staff merit increases and bonuses, and the elimination or reduction in certain discretionary expenses.

Also, in January Emcore completed a two-step transaction involving the sale of its remaining minority stake in Entech Solar Inc (formerly WorldWater & Solar Technologies Corp) for \$11.6m. It also greatly lowered its quarterly capital expenditure.

During the quarter, Emcore generated \$7.8m in cash from improved working capital management, and its satellite business generated positive cash flow from operations. In addition, the Fiber Optics segment generated positive cash flow from operations for the last two months of the quarter.

Nevertheless, cash, cash equivalents and restricted cash fell further from \$18.8m to \$11.6m, while working capital fell from \$75m to \$57m. Loans outstanding were \$6.2m.

Emcore has amended the terms of its loan and security agreement with Bank of America to provide

additional borrowing capacity. "We think we will have enough cash to ride out this storm if the situation does not deteriorate," says CEO Hong Q. Hou. "We continue to evaluate options for the capital raisings just in case the situation does not improve," however. The firm therefore continues to pursue and evaluate capital-raising alternatives including debt or equity financing, product joint-venture opportunities, and the potential sale of certain assets. "We expect to finalize a definitive agreement within this quarter," noted Hou.

"The decline in demand that we experienced in our Fiber Optics segment over the last several quarters continued into the second quarter," says Hou. During the quarter, order backlog fell from \$53.2m to \$30.7m (\$19.8m in Photovoltaics; \$10.9m in Fiber Optics). "However, order activity began to pick up towards the end of the quarter [especially in March], indicating that industry conditions may be stabilizing... I think the market might have bottomed out and we might be on our way climbing out of this trough," he adds.

"Despite the recent soft demand in the fiber-optics sector, we have continued to invest in developing new leading-edge products," Hou continues. At the Optical Fiber Communications conference (OFC 2009) in late March, Emcore announced the introduction of the industry's first full-band tunable XFP (TXFP) optical transceiver product, capable of replacing fixed-wavelength dense wavelength division multiplexing (DWDM) XFPs as well as high-performance tunable 300-pin multi-source agreed (MSA) transponders. Powered by Emcore's field-proven tunable external cavity laser (ECL) technology, the TXFP can be optimized for low power

We think we will have enough cash to ride out this storm if the situation does not deteriorate... We continue to evaluate options for the capital raisings just in case the situation does not improve

consumption to comply with existing XFP designs or for high optical performance to meet the requirements of existing 300-pin designs. Emcore also announced plans to release a full-band tunable TOSA (transmit optical sub-assembly) product line, combining its tunable ECL technology with a co-packaged Mach-Zehnder modulator for next-generation ultra-high-density 10Gb/s tunable interfaces. With its low power consumption, the tunable TOSA is compatible with existing XFP module and line-card requirements. It also has optical performance similar to existing solutions using a discrete tunable laser and external lithium-niobate modulator, Emcore claims. Both the TXFP and the tunable TOSA can tune across more than 90 channels on the 50GHz ITU grid.

"In our Photovoltaics segment, we continue to see very favorable trends in our satellite business and are making solid progress in the development of our Gen-III CPV terrestrial solar power system with a very competitive cost structure," says Hou. Over the last several months, Emcore signed several new long-term purchase agree-

ments with increased selling prices. The firm also expects to sign a significant multi-year supply agreement (worth \$70m) with a major aerospace company in the next month (expecting to begin shipping products this quarter).

Hou says that Emcore is making significant headway into some major European aerospace customers. The firm expects the performance advantage of its inverted metamorphic multi-junction (IMM) technology to eventually overcome the local geopolitical advantages of European solar cell suppliers to European aerospace companies. "This should result in substantial revenue growth through the extension of our customer base," adds Hou. Efficiency levels of about 45% are expected when the IMM design platform is adapted for use under a 500-1500x concentrated illumination for terrestrial applications. "We expect to commercialize this technology through applications for space power first and then for terrestrial applications [in its Gen-III CPV system] by the end of 2009," says Hou.

On the terrestrial side, Emcore deployed a new 50kW system in

China, received three additional CPV system purchase orders from US and European customers, and continued to meet internal Gen-III cost and performance targets. The demonstration Gen-III CPV system is up and running in Emcore's solar test field. "It looks like we can achieve module efficiency of 30% at a cost which would be very competitive with the future price of silicon and thin-film products," says Hou. Production of Gen-III products is expected to begin in calendar second-half 2009.

For fiscal third-quarter 2009, Emcore will continue to focus on cost and liquidity management. Compared to fiscal Q2, the firm expects Fiber Optics revenue to decline moderately (by 5-10%) but Photovoltaics revenue to rise by at least 10%, and for gross margin to rise.

Emcore also expects the satellite business to be profitable on an ongoing basis, due to increased revenues, improved product pricing, and lower costs derived through engineering projects and more effective supply chain management.

www.emcore.com

Emcore secures long-term PV contract with Space Systems/Loral

Emcore says that its Photovoltaics Division has won a long-term contract (2009 through 2014) to supply high-efficiency, multi-junction solar cells for the spacecraft programs of Space Systems/Loral.

"We have been supplying Space Systems/Loral with solar cells for more than 10 years, and we are delighted and grateful to continue this relationship for the foreseeable future," says Christopher Larocca, executive VP & general manager of Emcore's Solar Photovoltaics Division. "We look forward to working with Space Systems/Loral to power their satellite missions for many years to come," he adds.

"Emcore's Photovoltaics Division

continues to grow at a rapid pace, and has recently secured more than a dozen new production programs for fully integrated space solar panels as well as solar cells," says president & CEO Dr Hong Hou.

Emcore claims to be the world's largest manufacturer of highly efficient radiation-hard solar cells for space power applications. With a beginning-of-life (BOL) conversion efficiency of 30% and the option for a patented, onboard monolithic bypass diode, Emcore claims that its III-Vs-based multi-junction solar cells provide the highest power to interplanetary spacecrafts and earth orbiting satellites.

www.ssloral.com

PV unit general manager made COO

Emcore has appointed Christopher M. Larocca (executive VP & general manager of the Photovoltaic unit) as chief operating officer, reporting to president & CEO Dr Hong Q. Hou.

Larocca joined Emcore in 2004 as senior director of business development and product strategy. He was previously VP of GELcore, the solid-state lighting joint venture with General Electric. Prior to that, he held commercial and Six Sigma roles within General Electric's Lighting division.

"During Larocca's eight-year tenure with Emcore, and its joint venture with GE, he has been an invaluable contributor across several of our business units," says Hou.

IN BRIEF

NREL's IMM solar cell wins prize

The Federal Laboratory Consortium (FLC) for Technology Transfer has named the Department of Energy's National Renewable Energy Laboratory (NREL) of Golden, CO, USA a winner of the 2009 Award for Excellence in Technology Transfer for the commercialization of federally funded research on inverted metamorphic multi-junction (IMM) solar cells.

The original IMM cell was invented by Mark Wanlass of NREL's Concentrating Photovoltaics (CPV) Group. In 2005, the design established a solar cell efficiency of 37.9% under concentrated light equal to 10 suns. Last August, a modified version of the IMM design set a new record of 40.8% efficiency under 326 suns at NREL (since superseded by Germany's Fraunhofer Institute for Solar Energy Systems achieving 41.1% under 454 suns using a metamorphic triple-junction GaInP/GaInAs/Ge solar cell).

Since 2005, NREL and Wanlass have worked with Emcore Corp of Albuquerque, NM, USA to develop a commercial version of the IMM cell under a Cooperative Research and Development Agreement (CRADA). Commercialized versions are targeted at the space satellite market and at terrestrial use in CPV arrays, which use lenses or mirrors to focus sunlight onto the solar cells.

Wanlass and Emcore's director of R&D Paul Sharps received the award at the FLC national meeting in Charlotte, NC. Sharing the award is NREL's solar cell R&D team, including Jeff Carapella, Anna Duda, Daniel Friedman, John Gneiss, Sarah Kurtz, Bill McMahon, Tom Moriarty, Andrew Norman, Waldo Olivarez, Jerry Olson, Manuel Romero, Scott Ward, and Michelle Young.

www.federallabs.org/awards

Taiwan building demo solar farm

Taiwan's Institute of Nuclear Energy Research (INER), under the cabinet-level Atomic Energy Council, has inaugurated its photovoltaic testing center in the Kaohsiung Science Park in southern Taiwan.

The center's laboratory will provide testing services in 17 categories for Taiwan's solar industry, and help local photovoltaic firms to obtain international certification and explore the overseas market, says INER.

INER director-general Yeh Taun-ran presided over the opening, which was witnessed by Kaohsiung County magistrate Yang Chiu-hsing; Atomic Energy Council chairman Tsai Chuen-hong; and Chen Chun-wei, director-general of the Southern Taiwan Science Park Administration, who also attended the ground breaking for a demonstration solar farm in Lujhu township near the science park that is scheduled to be completed by the end of this year.

The 3.4-hectare farm will have the largest high-concentration photo-

voltaic system in Asia, reckons INER scientist Kuo Cherng-tsong, who is leading the demonstration project. Kuo says that the farm's PV system will use high-efficiency III-V solar cells. Previously, in Q4/2008 INER ordered an AIX 2800G4 MOCVD reactor from Germany's Aixtron, for delivery in Q1/2009 in 15x4" wafer configuration for its High Concentration Photovoltaic System R&D Project.

INER says its research results show that the new PV system not only offers higher efficiency in solar energy supply but can also reduce manufacturing costs.

The aim is that technology developed at the demonstration farm will be transferred to local companies.

Taiwan's cabinet has mapped out a plan to upgrade the country's renewable energy industry. The aim is to develop PV clusters so that Taiwan ranks among the world's top three solar cell producing countries.

www.iner.gov.tw

Cyrium claims record efficiencies for commercial multi-junction solar cells

Cyrium Technologies Inc of Ottawa, Ontario, Canada claims that its multi-junction photovoltaic cells now offer the highest efficiencies available for commercially manufactured solar cells.

The firm says its first-generation solar cells offer efficiencies of 40% or higher, together with a nearly constant conversion efficiency for solar concentrations from 200 to more than 1000 suns. It claims this sets a new standard for solar cells intended for use in the concentrator photovoltaic (CPV) industry.

"The most outstanding feature of Cyrium's approach is an optimized design for multi-junction cells that does not add complexity or cost," says founder & chief technology officer Dr Simon Fafard. The cells employ Cyrium's unique quantum dot technology to modify the internal struc-

ture of the semiconductor material, creating improved efficiencies over conventional multi-junction or other manufacturing techniques, he adds.

"Cyrium is pleased to set new performance standards for the solar cell suppliers to the Concentrator Photovoltaic (CPV) industry," says Fafard. "We believe the exceptional performance of our cells will enhance CPV's business case and is a key to moving the cost of renewable solar energy toward grid parity."

Cyrium is proceeding with small-volume manufacturing and qualification of its current-generation cells, which are now available to qualified CPV clients for evaluation.

Also, it expects 43% efficiency with its second-generation cells within one year, and 45% with its third-generation cells within two years.

www.cyriumtechnologies.com

SolFocus first to receive IEC certification on CPV modules

SolFocus Inc of Mountain View, CA, USA says that its SF-1000P module is the first concentrator photovoltaic (CPV) product to meet the performance, qualification and safety standards of the International Electrotechnical Commission (IEC) 62108 standard.

"The real-world testing conducted for the IEC CPV standard proves that SolFocus systems meet both the performance, qualification, and reliability criteria, critical in bringing CPV to a truly global scale," says president & CEO Mark Crowley.

"We have already proven that CPV can yield nearly twice the efficiency of traditional PV systems, but meeting the IEC's rigorous CPV requirements proves that SolFocus systems can perform consistently across a variety of climates and environments," Crowley adds.

"This validation sends a message to developers, investors and customers that CPV is on track to global commercialization."

The IEC 62108 standard for photovoltaic concentrators and receivers was created to verify the safety, photoelectric performance and environmental reliability of panels designed with CPV technology and ready to be introduced to the emerging market. The standard was designed to be universal, taking into account different environments and manufacturing technologies across geographies.

SolFocus says that its system was shown to meet all requirements of the standard, which specifies the design qualification and type approval of concentrator photovoltaic modules and assemblies suitable for long-term operation in general open-air climates. The system's electrical, mechanical, and thermal characteristics were shown to be safe, high-performing and capable of withstanding prolonged exposure in varied climates, the firm adds.

In addition, SolFocus has also just had its SF-1100 modules approved



Close-up of SolFocus' CPV system.

by the California Energy Commission (CEC) to be placed on the Eligible California Solar Initiative (CSI) Solar Electric Equipment List, which assures customers that equipment has been thoroughly tested for safety and meets the requirements of the CEC. SolFocus remains the only CPV system maker to achieve CEC listing, which is required for customers in California to receive rebates for energy produced by solar systems.

SolFocus' CPV design uses a system of reflective optics (curved mirrors) to concentrate sunlight 650 times onto gallium arsenide-based solar cells on germanium substrates that have high solar energy conversion efficiency (approaching 40%, more than twice that of traditional silicon solar cells). Like its smaller SF-1000S system (approved by the CEC last September), the SF-1100S (the firm's second product, launched last November) uses about a thousandth of the active solar cell material compared to traditional silicon-based PV panels, but boosts panel conversion efficiency from 18% to more than 25%. It is also built primarily with readily available and cost-effective materials such as aluminum and glass, delivering zero emissions energy, with the lowest carbon footprint in manufacturing (being over 97% recyclable), claims the firm.

www.solfocus.com

IN BRIEF

Mesa Glassworks factory expanded

SolFocus has opened its expanded solar glass reflector manufacturing plant in Mesa, AZ.

