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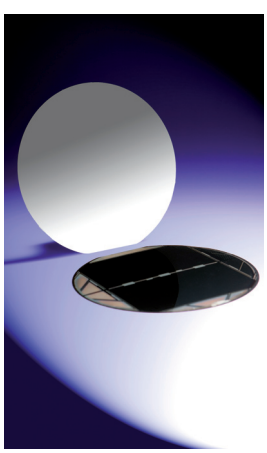

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semiconductorTODAY

COMPOUNDS & ADVANCED SILICON

Vol. 6 • Issue 1 • February 2011

www.semiconductor-today.com

Mobile World Congress sees product launches for 4G, smart-phones, tablets

Sapphire makers expand to 8" & 12" • Epistar raising $280m
NeoPhotonics' IPO raises $82.5m • News from Photonics West

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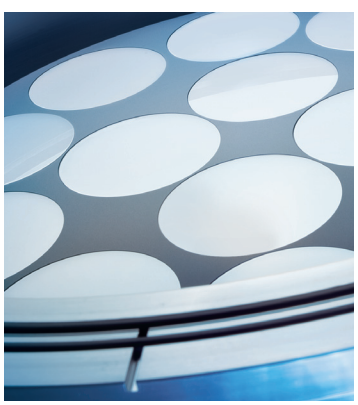

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COMPOUNDS & ADVANCED SILICON

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p12 Anadigics' booth at the 2011 Mobile World Congress in Barcelona, which saw product launches for smart-phones and tablets.

p41 Veeco's new TurboDisc MaxBright GaN MOCVD multi-reactor system for HB LEDs, offering 500% productivity gain on its standard K465i reactor.

p72 Launched at Photonics West, Opnext's 60mW 445nm blue laser by Light Touch from Light Blue Optics for embedded device mini projectors.

Cover: The 2011 Mobile World Congress in Barcelona saw many product launches from the likes of RFIC makers Anadigics, Skyworks, RF Micro Devices and TriQuint for booming 3G/4G applications focused on smart-phones, tablets, data-cards and dongles. **p12**

editorial

Consumer demand

The last month or so has seen the regular annual events Photonics West and Mobile Wireless Congress take place, with both evidencing the rapid technical developments being commercialized as a result of thriving demand from consumers for ever more capable applications (see pages 71–75 and 12–24, respectively).

Aided by the economic recovery, the rapid consumer adoption of multi-band, multi-mode smart-phones (with greater GaAs power amplifier content and hence dollar value per handset) and data-centric networks has driven greater-than-expected annual growth in the GaAs device market of 32% (rather than the expected 15–20%), according to market research firm Strategy Analytics (see page 10). The leading GaAs component makers RFMD, Skyworks, TriQuint, Avago, Anadigics and Hittite hence grew revenue 24–52% in 2010. Nokia's cell-phone handset market share has fallen from almost 37% in Q4/2009 to 31% in Q4/2010, losing out to rising low-end handset vendors such as China's ZTE as well as smart-phone vendors such as Apple and Blackberry-maker RIM and handset vendors with stronger smart-phone portfolios such as Samsung, LG and China's HTC (boosted by the success of the Android system). Mobile Wireless Congress hence saw great emphasis from RFIC makers on product launches for 3G and 4G (LTE and WiMAX) technology. It also saw announcements of design-ins into new models such as Samsung's Galaxy S2 smart-phone and Tab 10.1 as well as tie-ins with Texas Instruments' WiLink mobile platform.

Consumer applications were also evident as market drivers at Photonics West. There — in addition to the established LED display backlighting applications — projection displays provided the motive for UCSB spin-off Soraa's demonstration of record-power 4W blue (450nm-wavelength) laser diodes as well as Opnext adding a 60mW 445nm blue laser to its range of commercially available red and infrared lasers (pages 71–72). In addition, Oclaro continues to diversify its laser technology from its telecom base to consumer applications such as cosmetic sking treatment (page 75). Oclaro is also diversifying vertical-cavity surface-emitting lasers (VCSELs) to applications such as active optical cables (see feature article on page 116). Such bandwidth-intensive applications are also driving investment in manufacturers of photonic integrated circuits such as CyOptics and Neophotonics, which has just raised $82.5m in its IPO (see page 83).

Meanwhile, despite the recent inventory adjustment in LEDs for display backlighting applications, the LED market is still expected to grow strongly. In particular, the lighting market is expected to begin to take off in earnest as early as third-quarter 2011, driven partly by the falling cost per lumen (pages 6–8). The latter will be aided by economies of scale (especially in Korea, Taiwan and China) and by the use of larger-diameter substrates (with Russia's Monocrystal now shipping 8" sapphire, and the USA's Rubicon having just achieved 12" — see page 54).

To capitalize on such scale-up, MOCVD system maker Veeco has just launched its new MaxBright GaN multi-reactor system, which enables a 500% productivity gain on the firm's standard K465i MOCVD system. With vast numbers of MOCVD reactors forecast to be demanded in the next few years, it will be interesting to see the impact of this new cluster format.

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

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news

LED luminaire market to grow from $3.8bn in 2010 to $8.3bn in 2014

Growth rates among applications vary, but the global market for LED luminaires is expected to grow at a compound annual growth rate (CAGR) of 22% from $3.8bn in 2010 to $8.3bn in 2014, according to Strategies Unlimited's report 'LED Luminaires, Market Analysis & Forecast', which covers nine LED lighting application segments and analysis for 2008–2014.

The market research firm says that rapid improvements in the performance and price of commercially available high-brightness LED packages, heightened awareness about energy efficiency, the phasing out of incandescent bulbs, and fiscal stimuli undertaken by countries around the world have created conditions for the adoption of white-light LED technology, which otherwise would have faced the low-volume/high-cost conundrum.

Quality issues that affected the market penetration of previous energy-efficient lighting technologies continue to affect this market, but the resolve to reduce energy consumption is likely to propel the technology to be widely commercialized and adopted by the market, reckons Strategies Unlimited.

As the most efficient light source technology for applications requiring a directional beam of light and batteries, consumer portable applications were the largest segment of the LED luminaire market in 2010. The quality of LEDs has improved to a point that performance is no longer an issue, says the firm. The issue now is the price of designing LEDs into luminaires.

Color and color-changing application in architectural and entertainment applications collectively had revenue of more than $1bn in 2010. Meanwhile, starting from a small base, residential lighting (the fastest-growing segment of the market) is forecast to grow at a CAGR of 44% through 2014.

Global revenue for LED luminaires in commercial/industrial applications are expected to exceed $1bn in 2011.

Outdoor area lighting applications (which have benefitted from fiscal stimuli and the need for energy conservation) are expected to grow at a CAGR of 38% through 2014. In particular, solar-powered lanterns will be a low-margin/high-volume application, assisted by non-governmental organizations (NGOs) and governments aiming to save fuel subsidies. Revenue for this sub-segment is forecast to grow at a CAGR of 58%.

In addition, LED exit signs have become a mature market in the USA, and are in the initial stage of market penetration in white-light applications in egress signage lighting outside the USA.

The report concludes that China is the largest market as well as the largest supplier of LED luminaires.

www.strategies-u.com

Epistar targets $1/500lm in 2012 then $1/1000lm in 2015 for LED solid-state lighting

Plans to grow LED lighting market share to 10% in 2012, 25% in 2015

To gain an advantage in the global LED lighting market, Taiwan-based LED chipmaker Epistar will actively lower the brightness cost of its LED lighting products and aims to reach the goal of US$1 per 500 lumen in 2012, three years earlier than the schedule set by the US Department of Energy (DOE), report Digitimes.

Hoping to become the leading LED supplier in the global LED lighting market in 2013, Epistar intends to reach clients' expectation ahead of schedule and take a lead in reducing the cost per lumen, indicates chairman Lee Biing-jye.

Market sources also note that, due to benefits from increasing demand from TV backlighting and the general lighting market, Epistar's revenue is expected to rise 37% year-on-year to NT$27bn (US$931m) in 2011.

Based on Epistar's internal schedule, overall LED lighting costs will drop to US$1 per 250lm in 2011, and the firm should have a 5% share of the global LED lighting market. The firm aims to reduce the cost of LEDs to US$1 per 500lm and boost its share of the global LED lighting market to 10% in 2012, then to US$1 per 1000lm with a 25% market share in 2015, and to 60% by 2017.

Epistar indicates that the current market price is about US$1.5 for an incandescent bulbs and US$2.5 for an energy-saving lighting bulb, while quotes for an LED light bulb is about US$5 wholesale and US$12.5–15 retail. If the market price of an LED light bulb drops to US$7–8 in 2015, the share of LEDs in the global lighting market could reach 25%, and help to drive the value of the LED lighting industry to 50% of the total lighting market, the firm reckons.

www.digitimes.com

LED pricing pressure extends into Q1/2011

Inventory adjustment for large-size panels and lighting delays recovery

In fourth-quarter 2010, demand from LED applications had still not recovered, including continued inventory adjustment of large-size panels and lower-than-expected demand from general lighting, according to the latest price survey by LEDinside (an LED research division of TrendForce).

As a result, the pressure of LED price decline has extended from Q3/2010. In particular, the price of LEDs for large-size panel applications fell by 5–9%, with the most substantial decline being in TV backlight applications. The declined for high-power LED lighting applications was more than 12%. In contrast, due to the relatively stable demand from mobile phone applications, LED prices in this segment are fairly stable, with a mere 3% seasonally adjusted decrease.

Regarding prices of LEDs in large-size backlight applications, in Q4/2010 — due to the slower-than-expected recovery in panel shipments — vendors adjusted shipments, while LED demand recovery is not yet in sight. Hence, in TV backlighting the price of LEDs for the mainstream specification (5630) fell by 9% (to $0.11–0.15), while the price of LEDs for LCD notebook backlighting fell by 5–6%.

LEDinside notes that LED prices for mobile backlighting applications (including specifications 0.4t and 0.6t) are currently relatively stable due to the stable level of shipments; price decline for this segment was estimated to be 3% in Q4/2010.

In high-power LED lighting applications, LED prices declined substantially, affected by weak demand coupled with inventory pressure; in particular, prices for the mainstream specification (100–120lm) plummeted by 12% in Q4, says LEDinside.

In high-power LED lighting applications, LED prices declined substantially

Due to greater inventory pressure from large-size backlight applications, LEDinside expects demand in this segment to recover gradually at the end of Q1/2011, after which price pressure is expected to ease. Regarding the price of LEDs for LCD TV applications, LEDinside expects a 9% decline in Q1. High-power LEDs may face pressure from inventory clearing, so prices in this sector are expected to post a double-digit decline, concludes LEDinside.

www.ledinside.com

White LED pricing (US$). (Source: LEDinside.)

App	Type	Current (mA)	VF (typ.)	Luminous efficacy	Q4/2010 price ($) High	Low	Change
TV	5630	120	3.3	9000–10,5000 (24–30lm)	0.15	0.11	–9%
Monitor	3020	20	3.2	1800–2000mcd	0.06	0.03	–5%
	3014	20	3.2	1900–2200mcd	0.08	0.03	–6%
Notebook	0.8t	20	3.2	2000–2300mcd	0.09	0.06	–6%
	3014	20	3.2	1900–2200mcd	0.08	0.03	–6%
Mobile phone	0.4t	20	3.2	1400–1800mcd	0.10	0.06	–3%
	0.6t	20	3.2	1400–1800mcd	0.10	0.05	–3%
High power	Cool white	350	3.2	100–120mcd	1.3	0.70	–12%
		350	3.2	120–130mcd	1.6	1.2	–21%

LED lighting market take-off to start in Q3/2011

Falling cost per lumen to drive growth

The LED lighting market is expected to see significant growth as early as third-quarter 2011 as Taiwan-based LED chipmakers are expected to follow Cree Inc of Durham, NC, USA, which lowered prices for high-power LEDs by 10–15% in fourth-quarter 2010, reports Digitimes.

The LED lighting market is expected to take off in 2012 when the growth of the large-size market starts to slow down. LED-backlit TV panels should account for 50% of total TV panel shipments in 2011 due to promotion by vendors.

In late 2010, Cree introduced a white LED with a luminous efficacy of 160 lumen per watt (lm/W) at a price of US$3, which is still high. Also at the end of 2010, Osram introduced a high-power LED with a luminous efficacy of 135lm/W, while Nichia, Epistar and Formosa Epitaxy (Forepi) plan to mass produce 100–133lm/W high-power LEDs in first-quarter 2011. Philips aims to lower the cost of LEDs to US$1 per 400 lumen in 2011.

The mass-production schedule of Taiwan Semiconductor Manufacturing Company (TSMC) — the world's largest silicon foundry, which is entering the LED manufacturing sector using silicon substrates — has reportedly been delayed to the second quarter. TSMC's LED packaging subsidiary VisEra Technologies will focus on the LED indoor lighting market in 2011 and aims to reduce costs by 30% per year, reports Digitimes.

www.digitimes.com

Large-size LED-backlit LCD panels to reach 67% market share in 2011

...but over-supply looms in first-half of year

The proportion of large-size (>10-inch) liquid crystal display (LCD) panels shipped worldwide using LED backlights will rise from 44% in 2010 to an estimated 67% in 2011, as unit shipments rise 74.9% from 283.3 million units in 2010 to 495.6 million units, according to market research firm IHS iSuppli.

In particular, LED backlight penetration will rise from 91% to 100% for notebook and netbook panels, while LED backlight penetration in TV and monitor panels will rise from about 20% to slightly less than 50%.

By 2014, shipments of large-size LCD panels with LED backlights should reach 834.6 million units, forecasts iSuppli, growing at a CAGR (compound annual growth rate) of 47.9% from 117.8 million in 2009.

"LED-backlit panels have emerged as the main driver of large-size LCD panel shipment growth in 2010, representing the fastest-expanding — and soon to be the largest — portion of the LCD market," says Sweta Dash, senior director of LCD research at IHS. "Consumers increasingly are demanding LED-backlit TVs as the costs of such sets decline, allowing more users to take advantage of their superior image quality, lower power consumption and thinner form factors."

However, despite the strong growth in shipments of LED-backlight products, the large-size panel market in 2011 faces the specter of oversupply, which could result in falling prices, reckons the firm. Based on an analysis of the current production plans of panel suppliers, manufacturing capacity may significantly exceed market demand in first-half 2011. However, capacity expansion in second-half of 2011 may decrease to a lower level than demand. "If panel suppliers can control production skillfully and rationally, 2011 can be very positive year for the LCD industry," Dash says. "On the other hand, excessive production in the first half may lead to an inventory buildup and oversupply in 2011."

www.isuppli.com

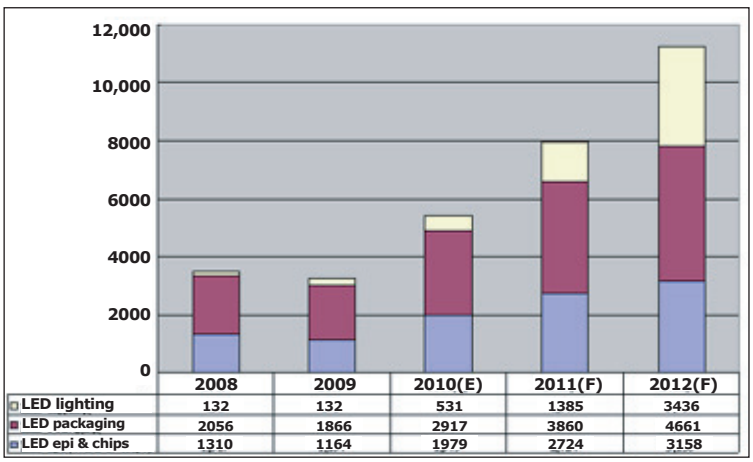
Taiwan LED production bounces back to $5.43bn in 2010

PIDA forecasts 40% year-on-year growth to US$11.3bn in 2012

The economic rebound drove Taiwan's total LED production value to bounce back by about 57% from the low of about US$3.46bn in 2009 to US$5.43bn in 2010, reckons the country's Photonics Industry & Technology Development Association (PIDA). Of this, LED epi (wafers and chips) comprised just under US$2bn, LED packaging just over US$2.9bn, and LED lighting just over US$0.5bn.

Also, PIDA forecasts that, due to the continued expansion of the LED application market, the total LED production value will grow 40% year-on-year in 2011 (to about US$8bn) and then again in 2012 (to US$11.3bn, including about US$3.1bn for LED epi, US$4.7bn for LED packaging, and up to as much as US$3.4bn for LED lighting).

With the rapid advance in LED technologies in Taiwan over the past few years, LEDs have been used as the backlight for cell phones, notebook computers and TVs. With the high-power LED technology of Taiwanese LED makers approaching that of the big LED makers in the industrial countries, product quality and sales have shown big improvements, says PIDA. Taiwan's LED makers have "become members of the international supply chain thanks to technical know-how, lower prices and outstanding quality, and have entered the high-growth application markets in backlight and lighting", adds the PIDA.



	2008	2009	2010(E)	2011(F)	2012(F)
LED lighting	132	132	531	1385	3436
LED packaging	2056	1866	2917	3860	4661
LED epi & chips	1310	1164	1979	2724	3158

Taiwan LED industry production value (2008–2012).

In 2010, Taiwan continued to be the top-ranked country in the world in terms of LED wafer and chip production output as its LED industry continues to grow. Its main products are InGaN LEDs, AlGaInP LEDs and traditional infrared and ultraviolet LED.

InGaN LEDs comprise 52% of the Taiwanese LED industry's production value. Currently, due to the large growth in backlighting for liquid-crystal displays and in lighting, the main product is the blue InGaN LED (with the addition of a phosphor to provide white-light LEDs), so this is what Taiwan's LED makers are focusing on, says PIDA.

www.pida.org.tw

Packaged HB-LED consumption to rise from $10bn to $46bn in 2020

Explosive growth forecast for general lighting

Global consumption of packaged high-brightness light-emitting diodes (HB-LEDs) was $10.09bn in 2010, according to ElectroniCast Consultants' 'HB-LEDs Global Market Review and Forecast (2010–2020)' for HB-LEDs with a lumens/Watt rating of 30–70lm/W as well as HB-LEDs with a lumens/Watt rating of over 70lm/W. Consumption is forecast to rise to $28.52bn in 2015 then $46.05bn in 2020.

"Decreasing average selling prices (ASPs) are forecast to cause challenging growth patterns in consumption value in some application segments; therefore competitors need to choose the right 'windows of opportunity' to climb through," says Stephen Montgomery, director of LED market research.

Use of HB-LEDs in Mobile/Portable Devices is forecast to remain a strong segment; however, organic LEDs (OLEDs) continue to take market share. The sector is relatively mature versus other sectors and already has a substantial consumption value. However, there are some emerging 'stars' in the portable device category, with a very impressive growth pattern forecast for white HB-LEDs (WLEDs).

In terms of consumption value (i.e. quantity x price = value), the use of HB-LEDs in the Vehicle category is forecast to multiply seven-fold (7x), before eventually slipping in value, since declining average prices will offset rising quantity growth in some LED color segments.

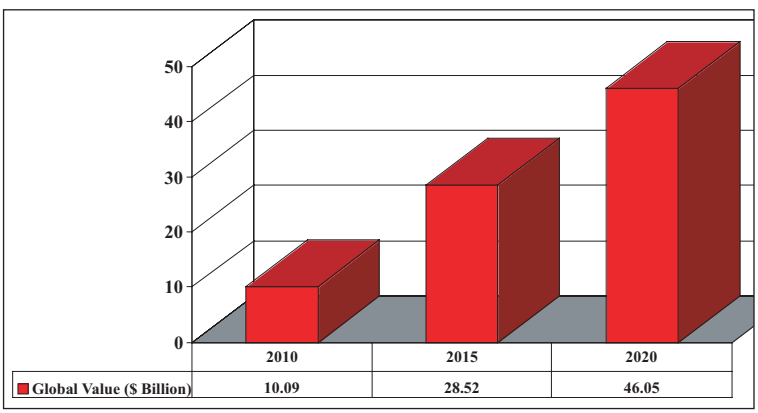
The use of HB-LEDs in stationary (non-vehicle) Signals is forecast to increase at an average growth rate of 25.8% (over 2010–2015). Use of HB-LEDs in solid-state lighting (SSL)/General Lighting products is forecast for explosive throughout 2010–2020. Use of HB-LEDs in the Signage/Professional Display application is forecast to rise at an impressive growth pattern, eventually consuming over $6bn in 2020.

The consumption of HB-LEDs in 'Other' or miscellaneous applications will become much more segmented with opportunities and accountable, partially attributed to the fact that the tracking of product usage will be (more) evident, aided by automated inventory and purchasing management at the retail and other supply levels.

In the backlighting of consumer-level TV/Desktop Monitor category, the number of packaged white LEDs that are required per backlighting unit (BLU) will decline, due to increased luminous efficacy and improvements (innovations) in supporting optics (waveguides, components and packaging), forecasts ElectroniCast.

"As we are looking as far as 10 years, many of the future products for the 2020 marketplace are not even at the idea stage yet," Montgomery notes. "It is also important to note that we, in effect, forecast lighting demand growth, which will drive demand for increased-capability/capacity HB-LEDs," he adds.

www.electronicast.com



HB-LED consumption market forecast ($bn).

Defense semis to still grow at 6% through 2015

While trying to save over $150bn in the next five years, the US Department of Defense will focus on technology that will translate into continued development on radar, EW (electronic warfare), communications and other advanced defense capabilities, according to the Strategy Analytics Advanced Defense Systems (ADS) service report 'US DOD Budget Cuts will Place Emphasis on Advanced Electronics Capabilities'.

The market research firm predicts that this continued emphasis will translate into an upwards trajectory for defense sector semiconductor market growth over 2010–2015, with a compound annual growth rate (CAGR) of more than 6%.

These efficiency decisions are designed to save the Department of Defense more than $150bn over the next five years, primarily by reducing overhead costs, improving business practices, and culling excess or troubled programs. Most of the resulting savings will be used by the Army, Navy, Marine Corps and Air Force to invest in high-priority programs that strengthen warfare capability.

"Despite defense budget growth dwindling to zero by 2015, there is recognition that the mistakes of the past should not be repeated by making drastic cuts to the overall defense budget," says Asif Anwar, ADS Service Director. "Progress made by China and Russia will require that the US continue its focus on technology," he adds.

"Investment in high-priority programs that strengthen fighting capability will translate into continued development on radar, EW, communications and other advanced defense issues," notes Eric Higham, ADS Service Director North America. "Strategy Analytics believes that this will maintain demand for semiconductors, with a particular emphasis on technologies such as GaAs, GaN and SiGe."

www.strategyanalytics.com

Opto sector continues growth in late 2010

driven by LEDs for general & automotive lighting plus higher-speed optical transport

The optoelectronics segment of the compound semiconductor industry continued to grow into the close of 2010, driven by trends such as the broader adoption of LEDs for general and automotive lighting applications as well as increased performance demand from the optical transport market, says market research firm Strategy Analytics in its recently published Strategy Analytics GaAs and Compound Semiconductor Technologies Service (GaAs) viewpoint 'Compound Semiconductor Industry Review September-November 2010: Optoelectronics, Materials & Equipment'.

"A good sign for this industry segment is the strength of new orders and revenue growth reported by makers of long-lead fabrication, manufacturing and test equipment, like Aixtron and Veeco," notes Eric Higham, director of the Strategy Analytics GaAs and Compound Semiconductor Technologies Service, who also cites capacity expansions announced by companies including TSMC and Optogan. "Adoption of LEDs and higher performance for optical transport networks is fueling investment to meet demand and product development to meet new requirements," he adds.

LED technology continues to expand into the general lighting and automotive applications, driven by companies like Cree, Asahi Electric and Bridgelux, Higham continues. Also, optical component and system companies like GigOptix, Opnext, Oclaro and Sumitomo Electric Industries are supporting the industry evolution to 100Gb/s transmission networks.

www.strategyanalytics.com

GaAs device market grows 32% from $4.3bn to $4.9bn in 2010

Smartphones and data-centric networks to drive market to $6.1bn in 2014

Driven primarily by the rapid adoption of smartphones, gallium arsenide device market revenue grew more than 30% from 2009 to $4.9bn in 2010, according to a report from market research firm Strategy Analytics, which describes an acceleration that resulted in an upward revision of both the growth rate and the overall revenue for the GaAs device market.

The Strategy Analytics analysis estimates that, for leading GaAs component makers RF Micro Devices, Skyworks Solutions, TriQuint Semiconductors, Avago Technologies, Hittite and Anadigics, GaAs revenue grew between 24% and 52% in 2010. In addition, these firms saw a strong upward trend in quarterly revenues throughout the year.

"The rapid adoption of sophisticated multi-band, multi-mode smartphones is increasing the demand for GaAs power amplifiers, which is driving the entire GaAs device market," notes Eric Higham, director of the Strategy Analytics GaAs and Compound Semiconductor Technologies Service.

"As 2010 progressed, the results of the major GaAs device suppliers were so strong that we knew the market was growing faster than originally anticipated," adds Asif Anwar, director in the Strategy Analytics Strategic Technologies Practice.

The market research firm has hence increased its estimate of the 2010 GaAs device market growth rate from the 15–20% range to 32%, rising from slightly less than $4.3bn to almost $4.9bn.

Strategy Analytics believes that the adoption of smartphones and data-centric networks will also fuel faster than originally forecast growth in the GaAs market in 2011 and 2012. The report shows a revised forecast indicating that revenue will reach nearly $6.1bn in 2014.

www.strategyanalytics.com

Micro segment of compound industry ends 2010 strongly

Consumer electronics recovery to drive growth

Evidenced by continued quarterly revenue growth and numerous product introductions by most companies, the microelectronics segment of the compound semiconductor industry ended 2010 on a strong note and is poised for continued growth in 2011, according to the recently published viewpoint 'Compound Semiconductor Industry Review September–November 2010: Microelectronics' from the Strategy Analytics GaAs and Compound Semiconductors Service, which captures product, financial, contract and technology announcements for microelectronic firms during that period.

"Compound semiconductor device use is driven by the strong consumer electronics market recovery, along with continued spending in the aerospace and defense markets," notes Eric Higham, director of the Strategy Analytics GaAs and Compound Semiconductor Technologies Service. "GaAs devices remain the most prevalent compound semiconductor option, but several recent product announcements will increase demand for SiGe and GaN devices," he adds.

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Anadigics expands 4G LTE power amplifier family to support 15 bands worldwide

Broadband wireless and wireline communications component maker Anadigics Inc of Warren, NJ, USA has expanded its fourth-generation HELP4 (High-Efficiency-at-Low-Power) LTE (long-term evolution) power amplifier family with seven new models (to supplement the existing five models).

The ALT67xx series HELP4 4G PAs have three selectable power modes to deliver the power and linearity required for 4G mobile devices over a full range of operating conditions.

As well as delivering a high level of integration (including integrated DC blocks on RF ports, internal voltage regulation, and integrated 'daisy chainable' directional RF coupler with 20dB directivity, all in a 3mm x 3mm x 1mm footprint), Anadigics' HELP4 4G PAs use the firm's InGaP-Plus technology to yield optimal power-added efficiency across low- and mid-range output power levels and to provide what is claimed to be the lowest quiescent currents in the industry (<4mA).

Average current consumption for the ALT67xx series is reduced by 30% compared with previous-generation PAs. The efficiency can hence extend battery life in handsets, smart-phones, tablets, netbooks, and notebooks, as well as providing highly efficient operation in WCMDA, HSPA and HSPA+ systems.

Joining the existing ALT6701 (1920–1980MHz, Band 1), ALT6702 (1850–1910MHz, Band 2), ALT6704 (1710–1785MHz, Bands 3, 4 & 9), ALT6712 (698–716MHz, Bands 12 & 17) and ALT6713 (777–798MHz, Bands 13 & 14; with no internal DC block on RF ports), the new PAs comprise the:

- ALT6705 (815–849MHz, Bands 5, 6, 18 & 19);
- ALT6707 (2500–2570MHz, Band 7);
- ALT6708 (880–915MHz, Band 8);
- ALT6714 (777–798MHz, Bands 13 & 14);
- ALT6720 (832–862MHz, Band 20);
- ALT6738 (2570–2620MHz, Band 38);
- ALT6740 (2300–2400MHz, Band 40).

"The rapid deployment of LTE networks is enabling manufacturers to design new mobile devices with unprecedented access to multimedia content," says Marcus Wise, VP of Wireless RF Products. "Our expanded HELP4 power amplifier family supports 15 LTE bands, enabling users around the world to experience the full potential of wireless 4G on long-lived mobile devices," he adds. The ALT67xx series PAs also provide support for paired FDD and unpaired TDD LTE spectrums.