The firm opened its first plant in Mesa in December 2007 with 50 staff, producing 45,000 mirrors for development projects in 2008. The second plant, in the same industrial park, will allow a move into commercial production.

The proprietary, convex mirrors are a critical component within the SolFocus CPV system design.

With over a 175% increase in manufacturing floor space and a new line of manufacturing equipment, the new Glassworks plant will have the capacity to produce 2 million reflectors annually for 30MW of solar power generation — more than 15 times the plant's capacity in 2008. There are now about 100 staff, with plans to grow to 150 by the end of 2009 on ramping up to full production.

SolFocus aims to utilize the 30% manufacturing investment tax credit, as set forth in the American Recovery and Reinvestment Act (ARRA), which can provide funds for investment in solar energy generation technology.

SolFocus says that the demand that drove this expansion signals the transition of CPV from the R&D stage to commercialization. "The 30MW of product enabled by this factory will allow us to meet the rising demand for CPV technology," says president & CEO Mark Crowley. "Government bodies, utilities and large-scale commercial operations are quickly recognizing that CPV can deliver three times the efficiency of traditional solar systems with lower land use. With more than \$150bn of stimulus money available for clean energy projects worldwide, competition for available product supply will be tight, so the time to act is now," he adds.

Spain's BETASOL gains funding for second, 2.375MW solar farm using OPEL's HCPVs

OPEL International Inc of Toronto, Canada says that its partner BETA-SOL, which builds utility-grade solar farm installations for subsequent sale to investor groups, has obtained a bank guarantee of more than US\$1.5m (€1,187,500) for a new HCPV project in Spain. BETA-SOL has hence applied for permits to build a new solar farm that will provide 2.375MW of solar power generated by OPEL's Mk-I high-concentration photovoltaic (HCPV) panels mounted on dual-axis tracking systems (sufficient to supply 2700 Spanish households).

"Once the permits are obtained for this deployment of 2.375MW of HCPV generated solar power, this will bring meaningful advancement and institutionalization of HCPV installations into the region's solar



OPEL's Mk-I HCPV panels.

marketplace," says OPEL's CEO Robert Pico. "Our relationship with BETASOL is expanding," he adds.

Last December, OPEL began shipping its Mk-I HCPV panels for the first BETASOL installation, a 440kW utility-grade solar power plant on a separate site in Spain (scheduled for completion this quarter) that is expected to supply more than 500 households.

"The Mk-I HCPV panel design is highly cost effective and concentrates light from the sun more than 500 times," says Pico. "This product has conversion efficiency up to twice that of silicon flat-plate solar panels and more than three times that of thin-film solar panels, making it the optimum solution for solar grid field installations," he claims. "The use of OPEL's energy efficient panels together with Spain's feed-in tariff structure allows attractive rates of returns for solar projects."

OPEL expands in USA with director of Western Regional Sales

OPEL International Inc of Shelton, CT, USA and Toronto, Canada, which makes high-concentration photovoltaic (HCPV) panels (as well as both roof- and ground-based dual- and single-axis solar trackers for mounting them), has recruited Larry Slominski to the new role of director of Western Regional Sales, based in southern California.

He will be responsible for business development and the sales process in the western USA, and will handle OPEL's dealer network expansion and project sales. The firm says that this should enable it to increase its responsiveness to customers and capitalize on growth of its solar business in the region.

"The expansion of our solar sales force in the US reinforces OPEL's commitment to the creation of green jobs, and it ties in nicely with President Obama's green energy initiatives and his vision to generate new US jobs," says CEO Robert Pico. "More specifically,

through his extensive solar photovoltaic experience, we expect Larry to play an important role in broadening OPEL's solar power grid installation business in the US market," he adds.

Slominski has more than 25 years of experience in solar power project development, systems and component sales, applications engineering, marketing, and project financing. He has worked for United Solar Ovonic and Maxwell Technologies, and established the solar consulting firm LTS Energy. Most recently, he was head of sales for the western region of WorldWater & Solar Tech (Entech Solar) in San Diego, CA.

In February, Slominski was a joint recipient of the Jay Hollingsworth Speas Award for his work on the 2.4MW solar project at the Fresno-Yosemite International Airport. He also holds a BS degree in Mechanical Engineering from Michigan Technical University.

OPEL continues year-on-year revenue growth

For first-quarter 2009, OPEL International has reported continued year-on-year revenue growth.

Additionally, OPEL has shipped about \$400,000 (138kW) of Mk-I HCPV panels to its grid field installation in the Tarragona region of Northern Spain. This will be recognized as revenue once the 440kW field is complete and sold to a third party.

"We are pleased to report OPEL's continued growth path during the first quarter with a solid cash position, particularly during these unprecedented economic conditions," says chief financial officer Michael McCoy. "OPEL is focused on making our first Spanish installation a showcase, growing our sales force to take advantage of new opportunities and identifying ways to reduce the cost of our products."

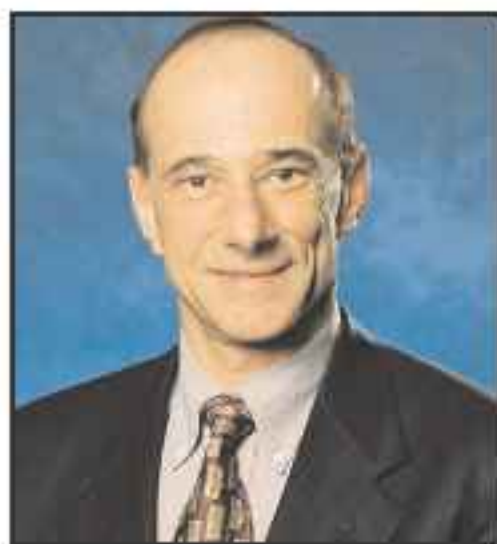
www.opelinc.com

PV developer Wakonda recruits Peter Borden as executive chairman

Wakonda Technologies Inc of Woburn, MA, USA has recruited Dr Peter Borden as executive chairman, focusing on the firm's strategic vision and direction (including work on product and market strategy and the development of strategic alliances).

Wakonda was founded in 2005 by Dr Les Fritzeimer and Dr Ryne Raffaele to exploit their respective expertise in metallurgical processing and photovoltaic devices. The firm is commercializing Virtual Single Crystal (VSC) thin-film technology that allows III-V triple-junction terrestrial photovoltaic cells to be fabricated on germanium film on flexible metal foil about 2 mils (0.0508mm) thick, rather than on germanium crystal wafer substrate (producing low-cost, high-efficiency PV cells that can be made using roll-to-roll manufacturing processes and integrated into buildings, infrastructure and personal power applications).

Investors include Advanced Technology Ventures, General Catalyst Partners, Polaris Venture Partners, Applied Ventures LLC (the venture capital arm of Applied Materials Inc) and the Massachusetts Green Energy Fund. Wakonda was named the US National Renewable Energy Laboratory's Entrepreneur of the Year in 2007.



"Peter brings an extensive solar industry background to Wakonda, as well as first-hand experience working with emerging companies, having founded and led two previous companies," says president & CEO Les Fritzeimer.

Previously, Borden was with Applied Materials from 2003 after its acquisition of Boxer Cross Inc, which he co-founded and led as chief technology officer to develop metrology systems for VLSI process control. Prior to that, he was VP & co-founder of High Yield Technology, where he pioneered the first commercially successful in-situ particle monitoring systems for VLSI process equipment. Earlier, Borden worked for Varian Associates, where he led the Photovoltaics Group, working on III-V and silicon concentrator cells and systems.

"Wakonda's approach creates new opportunities in solar cell manufacturing that will impact both existing and emerging photovoltaic markets," believes Borden.

Borden holds Ph.D. and MS degrees in Applied Physics from Stanford and BS degrees in Physics and Electrical Engineering from MIT. He is the author of over 80 publications on photovoltaics, silicon and III-V devices and processing, and VLSI process monitoring, and has over 30 patents.

www.wakondatech.com



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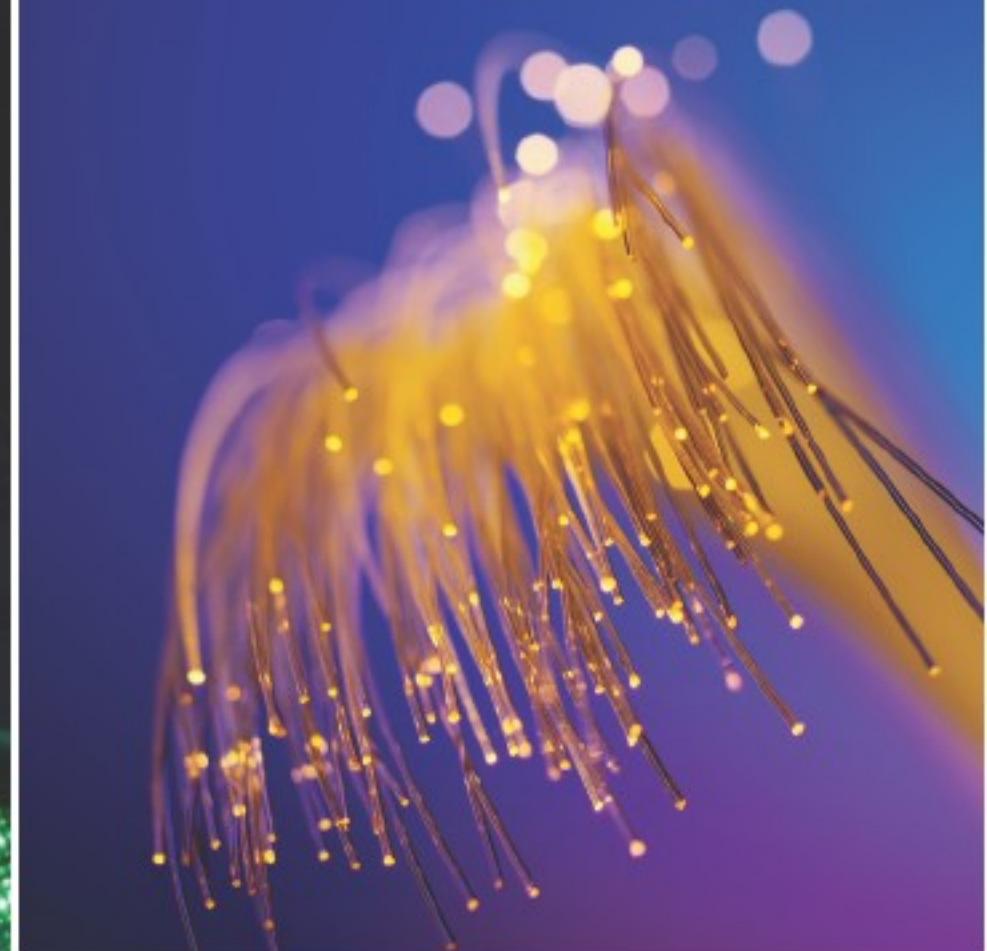
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Ascent's CIGS PV modules to be designed into development of Bye's hybrid unmanned aerial vehicle

Ascent Solar Technologies Inc of Thornton, CO, USA (north of Denver) says that its flexible thin-film copper indium gallium diselenide (CIGS) photovoltaic modules are to be designed into a hybrid unmanned aerial vehicle (H-UAV) called the Silent Sentinel developed by Bye Aerospace Inc (which was founded in 2007 and is based near Denver). The H-UAV will be designed primarily for military use. However, its capabilities will also include a broad spectrum of civil applications.

The first-of-its-kind hybrid uses stored electric power, thin-film PVs and other technologies to enhance its endurance, quiet operations and low emissions. Bye Aerospace signed a memorandum of understanding with Ascent Solar in late April to develop the solar energy capability on the aircraft. For primary propulsion, the hybrid UAV will be coupled with an advanced Williams International FJ33 turbo-

fan engine, which should enable a remarkable climb rate and high-altitude quick access to areas requiring surveillance.

The Silent Sentinel is a robust, long-range UAV that will incorporate several proprietary clean energy features, says Bye Aerospace's chief operating officer Charlie Johnson. "Ultimately, it will provide advanced tactical reconnaissance functionality while utilizing a uniquely long-endurance, highly capable tactical sensor platform that is operationally stealthy and cost-effective to operate," he adds. "The unique characteristics of the Ascent Solar flexible modules allow us to design this UAV to become very energy efficient," Johnson concludes.

"Our flexible, monolithically integrated CIGS PV technology offers the ideal combination of low weight, higher voltage, and high performance that makes it ideal for applications such as the Silent Sentinel,"

claims Ascent Solar's chief technical officer Dr Joseph Armstrong.

Potential military applications include border patrol, search and rescue, visual and thermal reconnaissance, and forward air control. Also, potential civil applications include traffic control, pipeline and power line inspection, aerial law enforcement, forest fire detection and aerial photography. Initial meetings are being conducted with US Government entities regarding the capabilities of the aircraft. More are planned in the near term.

CIGS PV products to support Bye Aerospace will be manufactured at Ascent Solar's existing 1.5MW production line at its former headquarters in Littleton, CO. The firm is currently equipping a new 30MW plant at its new headquarters in Thornton, which is due to start production late this year.

www.ByeAerospace.com
www.ascentsolar.com

Solyndra signs \$115m contract with EBITSCHenergietechnik

Solyndra Inc of Fremont, CA, USA, a start-up founded in 2005 that makes copper indium gallium diselenide (CIGS) photovoltaic (PV) systems consisting of panels and mounting hardware for commercial rooftops, has signed a long-term sales contract with solar integrator EBITSCHenergietechnik GmbH of Zapfendorf, Germany. The Euro-based contract, worth up to \$115m, extends through 2013 and brings Solyndra's contractual backlog to about \$1.8bn. The solar panels for these contracts will be manufactured at Solyndra's facilities in Fremont and Milpitas, CA.

EBITSCHenergietechnik has more than 20 years experience of installing renewable energy systems (totaling more than 1500 systems to date). "Together with Solyndra's innovative PV systems, EBITSCHenergietechnik's strong presence in

Germany and elsewhere in Europe should lead to world-class photovoltaic installations in the fastest-growing markets for commercial scale solar," says Dr Kelly Truman, Solyndra's VP of marketing, sales & business development.

Solyndra has developed a proprietary thin-film cylindrical solar panel built from tubes that capture sunlight across a 360° photovoltaic surface capable of converting direct, diffuse and reflected sunlight (from below) into electricity. The firm says that this 'self-tracking' design allows the capture of significantly more sunlight from low-slope commercial rooftops than conventional flat-surfaced solar panels, which require costly tilted mounting devices to improve the capture of direct light from the sun, offer poor collection of diffuse light, and fail to collect reflected light from rooftops

or other installation surfaces. Also, gaps between the tubes and their frame let wind pass through, reducing the need for heavy, roof-penetrating fastenings or anchoring; their lighter weight also allows installation on scantier roofs. Simple horizontal mounting hardware also allows fast and economical installation, claims the firm.

"The photovoltaics market is fast moving, so it is important to keep your eyes open for new products," says EBITSCHenergietechnik's founder & managing director Horst Ebitsch. "Solyndra's solution dramatically changes the model for installation of PV systems, expanding the market by addressing large numbers of industrial rooftops which are not economically viable with other PV technologies," he adds.

www.EBITSCHenergietechnik.de
www.solyndra.com

BioSolar expands BioBacksheet range to thin-film PVs to meet demand

BioSolar Inc of Santa Clarita, CA, USA says that it is nearing completion of the commercialization of its BioBacksheet product and is entering the pre-production stage on new versions to address the entire flat solar panel market.

Backsheets (the bottom-most layer of nearly all photovoltaic solar cell modules) are currently made from petroleum and designed to protect the solar cell from environmental hazards such as moisture and UV rays. BioSolar's BioBacksheet is a protective covering made from renewable plant sources (a cellulosic film combined with a highly water resistant and high-dielectric-strength nylon film made from castor beans). It is expected to cost substantially less than traditional petroleum-based backsheets.

"Contrary to common belief, commercialization of renewable energy technologies such as BioSolar's BioBacksheet is quite complex and requires both a comprehensive understanding and analysis of its potential, as well as the development of innovative models to help it gain market penetration," says chairman & CEO Dr David Lee.

"We continue our mission to develop new products that utilize our proprietary manufacturing and materials process to enhance the characteristics of traditional bio-based materials and turn them into robust and durable materials for solar applications," he adds.

Currently, the firm's patent-pending BioBacksheet technology for crystalline silicon (C-Si) photovoltaic solar cells is in the pre-production phase. "The C-Si area is the largest photovoltaic market segment," says Lee. "However, at BioSolar we recognize that the low-cost potential of thin-film modules, particularly CIGS (copper indium gallium diselenide) and CdTe (cadmium telluride), are emerging as formidable competitors in the global solar market and attracting gigantic investments."

In a report 'PV Technology, Production and Cost, 2009 Forecast', Greentech Media analysts forecast that, by 2012, CdTe and CIGS could comprise nearly 1.5GW and 3GW (6% and 12% of the global supply of solar panels), respectively.

"These products require a backsheet comprising an almost perfect moisture barrier," says Lee. "Glass is the material of choice. It works, but it is heavy and expensive. In response, we have started development on a BioBacksheet with the required barrier properties for this application. It is a composite film consisting of bio-based and 100% recyclable materials," he explains.

The resulting product is expected to be much lighter than glass as well as lower cost. "The greatest impediment to solar replacing fossil fuels is cost. Manufacturers struggling to make these technologies cost-effective are increasingly looking to various material choices," says Lee.

Also, many thin-film PV makers have expressed interests in a 'green' backsheet, says Lee. "Solar power produces clean energy, but for it to be considered truly sustainable, we need to ensure we are environmentally sensitive in the production and disposal process as well."

BioSolar is therefore expanding its BioBacksheet technology to accommodate CIGS and CdTe thin-film photovoltaic modules.

Two BioSolar products are in the pre-production stage. "The BioBackSheet-L, an enhanced performance backsheet for demanding PV applications, is nearing qualification for production, and the BioBackSheet-C, designed for cost-sensitive, economical PV modules, is making excellent progress in pre-production development and testing," says Lee.

"BioBackSheet-A with 'Absolute Moisture Barrier' is also doing well in the late R&D stage," adds chief technology officer Dr Stanley Levy.

www.biosolar.com

IN BRIEF

Showa Shell to spend ¥160bn to boost CIS PV panel capacity to 1GW

Tokyo-based oil refiner and solar panel maker Showa Shell Sekiyu KK plans to spend up to ¥160bn (\$1.7bn) over the next five years to increase its annual production of copper indium gallium (CIS) thin-film photovoltaic (PV) panels from the existing 80MW to 1GW, according to Bloomberg.

The firm plans to spend ¥500bn overall by the end of 2014, investing equally in refining and solar operations (allocating the remainder for investor returns, including dividends), says president Jun Arai.

After starting commercial production in 2007, Showa Shell aims to grow its share of the global solar panel market from less than 1% now to 10% within the next five years.

According to a five-year business plan released to the Tokyo Stock Exchange, the firm targets pretax profit (excluding inventory valuations) of ¥100bn (\$1.05bn) for 2014 — with the solar business earning half that total — up from break-even in 2008.

Showa Shell already has two solar-panel factories in Miyazaki Prefecture, southern Japan, with combined annual production capacity of 80MW.

The firm is now in talks to buy a mothballed Hitachi Ltd plasma TV panel plant in Miyazaki, with plans to build a third solar-panel plant there (costing about ¥100bn), to start production in 2011.

The company will decide on detailed plans for the plant in the fall of this year, says chairman Shigeya Kato.

www.showa-shell.co.jp/english
www.bloomberg.com

IN BRIEF

Abound signs deals with Wirsol and juwi

After April's opening of its fully automated commercial-scale manufacturing plant in Longmont, CO (which has an annual capacity of 65MW), cadmium telluride (CdTe) thin-film photovoltaic panel maker Abound Solar of Fort Collins, CO, USA has signed separate long-term sales agreements with two global solar integrators based in Germany: Wirsol Solar of Baden Württemberg and juwi solar of Wörrstadt.

Abound will partner with both firms to deploy its CdTe PV modules in large-scale projects, says CEO Pascal Noronha. The deals endorse Abound's ability to help deliver PV solutions for a variety of installations, he adds.

Wirsol is a full-service provider of PV systems with more than 2000 installations worldwide. "Abound Solar modules will enable us to significantly accelerate our deployment of multi-megawatt solar installations," says Wirsol's managing director Markus Wirth. "Our relationship with Abound Solar and the potential of the US market has led us to open our North American office in Fort Collins, CO so that we are in a position to work collaboratively to develop large projects around the world," he adds.

"juwi is a premier solar integrator in the large-scale segment of the market and has the scale and global footprint to support our aggressive growth plans," says Noronha. "Having carefully examined many emerging solar technologies, we are convinced that Abound Solar will be a leading photovoltaic manufacturer with modules that meet our strict requirements for cost-effective performance and reliability," says juwi's managing director Lars Falck.

www.abound.com

First Solar agrees multi-year supply contract with Germany's Pfalzsolar

First Solar has signed a long-term supply deal with Pfalzsolar GmbH, a solar project developer owned by Pfalzwerke AG (a public utility in the Rhineland-Palatinate, Germany).

The latest utility-linked agreement initially foresees delivery of cadmium telluride (CdTe) thin-film photovoltaic modules for use in rooftop and free-field solar projects in Germany.

"This agreement reinforces First Solar's relationships with utility-owned project developers and demonstrates that local utilities increasingly see photovoltaic power as a necessary component of their future electricity generation portfolio," says Stephan Hansen, managing director of First Solar GmbH of Munich, Germany.

Germany is a key market at a key period for the evolution of solar electricity in Europe, adds John Carrington, executive VP, global marketing & business development.

"The agreement gives us the guarantee of being able to offer high-performance modules at competitive prices, thereby helping us fulfill our ambitious growth targets," says Pfalzsolar GmbH's managing director Ali Boukhalifa.

First Solar initiates recruitment of new CEO

First Solar Inc of Tempe, AZ, USA has initiated an external search (led by a committee of its board of directors) for a new CEO to succeed Michael Ahearn.

As well as remaining a major shareholder, Ahearn will continue in the full-time role of executive chairman (focusing on the development of public policies needed for the global transition to low-carbon energy infrastructures).

"We are rapidly reaching the point where the evolution of the energy industry will be constrained not by technology or product costs but rather by policies, programs and institutions that cannot adapt rapidly to the innovations that are occurring in clean energy," says Ahearn. "Given First Solar's leadership position in the industry, I believe we are in a unique position to make a valuable contribution to those policy discussions," he adds. "This will require virtually full-time focus from the very top of the organization."

www.firstsolar.com

First Solar's revenue dips by 3.5% in Q1/09

For first-quarter 2009, First Solar has reported revenue of \$418.2m, more than double \$196.9m a year ago but down 3.5% on \$433.7m last quarter, due mainly to planned annual price reductions on 1 January under long-term contracts.

Nevertheless, net income was \$164.6m (\$1.99 per share on a fully diluted basis), up from \$46.6m (\$0.57 per share on a fully diluted basis) a year ago and \$132.8m (\$1.61 per share) the prior quarter.

First Solar's capacity expansion

| Plant | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|------------------|------|------|-------|---------|--------|--------|
| Ohio plant | 25MW | 33MW | 44MW | 48MW | 48MW | 48MW |
| Ohio expansion | * | 66MW | 88MW | 96MW | 96MW | 96MW |
| German plant | — | * | 176MW | 192MW | 192MW | 192MW |
| Malaysia 1 | — | — | * | 192MW | 192MW | 192MW |
| Malaysia 2 | — | — | * | ~192MW | 192MW | 192MW |
| Malaysia 3 | — | — | * | Ramp-up | 192MW | 192MW |
| Malaysia 4 | — | — | — | * | 192MW | 192MW |
| Ohio expansion 2 | — | — | — | — | — | 48MW |
| Total capacity | 25MW | 99MW | 308MW | ~720MW | 1109MW | 1152MW |

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Sunovia wins \$33m order for EPIR's MWIR wafers

Sunovia Energy Technologies Inc of Sarasota, FL, USA has finalized a \$33m basic order agreement to provide mid-wavelength infrared (MWIR) single-layer, undoped wafers for night-vision camera applications.

Through its partnership with infrared detector maker EPIR Technologies Inc of Bolingbrook, IL, USA, Sunovia has exclusive marketing rights to a growing line of infrared products for civilian and military night-vision markets. The firm has filed the required applications with the US Federal departments that govern the sale of infrared products, and expects to receive the necessary export permit to begin shipping during the third-quarter 2009.

EPIR was founded in 1998 by chairman & CEO Dr Siva Sivananthan, who pioneered mercury cadmium telluride (HgCdTe) on silicon infrared technology for night vision.

The firm uses molecular beam epitaxy to produce single- and multiple-element focal plane array IR detectors, which are supplied with packaged detector/cooler assemblies.

"As a primary supplier of night-vision technology to the US military and its allies, EPIR is held to the highest standards imaginable," says Sunovia's chairman & CEO Carl Smith. "Our business plan has been to underwrite a significant portion of the solar system development costs with revenues from the sale of both proprietary infrared products and our proprietary LED lighting solutions," he adds. "The successful commercialization of the infrared product lines by EPIR is a key milestone in the execution of this plan," concludes Smith.

Sunovia and EPIR win \$9m SBIR award from Department of Defense

Sunovia Energy Technologies Inc of Sarasota, FL and EPIR Technologies Inc of Bolingbrook, IL, USA (in which Sunovia has a stake) have received a \$9m Small Business Innovative Research (SBIR) Phase III contract from the US Department of Defense (DoD) that allows the expansion of production capacities and capabilities of the partners' cadmium telluride on silicon (CdTe/Si) manufacturing program.

Sunovia and EPIR claim to be the only firms in the solar energy sector that are capable of growing single-crystal, high-quality CdTe/Si wafers. CdTe/Si growth was pioneered by EPIR's founder, chairman & CEO Dr Siva Sivananthan for infrared imaging applications. After more than 10 years of R&D, the firms have commercialized CdTe/Si wafers, which can drastically cut the cost of infrared cameras for the US military, it is claimed. Most of the research was funded by the Department of Defense, but is resulting in increasing sales in

three different market sectors.

The technology is now being adapted for the solar market, and the firms are ahead of schedule in delivering high-efficiency solar cells that can be produced at about one-fifth of the cost of existing high-efficiency solar cells, it is claimed. The speed of commercialization of the solar cells has allowed Sunovia and EPIR to accelerate the marketing of solar power to global utilities and governmental markets. The firms are currently under contract to install 20MW of capacity at the Cibernetique Parque in Santo Domingo, Dominican Republic.

Sunovia and EPIR say that they are aware of no competitor in the industry, including CdTe thin-film photovoltaic (PV) module maker First Solar Inc of Tempe, AZ, USA and crystalline silicon PV panel maker SunPower Corp of San Jose, CA, USA, that is capable of achieving a comparable cost per Watt.

www.sunoviaenergy.com

www.epir.com

SAGFET/MOSFET inventor joins EPIR as senior director of Product Innovation

In late April, Dr Robert W. Bower, inventor of the self-aligned gate field-effect transistor (SAGFET) and metal-oxide semiconductor field-effect transistor (MOSFET), joined EPIR as strategic advisor & senior director of Product Innovation.