A report from the Global Mobile Suppliers Association (GSA) in January confirmed 128 operator commitments to deploy commercial LTE systems in 52 countries. The number of operators investing in LTE deployments and trials increased by more than 140% in just one year, making LTE the fastest-developing system in the history of mobile telecommunications.

www.anadigics.com

Anadigics launches 2.11–2.17GHz PA for small-cell base-stations

Responding to rising market demand for femtocell and picocell technology, Anadigics has launched a highly linear, efficient power amplifier (PA) designed to enable a new class of wireless infrastructure equipment.

Complementing other PAs in the AWB family (including the AWB7127 and AWB7123), the AWB7227 supports WCDMA, HSDPA and LTE air interfaces operating in the 2.11–2.17GHz band, and extends the firm's portfolio of PAs for use in small-cell base-stations, which are rapidly growing in popularity among service providers as an effective way to expand wireless network capacity and coverage.

Manufactured using InGaP HBT MMIC technology and offered in a 7mm x 7mm x 1.3mm SMT package (incorporating RF matching networks optimized for output power, efficiency and linearity in a 50Ω system), the AWB7227 delivers +27dBm of WCDMA power with an ACPR better than –50dBc and 14% power-added efficiency at rated output power. RF gain is typically 29dB. Such performance can enable femtocells and picocells with greater reach and smaller, more thermally efficient designs.

"Femtocells and picocells are a smart and cost-effective way to provide ubiquitous wireless coverage for end-users," says Joe Cozzarelli, senior director, Broadband RF Products. "As more service providers adopt small-cell base-station technology, we anticipate strong demand for PAs like the AWB7227, which provide flexibility in network architectures by delivering high linearity, output power, efficiency and reliability," he adds.

Wireless market analysts, as well as industry organizations such as the Femto Forum, are projecting significant expansion for the femtocell/picocell market. Reports predict femtocell shipments over the next 3 years to reach nearly 50 million units. In addition, the market for femtozone services, which include mobile voice and data applications triggered when a device comes within range of a femtocell, is expected to be nearly $2bn by 2015.

Engineering samples of the AWB7227 PA are available for qualified opportunities. The PA was one of the new products featured at Anadigics' booth at the 2011 Mobile World Congress in Barcelona, Spain (14–17 February).

Power amplifier added for 3.5GHz WiMAX bands in customer premises equipment & femtocell base-stations

Broadband wireless and wireline communications component maker Anadigics Inc of Warren, NJ, USA has launched the AWB7230 power amplifier (PA) module, a fully matched, multi-chip-module (MCM) that enables network performance across all the 3.5GHz WiMAX bands for use in Customer Premises Equipment (CPE) and femtocells.

Manufactured using InGaP HBT MMIC technology, the AWB7230 meets WiMAX spectrum mask requirements while delivering what is claimed to be exceptional linear RF power, and can serve as the final-stage amplifier in the transmit chain of either a CPE or femtocell. Covering the full 3.3–3.8GHz band, the device supports 3.5GHz WiMAX networks worldwide, and provides what is claimed to be the highest power efficiency available for such applications (16% power-added efficiency at rated output power, delivering up to +29dBm of WiMAX power with low EVM, and providing more than 30dB of RF gain). The AWB7230 also incorporates RF matching networks optimized for output power, efficiency and linearity in a 50Ω system.

Anadigics' new AWB7230 3.5GHz WiMAX power amplifier module.

The AWB7230 complements Anadigics' AWB7221 PA, which was launched last October to enable CPEs and femtocells operating in the 2.5GHz WiMAX bands. With the new PA, Anadigics now supports the two predominant sets of WiMAX frequency bands used around the globe.

"As WiMAX and other 4G technologies continue to emerge, Anadigics is responding to customer demands for high-performance PA modules that enable exceptional consumer and infrastructure solutions," says Joe Cozzarelli, senior director, Broadband RF Products. "With the AWB7230, Anadigics continues to expand its product portfolio and demonstrate industry-leading performance by providing wideband coverage at high linear power levels, and with best-in-class power efficiency," he claims.

WiMAX CPEs provide an alternative to DSL and cable modems, and also play a key role in the transition to 4G, by offering consumers high-speed wireless connectivity for their homes, shops or businesses. According to industry organization WiMAX Forum, nearly 600 WiMAX (fixed and mobile) networks have been deployed in 149 countries, with network coverage forecasted to be available to more than 1 billion potential subscribers worldwide this year.

Anadigics claims that the AWB7230 is an optimal solution for current and next-generation WiMAX CPEs and small-cell base-stations. Engineering samples are available now for qualified opportunities.

www.anadigics.com

HELP3E dual-band PAs power Sierra's AirPrime MC Series modules

Anadigics says that it is shipping production volumes of its third-generation (High-Efficiency-at-Low-Power (HELP3E) dual-band power amplifiers (PAs) to Sierra Wireless of Richmond, British Columbia, Canada, which provides mobile computing and machine-to-machine (M2M) communications products for cellular networks. Sierra Wireless' AirPrime MC7700 and MC7750 embedded modules are powered by Anadigics' AWU6615, while the AirPrime MC7710 is enabled by the AWU6618.

"AirPrime MC Series embedded modules help our customers take full advantage of new 4G network technologies," says Dan Schieler, senior VP & general manager, Mobile Computing for Sierra. "With unprecedented throughput, these modules open up new opportunities for mobile computing, multimedia, and HD video applications," he claims. "The superior performance and reliability of Anadigics' HELP3E power amplifiers play a critical role in our AirPrime MC series and support our efforts to deliver superior network 3G and 4G connectivity," Schieler adds.

"The AirPrime MC series unleashes the full potential of mobile devices by leveraging the latest 3G and 4G technologies," comments Anadigics' VP of worldwide sales Michael Canonico.

Anadigics says that its HELP3E PAs use the firm's exclusive InGaP-Plus technology to achieve optimal efficiency across low-range and mid-range output power levels and provide low quiescent currents of 4mA. The compact 3mm x 5mm HELP3E dual-band PAs feature an internal voltage regulator and RF coupler. This level of integration reduces printed circuit board (PCB) space by 25% compared with current-generation dual-band solutions, Anadigics claims.

www.sierrawireless.com

Anadigics' sales fall less-than-expected 1.7% in Q4

Cable & WiMAX inventory correction to drive 30% revenue drop in Q1

For fourth-quarter 2010, GaAs-based broadband wireless and wireline communications component maker Anadigics Inc of Warren, NJ, USA has reported net sales of $60.2m, up 44.1% on $41.8m a year ago but down 1.7% on Q3's $61.3m. However, this is better than the expected 7% drop to $57m.

Apart from Wireless revenue rising from $45.2m in Q3 to $46.1m ($1m higher than expected, due to higher 3G CDMA sales), increased demand for wireless LAN and cable products yielded a much lower sequential decline in Broadband revenue of 12.5% (from $16.1m to $14.1m) rather than the expected 25% (to $12.1m). In particular, despite set-top box revenue falling from $5.6m to $4.9m, infrastructure from $6.3m to $4.6m and WiMAX from $3.4m to $2.4m, WLAN revenue rose from $0.6m to $2.1m.

Revenue for full-year 2010 was $216.7m, up 54.3% on 2009's $140.5m. This included growth of 20% in Broadband business (from $47.5m to $56.7m) and 72% in Wireless business (from $93m to $160m). "Our strong performance in 2010 is a result of successful execution on the strategic initiatives that we outlined at the beginning of the year, including expanding our customer base and increasing our market share," says president & CEO Mario Rivas.

"We also exceeded our goals for both profitability and free cash flow," says Rivas. Gross margin has risen from Q3's 37.2% to a slightly better-than-expected 37.7%, while operating expenses were a lower-than-expected $18.3m. This yielded non-GAAP net income of $4.9m, compared with $4.4m last quarter and a net loss of $3.2m a year ago. Non-GAAP net income for full-year 2010 was $7.7m, compared with 2009's net loss of $33.7m.

Cash flow from operations was $8.6m, contributing to cash, cash equivalents and short- and long-term marketable securities rising during the quarter from $96m to $106.1m (well ahead of the targeted $100m), after capital expenditure of $1.5m.

"We are seeing indications of greater-than-normal seasonality in the first quarter of 2011, primarily due to softness in China and through our distribution channels relating to excess inventories, coupled with a continued market correction expected to further impact our cable and WiMAX revenue," cautions chief financial officer Tom Shields. Including Broadband sales down by perhaps $6m from Q4/2010 and a typical drop of 10–15% for Q1/2010 due to seasonality, Anadigics expects revenue to fall to $42–44m. However, even though Broadband sales of about $8m will be down more than 30% on Q1/2010's $13.2m, gross margin should still be up year-on-year.

"As we've seen historically, we know that Q2 typically rebounds very favorably," says Shields. "Looking forward, we remain well positioned to benefit from the continued growth in the 3G and 4G markets as we strive to expand our market share at new and existing customers, execute on design wins and continue to introduce superior new products," adds Rivas.

New products represented about 40% of business by the end of 2010 (a significant improvement on 2009). "Our long-term goal continues to be capturing 14% market share in wireless GaAs by 2014, which will equate to share gains of approximately 2% per year," states Rivas.

www.anadigics.com

Passive component maker Murata named 'Supplier of the Year'

Anadigics has awarded ceramic-based passive electronic component maker Murata Manufacturing Company Ltd of Kyoto, Japan its Supplier of the Year Award.

The Supplier of the Year Award program was launched in 2009 to recognize suppliers who go above and beyond to deliver on their commitments and service to ensure Anadigics' success.

"Murata has demonstrated outstanding performance in their ability to respond to rapid increases in demand for components, most notably our requirements for ceramic monolithic capacitors," says Anadigics' VP of operations Russ Wagner. "Murata consistently exceeds our expectations for quality, service and delivery. We view them as a strategic partner in our efforts to develop leading-edge RFIC solutions," he adds.

Wagner (left) presents Supplier of the Year Award to Murata Taiwan president Toshiyuki Sato.

"The business relationship we have established between our firms reflects our mutual commitment to achieving operational and service excellence at the highest levels, and we remain dedicated to growing our partnership well into the future," said Murata Taiwan president Toshiyuki Sato in accepting the award on behalf of Murata Electronics North America and the rest of Murata.

www.murata.com

Skyworks adds GaAs- and SOI-based antenna switch modules for smart-phones, tablets and datacards

Skyworks has launched a family of antenna switch modules (ASMs) for dual- and triple-mode smartphones, tablets and datacards, for volume production in second-half 2011.

The new devices cover a wide range of applications from low-cost 3G handsets to HSPA+/LTE-enabled datacentric devices such as high-end smart-phones, data dongles and tablets — all of which require design flexibility, high performance and cost-effective architectures.

Skyworks' RF switch products are based on both GaAs and SOI technologies and complement its front-end and power amplifier module portfolio, allowing it to capture extra dollar content per platform.

"Skyworks is excited to be augmenting our broad GaAs and silicon-based RF front-end solutions portfolio with these new SOI devices that help address real market needs and enhance performance requirements," says Gregory L. Waters, executive VP & general manager of front-end solutions. "Our ability to meet customers' needs on multiple fronts and with highly integrated architectures demonstrates the breadth and depth of Skyworks' technology and capabilities in this demanding market," he adds.

The SKY13402-466LF is a GaAs pHEMT single-pole, ten-throw (SP10T) antenna switch with an integrated mobility industry processor interface (MIPI) decoder and dual low-pass harmonic filters. The switch has six transmit (Tx)/receive (Rx) ports, suiting any combination of 2G/3G multi-mode cellular applications. Using advanced switching technologies, the device maintains low insertion loss and high isolation for both Tx and Rx switching paths. The switch also has what is claimed to be an excellent triple beat ratio and 2nd/3rd-order modulation distortion performance.

The SKY18108 is a single-pole, nine-throw (SP9T) antenna switch front-end module (FEM) packaged in a 3.2mm x 2.5mm, 20-pin multi-chip module (MCM). The low-cost switch has three high linearity ports suitable for transparent bridging (tri-band 3G/quad-band 2G or TD-SCDMA/2G multi-mode handsets and datacards). Based on SOI technology and including Tx harmonic filters, the device is designed for dual-mode, high-power switching applications that require low insertion loss. It is also optimized for both GSM/EDGE/WCDMA and TD-SCDMA systems.

The SKY18110 is a single-pole, eight-throw (SP8T) ASM packaged in a 3.2mm x 3.2mm, 20-pin MCM for use in multi-mode, high-power band switching applications that demand low insertion loss. Based on SOI technology and including Tx harmonic filters, it has six high-linearity ports, providing full flexibility for 2G GSM/EDGE, 3G and LTE handsets and datacards.

The SKY18116 is a SP8T ASM packaged in a 3.2mm x 2.5mm, 18-pin MCM designed for dual- and tri-mode, high-power band switching applications that require low-insertion loss. Based on SOI and including Tx harmonic filters, it has six high linearity ports, providing full flexibility for 2G, 3G and LTE handsets and datacards, and is optimized for GSM/EDGE, WCDMA and LTE systems.

The SKY18118 is a SP10T switch FEM packaged in a 3.5mm x 3.2mm, 20-pin MCM. The FEM has five high-linearity ports, providing full flexibility for 2G, 3G and LTE handsets and datacards. It is based on SOI and includes Tx harmonic filters as well as 2G Rx surface acoustic wave (SAW) filters and is optimized for compact layout and highly integrated RF front-end solutions.

Skyworks powering multiple LTE platforms

Skyworks says that its extensive LTE product portfolio is continuing to gain traction with leading handset OEMs and smartphone providers and is at the heart of several new, yet unreleased 4G devices scheduled for launch later this year.

Skyworks has previously enabled the world's first commercial LTE device (Samsung's high-speed 4G USB modem), the first mobile LTE handset, and several platforms from ST-Ericsson. Since then, the firm has secured additional design wins with HTC, among others, to power various 4G smartphones.

Today's 4G platforms allow consumers to access and stream data and multimedia applications anytime, anywhere at higher data rates than previous-generation networks. Skyworks says that its family of LTE products provides the most complete and flexible set of options for manufacturers developing and building 4G-enabled handsets, base-stations, wireless PC cards, and a host of other embedded solutions.

"By improving efficiency and performance, boosting network throughput, and simplifying roaming, Skyworks' broad product portfolio is offering tangible benefits to handset OEMs and smartphone providers, as well as infrastructure suppliers and operators worldwide to ensure consumers have access to high-speed mobile broadband data and global coverage," says senior director of engineering Dr Gene A. Tkachenko.

According to the Global Semiconductor Alliance (GSA), 180 operators are investing in LTE in 70 countries, with 17 networks already launched worldwide.

www.skyworksinc.com

Skyworks grows revenue 7% to record $335.1m

Debt slashed as smartphone demand drives profitability

For its fiscal first-quarter 2011, 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 reported record revenue of $335.1m, up 7% on $313.3m last quarter and up 37% on $245.1m a year ago (and just exceeding the $330–335m guidance).

On a non-GAAP basis, gross margin has risen from 42.2% a year ago and 43.8% last quarter to 44.7% (above the expected 44.5%), driven by an improving product mix, supply chain efficiencies, margin-enhancing demand-driven capital investments and continued manufacturing productivity enhancements.

Operating expenses have continued to rise, from $51.3m a year ago and $55.5m last quarter to $57m. Nevertheless, operating income has risen from $52.3m a year ago (an operating margin of 21.3% of sales) and $81.8m (26.1% margin) last quarter to $92.8m (27.7% margin), as Skyworks continues to make progress towards its mid-term operating model targeted at 30% with a minimum gross margin of 45%. Net income has risen from $47.7m a year ago and $78.8m last quarter to $84.7m.

During the quarter, Skyworks invested $33m in capital expenditure and back-end process investment (complementing the firm's hybrid outsourcing model). It also recorded $13.6m of depreciation, retired its $50m credit facility (part of its broader strategy to reduce debt), and repurchased about 800,000 shares (at an average price of $23.15 per share). The balance sheet is hence now virtually debt free, yet Skyworks still increased its net cash by $41m and exited the quarter with more than $450m of cash and cash equivalents.

"These improvements highlight the progress we've made in our broader strategy to reduce debt and strengthen our balance sheet," notes VP & chief financial officer Donald W. Palette. "Over the last three years we've improved our balance sheet from a negative $46m net debt position to a positive $426m net cash position," he adds.

"We continued to benefit from strong underlying demand in the mobile Internet enhanced by ongoing share gains and by new product ramps," says president & CEO David J. Aldrich.

During the quarter, Skyworks supported the rapidly emerging tablet market with wireless connectivity solutions compatible with all major mobile operating systems; ramped production of analog components supporting Cisco and Motorola's fiber-to-the-home applications; secured design wins with Johnson Controls in support of their HomeLink automotive system being adopted by leading vehicle manufacturers worldwide; partnered with Ember to deliver ZigBee solutions for the energy management, home area network and industrial automation markets; launched analog control ICs for the Nintendo 3DS gaming system; unveiled silicon RF limiters for military radar receiver applications; captured multiple base-station transceiver sockets with global infrastructure providers supporting LTE, GSM and femtocell platforms; powered HTC's next-generation smartphones with highly integrated front-end modules; and enabled the first commercial LTE handset on a 4G network to allow consumers anytime, anywhere connectivity at data rates up to 100Mbps.

Adoption of smartphones is happening at an accelerated pace with a growth rate of at least four times that of the traditional cellular handset market, Aldrich notes

"Skyworks is enabling wireless broadband connectivity across multiple high-growth platforms including smartphones, tablets, smart grids and home automation systems, as well as within the supporting network infrastructure," says Aldrich. "At a higher level, our goal remains to diversify across new vertical markets, develop differentiated products and deliver operational excellence, positioning us to outperform our addressed markets," he adds.

"Consumer appetite for anytime anywhere connectivity continues to grow exponentially," continues Aldrich. "In fact, 2010 holiday sales underscore the strong demand for Internet-connected mobile devices that provide 'always on' access to social networking sites, gaming, video, music and web access. Retailers have highlighted mobile devices as a bright spot in consumer spending this past holiday season, and we certainly benefited from this demand," he adds. "Adoption of smartphones is happening at an accelerated pace with a growth rate of at least four times that of the traditional cellular handset market," Aldrich notes. "Skyworks is in a unique position to capitalize on these healthy market dynamics based on our unique product offering and our broad customer base. Our products support all smartphone and tablet operating systems including Android, Symbian, Windows Mobile and others."

Based on overall business momentum and the ramp of new applications, for its fiscal second-quarter 2011 (to end March) Skyworks expects revenue of $310–320m (up 30–34% year-on-year — much better than normal seasonality), gross margin of 43.8% and operating expenses of $57.5–58m.

www.skyworksinc.com

Skyworks and Ember partner on next-gen ZigBee system solutions

Skyworks and Ember Corp of Boston, MA, USA, a provider of low-power, wireless mesh networking technology (chips, software and tools), have introduced solutions for ZigBee applications targeting the growing energy management, home-area network and industrial automation markets. ZigBee is a wireless network standard that solves the needs of remote monitoring and control, and sensor-network applications. Specific applications range from lighting control to door and window sensors, and appliance and temperature controllers.

"Continuing our partnering with Skyworks with our latest generation of ZigBee solutions was an obvious choice," says Ember's VP of sales Dennis Natale. "These industry-leading platforms are designed to power the next wave of energy management and home automation applications while delivering exceptional performance and long battery life," he adds.

"Ember is the undisputed ZigBee market leader and we are delighted to be combining Skyworks' front-end modules with their next-generation system-on-chips (SoCs)," says Liam K. Griffin, Skyworks' senior VP of sales & marketing. "Given the momentum and demand for green technologies, enhanced security and energy conservation, we are thrilled to be leveraging our scale and analog integration capabilities with the industry leader to serve multiple end markets."

Market research firm ON World Inc forecasts that more than 100 million 802.15.4 and ZigBee units will ship annually in the next few years. The largest markets are expected to be advanced metering infrastructure (AMI), home automation and consumer electronics. ON World also expects many emerging vertical markets (including medical devices, health and wellness monitoring, building automation and municipal/transportation) to also use ZigBee/IEEE 802.15.4 technologies.

Skyworks' SKY65343-11 and SKY65344-21 are both small front-end modules (FEMs) for ZigBee and other 2.4GHz ISM-band solutions that contains a 2.4–2.5GHz high-efficiency transmit (Tx) path and a low-loss bi-directional path.

The SKY65343-11's bi-directional path contains a high-isolation Tx/receive (Rx) switch and balun for low-noise differential output. The differential output receiver port is also bi-directional and can be used for operation in low-power Tx mode.

The SKY65344-21's bi-directional path can be used to directly connect the antenna port to a directional RF port. The Rx path contains a high-isolation T/R switch, low-noise amplifier, and balun for low-noise differential output.

The Tx path in both devices has a harmonic filter and high-efficiency power amplifier that can provide >20dBm of power at the antenna port. Also, an internal balun allows use of differential input signals. Both parts are mounted in a 20-pin SMT package, allowing a highly manufacturable, low-cost solution.

Skyworks claims that the FEMs can increase the usable range of a ZigBee solution by up to 700% and, when combined with Ember's EM350 series, results in the industry's most highly integrated and lowest total power solution.

The EM300 Series ZigBee chips are the industry's first ARM Cortex-M3 based family of system-on-chips (SoCs), delivering what is claimed to be unmatched performance, power consumption and code density in a compact package. The EM351 and EM357 combine a 2.4GHz IEEE 802.15.4 radio transceiver with a 32-bit microprocessor, Flash memory and RAM with powerful hardware supporting network-level debugging features. This, combined with ARM tools, enables OEMs to simplify development and accelerate time-to-market, it is claimed.

www.ember.com

IN BRIEF

Kopin wins fourth consecutive supplier award from Skyworks

Kopin Corp of Taunton, MA, USA, which makes CyberDisplay LCDs micro-displays for consumer, industrial and military applications and claims to be the world's leading producer of III-V heterojunction bipolar transistor (HBT) wafers for smart phones and other mobile devices, has received the 2010 Raw Materials Supplier Award from Skyworks Solutions Inc of Woburn, MA, USA, which makes linear products, power amplifiers, front-end modules and radio solutions for handset and infrastructure equipment.

The award was presented to Kopin during Skyworks' Supplier Day on 11 January in Newport Beach, CA for the supply of HBT and other advanced III-V epi-wafers to Skyworks' wafer fab in Newbury Park, CA. This is Kopin's fourth consecutive award in this category, in addition to a Lifetime Partnership Award bestowed in 2008.

"Partnership with Kopin has been invaluable during a period of rapid growth for Skyworks," comments Bruce J. Freyman, Skyworks' senior VP of worldwide operations. "We are confident Kopin will continue to provide Skyworks with the manufacturing strength and technology leadership required to meet the ever-increasing demands for 3G and emerging 4G wireless devices," he adds.

"We view it [the award] as a testament to our unwavering focus on quality, manufacturing, technology improvements and customer support," says Kopin's president & CEO Dr John C.C. Fan.

www.kopin.com

RFMD's revenue falls 2.4% due to 3G drop at Nokia

March quarter to be inflexion point from legacy transceivers to higher-margin components

For its fiscal third-quarter 2011 (ended 1 January), RF Micro Devices Inc of Greensboro, NC, USA has reported revenue of $278.8m. This is up 11.4% on $250.3m a year ago but down 2.4% on $285.8m last quarter, reflecting a decline in 3G revenue at its largest customer Nokia, offset partly by transceiver revenue above original estimates and sequential growth in high-performance switch-based products as RFMD continued to diversify its customer base and markets. Notably, RFMD delivered more than 60% year-on-year core business growth outside its largest customer.

In particular, the Cellular Products Group (CPG) saw accelerating design activity for 3G/4G smartphones across its PowerSmart power platforms, high-performance switch-based products, and recently launched family of high-efficiency single-mode power amplifiers (PAs). RFMD also supported the launch of a flagship 3G/4G smartphone and tablet product family featuring its PowerSmart and WiFi components.

The Multi-Market Products Group (MPG) enjoyed strong underlying demand in its end markets, with each MPG business unit growing sequentially, led by wireless infrastructure, smart energy, WiFi for 3G/4G smartphones and tablets, defense, and high-power gallium nitride (GaN) applications. MPG commenced volume production of GaN products for applications in high-power military radar and CATV.

On a non-GAAP basis, gross margin was 38.7%, up on 38.4% a year ago but down from 39.8% last quarter, with lower-margin transceiver business remaining dilutive to core business margins. However, core business (excluding the impact of transceivers) achieved gross margin of 41%. Net income has continued to rise, from $38.8m a year ago and $52.3m last quarter to $52.6m.

During the quarter, RFMD generated free cash flow of $54m (net cash from operating activities of $63.3m minus purchases of property and equipment of $9.1m). Over the past eight quarters, the firm has improved its net cash position by $405m.

RFMD believes the demand environment in its end markets supports the expectation that, for its fiscal fourth-quarter 2011 (to end-March), revenue will fall 10–15% seasonally (with gross margin flat-to-down 200 basis points). However, this includes a $25m drop in transceiver revenue (consistent with the anticipated end-of-life of legacy products, which should be immaterial to results for the June quarter and beyond, as POLARIS shipments fall from about 15% of total revenue in the September 2010 quarter towards 5% in the March quarter).

"The March quarter represents an inflection point for RFMD as we close out our legacy transceiver business and begin the ramp of new, higher-margin component solutions, including our PowerSmart power platforms [commencing volume shipments], our industry-leading high-efficiency single-mode PAs, our silicon-based switches, our GaN components, and our high-performance WiFi components," says president & CEO Bob Bruggeworth.

The March quarter represents an inflection point for RFMD as we close out our legacy transceiver business and begin the ramp of new, higher-margin component solutions

"We are forecasting sequential growth in the March quarter in 3G/4G smartphones, wireless infrastructure and GaN-based products, and we expect to ramp 3G/4G smartphones featuring PowerSmart at an additional leading smartphone OEM each quarter of calendar 2011," Bruggeworth adds.

Based on existing design wins, RFMD expects PowerSmart revenue in fiscal 2012 to exceed $75m. As the mix of design wins continues to shift towards 3G and 4G, RFMD is forecasting significant share gains in fiscal 2012 in both smartphones and in 3G feature phones. "This supports our expectations for broad-based share gains and positions RFMD to grow sequentially and expand gross margins during fiscal 2012, outpacing overall growth in our core markets," Bruggeworth continues.

"RFMD's capital-efficient business model has generated two years of industry-leading free cash flow, with an outlook for continued superior free cash flow," reckons chief financial officer & VP of administration Dean Priddy. RFMD remains on track to achieve free cash flow in fiscal 2011 of $180–200m (up on fiscal 2010's $177m).

"We are confident RFMD's business model enables us to substantially grow our revenues and expand margins while achieving industry-leading capital efficiency. In fact, we believe we can approximately double our revenue without requiring additional GaAs fabrication capacity," Priddy adds.

Based on this outlook, RFMD's board of directors has authorized a two-year $200m share repurchase plan. "This provides us with the flexibility, when market conditions warrant, to significantly reduce our outstanding shares and offset potential future dilution from our convertible debt and awards under our equity-based compensation plans," says Priddy.

www.rfmd.com

RFMD's PowerSmart power platforms achieve HSPA+ 4G data upload speeds with 15% less current

RF Micro Devices Inc of Greensboro, NC, USA says that it has achieved a major performance milestone related to its PowerSmart power platforms (a new product category for future multimode, multi-band cellular RF architectures).

During independent product testing, the PowerSmart power platforms achieved HSPA+ 4G data upload speeds while drawing about 15% less current than competitive solutions, the firm says. Product qualification tests, which are routinely performed to evaluate each new cellular product's front end, transceiver and baseband, are currently being conducted in support of a product family spanning multiple form factors, to be launched by a leading cellular device manufacturer in the March quarter.

PowerSmart power platforms feature a new RF Configurable Power Core that delivers multiband, multi-mode coverage of all cellular communications modulation schemes, including GSM/GPRS, EDGE, EDGE Evolution, CDMA, 3G (TD-SCDMA or WCDMA) and 4G (HSPA+, LTE or WiMAX). HSPA+ 4G devices are capable of maximum data upload speeds of 22Mbps. Because the RF Configurable Power Core in PowerSmart is compliant with all current and known future 4G data standards (HSPA+, LTE QPSK, LTE 16QAM, and LTE 64QAM), RFMD expects that subsequent smartphones featuring PowerSmart will support upload speeds significantly greater than 22Mbps.

In addition to the RF Configurable Power Core, which performs all power amplification and power management functionality, RFMD's PowerSmart power platforms include all necessary switching and signal conditioning functionality in a compact reference design, providing smartphone makers a single scalable source for the entire cellular front end, says the firm.

RFMD receives first production orders for PowerSmart power platforms

RF Micro Devices has received the first volume production orders for its PowerSmart power platforms. The orders are in support of a highly anticipated smartphone and tablet product family to be launched by a 'leading cellular handset manufacturer', beginning in the March quarter.

"RFMD's PowerSmart power platforms are a new product category reshaping the future of multi-mode, multi-band cellular RF architectures," says Eric Creviston, president of RFMD's cellular products group (CPG). "PowerSmart power platforms feature a revolutionary new RF Configurable Power Core that delivers multi-band, multi-mode coverage of all cellular communications modulation schemes, including 2G, 3G and 4G, up to LTE 64QAM," he adds.

In addition to the RF Configurable Power Core, which performs all power amplification and power management functionality, RFMD's PowerSmart power platforms include all necessary switching and signal conditioning functionality in a compact reference design, providing smartphone makers with a single scalable source for the entire cellular front end.

RFMD expects to start volume shipments of PowerSmart in this quarter, with sequential growth anticipated in the June quarter.

www.rfmd.com

Low-noise, high-output xPON video receiver IC

RFMD has made available samples of the RFRX8888 video receiver, which performs transimpedance amplification of the differential input from a high-performance 1550nm optical wavelength photo-detector (PD) with what is claimed to be best-in-class low noise performance (<3.0pA/rtHz equivalent input noise current, typical).

The IC's output is linear low distortion RF over an operational bandwidth from 48MHz to 1002MHz. Linearity is better than –63dBc CSO and –66dBc CTB at +23dBmV RF out per channel (79-NTSC analog channels and 75 digital QAM channels).

The RFRX8888 suits 1550nm optical wavelength RF analog or digital overlay video receive circuitry employed in xPON fiber-to-the-premises (FTTP) optical network termination (ONT) triplexer and quadplexer modules. Its first stage features integrated on-die bias circuitry, simplifying external-to-IC end-product design and reducing board area and overall end-product assembly cost. Optimized for operation from a single $+12V_{DC}$ power supply with highly efficient power consumption of just 1.4W, it eliminates the need for a supplemental ONT power supply in most xPON (passive optical network) applications.

Features include 33dB AGC range with recommended external control circuitry, +23dBmV per channel/carrier RF output with no 4:1 transformer required, and what is claimed to be best-in-class MER (38.5dB minimum).

The RFRX8888's ultra-low noise performance, combined with high output power, extends the performance and lifetime of wired networks by improving the link margin and/or allowing more passive optical splits.

Volume pricing begins at $4.45. For FTTP requiring $+5V_{DC}$ power supply operation, the RFRX8890 video receiver is also available.

RFMD unveils power platform for entry-level 3G handsets

RFMD has expanded its 3G product portfolio to include a complete power platform for entry-level 3G handsets, consisting of the RF323x and RF72xx product families, to provide handset makers a complete reference design for the implementation of multi-region multimode 3G handset platforms.

RFMD says that the RF323x power platform addresses the challenges confronting handset makers as they seek to meet the increasing global demand for affordable smartphones. Designers of entry-level 3G smartphones can achieve the optimum balance of cost, performance and flexibility in the RF front-end while satisfying critical requirements for quality and reliability in high-volume handset making, the firm claims.

"Customers see cost as a key driver in the entry-level 3G segment and want flexible front-end solutions that scale easily to address multiple operator and regional requirements," says Eric Creviston, president of RFMD's Cellular Products Group (CPG). "Our high-efficiency 3G entry power platforms provide a full array of tiered options at compelling price points, setting the benchmark for ease of implementation and current consumption in a single, scalable reference design."

The RF323x power platform features the high-efficiency PowerStar-based RF323x 2G transmit module with pin-compatible options supporting either one or two bands of WCDMA. The pin-compatible WCDMA power amplifiers are available in two product family options addressing all major frequency bands: the RF724x delivers DG.09 performance as low as 13mA through the use of multi-bias control; the RF722x is optimized for chipsets using three-mode control schemes.

The RF323x power platform is compatible with major chipset providers including Qualcomm, Mediatek, Broadcom and ST Ericsson. Volume production is planned this quarter.

4G HSPA+ power amplifiers launched

RFMD has announced availability of its RF724x family of HSPA+ power amplifiers (PAs), consisting of five single-mode PAs covering WCDMA bands 1, 2, 4, 5 and 8 to address the most common 3G/4G frequency bands and band combinations for smartphones, tablets and other high-performance data-centric connected devices.

The RF724x PAs support ultra-high peak efficiency of 48–51%, which is significantly above current competitive offerings, the firm claims. Also, when combined with one of RFMD's companion DC–DC converters or with chipsets featuring on-chip DC–DC converter functionality, they can deliver what is claimed to be best-in-class DG.09 performance as low as 13mA, translating directly into superior 3G talk-time.

"RF724x power amplifiers are specifically designed to reduce the thermal impact of data usage in smartphones while enabling increased battery life during data-based applications like web surfing, video calls and internet radio services," says Eric Creviston, president of RFMD's Cellular Products Group. "We anticipate significant customer adoption this year... first production shipments will commence for a leading North American smartphone manufacturer later this quarter."

All RF724x PAs are packaged in a standardized 3mm x 3mm footprint, improving smartphone platform flexibility and ease of implementation, says the firm. They also feature an integrated high-directivity coupler, standard 2-bit GPIO control logic, and low insertion phase shift between bias states.

RFMD FEM featured in smart-phones and tablets with TI WiLink platform

RFMD says that global smartphone and tablet makers designing around the WiLink 6.0 and 7.0 platforms from Texas Instruments can integrate its RF3482 front-end module (FEM) to gain reliable, flexible WiFi connectivity. Volume shipments of the RF3482 have begun.

RFMD is supporting TI across multiple high-volume mobile and embedded consumer programs. "The RF3482 delivers high levels of integration and best-in-class solution size while meeting stringent IEEE 802.11b/g/n requirements," claims Bob Van Buskirk, president of RFMD's Multi-Market Products Group. "RFMD is highly focused on the rapidly expanding WiFi market and expects continued growth, supported by explosive growth in the smartphone, tablet, PC, TV/Video, gaming, automotive, Smart Energy and consumer white-goods end-markets," he adds.

The RF3482 is a single-chip integrated FEM for WiFi applications in the 2.4–2.5GHz ISM band. RFMD says it greatly cuts time-to-market and bill-of-material (BOM) cost by delivering a highly integrated single placement solution. As well as satisfying smart-phone makers' needs for aggressive size reductions in 802.11b/g/n front-end solutions, the RF3482 delivers high linear output power and cuts the number of components outside the core connectivity chipset.

"TI's WiLink 6.0 and WiLink 7.0 platforms are powerful multi-radio solutions able to support a wide range of connectivity requirements for various end equipments," says Eran Sandhaus, TI's director of marketing, wireless connectivity solutions. "Customers seek complementary solutions that enhance the WiLink platform's capabilities exhibiting the same dedication to simplified integration and reliability as offered by TI's technologies. RFMD's RF3482 FEM is one such solution that customers can use."

www.rfmd.com

RFMD's PowerSmart power platforms and WiFi FEMs chosen for Samsung and LG 3G/4G devices

RFMD's PowerSmart power platforms and WiFi components have been selected by both Samsung and LG to enable broad portfolios of next-generation 3G/4G devices.

Samsung's Galaxy S2 and Tab 10.1 will both feature PowerSmart, while the Galaxy Tab 10.1 will also feature the RF5521 WiFi front-end module (FEM). Both were unveiled by Samsung at the 2011 Mobile World Congress in Barcelona, Spain (14–17 February).

"We're especially pleased to support the highly anticipated Galaxy S2 and Galaxy Tab 10.1 with our PowerSmart power platforms and market-leading WiFi components," says president & CEO Bob Bruggeworth. "PowerSmart power platforms are at the forefront of the technology shift to converged front ends in multi-mode, multiband smart-phones, and we anticipate strong growth in PowerSmart shipments this year."

PowerSmart power platforms feature a new RF Configurable Power Core that delivers multiband, multi-mode coverage of all cellular communications modulation schemes including 2G, 3G and 4G, up to LTE 64QAM. PowerSmart power platforms also include all necessary switching and signal conditioning functionality in a compact reference design, providing smart-phone makers a single scalable source for the entire cellular front end.

RFMD's PowerSmart power platforms and WiFi front-end modules are also enabling LG's 3G/4G smart-phones, including the LG Optimus 3D (the world's first full 3D smart-phone) — also unveiled at the Mobile World Congress.

"We're proud our PowerSmart power platforms and WiFi components are featured in such an innovative device as the Optimus 3D," says Bruggeworth. "PowerSmart power platforms lead a product category that is reshaping the future of multimode, multi-band cellular RF architectures, and we look forward to further leveraging our product and technology leadership across LG's growing 3G/4G product portfolio," he adds.

With the LG announcement, PowerSmart is now in production in support of multiple families of flagship 3G/4G smart-phones and tablet devices.

RFMD says its RF3482 and RF5521 WiFi front-end modules satisfy smart-phone and tablet makers' requirements for aggressive size reductions in 802.11b/g/n front-end solutions, while delivering high linear output power and greatly reducing the number of components outside the core connectivity chipset.

RFMD expects shipments of PowerSmart power platforms and WiFi components to increase sequentially throughout the year.

www.rfmd.com

Cellular FEMs unveiled for 3G/4G switching and signal conditioning

RFMD has added four new products to its expanding portfolio of front-end modules for 3G/4G switch and signal conditioning applications.

The firm's switch and signal conditioning product portfolio includes antenna switch modules, switch filter modules, switch duplexer modules, RF power management components, and low-noise amplifiers. The four new products (the RF8889A, RF1291, RF1194A and RF1196) are each optimized to solve the complex RF requirements of 3G/4G smartphones related to high band count and harmonics.

"RFMD's highly integrated, high-performance cellular front-end modules solve our customers' increasingly complex RF requirements and deliver unmatched ease-of-use benefits related to size, performance and platform flexibility by offering ascending levels of switch, filter and duplexer functionality within a single module," says Eric Creviston, president of RFMD's Cellular Products Group (CPG). "Importantly, our expanding portfolio of antenna switch modules, switch filter modules and switch duplexer modules is highly complementary to all of our power platforms and provide our customers a single scalable source for the entire cellular front end."

The RF8889A and RF1291 single-pole 10 throw (SP10T) antenna switch modules (ASMs) deliver what is claimed to be industry-leading linearity performance and excellent insertion loss for high-throw-count applications and are compatible with reference designs from Qualcomm, Intel and ST-Ericsson. They are specifically targeted at smartphone applications in which the coexistence requirements of multiple radio standards (GSM/WCDMA/LTE/WiFi/Bluetooth) place critical importance on switch linearity and harmonic performance.

The RF1194A switch filter module (SFM) delivers the linearity and insertion loss performance of the RF8889A and RF1291 ASMs and expands upon their functionality by adding GSM Rx SAW filters. The RF1196 switch duplexer module (SDM) delivers the switch and filter capabilities of RFMD's ASMs and SFMs and expands on their functionality by integrating a WCDMA band 1 duplexer. The RF1196 is first in a family of RFMD SDM products that significantly reduce total solution size by delivering complete front-end integration of all switch and filter requirements in a single front-end module.

TriQuint grows 7% in Q4, but more-than-seasonal 13% revenue drop expected in Q1

Capacity expanding 40% to accommodate 20% revenue growth in 2011

For fourth-quarter 2010, RF front-end product and foundry services provider TriQuint Semiconductor Inc of Hillsboro, OR, USA has reported revenue of $253.4m, up 7% on $237m in Q3 and up 31% on $193.3m a year ago. Foxconn International Holdings Ltd and Samsung Electronics each account for 10% or more of total revenue.

Revenue for full-year 2010 was a record $878.7m, up 34% on 2009's $654.3m. This was led by:

- 33% growth for Mobile Devices (fueled by the rapid adoption of Internet-rich mobile devices such as smartphones and tablets and the expanding RF content required, as well as 3G data driving RF content expansion); and
- 54% growth for Networks (led by new products in optical, automotive and emerging markets in combination with the market rebound from a weak 2009).

In addition, in 2010 TriQuint was awarded more than $20m in gallium nitride (GaN) development contracts for next-generation high-performance RF solutions. "Our five-year compound annual revenue growth rate is now at 24%," summarizes president & CEO Ralph Quinsey.

In Q4/2010, Mobile Devices (71% of total revenue) grew 12% on Q3 and 34% year-on-year. In particular (by air interface standard), 3G/2.5G continued its growth, from 60% of Mobile Devices revenue a year ago and 69% last quarter to 70%. CDMA has fallen from 17% of Mobile Devices revenue a year ago to 8% and GSM has fallen from 10% to just 6% (as TriQuint continues to back away from 2G business), whereas Connectivity has grown from 13% of Mobile Devices revenue to 16%.

Continuing a strong rebound from the low of 2009, Networks (21% of total Q4 revenue) were up 50% on a year ago. In particular, 40Gb/s optical revenue almost tripled (building on the firm's relationship with China's Huawei). However, Networks revenue has plateaued since mid-2010, with Q4 flat on Q3.

Defense & Aerospace (8% of total revenue) has fallen 12%, both year-on-year and sequentially from Q3, to $20m (44% from radar, 33% from standard products, and 14% from R&D contracts). However, the drop is due primarily to the timing of major programs (which lead to characteristically lumpy order patterns in this market).

Although up from 38.4% a year ago, non-GAAP gross margin has fallen from 42.3% last quarter to 40.1%, due to weaker Defense and Networks demand (for which gross margins are typically more than 50%) and stronger-than-expected revenue from lower-margin Mobile Devices. Despite this, full-year gross margin still rose sharply from 33% for 2009 to 41% for 2010.

Non-GAAP operating expenses have risen from $56m (23.6% of revenue) last quarter to $58m (22.9% of revenue, down from 26.4% a year ago). Full-year operating expenses for 2010 were $221m (25.2% of revenue, down from 27.2% in 2009).

"In 2010, TriQuint exceeded our non-GAAP targets of 30% gross margin and 15% operating income," notes Quinsey. "Overall, 2010 was a record year for revenue and earnings."

Non-GAAP net income for Q4 was $42.8m, up on $22.8m a year ago but down on $44.2m last quarter. Full-year net income more than tripled from $38.2m in 2009 to a record $137.7m in 2010.

During the quarter, cash and investments rose from $187m to $224m, after strong cash flow from operations plus proceeds from stock option exercises (partially offset by high capital expenditure of $42.7m).

Also during the quarter, TriQuint's complete 3G RF front-end was selected by Samsung for its popular Galaxy Tab and Galaxy S smartphone series. The firm also released a 77GHz chipset portfolio used in Delphi Automotive's motion detection products, and announced the availability of the first TRIUMF multi-mode power amplifier (MMPA) module. In addition, TriQuint became a key supplier to Europe's first 100Gb/s optical data link.

Correspondingly, in first-quarter 2011 non-GAAP operating expenses are expected to grow further to about $62m, due mostly to increased R&D spending. However, expenses from litigation with Avago Technologies are also expected to rise from Q4's $4.2m to $5.6m (before dropping back to about $3.5m in Q2).

For first-quarter 2011, TriQuint expects revenue of $215–225m (up 22% year-on-year but down a slightly more-than-seasonal 13% sequentially). Nevertheless, non-GAAP gross margin should rise slightly to 40–42%, due to a small favorable impact from product mix (with Defense & Aerospace and Networks revenue to be flat, but lower-margin Mobile Devices revenue down 19% due to seasonality plus some allocation hangover).

40Gb/s optical revenue almost tripled (building on the firm's relationship with China's Huawei)

However, for Networks, order bookings have stepped up in Q1, indicating sequential growth in Q2, while full-year growth is expected to be 15–20%. Meanwhile, Defense & Aerospace revenue is expected to stay at about $20m per quarter for

first-half 2011 then grow sequentially in the second half, leading to full-year 2011 Defense & Aerospace revenue being flat to up mid single digits as a percentage on 2010. Full-year Mobile Devices revenue is expected to grow by at least 20%.

"With the world transitioning to a mobile Internet, I expect a strong market and see another solid growth year for TriQuint in 2011," says Quinsey. For the full year, the firm believes continued robust growth in demand should lead to gross margin of 40–43% and non-GAAP operating margin of at least 20% on revenue growth of about 20%.

The firm has hence planned capacity to exceed that goal. "In 2010 we invested in capacity, and are doing the same in 2011," Quinsey adds. In particular, the 6-inch wafer line being added at TriQuint's GaAs fab in Richardson, TX should come online in second-half 2011, while the existing 6-inch GaAs line in Hillsboro is also being expanded. "We have positioned ourselves to maintain an aggressive growth rate for 2011 and beyond," says Quinsey. According to chief financial officer Steve Buhaly, TriQuint expects to be able to produce $300m of revenue in Q2/2011 and $350m in Q4, as it grows its production capacity by about 40% in 2011.

The 6-inch wafer line being added at TriQuint's GaAs fab in Richardson, TX should come online in second-half 2011, while the existing 6-inch GaAs line in Hillsboro is also being expanded

"TriQuint anticipates the RF market will be strong for years to come," comments Quinsey. "We remain in the early stages of a communications revolution," he believes.

www.triquint.com

TriQuint's WLAN PAs powering smartphones using TI's WiLink

TriQuint Semiconductor Inc of Hillsboro, OR, USA claims that its two power amplifiers (PA) for WLAN connectivity are now leading the market since ramping to production last year.

Offering what is claimed to be faster data exchange rates, extended battery life and better amplification of weak signals than competitive technologies, both the single-band TQM679002A and dual-band TQP6M9002 PAs are designed to augment the WiLink 6.0 solution and recently launched WiLink 7.0 solution from Texas Instruments Inc (TI).

Both the single-band 2.4GHz TQM679002A and dual-band 2.4GHz/5GHz TQP6M9002 are fully integrated MMICs incorporating power amplifier and detectors, pre-PA filters, T/R switches, and WLAN Rx Balun. The 2.4GHz-band SP3T switch seamlessly selects between WLAN TX, RX, and Bluetooth paths. The TriQuint solutions offer integration with both the WiLink 6.0 and WiLink 7.0 mobile platforms. The single-band TQM679002A comes in a 3.0mm x 3.0mm x 0.45mm package and supports 802.11b/g/n + BT. The dual-band TQP6M9002 supports 802.11a/b/g/n + BT and is available in a 4.0mm x 4.0mm x 0.45mm package.

Smartphones and tablets increasingly include both cellular and WLAN connectivity options, offering the choice of broadband connectivity between cellular networks or WiFi networks. The integration of both technologies benefits consumers and carriers by offloading cellular capacity onto local WiFi networks. Given the additional bandwidth that the 5GHz 802.11a frequency band offers, an increasing number of tablets, smartphones and other mobile internet devices (MIDs) are dual-band WiFi enabled.

TriQuint's integrated WLAN PAs are fabricated with the firm's in-house E/D pHEMT and copper bump (CuFlip) technologies and are found in smartphones such as the Motorola Droid & Droid2, RIM Blackberry Torch, and Samsung 'Giorgio Armani'.

TI's WiLink 6.0 mobile platform is a complete hardware and software offering comprising proven, carrier-quality mobile WLAN, Bluetooth technology and FM cores integrated into a single chip. The WiLink 6.0 single-chip solution delivers low battery consumption, small form-factor and low-cost requirements to meet the needs of handset and mobile device makers worldwide.

"Our goal with the WiLink 6.0 and WiLink 7.0 platforms is to enable our customers to build revolutionary designs and products with co-existing connectivity options that meet the surface area and power requirements of mobile designs," says Eran Sandhaus, TI's director of marketing, Wireless Connectivity Solutions. "TriQuint's RF solutions for WLAN and Bluetooth technologies offer faster data rates and better amplification of weak signals in the mobile device's often cramped board space," he adds.

"WiFi connectivity is becoming a 'must-have' feature for today's smartphones and tablets because it enables consumers the ability to leverage home networks and WiFi hotspots when the 3G networks are at capacity," says Tim Dunn, TriQuint's VP & general manager of Mobile Devices, who adds that the firm is investing in capacity to support the growing market demand.

TriQuint offers what it claims is the industry's largest in-house technology portfolio, enabling RF architectures that align with major chipset providers, which provides device manufacturers qualified, tested and certified solutions. The firm highlighted these platform solutions at the GSMA Mobile World Congress 2011 in Barcelona, Spain (14–17 February).

www.ti.com

IN BRIEF

EMEA distribution deal with RFMW

TriQuint Semiconductor has announced a distribution agreement with RFMW Ltd for Europe, the Middle East and Africa (EMEA).

RFMW is a specialized distributor that provides customers and suppliers with focused distribution of RF and microwave components as well as specialized component-engineering support.

The new deal expands and builds on the relationship that the two firms have had in North America since 2005 and in Israel since 2010.

"Capitalizing on their familiarity with our products and target customer base, they are able to recognize opportunities and engage customers early in the design process through their component engineering and product management skills," says TriQuint's VP of sales & strategic development Todd DeBonis. "RFMW has the expertise and resources to cover customers from small development groups up to OEMs and contract manufacturers," he adds.

"Teaming with TriQuint in Europe allows us to offer our customers more of the world's best RF/microwave semiconductors, filters and integrated circuits," comments RFMW's president Joel Levine. "TriQuint's focus on components for communications applications matches perfectly with RFMW's focus on serving customers in diverse markets who require a wide range of RF/microwave components," he adds.

RFMW established sales offices in the UK, Germany and Italy at the beginning of 2011. "The TriQuint product line helps ensure our successful start in Europe," continues Levine. "Our goal is to expand TriQuint's design-in opportunities and to provide a high level of customer support to TriQuint's current customers."

www.rfmw.com

Multi-mode power amplifier module for Qualcomm's 3G/4G chipset

RF front-end product maker and foundry services provider TriQuint Semiconductor Inc of Hillsboro, OR, USA has announced the availability of its first multi-mode power amplifier (MMPA) module developed for Qualcomm's 3G/4G chipset.

A member of the TRIUMF Module family, the TQM7M9023 combines with TriQuint's TRITIUM PA-Duplexer Module family to offer a complete RF system solution for smartphones and other mobile devices.

"It integrates WCDMA functionality around our core competence of GSM/EDGE power amplifiers while providing customers a flexible, high-performance platform solution to meet the increasing band-count combinations in 3G/4G handsets," notes Tim Dunn, VP & general manager of Mobile Devices at TriQuint. "Our ability to integrate passive and active devices into high-performance system solutions continues to propel TriQuint's value in the smartphone market," he adds.

TriQuint says that its MMPAs provide several benefits to mobile device vendors:

- decreased overall radio solution size to enable a greater feature set in a smaller form factor;
- simplified PCB routing for improved performance and design cycles; and
- a reduction in bill of materials (BOM) count that improves manufacturing efficiency.

The firm says that the combination of the MMPA and its Band 2 and Band 5 TRITIUM modules offers a flexible and simplified RF solution that can reduce mobile device engineering and development time.

Using TriQuint's in-house CuFlip technology, the TQM7M9023 has a compact 5.0mm x 7.5mm footprint. The MMPA integrates quad-band GSM/EDGE functionality with WCDMA Bands 1 & 8 into a single package. Building on its capabilities in the EDGE market, TriQuint says that the MMPA can provide additional value through improved system performance and lower overall cost by replacing three discrete power amplifier modules and associated matching components.

As a fully integrated MMPA, the TQM7M9023 includes a GSM/EDGE power amplifier, WCDMA power amplifiers, high-performance coupler, regulatory circuitry and matching components. It does not require an external DC/DC converter or complicated band switches, providing optimum RF performance at maximum output and backed-off power levels for both data and voice applications, respectively. The TQM7M9023 is sampling now and should ramp into production by mid 2011.

Designed to support the MMPA, TriQuint's Band 2 TQM61605x and Band 5 TQM66605x TRITIUM PA Duplexers integrate high-performance bulk acoustic wave (BAW) and surface acoustic wave (SAW) duplexer capabilities with low current consumption power amplifiers to customize traditional components for optimal performance.

The new TRITIUM PA-Duplexers are about 50% smaller in size compared to TriQuint's TRITIUM family, of which more than 200 million units were shipped in 2010. Leveraging TriQuint's new second-generation BAW technology as well as its SAW capability, the modules allow multi-mode CDMA and WCDMA operation, enabling use of a single product across multiple platforms. Each module contains a flip-chip BiHEMT power amplifier die, achieving what is claimed to be industry-leading current consumption for maximum talk-time and thermal efficiency (critical for smartphone applications). The new TRITIUM PA-Duplexers will sample in second-half 2011.

TriQuint highlighted the platform solutions at the GSMA Mobile World Congress 2011 in Barcelona, Spain (14–17 February).

www.triquint.com

CMP chooses TriQuint as GaAs foundry services partner

Circuits Multi-Projects (CMP) of Grenoble, France, a broker in ICs and MEMS technology for prototyping and low-volume production, has chosen the TQP15 process of RF front-end component maker and foundry services provider TriQuint Semiconductor Inc of Hillsboro, OR, USA for its gallium arsenide foundry process technology offering for universities and small company customers.

Since 1981, independent non-profit organization CMP has helped more than 1000 organizations from 70 countries to access affordable commercial foundries by consolidating their designs onto a single prototype mini-tile. CMP works with several foundry vendors supporting a range of technologies and has chosen TriQuint for its GaAs processes. The broker offers its customers experience with the entire design, layout, verification, and tapeout process, as well as export guidance.

"CMP's customers will have access to TriQuint's new mmWave [millimeter-wave] foundry process, TQP15, along with the design kits and other foundry support services," says Glen Riley, VP, TriQuint Semiconductor Commercial Foundry Services. "This enables a large number of university students to cost-effectively evaluate their designs in actual GaAs chips and helps TriQuint reach a new generation of RF designers," Riley adds.

CMP's customers will have access to TriQuint's new millimeter-wave foundry process, TQP15, along with the design kits and other foundry support services... This enables a large number of university students to cost-effectively evaluate their designs in actual GaAs chips and helps TriQuint reach a new generation of RF designers

"CMP is pleased to be working with the industry's leading gallium arsenide foundry and introduce GaAs design and fabrication to the next generation of electrical engineers," says CMP director Bernard Courtois. "TriQuint offers comprehensive support services ... This program will bring GaAs technology to a whole new audience."

Manufactured in TriQuint's high volume GaAs fabrication facility in Hillsboro, TQP15 is the latest offering in TriQuint's well-established pseudomorphic high-electron mobility transistor (pHEMT) process portfolio. TQP15 combines high power density with low noise and supports designs operating up to 80GHz. It also uses optical lithography to reduce cost compared with traditional electron-beam-based solutions.

CMP exhibited at the DesignCon 2011 event in Santa Clara, CA, USA (31 January – 3 February).

http://cmp.imag.fr

Broadband WCDMA solution unveiled for ST-Ericsson platforms

RF front-end product maker and foundry services provider TriQuint Semiconductor Inc of Hillsboro, OR, USA has added to its TRIUMF (TriQuint Unified Mobile Front-end) Module family (launched in February 2009) with the TQM7M9070, a broadband power amplifier module (PAM) that aligns with ST-Ericsson's MM5730 and U5500 platforms.

TriQuint says that the new module's integration technology offers 3G designers building global smartphones and other mobile devices a streamlined RF footprint, through support for multiple modulations and multiple bands in one module.

In addition to reducing the component count, the power amplifier provides WCDMA/HSUPA modulation over multiple bands by enabling what is claimed to be outstanding power-added efficiency (PAE) — a critical contributor to longer battery life — without requiring a DC-to-DC converter.

In close collaboration with ST-Ericsson, all system-critical parameters will be verified as a platform reference design. "The solution has been tested and works together to deliver a new level of power added efficiency," says Tim Dunn, VP & general manager of Mobile Devices. "Given the real-estate limitations in today's devices, our new broadband power amplifier module offers a competitive advantage to our customers since it reduces the transmit area by more than 20%, and optimizes the electrical RF performance for each unique device," he adds.

The new broadband power amplifier supports WCDMA high bands 1, 2 & 4, and WCDMA low bands 5, 6 & 8. Its scalability from dual-band to penta-band applications addresses the demand for mid- to high-end feature and smartphones. Enabled by TriQuint's CuFlip technology, the broadband PAM inherently manages heat in a small form factor of 5mm x 4mm x 1mm.

Complementary to the TQM7M9070, TriQuint offers the highly efficient TQM7M5022R quad-band power amplifier module for GSM/EDGE to support a complete amplification solution for any cellular multimode/multiband application.

TriQuint highlighted its RF platform solutions at the telecom industry's largest annual gathering, GSMA Mobile World Congress 2011 in Barcelona, Spain (14–17 February).

www.triquint.com

Linear PA enables WiMAX to coexist with other radios in portable devices

Avago Technologies Ltd, a supplier of analog interface components for communications, industrial and consumer applications, has launched a new linear power amplifier module for mobile and fixed-wireless data WiMAX applications that include WiFi and other cellular radios.

The MGA-22103 module features an aggressive gain shape that limits the noise injected into radio receivers co-located in the same device, enabling WiMAX to coexist with WiFi, GPS, PCS and other radios in handsets, tablets, USB dongles and other portable electronics.