Bower is an emeritus professor of the Electrical and Computer Engineering Department of the University of California at Davis

Bower is the only person ever inducted as a member to both the National Inventors Hall of Fame and the Semiconductor Hall of Fame. The firms say that his expertise further enhances their low-cost, high-throughput multi-junction solar cell manufacturing processes.

"The CdTe/Si solar substrate that EPIR and Sunovia are currently

commercializing has the potential to become the standard for solar chip development in much the same way SAGFET and MOSFET became the standard for ICs," says Bower. "EPIR has already established dominance in the infrared field, and my assessment is that EPIR and Sunovia will fulfill their great promise in becoming dominant in solar energy," he reckons.

"Bower is already contributing greatly to our ultra-high-efficiency solar cell development and new infrared imaging products," says EPIR's founder & CEO Dr Siva Sivananthan. "Bower is also developing a new product line of silicon ICs that cost effectively add light emission from the circuit's nodes," he adds.

DOE selects EPIR/Sunovia's CdTe-on-Si PV technology

The cadmium telluride on silicon (CdTe/Si) solar technology of Sunovia Energy Technologies Inc of Sarasota, FL and EPIR Technologies Inc of Bolingbrook, IL (in which Sunovia has a stake) has been selected for award negotiation for the Solar America Initiative (SAI) Photovoltaic Technology Pre-Incubator award, as announced by US energy secretary Steven Chu. The selection process was conducted in accordance with the 'Best Value Selection' requirements of the Department of Energy. The Solar America Initiative is the US program for the development and commercialization of solar energy, and the Pre-Incubator award is one of the most prestigious SAI awards.

The primary SAI program goal is the development and commercialization of environmentally friendly solar energy technologies to produce electricity at costs competitive with electricity generated from fossil and nuclear fuels. Sunovia and EPIR expect to achieve such grid parity by commercializing high-effi-

ciency multi-junction CdTe-based concentrator solar cells at a small fraction of the cost of the III-V multi-junction solar cells that are currently used in concentrating photovoltaic (CPV) applications. CPV technology uses inexpensive lenses to concentrate sunlight onto small, highly efficient solar cells, thus requiring less land and far less costly material than other photovoltaic technologies.

"The selection of our solar technology by the Department of Energy is a confirmation by the government's leading solar energy experts of the potential commercial

Our partners at EPIR have a virtual monopoly on single-crystal CdTe/Si production, which provides us with critical advantages and protections as we commercialize this new product line

value of the developments that EPIR and Sunovia have accomplished," says EPIR's founder, president & CEO Dr Siva Sivananthan.

"Our partners at EPIR have a virtual monopoly on single-crystal CdTe/Si production, which provides us with critical advantages and protections as we commercialize this new product line," says Sunovia's CEO Carl Smith.

"We have already signed a contract to construct the largest CPV solar energy power plant in the world, which will create important manufacturing jobs for many workers laid off by the US semiconductor and automotive industries," he adds.

"EPIR has already begun hiring skilled technicians and workers in Illinois who were laid off by these industries, and we are working through the appropriate channels to ensure that new manufacturing jobs are created in states with important demographic synergies."

www.sunoviaenergy.com

www.epir.com

Sofradir demonstrates MCT-based avalanche photodiode mid-waveband infrared detector for extreme low light

At the SPIE Defense, Security & Sensing Conference 2009 in Orlando, FL, USA (14-17 April), Sofradir of Châtenay-Malabry, near Paris, France, which manufactures cooled infrared detectors based on mercury cadmium telluride (MCT/HgCdTe) for military, space and industrial applications, demonstrated its new low-noise avalanche photodiode (APD) mid-TV format infrared (IR) detector for amplifying low input signals.

The 30µm-pitch APD detector offers a flexible solution for emerging opportunities in IR applications where input light signals are very low, says Philippe Tribolet, VP R&D, technology & products. The new low-noise APD IR detector offers system integrators a choice of wavebands, more compact optics

and an ability to overcome any low-input-signal read-out integrated circuit (ROIC) performance degradation, he adds.

The new APD expands Sofradir's portfolio of MCT IR detectors in the short-waveband (1-2.5µm) and mid-waveband (3-5µm) regions of the spectrum. It can be used for active imagery (2D or 3D) as well as passive imagery, where low input signals are amplified.

Designed for military applications, active imagery (laser-gated imaging), spectrometry, gas detection and a range of scientific applications, the MCT-based 30µm-pitch APD IR detector enables users to operate cameras with small apertures or with narrow wavebands in extreme low light detection.

It can amplify low input signals by a factor of 5300, keeping the photodiode signal-to-noise level constant, which is a result unmatched by competing technologies, the firm claims.

* At the conference, Sofradir also presented five technical papers on MCT technology:

- 'Uniting IR detectors for tactical & space applications: a continuous cycle of reliability';
- '50 years of successful MCT research and production in France';
- 'New high-gain IR detectors for active imaging';
- 'Ultra-low-power ADC on chip for high-performance IR detectors'; and
- 'Sofradir MCT technology for space applications'.

www.sofradir.com

MANTECH sheds light on new applications

Compound Semiconductor Manufacturing Technology conference saw increased diversification and a new focus on photovoltaics in the light of inventory correction in established wireless markets, reports Mark Telford.

Falling just the week after the 21st IEEE conference on Indium Phosphide and Related Materials (IPRM 2009) in Newport Beach, CA, which drew just 110 delegates, attendance at this year's International Conference on Compound Semiconductor Manufacturing Technology (CS MANTECH 2009) in Tampa, FL (18–21 May) was also well down on last year (from 420 to 255 delegates) due to the ongoing impact of the credit crunch and ensuing economic downturn since last Autumn.

However, compared to IPRM, the MANTECH event is less dependent on delegates from Japan, where some firms imposed home quarantine on employees returning from the USA due to the H1N1 swine 'flu epidemic. Nevertheless, out of the 66 scheduled conference papers at MANTECH (including 25 non-US), several from Japan were either withdrawn or presented in their absence by international colleagues.

The exhibition likewise suffered several withdrawals (leaving about 50 exhibiting firms). These included China Crystal Technologies Co Ltd and the five AXT materials joint ventures in China, due to the quarantine regulations imposed by the Chinese government.

Nevertheless, despite there being just four delegates from the biggest RF component supplier, RF Micro Devices of Greensboro, NC (which has been cutting costs more severely than most during the downturn), there was still a healthy presence from less hard-hit rival GaAs RFIC makers Skyworks and TriQuint Semiconductor (from both its Oregon and Texas fabs).

Upheaval making industry leaner and broader

Conference chairman Scott Davis of Sumitomo Electric Industries opened the conference by describing how, in a turbulent year of economic change, compound semiconductor manufacturers have been having to adapt to unpredictable markets, inventory corrections, and tighter access to capital. Nevertheless, the industry is well positioned to weather the storm, he reckons. As a source of technological change, it enables more to be done with less, and will emerge from economic upheaval both leaner and broader, he believes.

Compared to previous MANTECH conferences, there were fewer reports of record-setting performances of transistors in R&D and more papers focusing on manufacturing and reliability issues. This is perhaps a healthy sign of the maturing of the industry and its focus on high-volume, cost-conscious mainstream applications. It was also perhaps an indication of concerns over the slowdown of established markets such as mobile wireless handsets as well as diversification through the potential application of technology to fast-developing markets such as LEDs and concentrator photovoltaic (CPV) solar cells.

Prospects for riding out the slump

In an invited presentation 'The Impact of the Financial Crisis on the Compound Semiconductor Industry' in the first plenary session, market analyst Earl J Lum of EJM Wireless Research LLC explained how, compared to the previous telecom downturn of 2001 (driven by the Asian financial crisis and the Internet bubble), the current financial crisis is neither regional nor sector-specific but global and wide ranging, with a greater impact on the banking sector and capital markets. With consumers choosing to upgrade their mobile handsets later than in prior years, 2009 will see the first annual decline in handset shipments. Lum pointed out that, whereas the compound semiconductor industry's growth has previously been fueled

The difficulty in securing debt and equity financing in capital markets now will cascade into the compound semiconductor industry supply chain

partly by extraordinarily forgiving capital markets, the difficulty in securing debt and equity financing in capital markets now will cascade into the

compound semiconductor industry supply chain, placing companies low on cash reserves with marginal profitability (and debt payments due in the short to medium term) in a particularly precarious situation. The challenge is how to survive through the next 18–24 months of the downturn into 2011.

However, Lum points out that, despite the credit situation being worse than in 2001, mobile operators now at least have cash reserves and are making money (and, unlike 3G, have no hefty license fees to pay for 4G, LTE and WiMAX). Also, compared to mobile phones being a luxury in 2001, they are now a necessity. Despite the downturn in shipments expected in 2009, the number of users is expected to grow from 1.2bn in 2008 to 5bn in 2012.

Nevertheless, the debt incurred in 2001–2003 is now due, so Lum anticipates further consolidation following Alcatel–Lucent and Nokia–Siemens in the last downturn (starting with Nortel Networks, currently in Chapter 11 bankruptcy). In particular, he expects that, after Ericsson, China's Huawei will become the second-biggest telecom infrastructure provider in 2009, closely followed by ZTE, such that domestic OEMs will take a 40–50% market share of contracts in China (fueled by ready funding from state-controlled banks). In total global handset shipments, he expects Motorola and SonyEricsson to be overtaken by Chinese firms breaking into the list of top 5 vendors (with Huawei and ZTE currently shipping 10m handsets per quarter, up from none in 2001).

Regarding GaAs component suppliers for wireless handsets, Lum points out that, since 2007, only Skyworks' stock price has remained relatively flat, compared to declines of 60% for TriQuint and about 85% for both Anadigics (after difficulties last year in expanding GaAs fab capacity) and RFMD (following concerns over its acquisitions and debt levels).

Lum says that RFMD's late 2007 acquisition of Sirenza Microdevices of Broomfield, CO was completed at an extremely high valuation, draining its cash reserves (to \$257m at the end of 2008) and sharply increasing long-term debt due in 2010–2014 (to \$582m) just as the financial crisis was beginning. The firm's reduced market capitalization (barely more than its cash reserves) makes it difficult to refinance this debt, but also diminishes the firm's appeal as a takeover target, says Lum. However, he points out that, after its rapid cost-cutting efforts of Q4/2008, in Q1/2009 RFMD generated \$50m in free cash flow, allowing it to repurchase \$22m of debt and add \$28m to cash reserves. RFMD reckons on generating \$80–120m in free cash flow per quarter during Q2–Q4/2009. At the current profitability level, RFMD should be able to make its debt payments, says Lum.

In contrast, at the end of 2008, Skyworks' total debt of \$238m was outweighed by its cash reserves of \$391m (which also grew in Q1/2009). TriQuint has just \$43m in cash reserves, but this also rose in Q1/2009, and the firm has no long-term debt.

CS MANTECH awards

For last year's CS MANTECH 2008, the Best Paper Award was presented to Dorothy June, M. Hamada and William J. Roesch for 'Reliability and MMIC Technology Development and Production'.

The Best Student Paper was co-awarded to: the University of Illinois' William Snodgrass and Milton Feng for 'Nano-scale Type-II InP/GaAsSb DHBTs to reach THz Cutoff Frequencies' and Pennsylvania State University's David J. Meyer, Joseph R. Flemish and Joan M. Redwing for 'Pre-passivation Plasma Surface Treatment Effects on Critical Device Electrical Parameters of AlGaIn/GaN HEMTs'.

Anadigics had \$136.8m in cash reserves at the end of 2008, but made a net loss of \$22m in Q1/2009 and is expected to have cash burn of \$5–7m per quarter during Q2–Q4/2009. Lum therefore reckons that Anadigics will need to raise funds by 2012.


Regarding epiwafer suppliers, Kopin of Taunton, MA has more than \$100m in cash reserves, no long-term debt, and a long-term supply relationship with the best-performing GaAs IC maker, Skyworks. In contrast, IQE has 'significant' debt obligations and little cash.

If Anadigics and AXT can stabilize their cash burn by 2010, then they should be able to raise cash from the capital markets, ensuring survival

Regarding bulk GaAs substrate suppliers, AXT Inc of Fremont, CA has no significant debt plus cash reserves of \$31.3m, but needs to balance its revenues (\$7.7m, down 51% on the prior quarter) with its cost structure (making a loss of \$5.5m in Q1/2009). At an expected cash burn rate of \$2–3m per quarter during Q2–Q4/09, if its financial picture does not improve then it could run out of cash in 24 months, says Lum. With a market capitalization below \$30m, AXT has been mentioned by securities analysts as a possible acquisition target.

In contrast, rival GaAs substrate makers Sumitomo Electric and Hitachi Cable of Japan have ample cash reserves, while Germany-based Freiberger Compound Materials can draw on the reserves of main shareholder Federman Enterprises Ltd.

Despite the concerns, Lum concludes that, if Anadigics and AXT can stabilize their cash burn by 2010, then they should be able to raise cash from the capital markets, ensuring survival.

Overall, Lum thinks that the economic slump will bottom by the end of 2009/early 2010. In 2010, although the infrastructure market will continue to be weak (except in China and India), the handset market should be stable (with shipments of 1bn, $\pm 10\%$), boosted by a high mix of smart-phones. 

At the current profitability level, RFMD should be able to make its debt payments

New focus on photovoltaics

This year's MANTECH conference was also distinguished by the increased focus on photovoltaic technology with, for the first time, a whole session on solar cells (chaired by Noren Pan of III-V based PV cell maker MicroLink Devices in Niles, Chicago, IL).