Covering a frequency range of 2.5–2.7GHz and including fully integrated RF matching, Avago says that the new linear power amplifier is cost-effective and meets industry-standard Spectral Emission Mask (SEM) tests operating at 3.3V. These features are integrated in a compact 3mm x 3mm x 1mm package, allowing designers to achieve standards-compliant performance in space-constrained designs.

Leveraging Avago's proprietary GaAs enhancement-mode pHEMT technology, the MGA-22103 module can be used for most high-linearity applications. With what is claimed to be superior performance across a range of voltage and operating temperature levels (-40°C to +85°C), the module exhibits flat gain and good matching while providing linear power efficiency to meet stringent mask conditions. The module meets the IEEE 802.16 WiMAX mask at over 25dBm power, with high gain of 35dB across the band. Additionally, a low-power mode allows operation at about 80mA when only minimal power is required.

The MGA-22103 is priced at $2.20 each in 10,000 piece quantities. It is available as part of the Sequans SQN1210 reference design for USB dongles.

www.avagotechwireless.com

Hittite buys mixed-signal firm Arctic

Norwegian firm provides IC design and integration capability

Hittite Microwave Corp of Chelmsford, MA, USA, which designs and supplies analog and mixed-signal RF, microwave and millimeter-wave ICs, modules, subsystems as well as instrumentation, has acquired advanced mixed-signal IC technology developer Arctic Silicon Devices of Trondheim, Norway for about $12m in cash and equity.

Arctic Silicon Devices is a private fabless semiconductor firm previously owned by the employees, Incitia Ventures and ProVenture.

Hittite says that the acquisition provides it with new IC design and integration capability as well as a product line of analog-to-digital converters (ADCs). Arctic has designed and launched multi-function low-power ADC products that target high-performance applications, including test & measurement systems and communication infrastructure.

Arctic's staff will continue to work at their existing facility.

www.hittite.com

Hittite reports revenue up 50% year-on-year

For full-year 2010, Hittite Microwave has reported revenue of $244.3m, up 49.9% on 2009's $163m. This includes record revenue of $65.6m in fourth-quarter 2010, up 50.2% on $43.7m a year ago and up 2.2% on Q3's $64.2m.

In Q4/2010, 45.7% of revenue came from the USA ($30m, up 6.6% on $28.1m last quarter, driven by the military market) and 54.3% from outside the USA ($35.6m, down from $36.1m). This compares with Q3's split of 43.8%:56.2%. The full-year 2010 split was 45%:55% (similar to 2009).

Growth is attributed to both the worldwide economic recovery and increased account penetration at both new and existing customers.

Gross margin has fallen from 74.8% a year ago and 74.6% last quarter to 74.5%. However, for full-year 2010, gross margin was 74.4%, up on 2009's 72.2%.

Operating income was $32.2m in Q4, level with Q3 (though down from 50.2% to 49.1% of revenue) but up from $19.8m a year ago (just 45.5% of revenue). Full-year operating margin has risen from 2009's 43% to 48.8% for 2010.

Net income has risen further, from $13.4m a year ago and $20.8m last quarter to $20.9m in Q4/2010 (at the high end of the guidance of $20.2–21m due to slightly stronger-than-expected gross margin). For full-year 2010, net income was $77m, up from 2009's $46.2m.

Capital expenditure was $6.2m in Q4 (above the expected $5m, on completing expansion into the firm's new engineering facility, but returning to normal $2m levels from now). Full-year CapEx was $14.7m.

Despite this, total cash and cash equivalents rose by $22.5m during Q4, from $273m to $295.5m (up from $220.5m a year ago).

Orders were $74,.5m in Q4 (up 16.6% on Q4/2009). This took net bookings for 2010 to $254.9m, up 36% on 2009's $187.3m. Order backlog at end-2010 was $74.5m, up on $63.9m at end-2009.

For first-quarter 2011, Hittite expects revenue to be flat to slightly up, at $65.5–67.5m. However, net income should fall slightly to $19.2–20.1m, after including transaction costs and expected operating expenses attributable to mixed-signal IC technology developer Arctic Silicon Devices of Trondheim, Norway (acquired in mid-January for about $12m in cash and equity).

Summit Partners takes minority stake in M/A-COM Tech

Growth equity investor Summit Partners has invested a minority stake in M/A-COM Technology Solutions Holdings Inc of Lowell, MA, USA (which manufactures semiconductors, components, and subassemblies for RF, microwave and millimeter-wave applications).

M/A-COM Tech provides solutions to a broad range of complex RF and microwave circuit design, packaging and manufacturing challenges faced by top OEMs and systems integrators in markets including cellular base-stations and infrastructure, military communications, avionics, radar, medical equipment, point-to-point and broadband radios, and broadcast equipment. Products are sold and distributed globally via multiple sales channels—including a direct field sales force, authorized sales representatives and industry distributors.

"We are very pleased to add Summit Partners as an investor in and adviser to M/A-COM Tech," says John Ocampo, chairman of the board of M/A-COM Tech. "With Summit's unparalleled sector expertise and track record in communications technology, we believe M/A-COM Tech will be even better positioned to invest in new products and technologies," he adds.

M/A-COM was founded in the 1960s, but in 1995 was bought by AMP Inc before becoming Tyco Electronics' Wireless Systems Segment (after Tyco International Inc's acquisition of AMP in 1999). In September 2008, the defense & aerospace and commercial segments of M/A-COM Inc was acquired by UK aerospace technology developer Cobham plc, which in March 2009 sold off the commercial segment (renamed M/A-COM Technology Solutions Inc) for up to $90m to John Ocampo, co-founder, owner & president of Silicon Valley-based private equity fund GaAs Labs LLC.

Ocampo previously co-founded former Summit Partners portfolio company Sirenza Microdevices Inc of Broomfield, CO (a diversified supplier of RF semiconductors and components), which he led through an IPO and eventual sale to RF Micro Devices Inc of Greensboro, NC, USA in 2007.

Summit Partners' managing director Peter Chung will join M/A-COM Tech's board of directors. "M/A-COM Tech enjoys a unique position in the RF component sector, with its rich history of innovation and, more recently, its significant growth and development as an independent company," says Chung. Last June, M/A-COM Tech acquired Mimix Broadband Inc of Houston, TX, a fabless developer of GaAs semiconductors from DC to 50GHz for RF, microwave and millimeter-wave applications in the telecom, satellite and defense markets. "We look forward to working closely with the M/A-COM Tech management team and board," adds Chung.

www.summitpartners.com

M/A-COM Tech realigns management structure

M/A-COM Tech has realigned its management structure.

After more than 35 years, Joseph G. Thomas (CEO since March 2009) is retiring. Thomas has held senior management roles throughout his career with M/A-COM, Cobham Defense Electronic Systems, Tyco Electronics and others. He also led M/A-COM Tech through milestones such as divestiture from Cobham in 2009 and merging with fabless RF, microwave and millimeter-wave IC firm Mimix Broadband Inc of Houston, TX, USA last year.

As its new CEO, M/A-COM Tech has appointed Chuck Bland (chief operating officer since last June, with responsibility for worldwide business units and operations). Bland was formerly chief financial officer and chief operating officer of Sirenza Microdevices Inc and president & CEO of Vari-L Company Inc (a maker of microwave and RF signal processing components). Previously, he held senior leadership roles at Growzone Inc, Quark Software, and Owens Corning.

Robert S. Donahue (chief strategy officer since August 2009) becomes chief operating officer (reporting to Bland) with responsibility for sales, marketing, corporate strategy, worldwide operations, and new business development. Previously, he held leadership positions at GaAs foundry WIN Semiconductors, Hittite Microwave, and Raytheon.

"As our global presence expands, it is important that we fill our leadership positions with individuals, like Bob, who have extensive industry experience and a history of delivering outstanding results," says Bland.

Also, the responsibilities of VP & general manager Suja Ramnath are increasing to add leadership of all market-facing businesses, including all Semiconductor and Automotive businesses. Ramnath has had leadership roles of increasing responsibility at M/A-COM Tech, Cobham Defense Electronic Systems and Tyco Electronics since 1998. Most recently, she managed the firm's RF Semiconductor Business. She was previously a key account manager with RF Micro Devices Inc of Greensboro, NC.

"She is a seasoned M/A-COM Tech manager with broad product knowledge and solid market insights," comments Bland. "Her vision and experience can only help accelerate the progress we have seen at M/A-COM Tech," he adds. "With our extensive heritage and the new products we have in the pipeline, we are uniquely positioned to take advantage of the potential opportunities in our target markets," believes Ramnath.

www.macomtech.com

TowerJazz adds high-speed and high-power 0.18µm SiGe PDKs for Agilent's ADS software

Specialty foundry TowerJazz of Migdal Haemek, Israel and Newport Beach, CA, USA has announced the availability of additional process design kits (PDKs) for its 0.18µm silicon germanium (SiGe) process platform, targeting high-frequency products for optical networks, automotive radar and 60GHz WiFi, as well as high-power front-end-modules for wireless handsets.

The PDKs were developed for use with the Advanced Design System (ADS) 2009U1 software of Agilent Technologies Inc of Santa Clara CA. Advanced Design System is electronic design automation (EDA) software for RF, microwave, and signal integrity applications. Both TowerJazz and Agilent showcased the new PDKs at the 2011 IEEE Radio Wireless Week (RWW) event in Phoenix, AZ (17–18 January).

The PDKs from TowerJazz and Agilent Technologies' EEsof EDA organization include ADS design kits for SBC18HA/HXL/H2 (high-speed SiGe technology with cutoff frequency as high as 200GHz) and a power amplifier design library (PADL) with characterized power cells for use in wireless front-end-module applications for cell phone and WiFi devices. The objective is to help users get new products to market faster by providing an accurate and productive work environment for SiGe monolithic microwave integrated circuit (MMIC) and power amplifier (PA) design solutions.

As an example, the PADL reduces design spins through availability of fully silicon verified power cells ready for use in addition to a custom power cell design flow that encompasses Agilent's ADS software. This, combined with TowerJazz's library of high-quality passive devices (including thick-metal inductors and high-density MIM capacitors) enables complete PA design. The PADL delivers a full PA design flow from schematic to layout, including device models characterized over DC, temperature, small-signal, and large-signal load-pull measurements. In addition, the PADL contains silicon-verified power cells with P1dB (compression point) of 20–33dBm (equivalent to 2W). Full simulation test benches are available in ADS and silicon load-pull data for cellular and PCS bands are provided.

As another example, TowerJazz SBC18HA/HXL and H2 PDKs are used with Agilent's ADS to enable RF designers to design first-in-class ICs that meet the demands of high-speed optical and high-frequency wireless markets such as automotive collision avoidance, backhaul wireless, phased-array radar and aerospace, commercial and military markets. They support a complete ADS front-to-back design flow with embedded Jazz Inductor Toolbox (JIT) and CNEX netlist definitions for layout-versus-schematic (LVS) support.

"Our ongoing work with TowerJazz is in direct response to demand from our mutual customers for a fast, efficient and low-cost RFIC design flow," says Mark Pierpoint, VP & general manager of Agilent's EEsof EDA Organization. "With the new SiGe PDKs in ADS 2009U1, customers will now be able to design high-performance ICs operating at 60GHz and higher using the full breadth of capability ADS provides," he adds.

"The new Agilent ADS SiGe PDKs allow customers familiar with the ADS environment for GaAs-based high-frequency and power-amplifier design to smoothly transition and benefit from the features the ADS environment affords them today," notes Marco Racanelli, senior VP & general manager, RF and High Performance Analog business group and Aerospace & Defense business group at TowerJazz. "This will result in faster design cycles, consistent results and possibly higher yields for our mutual customers."

www.agilent.com/find/eesof-ads
www.towerjazz.com

Skyworks names TowerJazz best foundry supplier for third year

TowerJazz (which has two fabrication plants at Tower Semiconductor Ltd in Migdal Haemek, Israel plus one at its US subsidiary Jazz Semiconductor in Newport Beach, CA) has received the 2010 Foundry Supplier of the Year Award from Skyworks Solutions Inc of Woburn, MA, USA, which manufactures high-reliability analog and mixed-signal semiconductors. The award was granted to TowerJazz for the third consecutive year in recognition of its excellent quality, performance and solid alignment with Skyworks' supply chain requirements.

Skyworks, a TowerJazz customer since 2002, uses a broad set of the foundry's processes, including mixed-signal CMOS, RFCMOS, BiCMOS and SiGe BiCMOS, to develop products such as transmit/receive modules, power amplifier controllers, switch controllers, linear devices, and wireless LAN solutions.

"This accomplishment demonstrates TowerJazz' proven track record in delivering high-quality technology and design enablement services as well as in consistently meeting our supply chain requirements year after year," comments Bruce J. Freyman, senior VP of worldwide operations at Skyworks.

"Recognition from one of our major long-time customers demonstrates our commitment to our partnerships to not just meet, but rather, exceed expectations," says David Postula, TowerJazz's VP of sales.

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IN BRIEF

Amalfi ships 25m 2G GSM/GPRS cellular handset TxM ICs in first year

Fabless CMOS RF and mixed-signal IC firm Amalfi Semiconductor of Los Gatos, CA, USA says that in its first year of production it shipped more than 25 million CMOS 2G GSM/GPRS transmit module (TxM) ICs to cellular handset makers. Also, its Q4/2010 shipments were used in more than 5% of worldwide 2G GSM/GPRS handsets.

Amalfi launched its first family of CMOS-based 2G GSM/GPRS TxM ICs in 2009 and began shipping products in early 2010. It claims that the efficiency and ESD performance of its AM7801, AM7802 and AM7803 dual- and quad-band TxM ICs enabled cellular handset makers to develop lower-cost phones with longer battery life and smaller size. The devices are targeted mainly at entry-level and ultra-low-cost (ULC) GSM/GPRS handsets in emerging markets.

"The 2G GSM/GPRS market has outperformed forecasts over the past several years and remains the dominant air-interface standard for cellular handsets in the world, with a large subscriber base in China, India and other emerging economies," says CEO Mark Foley. "We offer our customers superior performance at competitive prices, and that combination has fueled our rapid growth in this large market," he adds. "CMOS-based power amplifier solutions allow us to provide a price down roadmap that can't be matched by our competitors' GaAs-based solutions," Foley reckons. "We expect steady market share growth this year."

Amalfi claims that, with its AM7801, AM7802 and AM7803, handset makers now have a CMOS-based TxM IC offering the best cost/performance trade-off.

www.amalfi.com

Black Sand launches 3G CMOS PAs

After demonstrating what was claimed to be the world's first 3G CMOS power amplifier (PA) in September 2009, fabless semiconductor firm Black Sand Technologies Inc of Austin, TX, USA, which was founded in 2005 with funding from Austin Ventures and Northbridge Venture Partners and specializes in power amplifier technology for wireless applications, has launched two new 3G CMOS RF PA product lines that significantly improve the reliability and data throughput of mobile phones, tablets and datacards, it is claimed. The product lines consist of six unique power amplifiers across multiple frequency bands.

The BST34 series has been designed as a drop-in replacement for existing 3G GaAs RF PAs, and are hence fully function and pin-compatible. Switching from GaAs to CMOS enables mobile device makers to benefit from an improved supply chain, higher reliability, and lower cost, the firm says.

The BST35 series, with its TrueDelivered high-performance power detector, improves total radiated power (TRP) performance by up to 2dB, reducing the incidence of dropped calls and increasing the data rates in real-world operating environments. In particular, the BST3501 is the industry's first chip to bring this functionality to the RF front end, it is claimed, with performance figures matching or exceeding those of GaAs power amplifier ICs for output power, linearity, efficiency and noise.

The BST34 and BST35 series are both packaged in a 3mm x 3mm 10-pin form factor. BST34 products include an integrated directional coupler with daisy-chain support, integrated overvoltage and overtemperature protection circuitry. BST35 products are robust to 100:1 VSWR (10 times that of GaAs PAs).

"Our technology has gained a strong positive reaction from both our initial customers and mobile operators," says CEO John Diehl. "In particular, the BST35 products help smartphone and data-card companies both meet their industrial design goals and achieve good TRP performance in the real world – ensuring fewer dropped calls and faster data speeds with no additional eBOM components or cost," he claims.

"Mobile device manufacturers are looking for an alternative to GaAs PA technology, which has a known history of supply shortages and higher cost-structure," comments VP marketing Jim Nohrden. "The BST34 and BST35 products give our customers the rapid access to PA technology they need for ultra-high-volume manufacturing," he adds. "We have a strategic supply base larger than all existing GaAs PA vendors combined, and this will prove critical as the market continues to adopt 3G mobile devices, which have two to three times as many PAs as 2G phones. Our products will offer our customers better performance and a more reliable source of supply in 2011," Nohrden believes.

The BST34 product line includes:

- the BST3401 for '2100' Band 1 (1920–1980MHz),
- the BST3402 for PCS Band 2 (1850–1910MHz) and
- the BST3404 for AWS Band 4 (1710–1755MHz), Japanese Band 9 (1749.9–1784.9MHz) and Latin American Band 10 (1710–1770MHz).

The BST35 product line includes:

- the BST3501 for '2100' Band 1 (1920–1980MHz),
- the BST3502 for PCS Band 2 (1850–1910MHz) and
- the BST3504 for AWS Band 2 (1710–1755MHz), Japanese Band 9 (1749.9–1784.9MHz) and Latin American Band 10 (1710–1770MHz).

The BST3401 and BST3501 chips and evaluation boards will be sampling in February. The BST3402, BST3502, BST3404 and BST3504 will sample in second-quarter 2011.

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SPTS buys Primaxx for MEMS-related HF vapor oxide dry etch

Ownership of Primaxx Inc of Allentown, PA, USA has been transferred from Japan's Sumitomo Precision Products Co Ltd to its subsidiary SPP Process Technology Systems Ltd (SPTS) of Newport, Wales UK

Primaxx provides residue-free MEMS dry etch release equipment. The transfer hence strengthens SPTS' etch technology portfolio, which includes deep silicon etch, dielectric etch, inductively coupled plasma (ICP) etch, and now HF (hydrogen fluoride) vapor oxide etch.

Primaxx's patented HF vapor oxide etch technology uses a reduced-pressure, gas-phase, controlled anhydrous HF/alcohol process to deliver residue-free 'etch release' to remove the sacrificial silicon oxide layers used in MEMS manufacturing. Using HF, the sacrificial layer is etched with high selectivity relative to the structural layer.

"Considering the complementary products and synergies that already exist within both companies, bringing the Primaxx range of products and services into the SPTS family expands our customer offerings," says SPTS' president & CEO William Johnson. "It allows SPTS to provide an expanded manufacturing portfolio to our MEMS customers," he adds. "SPTS will also explore opportunities to provide more integrated process schemes related to HF release technologies."

Primaxx's president & CEO Paul Hammond adds that customers will benefit from SPTS' service, support and distribution infrastructure , via one consolidated contact point. "Primaxx has already been working closely with SPTS; the acquisition is a natural progression in the relationship that immediately augments Primaxx's sales and marketing capabilities," he adds.

The Primaxx brand is unchanged, but current process modules will be consolidated with SPTS' fxP wafer transport and control system.

www.primaxxinc.com
www.spp-pts.com

IMEC and Coventor collaborate on SiGe MEMS + IC design and manufacturing

PDKs to be developed for IMEC's SiGe MEMS-above-IC process

Nanoelectronics research center IMEC of Leuven, Belgium and Coventor Inc of Cary, NC, USA, which provides automated design software tools for micro-electro-mechanical systems (MEMS), have announced a strategic partnership to improve and expand the use of design and manufacturing techniques for the development of CMOS-integrated MEMS.

The partnership includes strategic alignment on R&D roadmaps and collaboration on advanced research topics. Teams at IMEC and Coventor will collaborate on expanding IMEC's use of Coventor's software tools suite for MEMS + IC design. They will also jointly develop process design kits (PDKs) for IMEC's silicon germanium (SiGe) MEMS-above-IC process.

Building on both organizations' success with MEMS design and manufacturing, the partnership aims to develop solutions to make MEMS more accessible to both MEMS and IC designers. PDKs will be developed to improve the efficiency of MEMS–IC co-design. The kits will target IMEC's SiGe MEMS technology that uses a MEMS-last approach, where the MEMS are processed after and on top of the CMOS circuits, enabling monolithic integration of MEMS devices with the driving and readout electronics on the same die. The SiGe MEMS platform's flexible and modular approach also allows application-specific tuning and optimization of MEMS layer thicknesses and properties, and the processing of optional functional layers on top of the MEMS devices.

The partnership will leverage Coventor's background in developing the necessary infrastructure for MEMS design environments. The firm's design tools have been production proven on hundreds of MEMS designs over the past 15 years. Recently, it introduced a new product line, MEMS+, aimed at integrating MEMS design with mainstream IC design environments. Also, IMEC has a SiGe MEMS process that allows monolithic integration on top of standard CMOS.

"More and more product developers from a wide range of industries look to integrate MEMS because of their powerful capabilities," says Rudi Cartuyvels, IMEC's VP Process Technology. "IMEC is well positioned to address this market through its CMORE initiative, which seeks to expand the scaling of CMOS micro- and nano-devices by adding functions other than logic and memory to chips," he adds. "By partnering with Coventor, we gain access to years of production experience and technology for MEMS design, and a breadth of expertise in developing a larger ecosystem for MEMS developers," Cartuyvels concludes.

"Coventor's strategy revolves around the 'democratization' of MEMS, which is about eliminating the obstacles and challenges in the way of more widespread adoption of these devices," says Coventor's CEO Mike Jamiolkowski. "By applying the talent and resources of one of the world's most prestigious semiconductor research institutes, our partnership with IMEC will help do that," he reckons. "Together, we can develop more efficient and practical approaches to MEMS development that meet the demanding requirements of markets and applications that have yet to leverage the vast potential of MEMS."

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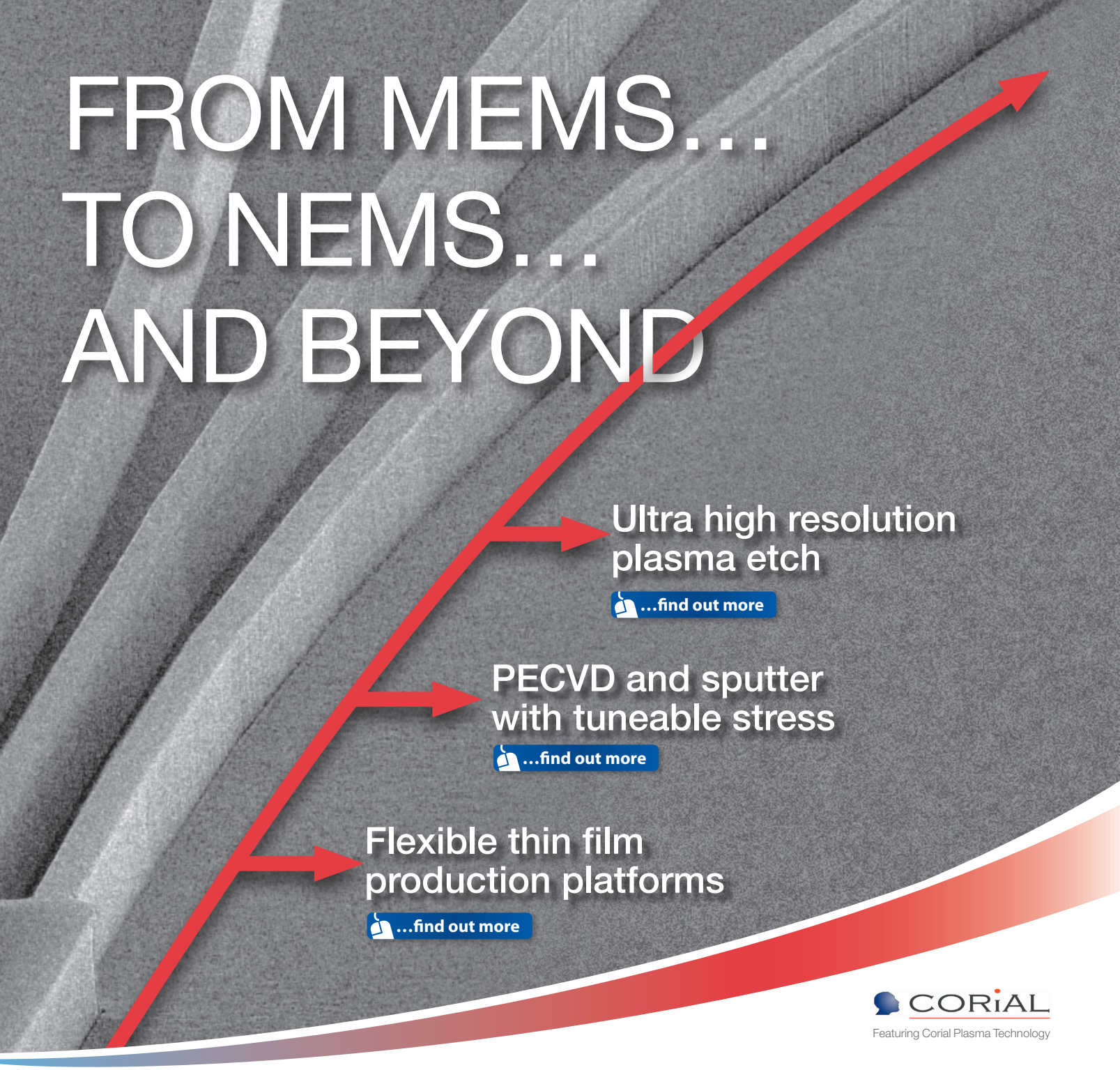

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Cree launches first commercial SiC power MOSFET

1200V blocking voltage aimed at replacing silicon in power electronics

Cree Inc of Durham, NC, USA has introduced what is claimed to be the first fully qualified commercial silicon carbide (SiC) power MOSFET, enabling the design of high-voltage circuits with extremely fast switching speeds and ultra-low losses.

The SiC MOSFET can be used today for solar inverters, high-voltage power supplies and power conditioning in industrial power applications. Over the next several years, SiC power switches and diodes could also expand into motor drive control, electric vehicles and wind-energy applications, says Cree. The market for power semiconductors in these applications is estimated to be about $4bn, rising to nearly $6bn by 2015.

Addition of the power MOSFET to Cree's SiC Schottky diode family enables power electronics designers to develop 'all-SiC' implementations of critical high-power switching circuits and systems with levels of energy efficiency, size and weight reduction unachievable with any commercially available silicon power devices of comparable ratings, the firm claims.

"Our SiC power MOSFET represents many years of materials research, process development and device design," says John Palmour, co-founder & chief technology officer, Power and RF. "The industry's first 'ideal' high-voltage switching device is no longer a future technology — it is commercially available and ready for design-in today," he adds. Together with our 600, 650, 1200 and 1700V SiC Schottky diodes, Cree Power has established a new class of SiC power components that will "eventually replace silicon devices in the majority of critical power electronics applications with breakdown voltage requirements of 1200V or higher," Palmour reckons.

"Cree's release of the SiC MOSFET represents a major step forward in power technology and enables a new standard in performance and reliability to be reached," states Per Ranstad, product manager at Alstom Power — Thermal Services in Sweden. "We have been working with Cree to demonstrate the capabilities of this new device, in particular seeing its impact on energy efficiency in power systems."

Cree's CMF20120D SiC MOSFET provides blocking voltages up to 1200V with an on-state resistance (R_{DSon}) of just 80mΩ at 25°C. In contrast to comparable silicon devices, the R_{DSon} remains below 100mΩ across its operating temperature range. Such consistency of performance characteristics across operating conditions, along with a true MOSFET device architecture (normally-off), suits power electronics switching circuits. Compared with commercially available silicon MOSFETs or IGBTs of similar ratings, in tests conducted by Cree the CMF20120D had the lowest gate drive energy (Q_G <100nC) across the recommended input voltage range. Conduction losses were minimized with forward drop (V_F) of <2V at a current of 20A.

Advantages over silicon devices enable what is claimed to be unprecedented system efficiency and/or reduced system size, weight and cost via its higher-frequency operation. It can meet or beat silicon MOSFET switching speeds and reduce switching losses in many applications by up to 50%, the firm adds.

Compared with the best silicon IGBTs, the device improves system efficiency by up to 2% and operates at 2–3 times the switching frequencies. Higher component efficiency also results in lower operating temperatures. Combining these lower operating temperatures with the CMF20120D's ultra-low leakage current (<1μA) adds significantly to system reliability, it is reckoned.

The CMF20120D suits high-voltage applications where energy efficiency is critical, e.g. in solar inverters SiC MOSFETs can be used in both the boost and inverter sections of the DC-to-AC converters. Switching losses are cut by over 30% using SiC MOSFETs and, when combined with Cree's SiC junction barrier Schottky diodes, system efficiency of >99% has been demonstrated.