Walter Wohlmuth, manager of the transparent conducting oxide (TCO) R&D group at First Solar Inc in Perrysburg, OH (and formerly of RFMD and TriQuint), gave an overview of the firm's manufacturing of cadmium telluride (CdTe) thin-film photovoltaic modules (using simple deposition technology on glass or metal substrates), which are in direct competition with silicon-based solar cells for flat panel applications. Wohlmuth reported that, after lowering the cost per module below \$1/Watt in Q4/2008, it has now reached \$0.93/W. Also, although the cell efficiency is currently just 11%, First Solar has a roadmap to improve this, including gains through improving the current collector (1%), conversion and transport (0.35%), and light collection (2.1%). Also, it does not yet use anti-reflection coatings.

In a contributed paper, Ruediger Schreiner, director sales project management of MOCVD equipment maker Aixtron, described the improvement of deposition quality and the reduction in cost of growing epilayer structures for triple-junction photovoltaic cells (by boosting the efficiency of source material usage as well as increasing the deposition speed). This is done by using a more flexible three-fold gas inlet head (already production proven for nitride-based LEDs, and now released as a standard feature for Aixtron's AIX2800G4 reactor).

The three-fold gas inlet head comprises a group-III metalorganic inlet for tri-methyl alkyls (e.g. TMGa, TMIIn, TMAI) sandwiched between upper and lower group-V hydride inlets for phosphine (PH₃) or arsine (AsH₃). With the aid of computational fluid dynamics (CFD) simulation of flow field velocity patterns, the ratio of flows on the upper and lower group-V inlets was adjusted in order to tune the steering of the source reactants towards the growth surface as well as to improve the uniformity of the growth rate on the rotated wafer satellite (settling on a 30:70 split between upper:lower flow rates).

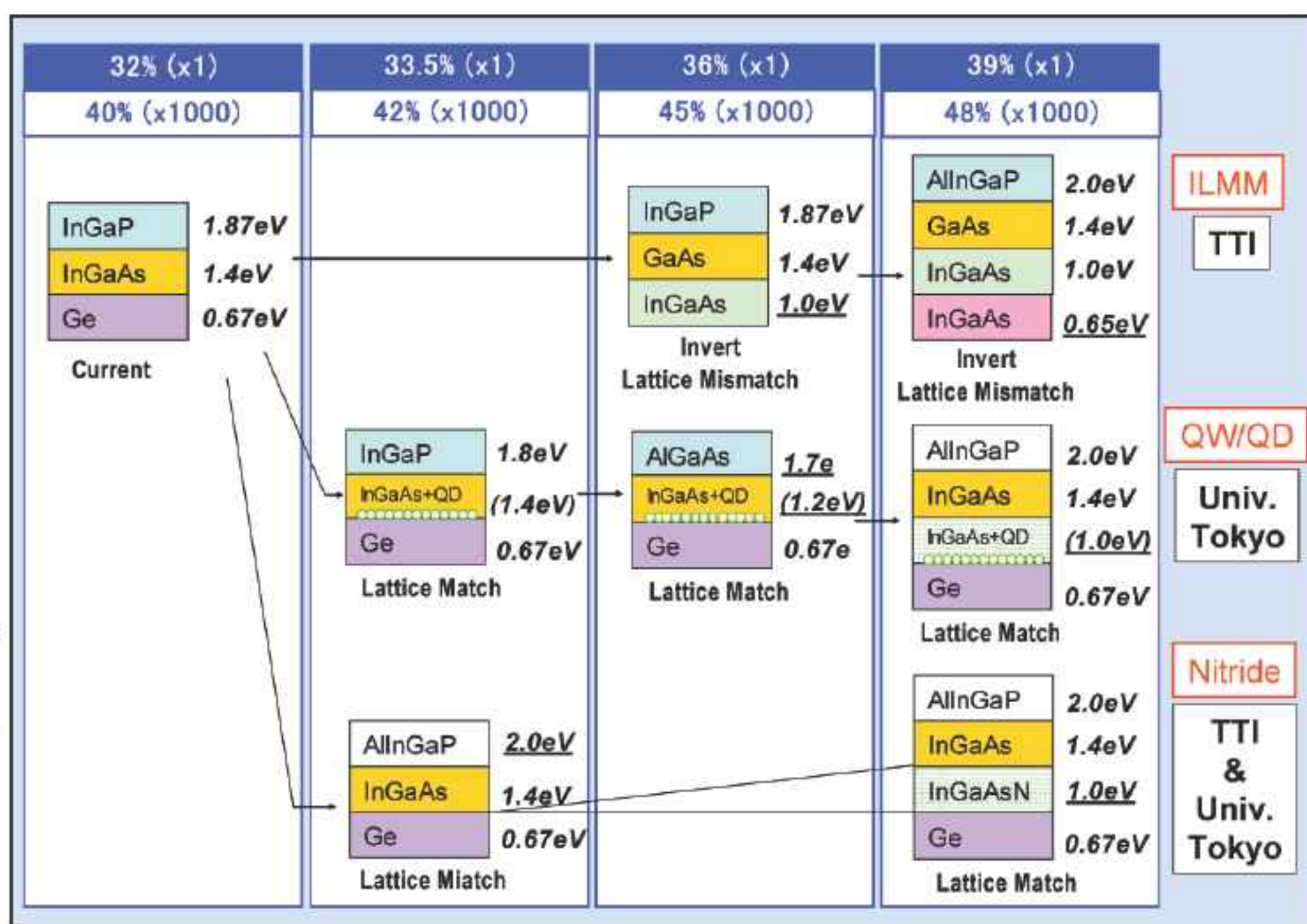
Experiments were performed using four 2" wafers across the 8" satellite of an Aixtron AIX2800G4 reactor, allowing an estimate of the transferability of results to 8" wafers (for which uniformity is key for managing strain in the growing epilayers and hence wafer bow, especially for GaAs-based devices on Ge substrates).

The experiments achieved Group-III precursor efficiencies of 42.7% (AlAs/GaAs) and 39.9% (GaInP) for TMGa, and 37.8% and 34.2% for TMAI and TMIIn, respectively (showing an increase of about 1.3% on average for all precursors). In addition, growth rates as high as 15.2µm per hour were achieved for InGaAs (at a reactor total pressure of 50mbar) without any roll-off from the linear dependence on the group-III molar flow. Combined, these two factors can cut the cost of ownership for mass production of terrestrial triple-junction photovoltaic cells, Aixtron reckons.

N.B. Comparative studies using an Aixtron AIX2800G4 HT reactor for GaN growth showed that increasing the reactor total pressure leads to roll-off in linearity with increasing TMGa flow at lower growth rates (due to the onset of gas-phase pre-reactions before the leading edge of the wafer). So, the growth rate cannot be increased infinitely by increasing the flow rate.

Dr Tatsuya Takamoto of Sharp provided an overview of the current status of various solar cell technologies. Solar cells based on Ge substrates are used for most high-efficiency solar panels for satellite applications. Research on high-efficiency PVs was covered, including inverted metamorphic, quantum dots, and wide-bandgap cells based on nitride materials, referring to work with University of Tokyo and Toyota Technological Institute on a program sponsored by Japan's New Energy and Industrial Technology Development Organization (NEDO).

Sharp reported preliminary results for inverted metamorphic triple-junction photovoltaic cells, achieving an efficiency of 30.4% without concentration. The firm has previously achieved an efficiency of 24.8% for thin-film InGaP/GaAs dual-junction cells, on thin, flexible 'solar sheets' (without a substrate) for space applications.



Roadmap for NEDO photovoltaic development program.

Also, the opening plenary session included an invited presentation from Sarah Kurtz of the US National Renewable Energy Laboratory (NREL) giving an overview of the competitive position of the emerging concentrating photovoltaics sector (with respect to other solar technologies that currently dominate the market) as well as future prospects. This drew much interest from microelectronics-focused delegates from companies interested in diversifying into such a promising growth sector (as exemplified by the recent announcement of RFMD's collaboration with NREL on developing PV processes and high-volume manufacturing).

Kurtz summarized how annual photovoltaic production capacity has grown from 371MW in 2001, through 2006 (when the weight of silicon used for solar cells exceeded that used for microelectronics) to 7GW in 2008 (leading to a shortage of silicon).

Although there will not be much growth this year (partly due to the strong Spanish government incentive program expiring), if the solar industry returns to doubling in capacity every year, then it should grow from comprising just 0.1% of electricity generation now to 5% in 2020, generating 100GW per year without any need for storage (or 4TW/yr with storage), she reckons.

For CPVs in particular, 2008 was the first year that multiple companies surpassed 1MW of installations, Kurtz says, concurring with a figure in PHOTON International of 14MW in total (including 6.5MW of high-concentration, multi-junction CPV systems). Kurtz counts more than 30 firms that are developing CPV systems. Although many are just getting started, many have already deployed 1–100kW in the field and are ramping up production, and several claim to have annual manufacturing capacity of more than 10MW (which she deems to be the threshold for low-cost manufacturing). For 2009, 50MW of high- and low-concentration CPV systems are expected to be installed, which could be a "turning point", says Kurtz (providing that the macroeconomic environment does not limit firms' ability to negotiate contracts). Citing other PV technologies requiring years of development before large-scale success (e.g. First Solar's current rapid expansion), she says that the multi-junction CPV industry is currently in the process of emerging from the development phase.

Just as some silicon PV companies are moving toward vertical integration, many CPV firms are considering vertical integration with cell companies to ensure adequate cell supply. In contrast, cell companies want to retain their ability to supply many CPV firms. However, this is easing as the established concentrator cell sup-

pliers Spectrolab and Emcore in the USA and Azur Space in Germany (which is now the primary supplier to some CPV systems makers) have been joined by several new entrants demonstrating epitaxial (single-crystal) growth of multi-junction concentrator cells. These include Spire (Bandwidth), Cyrium and Microlink Devices in the USA, CESI, Energies Nouvelles et Environnement (ENE), IQE and QuantaSol in Europe, and Japan's Sharp and Taiwan's Arima, Epistar and VPEC in Asia (making more than a dozen firms developing multi-junction concentrator cell manufacturing).

However, Kurtz cites the example of system integrators benefiting the LED industry, saying that the same is needed in the CPV industry. Given the small number of firms supplying multi-junction CPV cell assemblies, in the long term firms with cell assembly capabilities may be targeted for acquisition as the industry moves toward vertical integration, believes Kurtz.

News from Exhibitor's Forum

In the 'CVD/Deposition' session of MANTECH's Exhibitor's Forum, Jean-Luc Ledys, CEO of SOITEC subsidiary Picogiga International of Courtaboeuf, France, outlined the firm's R&D roadmap and product strategy.

Since 2006, the firm has been providing GaN epitaxy grown by molecular beam epitaxy (MBE) on multiple 3/4-inch or single 6-inch substrates of either sapphire, silicon or silicon carbide (SiC) for low-volume applications (e.g. mobile phone base-stations). Compared to MOCVD, MBE yields no reaction by-products and hence fewer impurities/traps, leading to a reduced kink effect in HEMT devices as well as better reliability. The firm offers 1.8–3µm thick epilayers for RF/low-voltage (<400V) power HEMT devices.

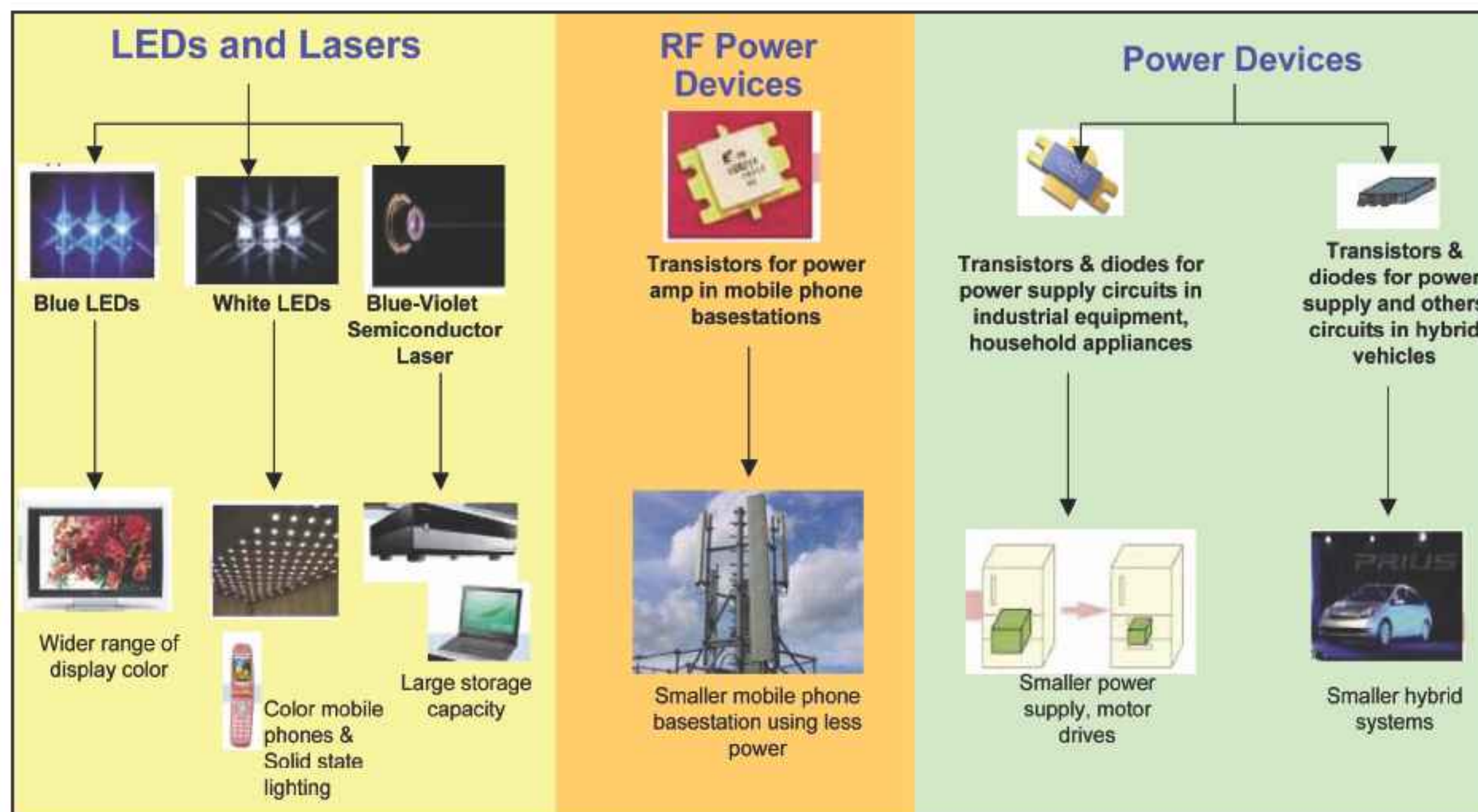
Also, from this year, for higher-volume power device applications (e.g. power supplies, motor drives, hybrid systems for vehicles) Picogiga is offering MBE-grown 3–4µm GaN epi on silicon for normally-on HEMT power transistors operating at 600V and 10A.

However, in the last few months Picogiga has acquired a 6-inch MOCVD reactor. MOCVD growth is faster and allows the firm to grow thicker epilayers for such high-voltage devices. From 2010, it aims to start supplying 4–6µm thick GaN epi on silicon for normally-on HEMT power transistors operating at 600V and 10A.

Meanwhile, beginning this year, the firm also aims to start offering MOCVD-grown horizontal Schottky barrier diodes using 3–4µm GaN epi on silicon, followed next year by Schottky barrier diodes using both 3–4µm GaN epi on silicon and GaN on polycrystalline silicon carbide).

In addition, Picogiga has designed its own hydride vapor phase epitaxy (HVPE) reactor. Compared to MOCVD, HVPE allows faster growth rates as well as lower threading dislocation densities (TDD). It therefore enables re-growth of thicker epilayers on free-

Firms with cell assembly capabilities may be targeted for acquisition as the industry moves toward vertical integration



Device applications targeted by Picogiga with its gallium nitride epitaxy technology.

standing GaN donor substrates with TDD reduced from about $10^8/\text{cm}^2$ to 10^4 – $10^6/\text{cm}^2$, i.e. GaNoX (GaN on either sapphire or pSiC). Starting in 2011, it aims to use this to offer normally-off vertical FET power transistors using 6–8 μm thick GaNoX for operation at 600–1000V and more than 20A, followed in 2012 by 10 μm thick GaNoX for operation at more than 1000V and more than 50A.

Apart from RF and power devices, Picogiga also has plans to offer GaN epi for LED and laser devices.

In another presentation on GaN epi, Ivan Eliashevich of IQE RF in Somerset, NJ, USA said that epiwafer foundry IQE is currently transitioning from 3-inch to 4-inch (100mm) substrates for its GaN HEMT epiwafer production. Eliashevich explained how IQE has achieved the same uniformity on 100mm as on 3-inch wafers ($\pm 1\%$ for thickness), as well as wafer warp of less than 20 μm and wafer bow of less than 10 μm . In addition, 100mm substrate prices are equal to or less than those for 3-inch substrates on a dollar per area basis, he added.

Greg Mills of Cree Inc of Durham, NC, which makes not only LED chips, lamps and lighting fixtures as well as GaN- and SiC-based RF/power transistors but also SiC substrates, reported how the firm just in the month prior to MANTECH had implemented as standard its 'CMP4' chemical-mechanical polishing process for all its high-purity semi-insulating silicon carbide (SiC) substrate products. Mills detailed how the new process had improved the quality of the wafer surface regarding scratches and defects. He added that the CMP4 process will also be implemented on all Cree's other SiC products (i.e. semiconducting SiC wafers) by the end of this year.

etch systems (including launching its latest Gen V product for the technology node at 32nm and below), Plasma-Therm also offers a range of plasma-enhanced chemical vapor deposition (PECVD) toolsets targeting markets from R&D and batch production (with the 790 series) to fully automated cassette-to-cassette Versaline systems. The firm has also secured the rights to market and support the Nextral range of equipment.

With a history stretching back to 1974, the firm's Ed Ostan says that Plasma-Therm has more than 1300 installed systems. The company has also re-initiated its network of sales representatives worldwide, enabling a renewed focus on the specialty semiconductor markets.

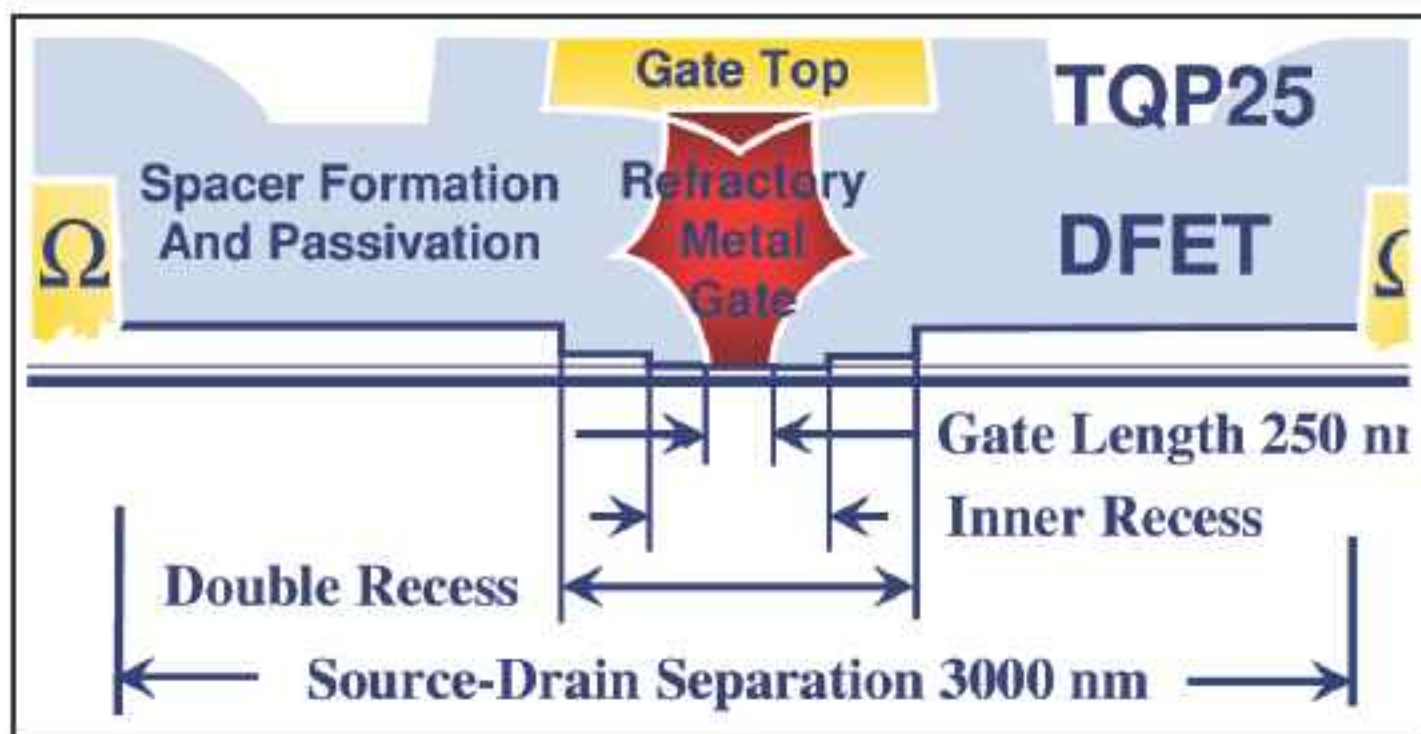
Optical lithography of 0.25-0.15 μm pHEMTs

The 'Process/Etch' session (chaired by Michelle Bourke of Surface Technology Systems and Scott Sheppard of Cree) was affected by the non-appearance of Fujitsu Laboratories Ltd's Naoya Okamoto from Japan, who had been due to discuss the optimization of a 3-inch SiC backside via-hole process for GaN HEMT MMIC devices that uses ICP etching to etch a via at 2 $\mu\text{m}/\text{min}$ (claimed to be higher than any previously reported rate).

Corey Nevers of TriQuint Semiconductor in Hillsboro, OR introduced the new TQP25 high-volume 0.25 μm AlGaAs/InGaAs enhancement/depletion (E/D)-mode pHEMT process on 150mm GaAs. This combines the firm's double-recessed 0.25 μm depletion-mode FET (DFET) with a 0.35 μm enhancement-mode FET (EFET) using standard i-line optical stepper technology (avoiding the higher cost and lower throughput of electron-beam or deep UV stepper gate formation used for many sub-0.5 μm processes).

Also present at CS MANTECH was local firm Plasma-Therm LLC of St Petersburg, FL, USA, which was highlighting its re-emergence as an independent company following late January's management buy-out, after being owned since 2000 by Oerlikon (Unaxis).

As well as continuing to offer photomask



Schematic cross section of a TQP25 DFET.

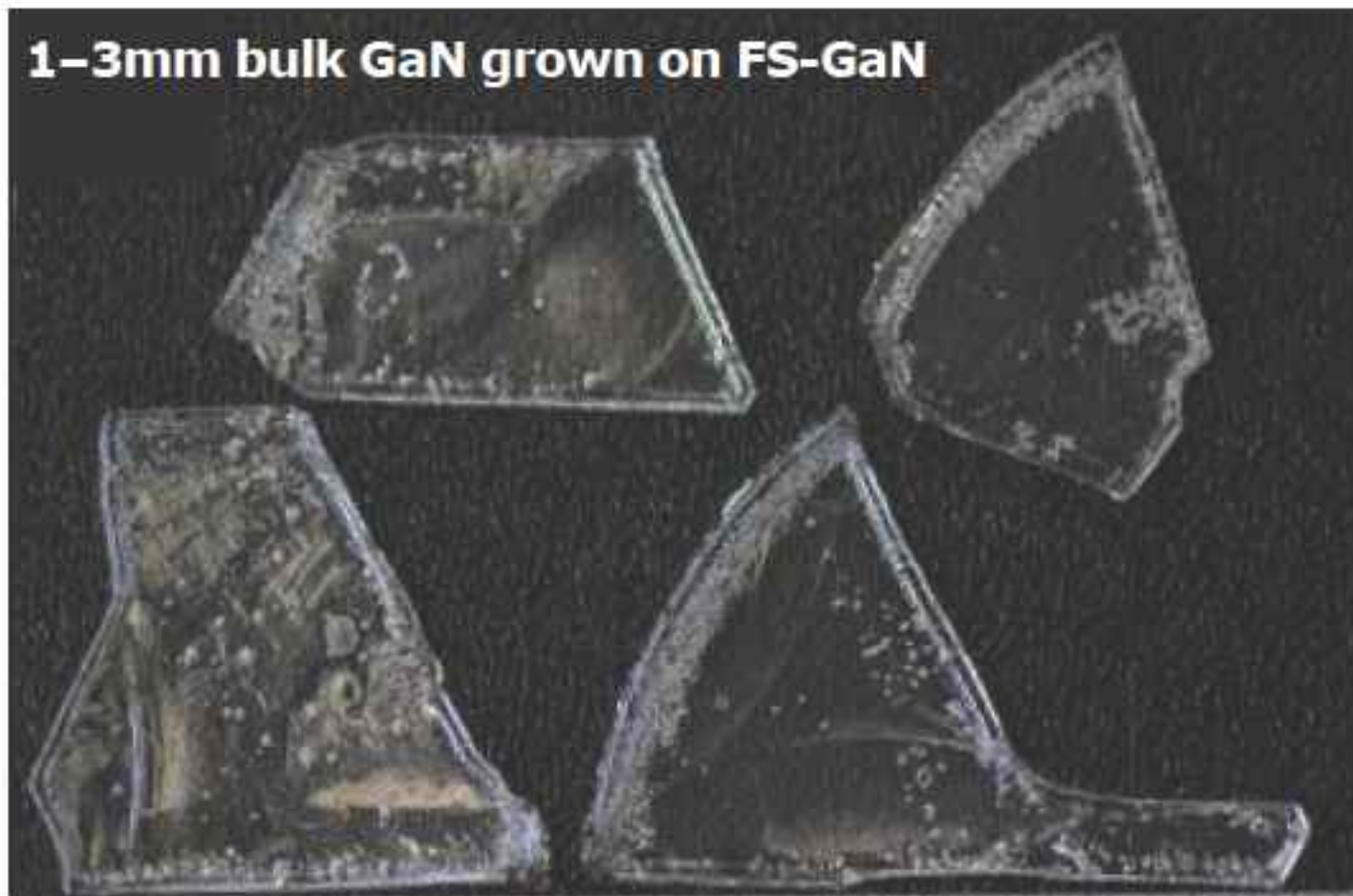
The 0.25 μ m gate length is enabled by using a side-wall spacer process and is a hybrid of TriQuint's 0.5 μ m TQPED E/D process (reported at the 2004 MANTECH conference) and its 0.13 μ m TQP13 pHEMT process (reported at the 2005 MANTECH conference), allowing functionality typically seen at the 0.5 μ m node. However, the reduced gate length allows higher-frequency DFET and EFET designs and E/D logic blocks to be realized. Typical parameters include a unity current gain cut-off frequency (f_T) of 50GHz for the DFET and 45GHz for the EFET. Additionally, the aggressive TQP25 layout design rules, the low off-capacitance (0.25pF/mm) and on-resistance of 1.0 Ω -mm allow very high-performance switches, low-noise amplifiers, and power amplifiers to be designed, allowing unique flexibility spanning the range between cellular handset bands through X-band to the Ku-band frequencies.