Similar efficiency benefits can be achieved in other applications that require high blocking voltages in combination with fast, efficient switching, such as industrial motor drives, high-power DC data center power architectures, power factor correction (PFC), boost and high-frequency DC/DC conversion circuits in industrial, and computing and communications power systems. The low switching losses of Cree's SiC MOSFETs and diodes can also enable design optimization at switching frequencies up to three times those built with commercially available silicon devices, the firm claims.

"Silicon carbide technology is critical to developing the next generation of advanced, energy-efficient power electronic system designs," explains Cengiz Balkas, Cree VP & general manager, Power and RF. "The addition of the industry's first commercial SiC MOSFET will speed the development of smaller, faster, lighter and more efficient power devices in certain critical power device applications, with the potential to reduce global electric power consumption," he believes. "This MOSFET is the first SiC MOSFET product that Cree plans to release, drawing on our technology and patent base."

Cree claims that it demonstrated the first vertical SiC MOSFET devices; the first SiC MOSFETs at >600V; and the highest-voltage MOSFETs ever fabricated (10kV); as well as processing developments to enhance SiC MOS interface quality and reliability. Cree has been awarded more than 50 patents on SiC MOSFET technologies, with many patents pending.

The CMF20120D is fully qualified and released for production. Samples are available from Digi-Key.

www.digi-key.com
www.cree.com/power

DOE's $5.15m grant to fund SiC power device development

A new grant from the US Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E) will support efforts by North Carolina State University (NCSU) to develop new technologies essential to the development of a 'smart grid' that can easily store and distribute energy from renewable sources, such as solar and wind.

The grant is for a total of $5.15m over three years, the bulk of which will go to Cree Inc of Durham, NC, USA, which is leading the initiative. Partners in the initiative include NCSU, high-power semiconductor manufacturers ABB Ltd of Zurich, Switzerland and Powerex Inc of Youngwood, PA, USA. NCSU will receive $750,000 over the duration of the grant.

NCSU's role is to develop a transformerless intelligent power substation (TIPS), says Dr Subhashish Bhattacharya, an assistant professor of electrical & computer engineering and primary investigator for NCSU on the project. "TIPS will enable the vision of the smart grid," he adds. "It will be a more cost-effective and efficient means of connecting renewable energy resources to the existing power infrastructure."

Specifically, TIPS will enable the direct interconnection of renewable energy resources and energy storage systems to the grid with bi-directional power flow control, Bhattacharya explains. It will also provide energy management, and improve grid power quality and reliability through enhanced communication. Dr Alex Huang, professor of electrical and computer engineering, is a co-primary investigator on the NCSU component of the grant.

The NCSU TIPS development project will be made possible by Cree's work under the grant to develop a power semiconductor device based on silicon carbide (SiC).

NCSU is home to the Engineering Research Center for Future Renewable Electric Energy Delivery and Management (FREEDM) of the National Science Foundation (NSF). Headquartered on NCSU's Centennial Campus, the FREEDM Systems Center is developing ways to speed renewable electric-energy technologies into every home and business.

www.cree.com
www.ece.ncsu.edu

Fox signs fourth SiC patent license

The Fox Group Inc of Warrenton VA, USA has entered into a license agreement with a US corporation for rights to patents in its portfolio. This is the fourth non-exclusive and royalty-bearing license agreement that Fox Group has signed for its patents related to silicon carbide (SiC), following the third — with the Wide Bandgap Materials (WBG) group of II-VI Inc's compound semiconductor business, which manufactures single-crystal SiC substrates — in August 2008.

Founded in 1999, Fox Group is a privately held corporation with technology and patents related to silicon carbide and to high-purity, epitaxial crystal growth for LEDs and lasers.

"Fox Group's key patents are for silicon carbide with low defect density, which is especially desirable for high-power semiconductor devices, and LEDs, lasers, and RF devices as well," says president & CEO Barney O'Meara. "At this time non-exclusive licenses are still available to companies in the silicon carbide industry worldwide," he adds. "Since Fox Group is not making silicon carbide wafers or devices, we wish for the public to benefit from the Fox Group technology by the entire industry licensing our patents."

www.thefoxgroupinc.com

IN BRIEF

All American to distribute GeneSiC's products

Electronic component distributor All American Semiconductor LLC of Tampa, FL, USA (which has branches across North America) has signed a distribution agreement with GeneSiC Semiconductor Inc of Dulles, VA, USA, which develops silicon carbide (SiC) and silicon-based devices for high-temperature, radiation and power grid applications.

Founded by Dr Ranbir Singh as president in 2004, GeneSiC's SiC products feature a high operating temperature range, small heat-sink requirements and fast switching speeds. They are also inherently radiation resistant and offer higher voltage and current capability. The firm's products — which include rectifiers, field-effect transistors (FETs), bipolar devices as well as particle and photonic detectors — are used in industries including aerospace, alternative energy, commercial, industrial and military. Applications include solar inverters, electric vehicles, wind power, medical power supplies, down-hole oil drilling and motor drives. Meanwhile, GeneSiC's cost-effective silicon technology is available with quick lead times and offers what is claimed to be the industry's best forward voltage drop.

"We recognize GeneSiC as a leader in the field and are glad to begin distributing their silicon carbide products," says All American's corporate product manager Cory Dana. "The company's field application engineers have worldwide experience in taking an off-the-shelf product and designing it to meet client needs," comments GeneSiC's vice president Michael DiGangi about All American.

www.allamerican.com

Dow Corning joins IMEC GaN Affiliation Program

Collaboration to bring GaN-on-Si epi to manufacturing scale

Dow Corning Corp of Midland, MI, USA has agreed to enter the IMEC multi-partner industrial R&D program on gallium nitride semiconductor materials and device technologies, which was formed in July 2009 and focuses on developing next-generation GaN power devices and LEDs. The collaboration of Dow Corning with the IMEC research center in Leuven, Belgium will focus on bringing GaN epitaxial technology on silicon wafers to a manufacturing scale.

Due to the combination of superior electron mobility, higher breakdown voltage and good thermal conductivity properties, GaN/AlGaN heterostructures offer high switching efficiency for next-generation power and RF devices compared with existing devices based on silicon (Si). A process for obtaining high-quality GaN epi-layers on Si substrates is therefore key to obtaining superior power & RF devices.

Accurate control of the epi growth process to master substrate bow, epi-layer defects and uniformity while maintaining high epi reactor throughput are needed to reduce overall cost. IMEC has pioneered epitaxial growth of GaN on sapphire, silicon carbide (SiC) and silicon substrates of 2–6" in size and is currently focusing on developing GaN epi-layers on 8" Si substrates. Leveraging economies of scale and compatibility with high-throughput and high-capacity process technology based on 8" silicon wafers should further reduce the cost of GaN devices and LEDs.

As a producer of SiC wafers and epitaxy, Dow Corning says that it is leveraging its capabilities in electronic materials to bring next-generation materials technology to global device manufacturers. "By joining the IMEC GaN Affiliation Program, Dow Corning will rapidly expand its substrate product portfolio with high-quality and affordable GaN epi-wafers for power, RF and LED markets," says Tom Zoes, global director, Dow Corning Compound Semiconductor Solutions (DCCSS).

Dow Corning is also the majority shareholder in the Hemlock Semiconductor joint venture (with Shin-Etsu Handotai and Mitsubishi Materials Corp), which provides polycrystalline silicon and other silicon-based products.

"Teaming up with IMEC's epitaxy and device researchers within our multi-partner environment creates a strong momentum to bring this technology to market," comments Rudi Cartuyvels, VP Process Technology at IMEC, about Dow Corning joining its GaN Affiliation Program.

www.imec.be
www.dowcorning.com/content/compsemi

NCSU's argon buffer boosts GaN power handling 10-fold

Edge termination yields near ideal parallel-plane breakdown voltage

Gallium nitride (GaN) material can facilitate emerging high-power devices that are more energy efficient than existing technologies, but GaN devices traditionally break down when exposed to high voltages. Now, researchers in the Department of Electrical and Computer Engineering on North Carolina State University's Centennial Campus claim to have solved this problem.

"For future renewable technologies, such as the smart grid or electric cars, we need high-power semiconductor devices, and power-handling capacity is important for the development of those devices," says Ph.D. student Merve Ozbek, author of the paper 'Planar, Nearly Ideal Edge Termination Technique for GaN Devices' (to be published in IEEE's Electron Device Letters).

Previously, research into developing high-power GaN devices has run into obstacles, because large electric fields can be created at specific points on the devices' edge when high voltages are applied, effectively destroying the devices. NC State researchers have addressed the problem by implanting a buffer made of the neutral element argon at the edges of GaN devices to form a high resistivity amorphous layer at the surface beyond the edges of the diode. The buffer spreads out the electric field away from these small areas, preventing premature breakdown and allowing the device to handle much higher voltages.

The researchers tested the new technique by fabricating Schottky diodes with and without the argon implant. Diodes that did not have the argon implant broke down when exposed to a voltage of about 250V, whereas the diodes with the argon implant could handle up to 1650V (a voltage almost seven times higher) before breaking down.

"By improving the breakdown voltage from 250V to 1650V, we can reduce the electrical resistance of these devices 100-fold," notes the paper's co-author Dr Jay Baliga, Distinguished University Professor of Electrical and Computer Engineering. "That reduction in resistance means that these devices can handle 10 times as much power."

The research was supported by NCSU's Future Renewable Electric Energy Delivery and Management Systems Center, with funding from the US National Science Foundation.

www.ece.ncsu.edu
http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=5680581

SemiSouth orders largest commercial SiC CVD reactor from Aixtron

In fourth-quarter 2010, Aixtron received an order from existing client SemiSouth Laboratories of Starkville, MS, USA for an AIX 2800G4 WW CVD reactor in 10x100mm- and 6x150mm-wafer configuration, for delivery in Q2/2011. The system will be used for the production of power silicon carbide junction field-effect transistor (JFET) and Schottky barrier diode (SBD) microelectronic devices.

Founded in 2000 as a spin-out from Mississippi State University, SemiSouth is a privately held firm with strategic investors including Power Integrations and the venture arm of Schneider Electric. Holding nearly 30 patents, it designs and manufactures high-voltage SiC power devices for high-efficiency, harsh-environment power conversion and management in applications ranging from 3kW to 100kW (with products in development to serve applications up to 1MW). Products include 1200V and 1700V transistors as well as high-voltage diodes and power modules.

"Aixtron technology is what we are familiar with after nearly seven years experience with Aixtron SiC reactors," says Dr Jeffrey B. Casady, SemiSouth chief technology officer & VP business development. "We now have an urgent need to move up to larger wafer diameters and increase our capacity for power device production. Therefore, it was an easy selection process for us because this machine provides the world's largest commercial CVD reactor capacity," he adds. "We will achieve optimum time to market because the AIX 2800G4 WW system is the production-qualified SiC Planetary Reactor platform."

www.semisouth.com
www.aixtron.com

IN BRIEF

Reactor ordered for graphene on SiC

In Q2/2011, Aixtron will deliver a VP508GFR 1x4"-wafer CVD reactor (ordered in Q3/2010) to a major corporate R&D center in northeast USA for a system.

Extra features include a Dual Tube Hot-Wall reactor with the Aixtron patented Gas Foil Rotation for individual wafer uniformity and high-temperature capability.

The reactor will be used to grow epitaxial SiC and convert it into monolayers of graphene.

"Graphene is an exciting material which possesses high electron mobility, making it a potential candidate as the channel material in future high-frequency devices and integrated circuits," says Dr Frank Wischmeyer, VP & managing director Aixtron AB of Lund, Sweden.

IN BRIEF

IQE supplying GaN wafers to TriQuint

IQE's facility in Somerset, NJ, USA will support TriQuint Semiconductor of Hillsboro, OR (which provides RF solutions and foundry services for communications, defense and aerospace firms) with GaN-based wafer products following its award of a US Air Force Research Laboratory (AFRL) contract.

TriQuint has been awarded the Defense Production Act Title III GaN manufacturing development contract, the overall goal of which is to increase yields, lower costs of high-power, high-frequency 100mm GaN wafers and improve time-to-market for defense and commercial GaN ICs.

"IQE is proud of its close working relationship with TriQuint Semiconductor in supplying reliable, high-quality products, ranging from high-volume GaAs-based RF materials to emerging technologies such as 100mm GaN epitaxial wafers," says Alex Ceruzzi, VP & general manager of IQE's New Jersey facility.

IQE has closely supported TriQuint with a number of products including GaN for many years. "We appreciate TriQuint's continued commitment in selecting IQE to support this key program," he adds.

The program is expected to conclude in 2013 and is divided into three phases with specific goals and assessment criteria at each milestone. The overall aim of the new contract is to demonstrate integrated device technology that meets stringent goals in terms of performance, cost and capacity. While the initial work will be designed for defense applications, it is anticipated that the technologies will eventually migrate to future generations of consumer and communications devices.

www.triquint.com

IQE reports record revenue and higher-than-expected profit for 2010

Opto grows as a proportion of revenue

In a trading update for full-year 2010, epiwafer foundry and substrate maker IQE plc of Cardiff, Wales, UK says that second-half revenue and profit continued to show strong growth as a result of higher demand across its increasingly diverse portfolio of semiconductor wafer products. Revenue is expected to be at least £38.7m (up 17% on first-half 2010's £33m), giving full-year revenue of a record £71.7m (up more than 36% on 2009's £52.7m).

IQE's high operational gearing is expected to translate into an increase in full-year earnings before interest, tax, depreciation and amortization (EBITDA) of more than 56% to a record £12.6m, ahead of consensus market forecasts of £11.9m and more than double 2009's £6.1m.

IQE says that its strong performance throughout the year reflects the increasing reliance on advanced semiconductor materials across a broad spectrum of consumer, industrial and communications applications. The dramatic growth in portable devices from smartphones to tablets has been the major driver for increased demand in gallium arsenide (GaAs) wafers, specifically for wireless applications. Industry analysts expect the trend towards greater functionality and portability to continue.

Also, demand for compound semiconductor materials is likely to accelerate following announcements at the Consumer Electronics Show (CES 2011) in early January that manufacturers and carriers are stepping up the rollout of 4G devices supported by networks capable of download speeds of up to ten times faster than 3G.

IQE's business growth has been further supported by increasing demand across the group's diverse range of markets, from advanced semiconductor materials for optoelectronic communications to high-efficiency solar cells and LEDs. Optoelectronic products will hence account for a growing proportion of the group's full-year revenue.

An oversubscribed £21m fundraising round was completed in fourth-quarter 2010. The funding was used to strengthen the balance sheet and to allow for expansion of manufacturing capacity. Also during the last quarter, IQE acquired Galaxy Compound Semiconductors Inc of Spokane, WA, the sole US provider of infrared imaging materials to high-value military and other markets. Now fully integrated within the group, Galaxy is performing ahead of initial expectations and is contributing well to the business, says IQE.

As a result of the fundraising, the end-of-year balance sheet is expected to show a significant increase in net funds, providing the resources for IQE to selectively invest in additional production capacity to satisfy projected growing demand over the coming months and years.

"Our core business of wireless-related products for all forms of mobile device has continued to show exceptionally strong growth, whilst new and emerging products for consumer, industrial and defence applications are generating demand across all our key markets," says chief executive Dr Drew Nelson.

"We continue to make excellent progress in the development and commercialization of key intellectual property that we expect will contribute to IQE's revenues during 2011 and help to increase the group's competitive advantage and leading positions in a number of high-growth markets," he adds.

IQE expects to report its preliminary results on 29 March.

www.iqep.com

Riber reports 2010 revenue up 20% to €20.7m

Order book of €17.3m up 6.9-fold year-on-year

Riber S.A. of Bezons, France, which manufactures molecular beam epitaxy (MBE) systems as well as evaporation sources and effusion cells, has reported revenue of €13.1m for fourth-quarter 2010, more than quadrupling from Q3's €3.2m and up 68% on €7.8m a year ago.

This takes full-year 2010 revenue to €20.7m, up 20% on 2009's €17.3m. Europe contributed 56% of revenue (of which In particular, MBE system sales rose 10% from 2009's €10.1m to €11.1m for full-year 2010, reflecting the good level of sales to research centers and the upturn in demand from industrial firms for compound semiconductors. A total of 10 MBE systems were delivered in 2010, including two production systems.

Services & accessories revenue continued to grow strongly, up 38% from 2009's €4.7m to a record €6.5m. Also, revenue for evaporation sources and cells rose by 24%, from €2.5m to €3.1m, vindicating the strategy of diversifying into high-growth markets such as organic light-emitting diodes (OLEDs) and thin-layer photovoltaics (CIGS).

Riber says that it has good order visibility for 2011. The backlog totals €17.3m (6.9 times higher than the €2.5m at the end of 2009). This includes 10 MBE systems (three production reactors and seven research reactors) — one deliverable after 2011. This amounts to a systems order book of €13.3m (up from just €1m a year ago). Services & accessories backlog is €1.8m (up 38% from €1.3m). Backlog for evaporation sources and cells is €2.2m (up from just €0.2m). Also, the reported order backlog does not include a major OLED effusion cell contract signed at the start of this January for several million euros.

Riber concludes that its commercial development illustrates the relevance of its business strategy, based on:

- continuing to strengthen Riber's market leadership in MBE research and production systems;
- capitalizing on the installed base and growing sales of epitaxy equipment (effusion cells, etc), spare parts and accessories, as well as corresponding services; and
- launching a range of high-value-added equipment and services for high-growth applications (thin-film solar panels, OLED lighting and flat screens, etc).

Riber is scheduled to report full-year 2010 earnings on 24 March. However, the firm says that it can already confirm its forecast that earnings will grow in 2010 compared with 2009.

www.riber.com

Veeco reports record quarterly revenue of $300m

Revenue to shrink in Q1, but exceed $1bn for full-year 2011

For continuing operations in fourth-quarter 2010 (excluding the Metrology business, sold to Bruker Corp of Billerica, MA, USA on 7 October), epitaxial deposition and process equipment maker Veeco Instruments Inc of Plainview, NY, USA has reported record revenue of $300m, up 8% on Q3's $277.1m and up 152% on $119.1m a year ago.

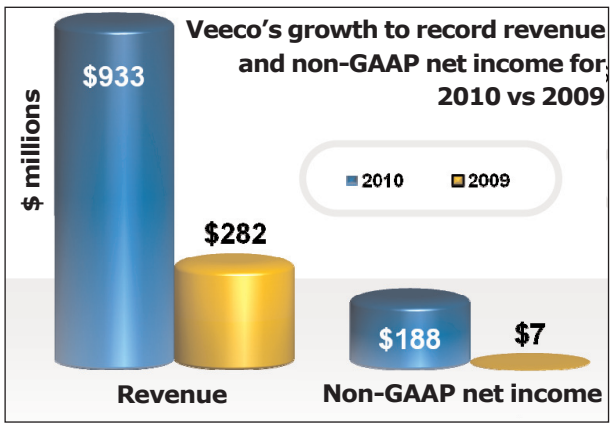
Of this, 14% came from Data Storage revenue of $41.9m (the best since Q4/2008), up 21% on Q3's $34.5m and double the $21m of a year ago.

The other 86% of total revenue came from record LED & Solar revenue of $258.1m, up 6% on Q3's $242.6m and up 163% on $98.1m a year ago. In particular, MOCVD revenue was a record $240m, up 2% on $236m in Q3. MBE business also contributed to growth.

"The fourth quarter of 2010 was the best in our history," says CEO John R. Peeler. Also, 2010 was the best year in Veeco's history. For full-year 2010, revenue was a record $933m, up 230% on 2009's $282.4m. In particular, Data Storage rose 75% to $135m. LED & Solar rose 289% to $798m, with MOCVD systems shipped to more than 40 LED customers worldwide. MOCVD market share rose from about 30% in 2009 to 46% in Q3, driven by the K465i (launched only in Q1/2010) becoming the industry's best-selling MOCVD system, according to a market report by IMS Research.

Gross margin has continued to rise each quarter, from 44.9% a year ago and 48.9% in Q3/2010 to 50.9% in Q4 (at the high end of the expected 50–51%). This was due to higher volumes, good traction on driving down material cost, and higher-valued products in the mix. Full-year gross margin rose from 2009's 39.4% to 47.6%.

On a non-GAAP basis, net income was a record $67.9m ($1.62 per share), up from $61.6m ($1.46 per share) in Q3 and just $13.6m ($0.36 per share) a year ago. Full-year net income was a record $188m ($4.42 per share), compared with 2009's loss of $7m ($0.21 per share).



Including net proceeds of $225m from selling the Metrology business, during the quarter Veeco's cash and short-term investments grew by $248.6m, from $466.8m to $715.4m. Also during the quarter, Veeco bought back about $6.5m of its stock at an average price of about $34.33 per share, bringing the total purchased so far under the year-long $200m buy-back program (authorized on 24 August) to $38m (about 1.1 million shares).

Peeler attributes the firm's results to its focus on high-growth market opportunities, operational excellence, and a flexible manufacturing strategy. "The total available market for MOCVD from 2011 through 2015 is greater than 5000 reactors," he reckons. To capitalize on this opportunity, drive business, and continue to gain market share, Veeco has launched the TurboDisc MaxBright multi-reactor (cluster) MOCVD system. "By dramatically accelerating our new product roadmap to create MaxBright — the most productive MOCVD system on the market — Veeco will help enable the industry's transition to LED lighting," Peeler says.

Q4 order bookings were $294.9m (up 6% on Q3's $278.2m). Of this, 14% came from Data Storage ($42m, down 21% on the very strong $53.1m a year ago — which had represented a catch-up in customers' capacity spending — but up 20% on Q3's $35m as technology buys for new Veeco deposition systems continue). The other 86% of total orders came from LED & Solar ($252.9m, up 4% on Q3's $243.2m and up 43% on a year ago). In particular, MOCVD system orders totaled $221m, coming from 20 customers across all regions (a record quarterly customer count). Bookings were again heavily concentrated in China (12 customers, with wins including multi-tool orders from EnRay-Tech, Shanghai Epilight and Focus Lighting). However, there were also key customer wins in the USA, Europe, Japan, Taiwan and Korea. MBE system orders also improved from the low level seen in Q3 to $32m, including several orders for production tools. For full-year 2010, orders of $1.12bn are more than double 2009's $538.3m.

For first-quarter 2011, Veeco expects revenue to fall to $215–265m. "Revenues will be lower than Q4/2010 because we are planning to ship 12–20 MOCVD reactors in the new MaxBright 'cluster' format, and will not be recording any revenue on these systems in the first quarter," notes Peeler. "Timing of revenue is also being impacted by the longer order-to-revenue cycle times associated with the high percentage of business currently coming from China, primarily due to customer facility readiness [since many are expanding or building new fabs]," he adds. "The average time to convert orders to revenue is currently several months longer in China than in other regions."

However, while non-GAAP earn-

ings per share should fall to $1.02–1.39 for Q1/2011, gross margin should rise further to 51–52%.

For first-half 2011, Veeco expects strong order bookings, as (i) Chinese government subsidies continue to drive LED fab expansion across a broad customer base, (ii) Korean customer utilization rates increase (with order rates improving in Q2–Q3 as customers are focused on LED backlight units and lighting), and (iii) Veeco continues to penetrate key accounts in the USA, Europe, Taiwan and Japan with the K465i (and now with the new MaxBright MOCVD systems expected to assist market share gain).

With starting order backlog of $555m at the beginning of 2011, for full-year 2011 Veeco therefore expects revenue to rise to more than $1bn and non-GAAP earnings per share to rise to more than $5.00. "We are optimistic about the future and confident that we are well positioned from a technology, product and operational standpoint to grow our LED & Solar and Data Storage businesses in 2011 and beyond," comments Peeler. In particular, Veeco expects 2011 to be a solid year for MOCVD tool demand, driven by LED back-light units and lighting (with a next-generation product already in development for 2012). In addition, the firm expects its CIGS (copper indium gallium diselenide) Solar business to begin to deliver revenue in 2011, as the firm is shipping tools to key customers.

www.veeco.com

Veeco launches multi-reactor system for HB-LEDs

MaxBright offers 500% productivity gain on standard K465i reactor

Epitaxial deposition and process equipment maker Veeco Instruments Inc of Plainview, NY, USA has launched the TurboDisc MaxBright gallium nitride (GaN) metal-organic chemical vapor deposition (MOCVD) multi-reactor system for production of high-brightness light-emitting diodes (HB-LEDs). The firm says that MaxBright has already been accepted by a leading LED maker and that it is currently shipping systems to additional manufacturers in Korea, Taiwan and China.

MaxBright leverages Veeco's Uniform FlowFlange technology and automation expertise by combining multiple, new, high-throughput MOCVD reactors in a modular two- or four-reactor cluster architecture. The MaxBright reactors, based on the production-proven K465i, feature both expanded wafer capacity and proprietary, closed-loop thermal control technology. The reactors achieve 25% higher throughput than the standard K465i, while extending its performance advantages (uniformity, repeatability and material quality). The MaxBright system offers what Veeco describes as industry-leading wafer capacity of up to 216 x 2", 56 x 4", 24 x 6" or 12 x 8" wafers. In addition, seamless recipe transfer from K465i to MaxBright enables users to achieve rapid production start.

TurboDisc MaxBright GaN MOCVD multi-reactor system.

"It's the highest-productivity MOCVD system for HB-LED manufacturing on the market," says William J. Miller Ph.D., executive VP of Veeco's Compound Semiconductor business. "The architecture enables single-chamber or multi-chamber layer growth capability, increasing process flexibility for demanding LED structures," he adds. "MaxBright's compact architecture also enables a footprint efficiency gain of up to 2.5 times standalone MOCVD systems. Overall, MaxBright delivers a 500% productivity gain compared to the K465i in a flexible and compact package," Miller continues.

"Veeco has dramatically accelerated our MOCVD technology investment and new product development programs to further reduce LED manufacturing costs," comments CEO John R. Peeler. The new, high-productivity system is part of Veeco's multi-generational roadmap for improving MOCVD process capability and capital efficiency. "MaxBright will enable the industry to accelerate its transition to LED lighting," he believes. "In 2010, the K465i became the market-leading MOCVD system. And now, MaxBright further extends Veeco's product leadership position as the most productive and lowest cost-of-ownership MOCVD tool on the market," Peeler adds.

www.veeco.com

IN BRIEF

Epistar JV Epicrystal to speed expansion with five Aixtron UHB GaN LED systems

Deposition equipment maker Aixtron SE of Herzogenrath, Germany has received a new order for five AIX 2800G4 HT MOCVD reactors from Epicrystal Corporation (Changzhou) Ltd in China, a joint venture formed last year between Taiwan's biggest LED chipmaker Epistar and its customers for manufacturing and distributing LED-based products.

Following delivery in second-quarter 2011 and commissioning by the local Aixtron support team working with a technical team from Epistar at the new purpose-built facility in Changzhou City, Jiangsu Province, east China (which broke ground last April), the reactors will be used for the production of ultra-high-brightness (UHB) GaN-based LEDs.

"While we are a new company registered in China and in the first phase of our capacity expansion, we rely on the excellent record with respect to device performance and yield obtainable from Aixtron systems through Epistar," says Epicrystal's president Easy Hwang. "The proven process compatibility and transferability from one Planetary MOCVD system to another will enable us to complete the ramp up of EpiCrystal's production capacities in a very short time," he adds. "The Aixtron MOCVD systems clearly demonstrate its competitiveness in terms of cost of ownership and productivity," Hwang continues. "This partnership will help provide the tools we need, as the characteristics of the AIX 2800G4 HT will ensure that our productivity goals will be met."

www.aixtron.com

China's HC SemiTek receives six more Aixtron CRIUS MOCVD reactors

Aixtron has delivered an order for six more CRIUS gallium nitride metal-organic chemical vapor deposition (MOCVD) epitaxial growth reactors in 31x2"-wafer configuration to HC SemiTek in Wuhan, China, to be used for ultra-high-brightness (UHB) LED manufacturing.

The past year has been a boom year for MOCVD LED product development and manufacture with, in particular, many major deployments in China, says Aixtron. In addition to major companies testing the market for new business in areas such as residential lighting and mobile display applications, start-ups are making significant investments. With the rapid expansion of LED-based displays, backlighting and solid-state illumination, manufacturers are choosing solutions that support flexibility and headroom to meet the diverse demands of volume applications, says the firm.

"We now wish to extend our manufacturing capacity quickly and conveniently, as per our strategic expansion roadmap for the displays environment," says HC SemiTek's president Dr Rong Liu. "While this poses many challenges for providers — how to efficiently create precision epiwafers at very low cost — management through the responsive Aixtron support team will enable optimized process set-up without incurring project delay," he believes. "The CRIUS enables significant operational flexibility and enhanced growth efficiency for state-of-the-art UHB GaN LEDs," Liu adds.