Furthermore, TriQuint has also developed the technology into the D-mode-only TQP15 0.15 μ m power process (again, using i-line optical lithography on 150mm GaAs wafers) in order to address the low-cost power amplifier markets for 30–60GHz Ka- and Ku-band applications. The typical f_T is 85GHz. Nevers told Semiconductor Today that there has already been 'heavy customer interest' in the TQP15 process, which is due to be released for production on the existing 150mm production line in Hillsboro in second-half 2010.

GaN growth and characterization

In the session 'GaN Growth and Characterization' (chaired by John Blevins of the US Air Force Research Laboratory's Materials and Manufacturing Directorate and Ruediger Schreiner of Aixtron) a multi-disciplinary group from the Radboud University Nijmegen, The Netherlands and the Wroclaw University of Technology described their use of hydride vapor phase epitaxy (HVPE) to grow bulk-like GaN about 3mm thick on free-standing (FS) GaN substrates. Conventionally, FS-GaN is grown by HVPE and then the substrate is removed by using either the void-assisted method, laser lift-off or facet-controlled epitaxial overgrowth. However, obtaining crack-free, large-size FS-GaN by laser lift-off is difficult due to fracturing during laser

1–3mm bulk GaN grown on FS-GaN



irradiation, while all techniques require complicated and time-consuming substrate processing prior to growth.

In contrast, the researchers used an optimized process to initially grow crack-free 200–350 μ m thick layers of GaN directly on the sapphire substrate. These layers were then used for overgrowth. However, high thermal stress built up between the GaN layer and the sapphire substrate causes spontaneous lift-off of a FS-GaN layer 400–650 μ m thick and up to 2-inches wide. The FS-GaN layer was then used for HVPE growth of bulk-like GaN that is 1–3mm thick. Defect densities are just 10⁶/cm² on average (and in some cases 10⁵/cm²). However, as was also reported in other work at the International workshop on Nitride Semiconductors (IWN 2008) in Montreux, Switzerland, the polygonal-shaped pits (of varying size and depth) in the bulk-like GaN recurred in successive overgrowth processes even if polished out of the surface first.

Ed Preble, chief operating officer of Kyma Technologies, reported the development of a hydride vapor phase epitaxy (HVPE) process for the growth of 2-inch diameter bulk GaN on sapphire (with an Al interfacial seed layer deposited by physical vapor deposition) that overcomes the difficulties associated with orientation control due to the lattice-mismatch-induced stress in the GaN leading to bowing of the underlying sapphire substrate and tilt of the crystal as it grows.

The method uses x-ray diffraction (XRD) to identify the material orientation followed by a lapping procedure for correction. This leads to control of the substrate orientation to within $\pm 0.25^\circ$ of the desired cut. A chemical-mechanical polishing (CMP) process then produced epi-ready surfaces with roughness values of less than 1nm.

N.B. Further coverage of CS MANTECH 2009 will be continued in the next issue of Semiconductor Today. ■

● Next year's International Conference on Compound Semiconductor Manufacturing Technology (CS MANTECH 2010) will take place at the Portland Marriott Downtown Waterfront hotel (17–20 May).

www.csmantech.org

Change in the air at OFC 2009

Bill Ring of WSR Optical Device Solutions reports from March's OFC 2009 event in San Diego which, despite the economic slowdown, saw much innovation reported in high-speed data transport and photonic integration.

This year's Optical Fiber Communication conference & exposition/National Fiber Optic Engineers Conference (OFC/NFOEC 2009) in San Diego, CA, USA (23–26 March) saw a downturn in both vendors exhibiting their wares and feet pounding the floor. Attendance was down from 13,000 for last year's event to just 9800. Similarly, the exhibition floor shrank from more than 600 vendors to just under 400 as the economic downturn has throttled the industry and seen many firms give up the opportunity to display their products. If there is an upside to this environment, however, it was that attendees of the show were more focused on doing business and understanding the path forward for next-generation networks.

Trends in network development

The conference kicked off with three interesting plenary discussions and insights on the global trends in information exchange and network development.

Shri Goyal of Indian public sector telecom company Bharat Sanchar Nigam discussed the changing environment in India and their plans for fiber-to-the-home (FTTH) networks. The presentation gave an insight into what is currently the world's fourth-largest economy in terms of gross domestic product (GDP). A growth rate of 7–9% per annum is being driven by the service sector, with the number of telephone lines increasing to almost 400 million in 2009. In contrast, the expansion of fiber for television is happening slowly, as only 50% of households have TV sets and 100 million homes do not have cable TV. With broadband penetration at less than 0.4%, Bharat Sanchar Nigam is expecting to add more than 1 million customers per year as it rolls out its Gigabit passive optical network (GPON) infrastructure. Consequently, India is definitely a growth opportunity for FTTH companies.

The second speaker, Philippe Morin of Nortel Networks, was more generalized in his approach to new network trends, classifying the major changes as 'mega trends'. He discussed how the Internet has changed the business mode, and how these new business models are accelerating bandwidth demand. Connectivity has

moved from being 'nice to have' to being a 'necessity'. Nortel (which is currently in bankruptcy) cited high-definition TV, which will generate the next wave of bandwidth growth (including 'virtual' trade shows), as well as the news and print media going online.

A key mega trend for the company is that data-center consolidation will occur and will be driven by virtualization, tele-working and tele-presence. Morin presented an example of the change in media by citing the Oprah New Earth show, which was streamed in 139 countries. Following time division multiplexing (TDM) then wavelength division multiplexing (WDM), Nortel believes that the next technology steps for greater bandwidth in communication network infrastructure is coherent transmission. Companies developing components now need to be thinking about Terabits per

Companies developing components now need to be thinking about Terabits per wavelength, as 100Gb/wavelength capacity is almost here

wavelength, as 100Gb/wavelength capacity is almost here. The emphasis should be on Terabit signaling and transport rather than Terabit Ethernet.

Morin concluded with several key issues faced by the industry. Consumers do not want to pay for bandwidth by the amount consumed. The current revenue stream from services provided by carriers therefore remains flat, but the network is costing more to run and upgrade. So, there is a major issue about how the new technology will be funded to enable the next generation of network requirements. For the Internet to continue to grow, the access infrastructure needs to be ten times cheaper than it is today, he reckons. Nortel believes that the cost points cannot be driven lower by volume, as the volume does not exist. Instead, cost reduction must be driven by innovation.

The final plenary speaker, Lawrence Lessig of Stanford Law School provided the most media-interactive session. The talk consisted of the idea that society had moved from idea generation and an interacting state to a stale consumptive state but, with the

advent of YouTube and other elements, that society is generating ideas and content again. Lessig's talk provided an insight into the influence that YouTube and other Internet social networking sites are having upon society today, and the different values that the 21st century Internet-savvy generation perceives.

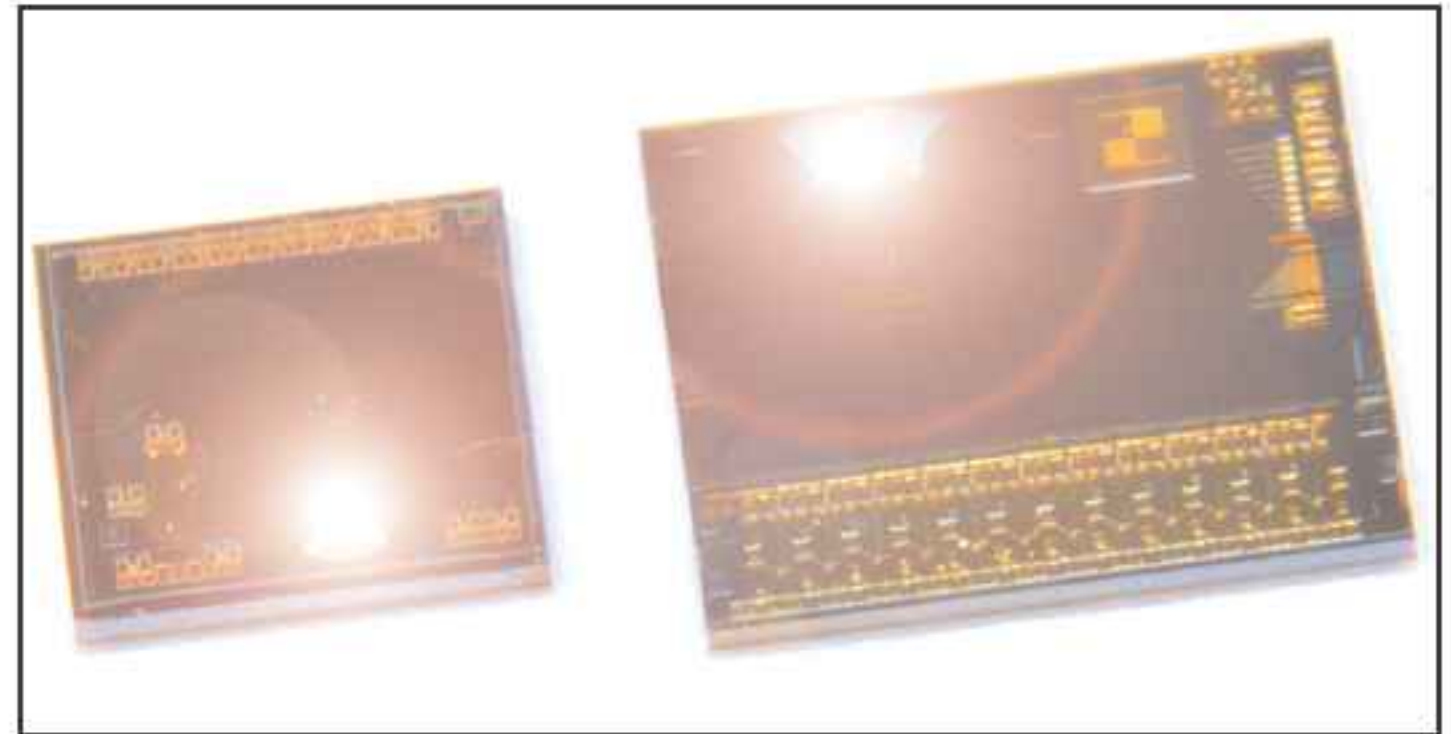
Market watch

During OFC there were several market-watch sessions on topics ranging from the state of the industry to photonic integration. Within the current economic climate, the state-of-the-industry session provided an interesting twist, considering all the downsizing that component vendors had been making shortly before the event.

The session was aptly named, considering the drop in attendance at the conference. Several key players discussed the positive outlook for the future, including the increasing level of data transport, new services such as FiOS (Fiber Optic Services), and the increasingly always-connected society. On the downside for the optics industry is the price erosion for components. The representative from Corning highlighted this, stating that there have been three major price declines for the industry: the first in 1993, the second in 1998, and the last in 2001. He points out that price, performance and capacity are all factors for companies today, but components are currently in a period of low price stabilization. Financially, Corning finds that its fiber preform plant utilization is running at 85%, and that the economics of the business are such that no new plants can be built, since the plants that it was forced to close can be re-opened. One key point from Corning is that China remains a location with strong demand for fiber due to its continuing fiber-to-the-home (FTTH) build-outs.

The overview on the state of the industry from market research firm Ovum was not optimistic. The market projection for the telecom sector has had to be revised down to \$15bn or 0% growth between 2009 and 2010. For carriers in the long-haul space, the fixed-line revenue is currently flat and less than mobile revenue. However, due to upgrades in the wireless handset market from 2.5G to 3G, back-haul of traffic is increasing substantially. Ovum reported that T-mobile realized a 300% increase in traffic when they up-graded to a 3G network. This is against the backdrop of fixed pricing in the wireless service market, where 75% of traffic is still voice (although this will decrease as more mobile applications appear). New services such as IPTV have been introduced and are generating revenue. However, they are not yet profitable.

Verizon's view in this session was principally that technology for higher-capacity networks is becoming more challenging but is necessary. The constraints that carriers see for their existing networks is that new



Infinera's InP-based photonic integrated circuits.

equipment needs to meet several of the requirements of both 2.5Gb/s and 10Gb/s systems, i.e. the wavelength spacing should be 50GHz and sources must be able to tolerate 10Gb/s chromatic dispersion and polarization mode dispersion limits. Verizon needs to be able to transmit 10Gb/s and 40Gb/s signals over the same fiber without interference or issues. As the firm does not develop technology but only uses the technology, it requests component vendors to consider a single technology for new equipment that, of course, is low cost.

Photonic integration to meet cost demands

This issue of low cost and low-volume applications is a key concern for many of the component companies that were in attendance. Many believe that photonic integration is the only solution to the problem (similar to the issue of the discrete transistor versus the integrated circuit that the silicon industry had to face). To discuss this topic, the market-watch session on photonic integration brought some of the key players together to discuss the opportunities and issues.

The session began with the comment that R&D in photonics has been hit by the component industry being unprofitable. Despite this, the idea of CMOS photonics as a solution in telecom networks has been realized. Lightwire, a small startup company based in Pennsylvania, provided in-depth details of their CMOS photonics development and the advantages of integrating CMOS electronics with optical functionality. The firm stated that devices can be made in 130nm CMOS on standard fabrication lines and provide an advantage in terms of Volts-mm compared to lithium niobate modulators, providing a reduction from 100V-mm to only 2V-mm in the CMOS devices. A key element of this technology for the company is the reduction in total power budget. For a 4 x 10Gb/s CDWDM link, the transceiver consumes less than 2.5W, even with a CDR (clock and data recovery) function. One area where Lightwire expects CMOS photonics devices to have a large impact is in the area of active cables. To reduce power consumption further, 45nm CMOS can be employed for future devices. ▶

Similarly, John Bowers from University of California Santa Barbara (UCSB), whose work on integration for Intel has been widely published, stated that a flip-chip III-V device on CMOS circuits enables the first stage of CMOS photonics, e.g. the solution adopted by Luxtera Corp. But integrating the III-V material into the semiconductor process by either wafer bonding or growth would enable better devices to be made. Bowers believes that better devices than InP devices can be made by using CMOS photonics. This, he pointed out, was definitely true for existing work on avalanche photodiodes (APDs), where CMOS photonics have a better gain-bandwidth product.