Aixtron says that the CRIUS facilitates the ongoing evolution of the deposition of wide-bandgap compound semiconductors by extending the user's control and accuracy while achieving the highest efficiencies demanded by the market. It also supports multiple wafers, throughput and safety with ergonomics and low running costs, the firm adds.

www.hcsemitek.com/en

China's ISCAS to receive Aixtron MOCVD reactors for electronics and red LEDs

Aixtron says that in third-quarter 2010 it received an order for two MOCVD reactors (one AIX 200/4 in 3x2"-wafer configuration and one AIX 2600G3 IC in 8x3"-wafer configuration) from existing customer the Institute of Semiconductors of the Chinese Academy of Sciences (ISCAS) in Beijing.

Following delivery in second-quarter 2011, the systems will be used for the production of electronic devices and red LEDs. The local Aixtron support team will commission the new reactors in a dedicated facility.

"This is a repeat order for us and, over half a decade, we have formed a good long-term relationship with the Aixtron group," says a spokesperson for ISCAS.

"We have been impressed in initial trials how effectively and easy it has been to scale up device processes from our existing deposition systems to the new Aixtron systems," they add.

"Our relationship with Aixtron began way back in 2003 when ISCAS expanded its R&D capabilities, installing a state-of-the-art Close Coupled Showerhead¨ (CCS) MOCVD reactor," the spokesperson continues. "That 3x2"-wafer enabled us to grow high-quality gallium nitride (GaN) on sapphire layers on 4" wafers as well as GaN on silicon, primarily for the development of short-wavelength laser diodes and UV photo-detector based devices."

http://english.semi.cas.cn

China start-up EnRayTek chooses Veeco's reactors for LED plant

Epitaxial deposition and process equipment maker Veeco Instruments Inc of Plainview, NY, USA has been selected as the primary supplier of metal-organic chemical vapor deposition (MOCVD) systems by Enraytek Optoelectronics Co Ltd (EnRayTek), a new firm founded by Dr Richard R. Chang focused on the design, development and manufacture of LEDs for backlighting TVs. EnRayTek's scope includes sapphire substrate materials and patterned sapphire substrates, gallium nitride (GaN) epitaxy on wafers, LED chip processing, and assembly & testing.

In fourth-quarter 2010, EnRayTek placed initial orders for TurboDisc K465i MOCVD systems to be installed at its new LED factory in Shanghai, China.

"We selected Veeco because of their excellent tool performance, MOCVD technology leadership, strong customer support, and commitment to the China marketplace," says EnRayTek's chief operating officer Dr George Cherng. "Our facility is expected to be ready to begin to receive MOCVD tools in Q2, and we believe Veeco will be the best partner to help get us up and running and making high-quality LEDs fast," he adds.

"We believe they have an excellent business plan, good financial backing and solid LED technology and personnel to meet their goal of becoming a major provider of LEDs for TV backlighting," comments William J. Miller, Ph.D., executive VP, Veeco's Compound Semiconductor Business, about EnRayTek. "It is our goal to help EnRayTek to ramp to production capacity quickly," he adds.

Revenues from LED-backlit LCD-TVs are expected to exceed those of CCFL-backlit models for the first time in China during 2011 EnRayTek is focused on capitalizing on this trend

"Recent industry articles have forecasted that revenues from LED-backlit LCD-TVs are expected to exceed those of CCFL-backlit models for the first time in China during 2011," notes Jim Jenson, VP of marketing for Veeco MOCVD. "EnRayTek is focused on capitalizing on this trend."

www.hiraygroup.com

Shanghai Epilight chooses Veeco MOCVD systems for new LED fab in Hefei

Veeco says that in fourth-quarter 2010 Shanghai Epilight Technology Co Ltd placed a large multi-tool order for TurboDisc K465i MOCVD systems for its new high-brightness light-emitting diode (HB-LED) fabrication plant in Hefei, China.

"We installed a number of Veeco K465i tools in our Shanghai factory in mid-2010 and have been extremely pleased with their performance in our demanding high-volume LED production facility," says Epilight's president Wendi Liu. "We have therefore decided that Veeco equipment should form the foundation of our next round of capacity purchases for the Hefei Epilight fab," he adds.

Epilight is one of the largest LED makers in China, notes William J. Miller, Ph.D., executive VP, Veeco's Compound Semiconductor Business. The firm is engaged in the design, development, manufacture and distribution of HB-LEDs, epitaxial wafers, and chips.

www.epilight.com.cn/en
www.veeco.com

IN BRIEF

Saturn expands PV production with 15x4"-wafer reactor

In Q4/2010, Aixtron received an order from Saturn Joint Stock Company of Krasnodar, Russia for an AIX 2800 G4-R MOCVD reactor in 15x4" wafer configuration, including an automated wafer transfer system.

After delivery in Q2/2011, the system will be used to produce GaAs solar cell epitaxial materials for the Russian space market. It will be commissioned by the Aixtron Europe support team in a dedicated facility alongside the existing Aixtron reactor at the Saturn JSC production plant.

Saturn ordered its first Aixtron MOCVD GaAs system for the production of solar cells in April 2006 (an 8x4" AIX 2600G3 — the first solar cell production MOCVD system in Russia).

"Our company has been very satisfied with the excellent performance and ease of use we have enjoyed with our existing Aixtron system," says Saturn's director general Anatoly Skursky. "The service support we have received from the Aixtron Europe Process Team was of a very high standard, too. As promised, they enabled us to reach full production status in a very short time," he adds. "Moving up to the 15x4" configuration system will give us even better productivity as well as the uniformity, performance and reliability we have come to expect from Aixtron equipment."

Saturn has been developing and producing solar cells and solar arrays for space applications since 1971. In this period, more than 1200 spacecraft were provided with solar arrays. Not only most Russian spacecraft but also many foreign spacecraft are equipped with solar arrays and storage batteries made by Saturn.

www.aixtron.com

SEMI Europe's Advisory Board gains Aixtron CEO Hyland and centrotherm photovoltaics COO Stenkamp

Global industry association SEMI has announced the appointment of two new members of Brussels-based SEMI Europe's Advisory Board: Paul Hyland, president & CEO of deposition equipment maker Aixtron SE of Herzogenrath, Germany; and Dr Dirk Stenkamp, a member of the management board & chief operating officer (COO) of centrotherm photovoltaics AG of Blaubeuren, Germany, which provides equipment and production lines for crystalline silicon solar cells and copper indium gallium diselenide (CIGS) thin-film solar modules.

Paul Hyland.

"I am delighted to have been asked to join the SEMI European Advisory Board at a time when the global challenges and opportunities within the Technology sector have never been so important for the European Technology industry," says Hyland. "Europe has a long, rich and often under-appreciated history in technology innovation and has some of the world's leading players in cutting-edge technology within its borders. The opportunity to leverage that strength globally depends greatly on the ability of industry, the research community and governments to sustain a 'joined up' and focused approach to technology development," he adds. "I would like to see a more concerted effort by all parties to appreciate the valuable intellectual assets we have within Europe and to bring a coordinated technology strategy to the forefront of regional and national investment agendas," he continues.

Hyland has been at Aixtron since 2000 and president & CEO through a period of extraordinary volatility, culminating in three record years of growth and global market leadership.

Dirk Stenkamp.

"I am looking forward to contributing my experience and knowledge from the semiconductor and photovoltaic equipment sector to the association's work," says Stenkamp. "One of my central concerns in this context is the cost-efficient, prompt and high-volume production and provision of new product generations," he adds. In the equipment sector this also entails the combination of the terms 'time to market' and 'volume to market'.

Further topics for Stenkamp concern the strengthening of Europe as a globally leading region for high-end and high-quality equipment, the securing of increasingly scarce raw materials, as well as the securing of highly qualified personnel for the sector. The question "How can photovoltaics benefit from semiconductor technology, and vice versa," concerns Stenkamp since centrotherm photovoltaics operates in both areas. The firm's Semiconductor & Microelectronics division is to be expanded further over the next few years.

The SEMI European Advisory Board has gained additional recognized experts and leaders, comments SEMI Europe's president Heinz Kundert, who adds that the organization is looking forward to their strategic guidance, as well as them sharing their industry insights and representing the collective interests of SEMI's members towards sustainable growth and profitability.

Both Aixtron and Centrotherm have been actively involved with SEMI Europe for many years, and became members of the organization in 2002.

www.semi.org/europe

Beneq receives €9m funding

Cd-free Zn(O,S) ALD buffer boosts efficiency

Beneq Oy of Vantaa, Finland has won €9m in funding from government-owned investment firm Finnish Industry Investment Ltd, Nordic venture capital fund Via Venture Partners, and private investors.

Via Venture Partner has been an investor in Beneq since 2007. "Beneq is an extremely promising company with a strong management team that has proven capable of bringing Finnish technology to the global scene," says partner Peter Thorlund Haahr.

Founded in 2005, Beneq supplies equipment for nano-scale thin-film coatings used in solar cells, glass coatings, and flexible electronics such as organic light-emitting diode (OLED) lighting, as well as offering complete coating services. Coating is based on two platforms: atomic layer deposition (ALD) and aerosol coating (nHALO and nAERO).

In particular, Beneq's TFS 1200 Thin Film System is an ALD processing module designed to be integrated into copper indium gallium diselenide (CIGS) evaporation or rapid thermal processing (RTP) selenization lines for in-line production of buffer layers on CIGS thin-film photovoltaic cells.

Using ALD eliminates the only liquid phase deposition step — chemical bath deposition (CBD) — from the process flow, so there is no excessive water handling, no toxic effluents and no need for waste water purification. As well as being more compact, the dry coating process simplifies production routines, allowing integration into the production line alongside other vacuum deposition steps (minimizing exposure of the substrate to atmospheric gases) as well as reducing cost, says the firm.

In addition, ALD allows the introduction of cadmium-free buffer layers, which means less of a load on the environment and less stringent in-house material safety routines, says Beneq. In particular, ALD enables replacement of the conventional cadmium sulfide (CdS) buffer layer with one with a higher bandgap energy and light transmission — specifically by depositing a dense and conformal zinc oxysulfide Zn(O,S) buffer layer — resulting in an increase in conversion efficiency of more than 1 percentage point. Beneq says that, with ALD, it is possible to adjust and optimize the oxygen/sulfur (O/S) ratio of the film type for the CIGS panel. Also, the intrinsic properties of ALD coatings, conformal and dense, enable enhanced blocking of pinholes in the CIGS cells.

The TFS 1200 can accommodate a maximum substrate size of 1200mm x 1200mm (a record for ALD, it is claimed). Deposition time for a 30nm-thick Zn(O,S) buffer layer is less than 5 minutes, giving an in-line throughput of 12 panels per hour and hence 100,000m^2 per year (equivalent to 12MWp). In an off-line configuration, throughput can be doubled.

Beneq employs more than 60 staff in Vantaa and in sales offices in Germany, China and USA. Over the last three years, the firm's revenue has shown an average annual growth rate of 93%, to about €10m in 2010. The firm is now moving from pilot to industrial production.

"The company has already proven its growth capabilities and we are expecting strong export-driven growth also in the future," says Juha Lehtola, investment manager at Finnish Industry Investment.

"This investment in Beneq is, on the one hand, a definite sign of confidence in our corporate strategy, our technical expertise and our projected continued growth," says CEO Sampo Ahonen. "On the other hand, it is also a guarantee of constant expansion and development of our services for our customer base, be that full-scale industrial production, research or R&D," he adds.

www.beneq.com/tfs-1200.html

Altatech certified to ISO 9001:2008

Altatech Semiconductor S.A., which was incorporated in 2004 and makes wafer inspection and analysis, liquid-vaporization chemical vapor deposition (CVD) and nanoprinting equipment, has gained ISO 9001: 2008 certification for all operations at its base in Montbonnot, near Grenoble.

The quality-management certification covers all design, development, manufacturing and sales activities concerning equipment and associated services for global microelectronics markets.

The ISO 9000 family of standards is an internationally recognized protocol for quality management. In particular, ISO 9001:2008 focuses on enhancing customer satisfaction and establishing product compliance with the requirements of users and regulatory groups.

Over 18 months, Altatech's research, development and production processes for its wafer-inspection, CVD and inkjet-printing products were assessed by Lloyd's Register Quality Assurance, an accredited ISO organization. All non-conformities were analyzed and resolved, with key performance indicators put into place to avoid any recurrence.

"With this ISO certification, Altatech can improve its product quality and performance faster," says manufacturing & services director Fabienne Guennou. "Implementing this continuous improvement approach further increases our operating efficiencies while also reducing waste," he adds. "Our closed-loop management system enables a more responsive organization to increase customer satisfaction."

In support, Altatech has conducted staff training and hired a quality assurance manager and external consultants. Evaluations of its quality management systems are conducted monthly by in-house staff and annually by external auditors.

www.altatech-sc.com

ITRI & Oxford Instruments agree research collaboration

Tool installations allow Far East process demo and customer support

A research-based collaboration agreement has been signed based on UK-based etch, deposition and growth system maker Oxford Instruments providing a high-brightness light-emitting diode (HB-LED)-related process research center staffed by its process engineers at the Industrial Technology Research Institute (ITRI) in Hsinchu, Taiwan, benefitting both ITRI and Oxford Instruments' extensive Far Eastern customer base.

ITRI is a not-for-profit applied research organization working across multiple industrial technology fields and, since its inception in 1973, it has focussed on R&D related to industry in order to improve domestic industrial technologies.

Oxford Instruments will soon be installing several more systems in ITRI's cleanroom. The firm's process engineers will have use of this and selected other equipment at the institute, in order to provide process demonstrations and to support customers in the Far East in the performance of their tools.

Oxford Instruments says that this will in effect expand its research capabilities so that the firm can now provide its process offering more effectively to customers in Asia. Oxford Instruments already has a number of systems installed at ITRI including a PlasmaPro System100 multi-chamber cluster tool incorporating plasma-enhanced chemical vapor deposition (PECVD), reactive ion etching (RIE) and atomic layer deposition (ALD), a PlasmaPro System100 ICP380 plasma etch tool, and a PlasmaPro System80Plus PECVD plasma deposition tool, all used for advancing research at the facility.

Three further systems have been installed in the dedicated Oxford Instruments Optoelectronics Laboratory — a PlasmaPro NGP1000 PECVD system, a PlasmaPro NGP1000 Etch system, and a PlasmaPro System133 ICP380 — with additional tools to follow in the next phase.

"In the materials chemical technology and nano technology fields, amongst others, ITRI collaborates with prominent industries in Taiwan and worldwide to develop and to promote the establishment of high-value industries and application of nanotechnology by traditional industries," says ITRI vice president Dr Shing-Yuan Tsai.

"One of Oxford Instruments' key objectives is to pursue responsible development and deeper understanding of the world through science and technology, and this collaboration with such a prestigious research institute is precisely the type of activity that will achieve this goal," comments Jeffrey Seah, head of Asia Sales at Oxford Instruments Plasma Technology (OIPT).

www.itri.org.tw/eng

Oxford Instruments deposits first PECVD films on 450mm wafers

In collaboration with SEMATECH subsidiary ISMI (International SEMATECH Manufacturing Initiative), the technology and applications teams at Oxford Instruments Plasma Technology (OIPT) have coated 450mm silicon wafers with PECVD SiO_2 (a world first).

The wafers were processed using the recently launched Oxford Instruments PlasmaPro NGP1000 PECVD system, which is capable of coating single wafer substrates up to 450mm diameter or larger batches of smaller diameter wafers.

"Our collaboration with ISMI and Semilab gave us access to 450mm wafers and the first opportunity for partners to deposit and measure layers on such wafers," says OIPT's chief technology officer Mike Cooke. "The wafers processed at Oxford Instruments will be used in ISMI's Test Wafer Generation program to enable the development of 450mm process and metrology tools. The SiO_2 film thickness uniformity is expected to achieve ±3% based on measurements taken from batches of smaller diameter wafers.

The first 450mm silicon wafer coated with PECVD SiO_2.

ISMI is building the infrastructure for the transition to 450mm as part of its portfolio of programs dedicated to improving productivity and reducing costs in today's and tomorrow's fabs. The ISMI 450mm Program is committed to enabling a cost-effective transition through coordination and development of infrastructure, guidance, and industry readiness.

Oxford Instruments is also involved in the EEMI 450mm project, specifically in the development of 450mm etch tools. The project supports the migration to the larger wafer size and aims to strengthen the competiveness of European industry and research infrastructure. The project is supported by the ENIAC Joint Undertaking and the UK Technology Strategy Board.

http://ismi.sematech.org

OIPT supplies plasma systems to Midwest Institute for Nanoelectronics Discovery

To expand and facilitate its research capabilities, the Midwest Institute for Nanoelectronics Discovery (MIND) has bought two plasma etch and deposition systems from UK-based Oxford Instruments Plasma Technology (OIPT). The FlexAL atomic layer deposition (ALD) system and PlasmaPro System100 ICP etch system will be installed in the Notre Dame Nanofabrication Facility, a 9000ft^2 cleanroom in the Stinson-Remick Hall of Engineering on the campus of the University of Notre Dame, IN, USA.

OIPT says that FlexAL systems provide flexibility and capability in the engineering of nanoscale structures and devices by offering remote plasma ALD processes and thermal ALD within a single system. The PlasmaPro System100 ICP etch tool features the new Cobra source, which provides additional plasma control capabilities, providing high flexibility for advanced processing.

MIND is one of four centers sponsored by Semiconductor Research Corp's Nanoelectronics Research Initiative (NRI). Collaborations also link MIND to the US National Institute of Standards and Technology (NIST), Argonne National Laboratory, and the National High Magnetic Field Laboratory.

"The goal of the NRI centers is to discover and develop the next nanoscale logic device — one with performance capabilities beyond conventional devices, enabling it to become the basic building block of future computers," says professor Alan Seabaugh of Notre Dame, the Frank M. Freimann director of MIND. "We have chosen Oxford Instruments' systems to facilitate this work, due to the advanced features they provide; the versatility and cost effectiveness of their systems for research and the support the company offers," he adds.

www.oxford-instruments.com

OIPT seminars

Like last year, OIPT is again holding seminars and workshops in conjunction with key research institutes and universities worldwide.

Speakers will come from the host universities and from other institutes and industry, in addition to process and applications experts from OIPT:

- 11–12 March: 'Nanoelectronics: Growth, deposition, etching', hosted by the Institute of Semiconductors Chinese Academy of Sciences (IOS) & Oxford Instruments in Beijing;
- 30 June: 'Knowledge creation partnership — from funding to results', a workshop hosted by the University of Southampton and Oxford Instruments at the University of Southampton;
- 14–15 July: 'New Frontiers in Plasma Nano patterning', hosted by the Molecular Foundry, Lawrence Berkeley National Laboratory, CA, USA.
- OIPT also plans a seminar/workshop in France (date to be confirmed).

To register, e-mail plasma@oxinst.com

SPTS buys Tegal's DRIE assets

Tegal Corp of Petaluma, CA, USA has sold its deep reactive ion etch (DRIE) and certain related assets (including the 200, 110, 3200 and 4200 series products, along with its Compact and Pluto development assets, intellectual property and process know-how) to SPP Process Technology Systems Ltd (SPTS) of Newport, Wales, UK, the plasma etch, deposition and thermal processing equipment subsidiary of Sumitomo Precision Products Co Ltd.

For its fiscal second-quarter 2011 (to end-September 2010), Tegal reported net income of just $0.1m on revenue of $3.2m, but cash balance fell further from $6.2m to $4.4m, while systems order backlog was just $1m.

Tegal will receive about $2.1m, including $1.6m in cash and the assumption by SPTS of about $0.5m of short-term liabilities. The deal includes the transfer to SPTS of the capital stock and operations of Tegal France SAS, a subsidiary formed after Tegal's acquisition in September 2008 of the DRIE and plasma-enhanced chemical vapor deposition (PECVD) assets of Alcatel Micro Machining Systems (AMMS) of Annecy, France.

SPTS will provide continued global support to existing Tegal DRIE customers — which use the tools for etching silicon and dielectric films in the micro-electro-mechanical systems (MEMS), bio-tech, power IC, optoelectronic, and 3D-IC (interconnect) sectors — and will integrate the technologies into its broad range of product offerings in etch, deposition and thermal technologies.

Previously, last March, Tegal sold its legacy thin-film etch and physical vapor deposition (PVD) product lines to OEM Group Inc of Gilbert, AZ, USA for up to $3m.

"The sale of the DRIE product lines to SPTS represents another major step in Tegal's transformation," says the firm's president & CEO Thomas Mika. "We recently announced our participation in the formation of sequel Power, a company dedicated to the development and operation of large-scale photovoltaic (PV)-based solar utilities in the USA, Latin America, the Middle East and Africa," he adds. "From this platform, we intend to build additional operations and make further investments as we transition from being a supplier of semiconductor capital equipment to pursuing a leading role in green energy," Mika continues. "The sale of the DRIE assets to SPTS ensures a smooth transition of our technology, team members, active joint development projects in France, and our commitments to customers globally."

This acquisition enhances the DRIE product portfolio SPTS offers to our served markets, broadens our customer base, and expands our ability to deliver world-class DRIE solutions

"This acquisition enhances the DRIE product portfolio SPTS offers to our served markets, broadens our customer base, and expands our ability to deliver world-class DRIE solutions to our global customers," comments SPTS' president & CEO William Johnson. "We expect to enhance support to Tegal customers through our worldwide support network, and intend to continue the leading-edge development efforts of the former Tegal team in Annecy."

SPTS was formed by SPP in October 2009 to merge predecessor firm Surface Technology Systems plc (STS) together with assets acquired from Aviza Technology Inc, including Newport-based single-wafer process equipment subsidiary Aviza Technology Ltd (ATL) and Aviza's Scotts Valley-based Thermal Products business (which provides spare parts, upgrades, and new or remanufactured systems to existing customers of Watkins Johnson, SVG, and Aviza furnaces and APCVD systems).

www.Tegal.com
www.spp-pts.com

SPTS ships APS etch system to Germany's Fraunhofer ISIT

SPP Process Technology Systems Ltd (SPTS) of Newport, Wales UK, the plasma etch & deposition equipment subsidiary of Japan's Sumitomo Precision Products Co Ltd (SPP), has shipped an APS etch system to Fraunhofer-Institut für Siliziumtechnologie ISIT (FhG-ISIT).

The system will add new process capability to ISIT's micro-electro-mechanical system (MEMS) manufacturing line to fuel next-generation development of devices such as actuators, sensors and energy harvesters.

"We have chosen to add APS to extend our offerings to the full range of deep etch processing for all MEMS and related technologies," says Christian Schroeder, FhG-ISIT's MEMS technology manager. "We are now capable of not only high-performance deep silicon etching, but also for challenging etches in hard materials, such as piezoelectric films, oxide films, glass and Pyrex," he adds.

"We are pleased to strengthen our existing relationship with this important R&D customer," says Kevin T. Crofton, executive VP & managing director of SPTS' Single Wafer Division. "The APS source offers unique processing capabilities with its patent-protected source design, proving to be extremely effective for customers who work with a variety of materials that are difficult to etch using conventional inductively coupled plasma tools."

www.isit.fraunhofer.de

Steed buys Applied Technology Specialists Inc

Thermal processing firm adds gas abatement/scrubber and pollution control equipment

Steed Technology Inc of Scotts Valley, CA, USA, which provides thermal processing equipment for the semiconductor, LED and solar industries, has acquired Applied Technology Specialists Inc (ATSI) of Bixby, OK, which develops pollution control equipment and technology to render safe volatile organic compounds (VOCs) and toxic exhaust gases.

Both firms will share the Steed name. The manufacturing of all products will remain in Northern California, while R&D of new products and technologies will remain in Oklahoma. Sales channels will be expanded both domestically and internationally to accommodate existing and new customers, focusing on regions with new air-quality restrictions.

Steed says that the acquisition steps up its product offering through incorporation of the ATSI EcoGuard line of point-of-use (PoU) gas abatement/scrubber and pollution control equipment. Steed is currently working to combine these technologies to work in unison. Customers of both Steed and ATSI should soon be able to purchase diffusion/LPCVD (low-pressure chemical vapor deposition) process and abatement equipment as a totally integrated system with onboard environmental control features developed by ATSI. Customers of both firms should receive the same level of service and support previously offered by Steed and ATSI for all new products.

Steed says that, with new, increasingly strict, environmental regulations such as the 'Greenhouse' law (AB32), many firms in the semiconductor, LED, solar and other industries are closely examining ways to increase the effectiveness and efficiency of their existing abatement systems. Environmental control will play a major roll with manufacturing companies in the years ahead, it adds. To help meet this need Steed will, in addition to offering products that help companies to meet such strict requirements, offer 'Green' consulting and solutions services to help companies reduce emissions of gases such as perfluorocarbons (PFCs), oxides of nitrogen (NOx), and carbon dioxide (CO_2), to levels that comply with local and federal laws, while reducing consumption of utilities such as fuel and water. Steed reckons that the merger adds value to this consulting service through the addition of the ATSI solutions team, which has a combined 50 years of gas abatement and clean-air solutions experience in the semiconductor processing industry.

Existing abatement solutions aim to scrub then dispose of hazardous by-products created during the production of LCD, semiconductor and solar products. With increasing regulations, and the high cost associated with utilities such as power and water, the common wet scrubber and chemical adsorption methods used by such technologies have become inefficient, claims Steed. The firm's EcoGuard products are designed to destroy and eliminate hazardous by-products, versus capturing the by-products for further, costly, hazardous waste disposal. Steed's abatement product line also offers a low-operating-cost solution for process and abatement savings through its 'On-Demand' Control Program. Using sensor-driven process signals, operators can control the type of abatement required for the particular gas and only use what is necessary to abate and emit clean air to the environment.

"Companies face steep and complex challenges when working with separate vendors and technologies while trying to piece together environmentally responsible solutions to the toxic and harmful exhaust created in their manufacturing process," says Steed's president & CEO Gerry Catalano. "High-tech companies will face tougher standards in the future and will need advanced abatement equipment to be in compliance," he adds.

"The technology we have developed for the EcoGuard product line provides our customers with extremely reliable and efficient exhaust gas treatment solutions that conform to regulatory limits," claims chief technology officer Earl Vickery. "They do not a require a bypass line, because they are specifically designed to prevent by-product solids from building-up within the abatement system," he adds. "Existing brands require a bypass and may still clog over time, regardless of preventive maintenance."

www.cleanair-tech.net

Austin Scientific wins order from HB-LED maker

Austin Scientific of Austin, TX, USA, a subsidiary of UK-based Oxford Instruments (which also owns etch, and deposition equipment maker Oxford Instruments Plasma Technology) has secured an order worth $770,000 from a major US-based high-brightness LED maker for cryopump systems to support its continuing expansion.

"There is a tremendous focus on finding more efficient, cost-effective tools for the manufacture of HB-LEDs as they will be key to both conserving energy and preserving our environment," notes Austin Scientific's general manager Donald Gordon.

www.oxford-instruments.com

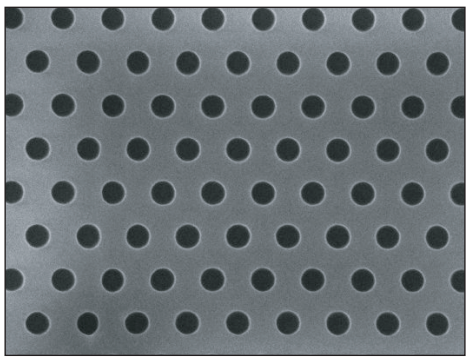
Dai Nippon Printing uses Eulitha's PHABLE technology

600nm-period photonic crystal patterned on full 4" wafers

Photomask maker Dai Nippon Printing Co Ltd (DNP) of Japan has patterned 4-inch wafers using the proprietary PHABLE (Photonics Enabler) technology of nanolithography firm Eulitha AG (a spin-off of the Paul Scherrer Institute in Villigen, Switzerland). Photonic crystal patterns with a period of 600nm and hexagonal symmetry were created uniformly over the 4" wafers.

PHABLE is a mask-based ultraviolet (UV) photolithography technology that targets production of photonic structures such as photonic crystals, diffraction gratings and anti-reflection surfaces. Eulitha says that high-throughput fabrication of such patterns over large areas is required for the manufacturing of future high-performance devices in fields including LEDs, solar cells and flat-screen displays. In PHABLE, a mask is illuminated with a UV beam to form a high-resolution image that has a very large depth of focus, so substrates with non-flat surfaces can be patterned easily.

The necessary high-resolution mask with the same 4" area as the final pattern was produced by DNP on a standard quartz/Cr plate. UV photolithography exposures were performed on a PHABLE-R lithography tool made by Eulitha. Photonic crystal patterns consisting of circular holes on a 600nm-period hexagonal lattice were printed in a commercially available photoresist coated on silicon wafers. The patterns that were produced were highly uniform over the whole 4" area of the wafers.



Close-up view of pattern on 4" wafer. Array of 300nm-diameter holes in photoresist. Pattern period is 600nm.