Infinera Corp of Sunnyvale, CA, USA discussed its approach of fully integrated photonics circuits on indium phosphide and stated that, in dense wavelength division multiplexing (DWDM) systems deployed today, 45% of the 10Gb/s systems are PIC-based and developed by Infinera. The main discussion centered on the reliability and yield that the company achieves, and their view that photonic integration will enable the future development of systems for Terabit transport and beyond. Advantages provided by the PIC approach include moving to 25GHz wavelength spacing and enabling complex modulation schemes on a single chip. Infinera stated that the Shannon limit (the maximum data transport rate for a single channel) will be reached by 2015 for C-band frequencies, so the solution is to extend the number of wavelengths that are used as well as the wavelength window. To achieve 100Tb/s systems, other wavelength windows outside the C-band will be necessary. Clearly a leader in the photonics integration field, Infinera is viewed as being a few years ahead of its competition and a success story for the current telecom industry.

The theme of photonic integration is clearly the 'future' for component vendors to enable the lower-cost solutions with low volume that the industry needs in telecoms. Whether silicon CMOS photonics or InP photonics or a hybrid solution is best for photonic integration is still not clear. Evidently, integration will become more prevalent, but will need to displace hybrid and discrete solutions that are the mainstay today in the low-cost data-center area.

Several major companies in this sector did not have an exhibition booth for their products but had private conference rooms for customer demonstrations and meetings. This provided a different scenario for exhibition visitors and marked a change for some companies, including Avago Technologies Inc of San Jose, CA, USA, which is a major player in the data communications space.

Whether silicon CMOS photonics or InP photonics or a hybrid solution is best for photonic integration is still not clear

OIF project goals for 100Gb/s transport

- 100Gb/s long-haul DWDM framework and architecture
- Photonic integration of the transmitter and receiver modules
- Forward error correction using DP-QPSK in DWDM
- Module requirements for 100GE DWDM

100Gb/s standardization

The final market-watch session of the week concerned the '100Gbit standard update'. John D' Ambrosia, who is the current chair of the 802.3ae task force, discussed the state of the standard and posed the question, where next? Ambrosia believes that Terabit Ethernet will be the next evolution (agreeing with the statement by Bob Metcalfe at last year's OFC 2008). Some participants considered 2015 as the date when Terabit Ethernet will be required, based on the repeated discussions of carriers on the doubling of Internet traffic every year.

For the long-haul 100Gb/s market, Joe Berthold of network equipment maker Ciena discussed the current ideas that the Optical Internetworking Forum is pursuing for long-haul transport. This included the current implementation agreements that OIF is developing to enable dual-polarization quadrature phase shift keying (DP-QPSK) modulation devices for 100Gb/s on a single wavelength. The OIF believes that it can play an active role for long-haul systems and liaise with both the IEEE and the International Telecommunications Union (ITU) to enable low cost solutions for the DWDM market. Through its implementation agreements and projects the OIF hopes to enable systems to be brought to market in a timely fashion through industry collaboration.

Several product releases were on display at the exhi-

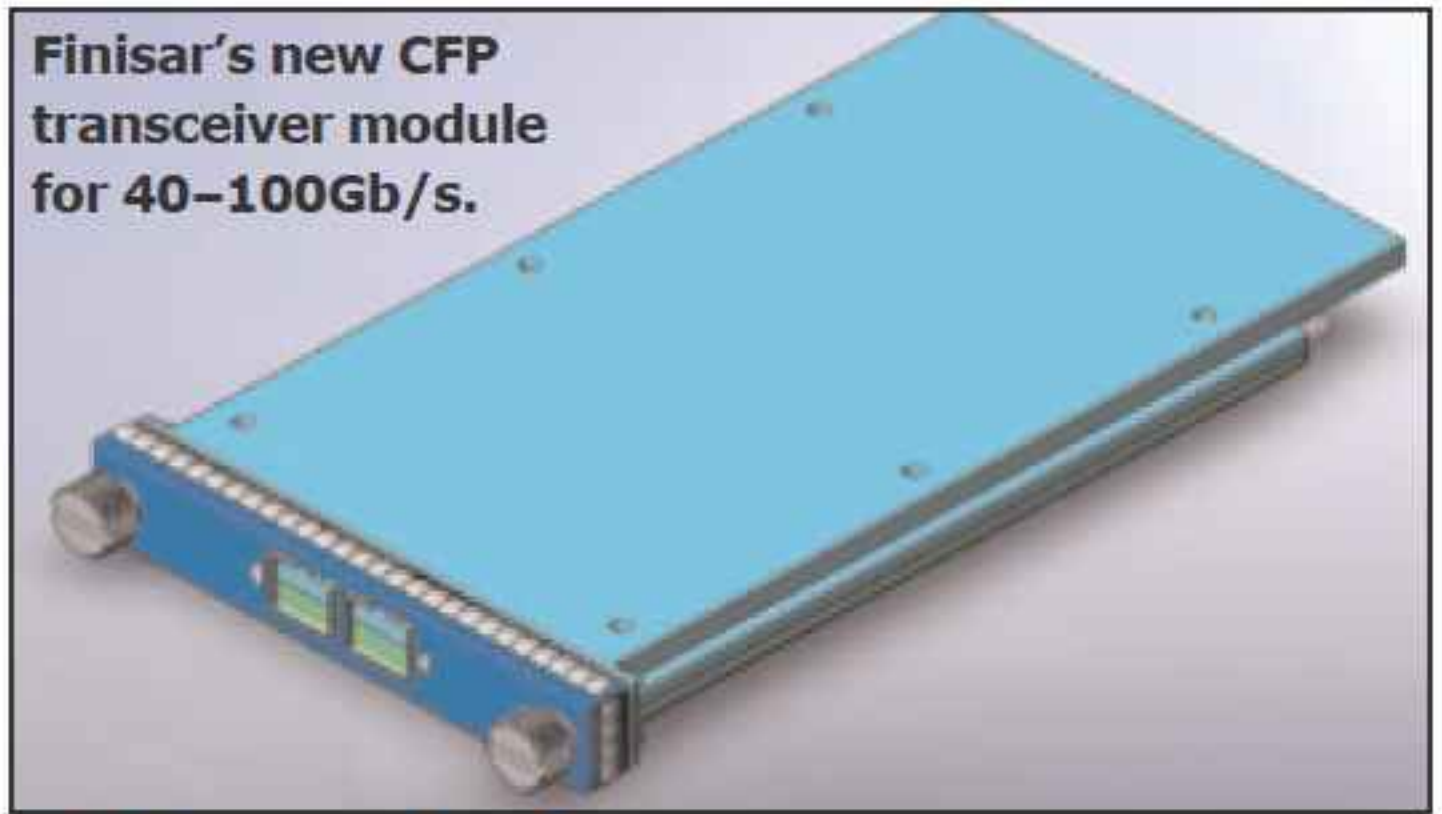


Opnext's 16G Fiber Channel SFP+ module.

bition, including for the next Fiber Channel data rate of 17Gb/s. Opnext provided a live demonstration of their long-wavelength transceiver module for Fiber Channel applications, Finisar demonstrated its short-wavelength 17Gb/s (16x) Fiber Channel module and its new CFP transceiver modules for the 40–100Gb/s MSA. In addition, the CXP multi-mode module for Infiniband applications was released for view and is targeted at 12 x QDR (quad data rate) applications. Agilent Technologies released a new analyzer for 16x Fiber Channel and several companies provided new releases for test equipment, including a Yokogawa transport analyzer.

As OFC is a busy conference with multiple parallel sessions, choosing the right topic can be difficult. Overall, the technical sessions were well attended. This was highlighted by the standing-room-only audience for digital signal processing, which has a key role to play in coherent detection for long-haul telecom applications. Several papers discussed the modulation formats for 100Gb/s. A personal favorite was the higher-speed laser session, which discussed pushing the current distributed feedback (DFB) edge-emitting technology using direct modulation up to 25Gb/s and 40Gb/s. These devices would be advantageous for high-speed Ethernet transceivers to enable lower cost. The discrete devices demonstrated show that InGaAlAs ridge waveguide devices are preferred and can potentially provide a solution. Meanwhile, the silicon photonics papers were more concentrated on the receiver side of the technology and waveguides rather than transmitter technology and light emission. Several papers discussed avalanche photo-detectors (APDs) for high-speed interconnects operating around 10Gb/s, which is perceived to be a key area for the computer interconnect market.

Finisar's new CFP transceiver module for 40–100Gb/s.



Challenges ahead

The Optical Fiber Communications conference remains the principal show for optical component vendors. It is definitely a place to catch up and get to grips with the latest directions in the industry. The lower number of attendees this year was a reflection of both the economic climate and the difficulty that component vendors have had in attaining profitability since the bust of 2001.

The need for more speed and the ability to transport more data remains unabated. To this end, Terabit Ethernet is starting to be discussed, while 100Gb/s is being planned. The general trend to more photonic integration is clearly becoming more prevalent in the photonics industry. Whether it is eventually based on CMOS photonics or InP photonic integrated circuits remains unclear long term. Both exist today and are finding homes for products.

Overall, considering the business environment, OFC 2009 was a success, and San Diego remains a great place to visit. As long as people increasingly want to use cell phones and play games and use the Internet, the optical industry will need to meet this challenge through innovation and technology development. ■

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Fax: +44 (0)1223 352444
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Power + Energy Inc
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(see section 8 for full contact details)

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9 Materials & metals

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11 Process monitoring and control

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www.pvjapan.org

30 June – 2 July 2009

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Rome, Italy

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www.pvsummiteu.com

1–2 July 2009

UK Semiconductors 2009

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E-mail: registration@uksemiconductors.com

www.uksemiconductors.com

2 July 2009

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University of Southampton, UK

E-mail: process.news@oxinst.com

www.oxford-instruments.com

13–15 July 2009

Voices for SSL Efficiency 2009: 4th annual DOE Solid-State Lighting (SSL) Market Introduction Workshop

Chicago, IL, USA

E-mail: solidstate@courtesyassoc.com

www1.eere.energy.gov/buildings/ssl/chicago09.html

13–17 July 2009

14th International Conference on Narrow Gap Semiconductors and Systems (NGS2)

Tohoku University, Sendai, Japan

E-mail: nitta@material.tohoku.ac.jp

www.material.tohoku.ac.jp/~kotaib/NGS14front.html

14–16 July 2009

SEMICON West/Intersolar USA

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E-mail: ktorres@semi.org

www.semiconwest.org

16–17 July 2009

Plasma Etch Tech 2009 – Pushing the Limits

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E-mail: process.news@oxinst.com

www.oxford-instruments.com

19–22 July 2009

9th International Conference on Atomic Layer Deposition (ALD 2009)

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www2.avs.org/conferences/ALD2009

2–6 August 2009

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9–12 August 2009

26th North American Conference on Molecular Beam Epitaxy (NAMBE)

Princeton University, NJ, USA

www.nambe2009.com

9–14 August 2009

14th US Biennial Workshop on Organometallic Vapor Phase Epitaxy (OMVPE-14)

Lake Geneva, WI, USA

www.crystalgrowth.us/accge17/index.php

23–28 August 2009

6th International Workshop on Bulk Nitride Semiconductors (IWBNS-VI)

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www.unipress.waw.pl/iwbns6

25–28 August 2009

Romanian Conference on Advanced Materials (ROCAM 2009)

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<http://rocam.unibuc.ro>

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E-mail: cleopr2009@siom.ac.cn

www.siom.cn/cleo

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Gwangju Institute of Science and Technology (GIST), South Korea

E-mail: piprek@nusod.org

www.nusod.org/2009

6–9 September 2009

11th China International Optoelectronic Exposition (CIOE 2009)

Shenzhen Convention & Exhibition Center, China

E-mail: nancy@cioe.cn

www.opto-china.com

14–18 September 2009

Solid-State Device Research – 39th European Conference (ESSDERC-2009) and Solid-State Circuits Research – 35th European Conference (ESSCIRC-2009)

Athens, Greece

www.esscirc2009.org

14–18 September 2009

4G World 2009 (formerly WiMAX World USA)

Chicago, IL, USA

E-mail: info@trendsmia.com

<http://4gworld.com>

15–16 September 2009

Photovoltaics Beyond Conventional Silicon

Denver, CO, USA

E-mail: s.lee@IDTechEx.com

www.idtechex.com/photovoltaicsusa09

16–17 September 2009

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Yokohama, Japan

E-mail: tcarli@strategies-u.com

<http://led08.events.pennnet.com>

20–24 September 2009

ECOC 2009 (35th European Conference and Exhibition on Optical Communication)

Austria Center, Vienna, Austria

E-mail: ecoc2009@ove.at

www.ecoc2009.at

21–25 September 2009

2009 International Conference on Infrared, Millimeter and Terahertz Waves (IRMMW-THz)

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E-mail: phs@caltech.edu

www.irmmw-thz.org

21–25 September 2009

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www.photovoltaic-conference.com

28 September – 2 October 2009

12th European Microwave Week (EuMW2009)

Rome, Italy

www.eumwa.org

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