High-throughput fabrication of such patterns over large areas is required for the manufacturing of future high-performance devices in fields including LEDs

Eulitha says that the demonstration of uniform patterning on 4" substrates is an important milestone as most targeted applications require patterning of large areas. For example, the high-brightness LED industry is switching to 4" and 6" wafers from the traditional 2" base. Photonic crystal structures that enhance light extraction in LEDs or patterned sapphire substrates that improve performance of LEDs grown on them can be fabricated using PHABLE technology. Similarly, the technology can be used to produce the required substrates for nanowire-based LED or solar cell applications.

Eulitha currently offers samples and wafer batch processing services to companies and researchers developing nanostructure-based products. It also offers laboratory lithography tools for 2–4" wafers that are suitable for product development.

www.eulitha.com
www.dnp.co.jp/index_e.html

Sabanci University orders Vistec e-beam litho system

Vistec Lithography Inc of Watervliet, NY, USA has received its first order from a Turkish university — an EBPG5000plusES electron-beam lithography system for the newly formed Nanotechnology and Application Center (SU-NAC) at Sabanci University in Istanbul. It says that the Gaussian beam system fulfils the challenging requirements of the center, which will collaborate on nanotechnology research with other institutions.

"The EBPG5000plusES is a 100kV high-performance system, which is state of the art," says SUNAC director Dr Volkan Özgüz. "It will enable us to address the nanotechnology development needs of natural sciences, applied sciences and engineering programs," he adds. "Due to its flexibility and advantages, the EBPG5000plusES is a perfect investment for the future and will help to establish SUNAC as one of Turkeys leading nanotechnology institution."

Vistec's EBPG5000plusES is a dedicated e-beam lithography system developed to meet the diverse requirements for nanolithography applications in direct write for both R&D and production of GaAs devices. It enables rapid exposure at a rate of 25MHz and a minimum feature size of less than 8nm. The system can also expose various substrate types, including masks, with dimensions up to 150mm in size.

"Due to their flexibility and the multi-user environment, our systems are a perfect match to the needs of universities or industry research institutions," reckons Vistec Lithography's general manager Rainer Schmid. "After selling a number of electron-beam lithography systems to internationally known institutes in the last year, we are highly motivated to continue this positive development in the upcoming year," he adds.

www.vistec-semi.com

Rudolph expands into LED market

Rudolph Technologies Inc of Flanders, NJ, USA, which manufactures defect inspection, process control metrology, and data analysis systems and software for microelectronics and solar manufacturing, has expanded into the LED market with two significant orders.

Rudolph has shipped its Explorer automated macro defect inspection system and Discover Enterprise data analysis software to a 'leading worldwide producer of LEDs'. In addition, a US-based market leader in LEDs has placed new orders for ProcessWORKS and ARTIST process control software, along with repeat orders for AutoShell factory automation software.

"Rudolph offers a suite of inspection, metrology and data analysis technologies that help high-volume LED makers better understand the causes of defects and yield loss in their front- and back-end processes, ultimately lowering manufacturing costs and enhancing the performance and reliability of their products," says marketing vice president Ardy Johnson. "As the LED industry enters what promises to be a period of rapid expansion, rising costs and increased competition are driving a focus on yield management," he adds. "This is similar to developments we have seen in semiconductor manufacturing, where the effort to maximize yield has been in place for many years."

Newer, high-brightness (HB) LEDs deliver higher performance but require tighter control of variability and defectivity in the front-end processes of LED chip fabrication, in order to ensure process yield and consistent performance of these high-output devices.

"Understanding and improving front-end processes is critical to achieving the performance and reliability required, while maintaining manufacturing costs that allow LED manufacturers to succeed in a very competitive industry," Johnson says.

Rudolph's Explorer system provides automated macro defect inspection of front-end processes, while its NSX Series enables high-throughput inspection in the back-end. Discover Enterprise software collects and analyzes data from various inspection and metrology sources throughout the process to provide feedback on yield loss and systematic process variation.

"Adding ProcessWORKS, ARTIST and AutoShell to the manufacturing line has demonstrated further improvements to yield, with a very high return on investment," says Mike Plisinski, VP & general manager of Rudolph's Data Analysis and Review business unit. "One customer is using the AutoShell system automation software to connect process tools to their factory systems. They have seen firsthand how AutoShell can reduce errors and improve operator productivity," he adds.

"As the industry turns its focus from capacity expansions to better yields and tighter process control, software like ARTIST, AutoShell, and ProcessWORKS will become invaluable to LED manufacturing, as they are now to the semiconductor industry," Plisinski reckons.

www.rudolphtech.com

Avago orders Rudolph's automated inspection system for Singapore

Rudolph has received orders for its NSX Series from Avago Technologies Manufacturing (Singapore) Pte Ltd for front-end inspection at its optoelectronic devices wafer fabrication plant, which makes high-speed VCSELs, detectors and LEDs.

The NSX automated macro defect inspection system will provide both metrology and inspection data, and play a central role in assisting the enhancement of Avago's process yields, says Rudolph. Scheduled for shipment in first-quarter 2011, the system is the second purchased by Avago. The first was shipped in Q4/2010. Further orders to extend automated inspection and metrology across its entire manufacturing enterprise, including back-end assembly & packaging processes, are expected in the coming year.

"As our production volumes scale up, we have turned increasing attention to improving process yields," says Tom White, Avago's worldwide director of Optoelectronics Devices Operation. "The NSX system will allow us to improve the reliability and repeatability of our inspection procedures and our operation efficiency... we are using the Rudolph tools to measure critical dimension and overlay metrics at a significant cost savings over standalone metrology tools," he adds.

"We are particularly excited to win this business in the rapidly expanding market for advanced optoelectronic devices," says KeeAnn Tan, Rudolph's S.E. Asia general manager. "Pricing of these devices typically provides extremely high leverage and fast payback."

Rudolph says its NSX Series is a fast, precise, production-proven solution for automated macro defect inspection throughout device manufacturing. Macro defects may be created during wafer manufacturing, probing, bumping, dicing, or by general handling, and can have a major impact on micro- or optoelectronic device quality and process yield. The system detects yield-inhibiting defects, providing quality assurance and process information needed to reduce manufacturing costs and time-to-market for new products. Rudolph's Discover Enterprise software integrates data from inspection, metrology and manufacturing tools throughout the fab to provide enterprise-wide visibility of process performance.

www.avagotech.com

KLA-Tencor launches KLARITY LED defect analysis

Process control and yield management solutions provider KLA-Tencor Corp of Milpitas, CA, USA has launched KLARITY LED — an automated analysis and defect data management system for LED yield enhancement — and the new, scalable ICOS WI-2220 — a wafer inspection tool designed for LED defect inspection that helps LED makers to lower production costs while increasing device reliability.

"The industry's current consensus estimates state that by 2013 the LED market will be growing at a compound annual growth rate of 25% or higher," says Jeff Donnelly, group VP, Growth and Emerging Markets. "Today's LED device makers are challenged with increasing performance at a lower cost, while supporting the industry's aggressive growth rate," he adds. "With proven reliability and ease-of-use, KLA-Tencor's comprehensive portfolio of LED defect inspection and analysis solutions is designed to enable tighter process control and overall yield improvements for LED production at decreased cost per lumen."

Based on the KLARITY Defect product for integrated circuit manufacturing, the KLARITY LED includes automated in-line scan analysis for the entire fabwide manufacturing process. The LED industry is evolving from traditional tool-centric manual defect checks, with automated optical inspection only at the end-of-line stage, towards adopting sophisticated fabwide process control and defect analysis with in-line inspection. As a result of front-end to back-end connectivity, KLARITY LED delivers faster excursion detection and root-cause analysis than prevailing industry methods to enable effective decision making, helping to reduce the impact of materials risk and improve yields, KLA-Tencor claims.

With KLARITY LED, KLA-Tencor introduces to LED device makers an in-line alternative solution for automated defect analysis of LED production processes, and an option to more efficiently share performance and reliability data within their organization for faster yield learning, while replacing existing labor-intensive manual report generation methods, the firm adds.

Designed to help LED device makers accelerate yield learning cycles and prompt immediate corrective action, KLARITY LED includes:

- Automated analysis (intelligent statistical process control excursion and baseline monitor), which supports faster time-to-corrective action with automated knowledge-based reports, extensive drill-down capability and practical decision flow analysis that previously required expert intervention and interpretation;
- Advanced Defect Source Analysis, which automates the process of root cause analysis for defect sources providing flexible graphical analysis of common and adder defects;
- Proprietary Spatial Signature Analysis, which identifies spatial signatures, tracks dynamic signature count and leverages stack wafer signatures to identify the root cause for faster detection and corrective action;
- Defect image review, which provides wafer map point and click access, as well as an image gallery, allowing device makers to validate classification and defect transition commonality identification and rapidly generate automated reports;
- Repeater defect detection, which identifies repeat defects across an individual wafer, as well as from wafer to wafer.

KLARITY LED complements KLA-Tencor's wafer inspection systems — including the new ICOS WI-2220 — to provide an enhanced LED-specific portfolio solution for high return on critical LED inspection investments, the firm claims.

The ICOS WI-2220's automated optical inspection (AOI) capabilities aim to help LED device makers to realize increased yields and reduced production costs, allowing them to automate inspection of smaller die sizes that inhibit manual inspection, and of larger die sizes that require rapid corrective action to limit costly materials risk. The new system allows defect inspection of whole and diced wafers up to 200mm, with macro inspection sensitivity in the pre- and post-dice inspection (i.e. front- and back-end) of LED wafers.

KLA-Tencor claims that, compared to similar products on the market, the ICOS WI-2220 provides sensitivity to critical defects — while minimizing noise introduced by process variations — and offers outstanding over- and under-kill performance (die misclassification) at high inspection speed.

The new system also offers low image distortion, advanced optic filtering, rule-based binning (RBB) for real-time auto defect classification, and advanced metrology capabilities at high inspection throughput as a result of new proprietary inspection and data processing technology. This enables increased yields in the manufacturing process through yield base line improvement, excursion control as well as improved dispositioning in outgoing quality control inspections, the firm claims.

The ICOS WI-2220 works in conjunction with the Candela LED unpatterned wafer inspection system to provide comprehensive, yield-improving inspection coverage to the front-end of the line, including analysis for disposition, defect reduction and excursion control. The ICOS WI-2220 is also upgradable to the ICOS WI-2250 for flexible configurations.

KLA-Tencor's integrated LED portfolio of the ICOS WI-Series wafer inspectors, the new KLARITY LED yield management system, and the Candela systems will be showcased at LED Korea 2011, held in conjunction with Semicon Korea in the Coex Convention and Exhibition Center in Seoul (26–28 January). All tools are backed by KLA-Tencor's global service network.

www.kla-tencor.com

HB-LED inspection tool for improved substrate & MOCVD process control

Process control and yield management solutions provider KLA-Tencor Corp of Milpitas, CA, USA has launched the Candela 8620 substrate and epitaxy wafer inspection system, which is designed to provide automated defect inspection for high-brightness light-emitting diode (HB-LED) materials such as gallium nitride, sapphire and silicon carbide, enabling enhanced quality control of both opaque and transparent substrates, faster time-to-root cause, and improved MOCVD reactor uptime and yield.

With proprietary optical design and detection technology, the Candela 8620 detects and classifies sub-micron defects that are not consistently identified by existing inspection methods, it is claimed, enabling for the first time a production line monitor for these yield-limiting defects. As HB-LED manufacturers transition production to larger wafer sizes and introduce new patterned sapphire substrate (PSS) processes, the economic impact of resulting process-induced defects is estimated to be millions of dollars in lost product revenue per year, and MOCVD epi process issues may result in as much as 40% of overall defect-induced yield loss, KLA-Tencor says.

"The enhanced performance of KLA-Tencor's Candela 8620 is an important part of our yield and cost-reduction efforts," comments Iain Black, VP of manufacturing engineering and innovation at LED maker Philips Lumileds of San Jose, CA, USA, an early adopter of the Candela 8620 system. "The system has been an important element in accelerating our process ramp as we transition to 150mm substrates and is allowing us to select sapphire vendors with the highest quality," he adds.

Defects from substrate and epi processes impact device performance, yield and field reliability. The Candela 8620 can detect:

- Substrate defects such as micro-scratches and micro-cracks, which can create epi process defects and directly impact LED yield and reliability;
- Defect sources from lithography and etch processes for patterned sapphire such as missing bumps and resist voids, resulting in epi defects or reduced lumen output;
- Macro- and micro-defects in MOCVD processes, including hexagonal pits and bumps leading to electrical failure, and epi cracks, which can adversely impact field reliability.

LED substrates and epilayers pose significant inspection challenges due to high levels of background signal and nuisance defects, says KLA-Tencor. The Candela 8620's imaging and detection system is optimized to enhance the signal from relevant defects-of-interest while suppressing background noise. Aided by its multi-channel detection optics, the system also allows high-purity classification of such defects, allowing comprehensive statistical process control of critical MOCVD processes.

"KLA-Tencor is leveraging more than three decades of expertise in semiconductor process control to benefit customers in emerging markets like HB-LED," says Jeff Donnelly, group VP of Growth and Emerging Markets. "Recently, several HB-LED manufacturers have installed the Candela 8620 system, and the system's proven ability to identify hard-to-detect defects allows customers to realize higher substrate quality and maximize return on MOCVD investment."

KLA-Tencor currently has hundreds of Candela tools installed around the world. Candela is part of KLA-Tencor's integrated HB-LED portfolio, which includes the ICOS WI-2220 and WI-2250, and Klarity LED. Candela tools are backed by KLA-Tencor's global, comprehensive service network.

www.kla-tencor.com

Sandia solicits partners for surface patterning of GaN to allow epi lift-off

As a contractor to the US Department of Energy, Sandia National Laboratories is soliciting partners for commercializing a patent-pending surface patterning technology for MOCVD growth of gallium nitride and related materials that enables lower defect densities and facilitates lift-off of epitaxial layers (solicitation number 11_356).

The technique may provide improved-quality GaN material for applications in solid-state lighting and high-power transistors. A layer of silica microspheres is deposited over a GaN seed layer on an inexpensive substrate such as silicon.

As GaN is grown by MOCVD up through the interstices of the close-packed array of microspheres, strain is mitigated while threading dislocations bend and terminate at the microspheres, resulting in a uniform GaN layer with defect densities cut by about two orders of magnitude over GaN grown on unpatterned surfaces in similar conditions.

The epitaxial layer can then be bonded to a thermally conductive material such as aluminum nitride or diamond for better heat sinking, and released from the native substrate by selective etching of the microspheres. Sandia says that the etch process is less expensive and works on a greater variety of substrates than existing laser lift-off methods. The substrate can potentially be reused.

It is expected that commercial licenses may, on a competitive basis, grant exclusive rights in pre-negotiated, defined fields of use for reasonable consideration to qualified interested parties. Partnerships to commercialize the technology may also take the form of Cooperative R&D Agreements (CRADAs) or non-exclusive commercial licenses.

The deadline for responses to the solicitation is 3 March.

www.sandia.gov

Rubicon produces first 12" sapphire for LED manufacturing

Large-diameter range expanded from 6" and 8"

Rubicon Technology Inc of Franklin Park, IL, USA has announced the production of 12" polished wafers, the largest high-quality sapphire wafer ready for production of LEDs. The firm now offers a complete range of sapphire substrates including 2, 3 and 4" core, and 6, 8 and 12" wafers.

Rubicon says it is uniquely positioned to deliver the sapphire capacity necessary to support the growing demand for LEDs in the consumer electronics and general lighting industries in products such as light bulbs, large displays, traffic lights, HDTVs, tablets, netbooks, and mobile phones. Rubicon claims to be the only vertically integrated manufacturer of high-quality, large-diameter sapphire wafers in large volumes (with capabilities in crystal growth, high-precision core drilling, wafer slicing, surface lapping, large-diameter polishing and wafer cleaning processes).

"It takes unique technology with advanced processes to make high-quality, large-diameter sapphire at scale," says president & CEO Raja Parvez. "Rubicon's ability to affordably produce larger wafers, free of defects, is key to helping industries that make and use LEDs scale to the volumes necessary to support the growth needed in the general lighting and consumer electronics," he adds.

"The Rubicon team has built a highly specialized end-to-end process to ensure the high quality of our full range of wafer products," says Parvez. "It is very important to ensure that our customers can depend on us for uniform, particulate-free sapphire wafers as well as flat, stress-free wafers," he adds. "High-quality sapphire wafers help our customers produce high-quality LED wafers at volumes supporting the LED supply chain."

Rubicon says that its recent build-out of infrastructure optimizes its ability to make affordable, high-quality, large-diameter sapphire wafers in large volumes for customers worldwide. While its new 135,000ft^2 large-diameter crystal growth facility in Batavia, IL (which produced its first boule in early November) leverages the stability and lower cost of valuable resources such as power, the firm's new plant in Penang, Malaysia leverages the location to further lower costs and bring extensive experience in polishing large-diameter wafers closer to the LED, consumer electronics and general lighting manufacturers in Asia.

The transition to larger-diameter wafers in LED production has already begun, says the firm. Last August, Rubicon said that it had entered into a $71m agreement to provide 6-inch polished substrates to a major LED chip maker. Firms such as Philips Lumileds and Lextar Electronics have recently announced production of LED on 6" sapphire wafers.

www.rubicon-es2.com

Monocrystal ships 8" epi-ready sapphire to LED maker

R&D application follows 2 years of shipping 8" for RFIC use

Monocrystal Inc of Stavropol, Russia, which manufactures large-diameter sapphire substrates for LED and RFIC applications (as well as screen printing metallization pastes for silicon-based solar cells), has shipped 8-inch c-plane epi-ready sapphire substrates to one of the world's leading LED makers.

Monocrystal says that it was only recently that LED industry players considered transitioning from using 2-inch sapphire substrates in production to larger-diameter 3- or 4-inch substrates, while the use of 6-inch substrates seemed to be quite a remote prospect and any discussion of 8-inch substrates was mostly theoretical. However, now, leading manufacturers are already produce LEDs using 6-inch sapphire substrates and are beginning to consider 8-inch substrates too.

"It took leading LED manufacturers three years after the 6-inch sapphire substrates first became available on the market to launch R&D on their use for LED production," says CEO Oleg Kachalov. "The period was shorter for the 8-inch substrates — Monocrystal was the first to introduce and ship them to a MOCVD system manufacturer in August 2008, and about two years later we have supplied our premium 8-inch c-plane epi-ready sapphire substrates for R&D use at the forefront of LED manufacturing," he adds.

"The market dynamics in the LED space indicate a further shift toward the use of larger-diameter substrates, as well as the growing role of suppliers capable of meeting the high-technology standards of the today's LED market," Kachalov continues.

"Monocrystal has been supplying 8-inch sapphire substrates for R&D on RFIC applications for the last two years, and we have gained considerable experience in large-diameter sapphire substrate production," says VP sales & marketing Mikhail Berest. "We are glad to be able now to support also our LED customers in making a technological breakthrough which will help bring forth the widespread use of LED lighting," he reckons.

Last December, Monocrystal also announced the availability of ultra-large 10-inch c-plane epi-ready sapphire substrates.

www.monocrystal.com

Rubicon's revenue grows more-than-expected 44% in Q4

6-inch capacity expansion and increased pricing doubles profit

For fourth-quarter 2010, Rubicon Technology Inc of Bensenville, IL, USA, which makes monocrystalline sapphire substrates and products for the LED, RFIC, semiconductor and optical industries, has reported record revenue of $29.5m, up 44% on Q3's $20.5m (well above the expected 27% growth to $25–27m) and more than tripling from $8.5m a year ago. This took full-year revenue to $77.4m for 2010, almost quadrupling from 2009's $19.8m.

The fourth-quarter growth is attributed to a combination of increased pricing (resulting from strong demand from the LED market) and increased sales volume (enabled by the additional capacity from the firm's two new manufacturing facilities: the crystal growth facility in Batavia, IL, USA and the polishing facility in Penang, Malaysia).

Gross margin rose from 54% in Q3 to 63% (exceeding the forecast 'high 50% range'). Operating margin rose from 40% to 50% (exceeding the forecast 'mid 40% range'). Compared to a net loss of $0.76m a year ago ($0.04 per share), net income almost doubled from Q3's $8.3m ($0.35 per share) to $15.4m ($0.64 per share, far outstripping the expected $0.47–0.49). After generating $13.3m in cash flow from operating activities but spending $14.4m on property and equipment, during the quarter cash and cash equivalents rose from $12m to $16.1m (up from $3.9m a year ago).

Rubicon says that its capacity expansion remains on schedule and that there continues to be strong interest for its polished 6-inch wafers, for which revenue rose more than 70% sequentially to $8.1m. "Demand for 6-inch wafers is increasing and we expect significant growth in this product in the second half of this year as more LED chip manufacturers have announced their intention to move into production on 6-inch wafers later this year," says president & CEO Raja Parvez. "I am very pleased with the extraordinary finish to 2010 and look forward to what we expect to be a very strong 2011," he adds.

For first-quarter 2011, Rubicon expects continued strong demand, resulting in revenue growing about 20% sequentially to $34–36m.

Demand for 6-inch wafers is increasing and we expect significant growth in this product in the second half of this year as more LED chip manufacturers have announced their intention to move into production on 6-inch wafers later this year

"We expect substrate pricing in the first quarter to be consistent with fourth quarter pricing, and we expect to continue adding capacity on-schedule at our two new facilities," says chief financial officer William Weissman. "Utilization of newly added equipment and new hires will be lower in the first quarter, particularly in Malaysia, as we continue the qualification process with our customers," he notes. "We anticipate gross margin, therefore, to be slightly lower in the first quarter but still in the high 50% range." Diluted earnings per share should be steady at $0.62–0.65.

www.rubicon-es2.com

Thermal Technology sells 59 sapphire crystal growers to Taiwan, Korea and China for LED substrates

Thermal Technology LLC of Santa Rosa, CA, USA, which designs and manufactures crystal growth systems and high-temperature vacuum and controlled-atmosphere furnaces for the processing of metals, ceramics, glass and quartz, says that it recently received 59 orders for its Model K1 90kg sapphire crystal grower from customers in Taiwan, Korea and China. In total, the growers will produce 5.2 million TIE (two-in-equivalents) per year.

The firm claims that the Model K1 advances beyond the traditional Kyropoulos process and out-performs other sapphire crystal growth methods currently on the market, such as HEM (heat exchanger method) or Bridgman.

"I recently returned from our customer's site in Taiwan where they ceremoniously unveiled a perfect 90kg crystal grown in our K1 system," says president & CEO Matt Mede. "They own 14 K1 systems, which are being used for LED substrate production," he adds.

No other US producer of sapphire crystal growth technology has machines in successful production, according to Mede. "Previously, the Russian growers were the industry standard. The superiority of our design, crystal size and tool capability are quickly making Thermal Technology the industry leader in this market sector," he claims.

Thermal Technology's new Model K1 Crystal Grower is designed for LED substrate production. Its short cycle time makes it the most productive grower commercially available, it is claimed. To satisfy the high demand of the rapidly growing sapphire market, the firm says that it is shipping systems weekly.

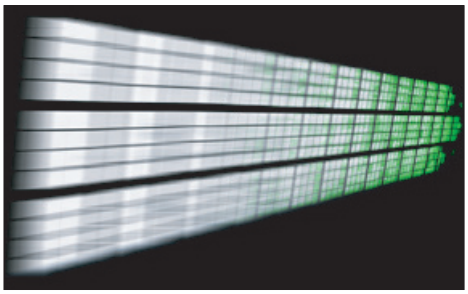
www.thermaltechnologyinc.com

Voids cut defects 100–1000-fold in GaN-on-sapphire

NCSU enables LED output to be doubled

Researchers from North Carolina State University have developed a new technique that reduces defects in gallium nitride epitaxial films grown on sapphire substrates, enabling the creation of more efficient LEDs ('Embedded voids approach for low defect density in epitaxial GaN films', Appl. Phys. Lett. 98, 023115 (2011), 17 January).

Normally, dislocations generated at the GaN/sapphire interface run through the crystalline structure of the GaN films until they reach the surface. The researchers started with a GaN film that was 2μm thick and embedded half of that thickness with large voids that were 1–2μm long and 0.25μm in diameter near the sapphire substrate (where high densities of dislocations are present). Generating a high-density network of embedded microvoids (~10^8/cm^2) in the film effectively created a 'surface' in the middle of the material, preventing the defects from traveling through the rest of the film. It was found that the defects were drawn to the voids (which act as dislocation sinks or termination sites for the dislocations, which therefore became trapped), leaving the portions of the film above the voids with far fewer defects.



Defect density in films cut by 2–3 orders of magnitude.

Both transmission electron and atomic force microscopy results confirm that the technique reduces the dislocation density uniformly by 2–3 orders of magnitude. "Without voids, the GaN films have approximately 10^{10} defects per cm^2. With the voids, they have 10^7 defects," says electrical and computer engineering professor Salah Bedair (co-author with materials science professor Nadia El-Masr, Ph.D. student Pavel Frajtag, and former post-doctoral researcher N. Nepal, now working at the US Naval Research Laboratory).

"This improves the quality of the material that emits light," Bedair adds. "So, for a given input of electrical power, the output of light can be increased by a factor of two." This is particularly true for low electrical power input and for LEDs emitting in the ultraviolet range.

"This technique would add an extra step to the manufacturing process for LEDs, but it would result in higher-quality, more efficient LEDs," says Bedair.

The research was funded by the US Army Research Office.

www.ece.ncsu.edu

http://apl.aip.org/resource/1/applab/v98/i2/p023115_s1

Entegris launches thin wafer shipper for LED making

Entegris Inc of Billerica, MA, USA, which provides products for purifying, protecting and transporting materials used in semiconductor manufacturing, has introduced a wafer shipper that specifically meets the critical handling needs of thin silicon and compound semiconductor wafers.

The Ultrapak 100mm Thin Wafer Shipper is designed to reduce damage and contamination in order to better protect thin substrates used in LED manufacturing and other applications. The new product is being featured with other LED solutions at the SEMICON Korea 2011 tradeshow in Seoul (26 January).

Currently, the LED industry predominantly uses shippers designed for mainstream semiconductor applications. These silicon wafer shippers are not designed for thin Si and compound semiconductor applications and can cause wafer damage or breakage, cross-slotting and particle generation via rotation if used in these sensitive applications. Entegris says that the new Ultrapak 100mm Thin Wafer Shipper, which leverages the proven technology and design of its Ultrapak family of wafer shipping products, offers several design features that help thin Si and compound semiconductor manufacturers reduce these risks, including:

- Cradle strap support (upper and lower cushions) of the wafer that limits wafer rotation (reducing particle contamination) and secures the wafers in the cassette to safeguard against breakage;
- Enhanced perimeter support of the substrate via extended upper cushion and lower cushion to reduce stress levels during impact events during transport;
- Ultrapure polypropylene materials that provide a clean shipping environment and assure low levels of outgassing to prevent haze or changes to the wafer surface;
- Robotic pickup flanges on the cassette to allow for convenient handling;
- Center notch track alignment and an 'H' bar to help assure accurate equipment interoperability for both vertical and horizontal wafer transfers;
- Secondary packaging design that holds eight shippers at a time, helping to protect up to 200 wafers.

The Ultrapak 100mm shipper passes the ISTA-2A procedure for free-fall drop with 150μm-thick germanium wafers using Entegris' designed secondary packaging. It also passed other functional tests using 300, 200 and 150μm wafers.

www.entegris.com

Nanowire LED firm Glo appoints Philips Lighting veteran as chairman

Glo AB of Lund, Sweden has appointed Dr K. R. (Kaj) den Daas as its new independent, non-executive chairman of the board.

Glo was spun off from Lund University's Nanometer Structure Consortium (nmC) in September 2005 to commercialize LEDs using the proprietary heterostructured semiconductor nanowire technology research of the team of Solid State Physics professor & nmC head Lars Samuelson (glo's chief scientific officer). Specifically, glo develops nanowire-based LEDs (nLEDs) emitting at brightness levels suitable for general illumination applications and with performance equal to or better than existing state-of-the-art planar chips, yet at much lower manufacturing cost at the die level, it is claimed, by using readily available, low-cost and large-area silicon substrates with mass-production-friendly technologies.

Glo controls a portfolio of patents and patent applications covering innovations in nanowire epitaxial growth and process technologies made by the Lund team and by glo itself. The firm says that it maintains a close working relationship with nmC and has access under contract to relevant labs and intellectual property developed there, as well as its own labs and facilities in Sweden, Denmark and Silicon Valley.

Glo announced last September that it had opened an engineering center in Silicon Valley, recruited Fariba Danesh as CEO, and raised SEK170m ($25m) in a financing round led by new investor Wellington Partners of London & Munich, joined by existing investors Provider Venture Partners of Stockholm, Hafslund Venture, Agder Energi Venture, Teknoinvest of Oslo, and VantagePoint Venture Partners of San Bruno, CA, together with LU Innovation and LUAB (the investment arm of Sweden's Lund University) as major owners, plus Glo's founders and employees.

New CEO Kaj Daas.

As chairman of Philips Lighting of North America and executive VP of Philips Lighting BV until his retirement from Philips at the end of 2009, den Daas led Philips in building the largest lighting firm in North America through both organic growth and acquisitions (such as Lumileds and Color Kinetics), with an emphasis on the emerging solid-state (LED) lighting market.

Prior executive assignments in Philips Lighting included periods as chief operating officer of BG Lamps (the largest and most profitable business of Philips Lighting), CEO Business Unit Lamps EMEA (including Lighting Components), CEO Business Unit Lamps Asia Pacific, senior VP & general manager Business Unit Luminaires Asia Pacific, and VP & general manager Philips Lighting Canada.

den Daas has a doctorate in Business Economics from Erasmus University in Rotterdam, The Netherlands, and is a member of the Illumination Engineering Society of North America and a former governor of NEMA (the National Electrical Manufacturers Association). He also serves on the boards of Hong Kong Stock Exchange-listed NVC Lighting and NYSE-listed Valmont Industries.

"He brings over 30 years of highly relevant commercial experience in the general lighting industry worldwide to Glo that will be very valuable to the company as it transitions from an R&D phase to its mass production and commercial phases," says Glo's retiring executive chairman G. Russell Mortenson.

"Glo's unique nanotechnology approach to LEDs has enormous potential," believes den Daas.

www.glo.se

SignalSure surface-mount LEDs for automotive signaling

LED maker Philips Lumileds of San Jose, CA, USA has launched its new SignalSure mid-power LEDs for automotive signaling applications, available in red-orange and amber colors (per automotive specifications).

The new LED is intended to be the most robust and reliable surface-mount LED available to the automotive industry and has undergone a rigorous Multi Environment Overstress Testing (MEOST) regime that exceeds the testing required by existing standards for automotive signaling LED source.

Lumileds says that the MEOST testing for SignalSure goes well beyond datasheet maximums to ensure ongoing reliability and performance. As part of the MEOST testing regime (developed in conjunction with tier 1 customers), SignalSure LEDs are exposed to extreme heat, humidity, and high levels of sulphur gas. Lumileds simulates high-voltage jump start and high-voltage alternator failure to ensure that the LEDs will continue

SignalSure LED for automotive signaling.

to operate without degradation in performance, quality and light output. The MEOST test regime is outlined in the SignalSure Reliability Datasheet (available on Lumileds' website). SignalSure LEDs are AEC-Q101 qualified and meet Japanese and SAE/ECE requirements.

"Reliability and confidence in a surface-mount signaling product has been our design objective for SignalSure from the start," says Paul Martin, senior director for Lumileds' mid-power automotive LEDs. "There are certainly other surface-mount LEDs in use today, but it was clear that the automotive industry's needs were not being met," he adds. "Only SignalSure achieves the automotive industry's desired level of reliability for a surface-mount product," Martin claim. "No other automotive SMD product we know of goes through the extreme testing applied to our LEDs and, as a result, we are delivering a superior SMD with a wide design margin for signaling applications."

SignalSure surface-mount LEDs expand a portfolio that includes Lumileds' SnapLED and SuperFlux LEDs. The firm claims that SnapLED has become the auto industry's standard for performance, flexibility and reliability, and its unique clinch frame assembly suits signature styling on vehicles worldwide. Lumileds expects SignalSure to be used for applications where thin, low-profile designs are preferred, including center stop, side-marker, tail, mirror turn, rear fog, and motorcycle signaling.

www.philipslumileds.com

Technology Innovation of the Year award for automotive lighting

Lumileds has been recognized with the '2010 Global Frost & Sullivan Award for Technology Innovation of the Year' for being a major factor driving the advance of improved lighting technologies for the auto industry. Frost & Sullivan commends it for "successfully differentiating itself in a difficult global market and expanding the market potential for automotive LED systems".

Compared to halogen, HID and incandescent lighting systems, LEDs offer enhanced functionality. A main benefit is unlimited service life: unlike a filament bulb, it never needs to be replaced, unless the vehicle is involved in a collision. But the most attractive feature is the ability to change color and brightness, giving designers the flexibility to develop mood lighting systems as a value-added feature.

Only three firms can produce automotive-grade LEDs that meet the needs of vehicle makers and their lighting suppliers, reckons Frost & Sullivan. Lumileds has done the most to advance the development of LEDs for motorists and the global auto industry, it adds. It has two main LED product lines for automotive lighting: LUXEON is designed for high-power headlamps and daytime running lights; SnapLED and SuperFlux are red, red-orange and amber LEDs for taillights and signaling applications.

"The main differences between Philips Lumileds products and its main competitors are its Thin Film Flip Chip (TFFC) technology, which offers improved thermal handling, and Lumiramic Phosphor technology, which improves light quality," notes Frost & Sullivan program leader Stephen Spivey. "This represents a significant competitive advantage against the high-power devices of its two main competitors, particularly for the front of the vehicle, where the light requirements present the biggest challenges."

By enhancing and refining its technology, Lumileds has increased the lumens per dollar, it is claimed.

"By 2020, revenues for LED lighting will exceed all other lighting technologies within the global auto industry," reckons Spivey. "Considering Philips Lumileds' enhanced technologies and relationships with automakers and headlamp manufacturers across the world, the company will be the leader in driving LED adoption rates," he concludes.

www.awards.frost.com

China's Pearl River lit by 700,000 LUXEON Rebel LEDs from Lumileds

Future Lighting Solutions of Montreal, Quebec, Canada (a division of Future Electronics), which provides LED components and support services for solid-state lighting products and installations (including engineering expertise, concept development, full system solutions and online tools that accelerate application development), has announced the illumination of the Pearl River in Guangzhou, China with 700,000 LUXEON Rebel LEDs made by Philips Lumileds of San Jose, CA, USA.

The city of Guangzhou recently completed a project to illuminate the banks of the Pearl River as part of their welcome ceremony for the Asian Games and to celebrate convening the Games in Guangzhou. The Guangzhou Municipal Government's open tender for the project called for an LED maker with reliable pre- and post-sales support, targeting a solution that could meet the requirements of energy efficiency, environmental protection, and sustainability for future development.

Roled Opto Electronics (Shanghai) Co Ltd won the tender, and was the main designer of the solution for the project, with support from Future Lighting Solutions. Deployment involved about 30,000 LED light fixtures and 700,000 LUXEON Rebel LEDs. China Construction Eighth Engineering Division (Guangzhou Subsidiary) was responsible for onsite installation.

LUXEON Rebel LEDs were selected based on their luminous flux, color temperature, color index and reliability. With the help of Future Lighting Solutions (FLS) and the use of its Usable Light Tool (ULT), LEDs best suited for the project were selected. Roled also made use of FLS' QLED Thermal Simulation Software to optimize the heat dissipation system. With the support of FLS' Lighting Resource Center (LRC) in Montreal, Canada and Shenzhen, China, Roled was also able to test and evaluate optical lenses, and deployed National Semiconductors' LM3404HV buck regulator as part of their electrical solution. With assistance provided by FLS and its LRC, Roled selected suitable LED models and optical lenses, which were able to resolve a number of lighting issues related to lighting efficiency and light distribution.

Also, since Guangzhou Municipal Government expected to recover its investment within three years, the solution was based on LED light fixtures as the technology delivers more than 60% savings in energy consumption and reduces CO_2 emissions by 80%, greatly shortening the return-on-investment time. FLS also provided support in terms of price, availability and supply continuity, enabling Roled to complete the project according to schedule.

"During the Guangzhou Asian Games, images along the banks of the Pearl River that were broadcast captured the essence of the dazzling skyline," says Wang Shiming, general manager at Roled Opto Electronics' manufacturing division.

A two-week free trial of Future Lighting Solutions' QLED Thermal Simulation Software is available online.

www.FutureLightingSolutions.com/QLED

The banks of Guangzhou's Pearl River, illuminated by night.

IN BRIEF

Roled recognizes Future Lighting as Outstanding Supplier

At its 2010 Supplier Summit, LED luminaire and lighting product maker Roled Optoelectronics (Shanghai) Ltd presented its award for 'Outstanding Supplier for 2010' to Future Lighting Solutions.

"The process is an extensive and complex process that includes a review of product quality, level of technical support, order and inventory management processes, post-sales service, and many others," says Roled's president Rock Hsuing. "Future Lighting Solutions has proven their excellence in each of these areas and consistently strives to improve their service process, quality, and support of Roled."

Roled's turnover exceeded RMB100m in 2010, with the completion of over 500 illumination projects. More than 80% of the luminaires installed by Roled use LUXEON LEDs made by Philips Lumileds of San Jose, CA, USA, for which Future Lighting Solutions provides engineering support and technical assistance in addition to supply chain services.

"The results of the relationship between Roled and Future Lighting Solutions, like the Pearl River project in Guangzhou, are testament to what can be accomplished with the right partnerships," says Jamie Singerman, corporate VP of Future Lighting Solutions.

Future Lighting Solutions was formed a decade ago, to support the lighting industry in the move from conventional analog lighting to digital solid-state (LED) lighting. It partnered with power LED maker Philips Lumileds, and provides technical expertise in optics, thermals, electrical, and manufacturing for the LED lighting market.

www.roled.com.cn

SemiLEDs' revenue almost doubles year-on-year
...but March-quarter fall-back slashes share price by third

SemiLEDs Corp of Boise, ID, USA (which has chip fabrication facilities in Hsinchu Science Park, Taiwan) has reported revenue for its fiscal first-quarter 2011 (to end-November 2010) of $13m, up 94.1% on $6.7m a year ago.

Founded in 2005, SemiLEDs' proprietary blue, green and ultraviolet (UV) 'metal vertical photon' (MvpLED) chip design features a vertical LED structure on a patented copper alloy base (after removal of the sapphire substrate) that provides what is claimed to be the best thermal resistance on the market (0.4°C/W) — allowing better heat removal than for LEDs that retain the sapphire substrate — as well as electrical and optical advantages such as greater luminous efficacy (more than 120lm/W) and longer lumen maintenance.

The firm fabricates LED chips for sale mainly to chip-packaging customers in China, Taiwan and other parts of Asia such as Korea, or to distributors who sell to packagers. It also packages some of its chips into LED components for sale to distributors and end-customers in selected markets (mainly for general lighting applications, including street lights and commercial, industrial and residential lighting).

Gross margin has risen from 27.4% a year ago to 51%, while operating margin has risen from 9% to 37.7%. Net income was $3.8m, up from $0.36m a year ago, despite a foreign currency transaction loss of $0.6m. However, despite cash flow from operations of $1.6m, cash and cash equivalents fell from $13.5m to $9.9m during the quarter.

Just over a week after the end of the quarter, on 9 December SemiLEDs completed its initial public offering (which was oversubscribed more than 10-fold), generating net proceeds of $95.5m (before deducting expenses estimated at $4m). SemiLEDs intends to use proceeds for expanding production capacity in Taiwan (doubling by August), R&D expenses related to LED chip production based on 6" wafers, and general corporate purposes (including working capital and capital expenditures). The firm is already building additional capacity through an LED chip-making joint-venture China SemiLEDs (Xurui Guangdian Co Ltd) formed in January 2010 in Foshan, Guangdong Province (to be operational next month).

After opening trading on NASDAQ under the symbol 'LEDS' at $24.01 (41% above the $17 IPO price), the firm's share price subsequently traded at $28–30 until the reporting of its fiscal Q1 results.

However, the firm also reported that, for its fiscal second-quarter 2011 (to end-February), it expects revenue to fall to $10.5–12.5m, with net income shrinking to $1.6–2.6m and gross margin falling to 44–46%.

This decline reflects pressure on selling prices during the quarter, according to chairman & CEO Trung Doan, attributing the main cause to "a particular customer going to a high-performance competitor based solely on price", which would have depressed margins if the contract had been taken up. "The magnitude of the pricing pressure was so large we chose not to pursue this business," he adds. SemiLEDs' share price subsequently fell by more than a third to about $19.

However, the lost business was with a client focused on the cell-phone camera flash market, which is not representative of other sectors of the LED market, such as general lighting. "The LED lighting market remains strong, particularly within Asia, and we are well positioned to take advantage of this, both through our Taiwan operations and China SemiLEDs," believes Doan.

www.semileds.com

SemiLEDs subsidiary Helios Crew launches LED using MEMS silicon packaging

High-brightness LED chip maker SemiLEDs Corp of Boise, ID, USA (which has chip fabrication facilities in Hsinchu Science Park, Taiwan) says that its subsidiary Helios Crew Corp (HCC) of Chu-Nan, Taiwan has launched the S35 LED product.

The S35 is a packaged LED that integrates MEMS (micro-electro-mechanical systems) with semiconductor processing to produce what is claimed to be a unique silicon packaging technology. In conjunction with a high-brightness SemiLEDs chip, the compact size, silicon sub-mount technology delivers high brightness along with what is claimed to be superior reliability.

In addition, the S35 silicon has a thermal conductance that is more than eight times higher than aluminum oxide ceramic packages, and at a considerably lower cost than aluminum nitride ceramic, the firm adds.

SemiLEDs' proprietary blue, green and ultraviolet (UV) 'metal vertical photon' (MvpLED) chip design features a vertical LED structure on a patented copper alloy base (after removal of the sapphire substrate) that provides what is claimed to be the best thermal resistance on the market (0.4°C/W) — allowing better heat removal than for LEDs that retain the sapphire substrate — as well as electrical and optical advantages such as greater luminous efficacy (more than 120lm/W) and longer lumen maintenance.

www.helioscrew.com

Seoul adds HB-LED lamps to speed penetration of lighting market

South Korean LED manufacturer Seoul Semiconductor Corp has added two new high-brightness (HB) LEDs, the Z6 and Z7, to its Z-series family. It has also unveiled a plan to release one or two new products each month to meet increasingly diverse customer needs and demands brought about as LEDs proliferate in the general illumination solid-state lighting (SSL) marketplace this year.

Seoul Semiconductor's new Z-Power LED Z6 (top) and LED Z7 (bottom).

The Z-Power LED Z7 series (4W) is a white HB-LED constructed on a special ceramic PCB. It offers 440lm brightness at 5500K color temperature. In particular, the Z series offers compact LED placement in a 9mm x 7mm x 3.2mm package for designing high-brightness solutions in demanding indoor and outdoor lighting products.

The Z-Power LED Z6 series has individually addressable 1W, red/green/blue and white LED die which can create full-color LED products. If all die are operated at the same time, white color (4W) can be created in a diverse range of color temperatures (pure, warm and neutral). Also, the Z6 offers more design flexibility, with independent circuits controlling each of the four LED chips inside the package.

The Z6 series, which is available in an ultra-small package (9mm x 7mm x 1mm), is designed especially to create dynamically colored lighting such as landscape lighting, stage lighting and digital signage with full-color performance. Color mixing properties are claimed to be superior to rival products. The series is also scheduled to be released at a 30% less expensive price point.

The Z6 offers more design flexibility, with independent circuits controlling each of the four LED chips inside the package

"We expect to impact new technological and economic inflection points in the LED lighting market with the new Z-Power LED Z6/Z7 series," comments VP of sales Brian Wilcox.

Samples for both the Z6 and Z7 series are available now, with mass production beginning in February.

www.acriche.com/en

Cree's sales fall 4% after standards-induced pause in China LED streetlights

Asian distributors' inventory correction to hit March quarter

For its fiscal second-quarter 2011 (ended 26 December 2010), Cree Inc of Durham, NC, USA (which manufacturers LED chips, lamps and lighting fixtures as well as gallium nitride and silicon carbide power-switching and RF/wireless microelectronic devices and SiC substrates) has reported revenue of $257m. This is up 29% on $199.5m a year ago but down 4% on $268.4m last quarter (and 5% below the targeted $270–280m).

In particular, although Power and RF device revenue rose 13% sequentially to $27.3m (mainly from the Power product line), LED product revenue fell 6% to $229.7m.

On a non-GAAP basis, gross margin has risen slightly from 47.5% a year ago to 47.7%, but fallen from 49% last quarter. Net income of $60.7m is up 51% on $40.2m a year ago but down 8% from $66.3m last quarter, due to the lower revenue and higher operating expenses. R&D expenses were $2.1m more than targeted (and up $4.1m sequentially) as Cree launched a large number of new products and increased its spending on 150mm LED wafer development. Cash flow from operations was $57.2m. However, capital expenditure was $64.7m, so free cash flow was –$7.5m (compared with +$26.9m last quarter). Nevertheless, during the quarter cash and investments rose $12m to $1110.8m.

"Q2 results reflected continued growth in our LED lighting product line, but revenue and earnings were lower than our targets due primarily to lower sales to our LED component distributors in Asia," comments chairman & CEO Chuck Swoboda.

While Power device product sales and LED chips were in line with targets, LED Lighting Product business again showed greater-than-expected double-digit growth due to sales to Home Depot, Zumtobel and continued growth in commercial downlight products. LED component sales to direct customers also showed double-digit growth, driven by new design wins and increased demand in Asia. However, LED component sales to distribution fell 30%, due mainly to an inventory correction at LED streetlight and bulb customers in Asia.

The over-supply of LED components has been caused by a pause in the China LED streetlight demand and lower-than-expected growth in LED bulb applications.

In particular, the LED bulb slowdown is related to Asian distributor customers working off inventory bought the prior quarter ahead of end-customer demand. The application is growing, but not as fast as customers had anticipated, resulting in the short-term inventory correction.

The China streetlight slowdown is related to a pause as new specifications were being developed by the government. These were published during the quarter, and a number of firms have recently been approved under the new guidelines. "We have design wins at the majority of these companies, and expect new projects to start being awarded after the Chinese New Year," notes Swoboda.

Results reflected continued growth in our LED lighting product line, but revenue and earnings were lower than our targets due primarily to lower sales to our LED component distributors in Asia

Cree's factory plan was based on shipping more distribution orders for LED components, which were rescheduled into fiscal Q3 very late in the quarter as distributors and their customers worked through the inventory correction, so LED component inventory ended higher than planned.

With backlog running behind Q2's order rate, for its fiscal third-quarter 2011 (ending 27 March), Cree expects revenue to be flat on Q2 at $245–265m due to seasonality (the Chinese New Year holiday) and the on-going inventory correction at LED component distribution customers in Asia offsetting growth in LED lighting product sales and increased direct LED component sales. Meanwhile, lower RF device sales will offset growth for power devices.

Gross margin should fall to 46%, due to a more price-competitive environment and lower factory utilization, partially offset by yield improvements. Factory execution will be critical, given the shorter lead-time environment, says Swoboda.

"Although revenue growth has slowed in the near term, we are still in the very early stages of the LED lighting revolution, and we continue to invest in our business to drive LED lighting adoption," he notes.

Operating expenses are expected to rise by about $7m to $73m, due to R&D spending rising by $3m (to support 150mm wafer qualification and new product developments in LED components and LED lighting fixtures) and SG&A spending rising by $4m (mainly in sales & marketing of LED components and lighting to expand field sales and application resources, in order to drive demand creation). Non-GAAP net income should correspondingly fall to $42–50m.

"We are actively managing our capital additions in light of our near-term revenue targets, while continuing to invest in long-term growth,"

says chief financial officer John Kurtzweil. "We continue to invest in our strategic priorities such as the 150mm production line in the US and building out our back-end operations at our new factory in China." Cree's targeted capital expenditure for the fiscal year therefore remains at $250–260m.

"The opportunity in LED lighting has not changed," believes Swoboda. "Based on the market trends we are seeing, and the success of our own LED lighting business, we are more confident that we will see continued adoption of LED lighting over the next several years," he adds. For example, during the quarter, Cree announced that US-based Denny's Corp has chosen its LED lights as the preferred lighting standard for all its new and remodeled stores across the USA.

"Although the China streetlight slowdown has affected our revenue growth in the short term, we continue to believe this is a net positive for Cree as the new requirements raise the efficiency and lifetime standards, which should favor higher-performance LED designs," says Swoboda. "We target increased demand for China streetlights starting in Q4, as well as new designs for indoor commercial applications."

During the quarter, to accelerate adoption of indoor LED lighting, Cree introduced the XLamp CXA20 (the first lighting-class LED array that can enable a 60W A-Lamp equivalent). In addition, the firm launched the XLamp XP-E High Efficiency White (HEW), the first high-power LEDs featuring its new Direct Attach LED technology (which enables fixture designs to use up to 50% fewer LEDs). Cree also launched the XLamp XM-L, which is claimed to be the industry's brightest, highest-performance lighting-class LED (delivering 1000 lumens with 100 lumens per watt efficacy at 3A, and efficacy of 160lm/W at 350mA).

Cree is still on track to qualify its first 150mm products by the end of fiscal 2011, with the first production volumes starting in early fiscal 2012

Swoboda notes that Cree's transition to 150mm wafer production has been accelerated by the increased R&D spending in fiscal Q2 (which should increase again in fiscal Q3). This has supported additional wafer turns for both process development and new tool qualifications. The new 150mm tools for the firm's Research Triangle Park (RTP) wafer fab are currently being installed. Although there has been some tool delivery delays, says Swoboda, Cree is still on track to qualify its first 150mm products by the end of fiscal 2011, with the first production volumes starting in early fiscal 2012.

"The near-term increase in R&D spending will pay for itself in fiscal 2012, with new design wins and lower LED costs," Swoboda believes.

www.cree.com

IN BRIEF

Cree boosts XLamp MX-6 LEDs; includes ENERGY STAR LM-80 data

Cree says that it has further simplified indoor LED fixture design with its newly optimized XLamp MX-6 LEDs, which feature higher flux options, new, longer lifetime estimates, and higher CRI (color rendering index) options. The firm has also completed LM-80 testing on MX-6 LEDs, which can enable quicker time to market for manufacturers designing ENERGY STAR-rated fixtures.

"By delivering high efficacy, uniform light output and extended lifetime, as well as completed LM-80 data, MX-6 LEDs are an ideal choice for manufacturers pursuing ENERGY STAR-qualified indoor LED fixtures such as cove, wall washing, under-cabinet or desk lamps," claims Paul Thieken, Cree's director of marketing, LED components.

XLamp MX-6 LEDs are now available in higher flux order codes offering light output of up to 122 lumens at 300mA in cool white (6000K) and up to 100 lumens at 300mA in warm white (3000K). They are also available with 80 CRI minimum in warm white (2600–4300K) for both standard and high-voltage configurations.

Based on LM-80 extrapolations and under normal operating conditions, MX-6 LEDs can provide an L70 lifetime of more than 150,000 hours using ENERGY STAR lifetime prediction methods. If used 24-hours-a-day, this equates to more than 17 years.

XLamp MX-6 LEDs with 80-CRI minimum or higher flux bins are also available in sample quantities immediately and production quantities with standard lead times.

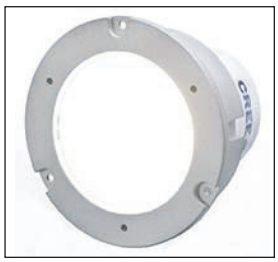
www.cree.com

Cree adds LMR2 module to speed adoption of LED lighting

Cree is extending its LED module family with the LMR2, a compact, high-efficiency module that aims to provide a simple solution for lighting designers and manufacturers. Also, the LMR4 module (launched last April) is now available in four color points — 2700, 3000, 3500 and 4000K — each based on Cree's TrueWhite technology.

The LMR2 module uses TrueWhite technology to provide efficient, high-quality light for applications such as restaurants, retail and hospitality lighting, where high color rendering index (CRI) and efficacy are required. Cree says that its 2.25-inch aperture allows increased design flexibility for applications including pendant lighting, sconces, wall washers, as well as small aperture downlights.

Designed to last at least 35,000 hours and dimmable to 5%, the LMR2 delivers 650 lumens at color



temperatures of 2700, 3000, 3500 and 4000K with a CRI of 90. It is drop-in ready and provides a comprehensive solution with integrated driver electronics, optics and primary thermal management. Fixture manufacturers also have the option to include a specially designed heat sink to accommodate high-heat applications such as downlights.

"We are extending our portfolio of application-optimized LED modules, which are designed to help OEM customers quickly and simply design, and bring to market, fixtures based on our lighting-class LEDs," says LED Module product line manager Scott Schwab.

www.cree.com/modules

LMR4 lighting modules available via Newark

Newark (part of Premier Farnell) has been named a distributor in North America for the latest range of LED modules from Cree. Available in TrueWhite and EasyWhite technology options (launched last April and August, respectively), the LMR4 modules provide a simple drop-in solution that integrates driver electronics, optics and primary thermal management.

TrueWhite LMR4 modules consume just 12W whilst delivering 700lm at a colour temperature of 2700K with a colour rendering index (CRI)>90. EasyWhite modules address a wide range of applications with a CRI>80. Both technologies support dimming to 5% and are designed to last at least 35,000 hours at L70.

Via its multi-channel approach and ability to support design engineers with extensive technical information and resources such as the element14 online technology portal and eCommunity, Newark aims to help to drive adoption of LED lighting for both new designs and those that currently use more traditional lighting approaches.

"Premier Farnell is helping bring the LED lighting revolution to lighting OEMs around the world, and Cree LMR4 modules are now available through its businesses: Newark (US/Canada/Mexico), Farnell (Europe) and element14 (Asia-Pacific)," notes Mark Despotes, Cree's VP of channel sales. "Simplifying the design-in process can shorten the time-to-market for new LED lighting products, and our Premier Farnell channel partner customers now have access to our industry-proven Cree TrueWhite technology and Cree EasyWhite solutions, allowing them to quickly deliver better products to the market, faster."

www.newark.com

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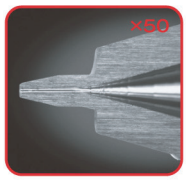

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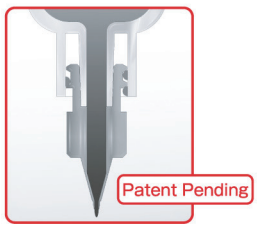
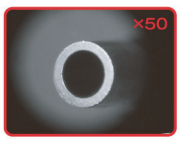


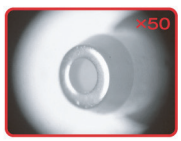
Tecdia Internal Taper

③ Lapped Nozzle Tip

- To minimize surface tension stiction



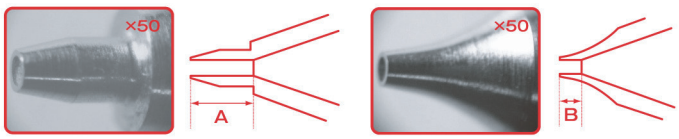
Stainless Steel Nozzle Tip



Ruby Nozzle Tip

④ Wide Selection of Shapes & Sizes

- Providing the right tool for the job



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WWW.TECDIA.COM

Russia's Kazan installs street lighting using Osram's Golden DRAGON Plus LEDs

Reducing Russia's primary energy consumption by 40% by 2020 is one of the country's core concerns. To help reach this goal the Republic of Tatarstan is tackling street lighting and has initiated a pilot project in its capital Kazan, a city on the river Volga with a population of about 1 million.

In ward 38 of Kazan's Novo-Savinsky district (which has about 25,000 households) its outdated 150W sodium halide lamps have been replaced by 500 'Sveteco-48' LED luminaires made by LED lighting firm LEDEL. By using Golden DRAGON Plus LEDs made by Osram Opto Semiconductors GmbH of Regensburg, Germany, the LED luminaires have a power input of just 48W.

Osram Opto's Golden DRAGON Plus LEDs have been developed specifically for energy-efficient lighting, enabling brighter and more evenly spread lighting without scattered light or glare and with much lower power consumption. Also, the favorable colour-rendering index (CRI) of

Street lighting using Osram Opto's Golden DRAGON Plus LEDs in Russian city Kazan.

LED light sources provides a natural colour impression and improves safety by outlining the surroundings more clearly, the firm adds.

According to the German–Russian Business Association, the Republic of Tatarstan (west of the Urals) is among the most active regions in the Russian Federation regarding government-imposed energy-saving initiatives. The project in Kazan should save about two-thirds of the original energy requirement and far exceeds the goals of Russia's energy-saving plans.

"With their long operating life and reduced maintenance costs compared with the previously installed sodium halide lamps, the city is saving extra money and protecting the environment," comments LEDEL's CEO Artur Kogdaning. The investment should pay for itself in about three years.

After the pilot project's positive results, Kazan is already planning to convert two other city wards to LED street lighting. "Osram Opto Semiconductors LEDs are the first choice solution for this job — their years of experience and understanding of street lighting requirements characterize our long-standing association," says Kogdaning.

http://ledel-europe.com

Award from French industrial electronic trader association

For 15 years the French industrial electronic trader association SPDEI (Syndicat Professionnelle de la Distribution en Electronique Industrielle) has been awarding a prize for outstanding services and support to French manufacturers. Osram Opto Semiconductors is one of the winners for 2010 in the category Opto electronics/display (LED/LCD) for its distribution structures.

Antoine Leveau, head of Osram Opto Semiconductors in France, received the award at a ceremony at the Automobile Club de France in Paris attended by about 150 people, including manufacturers, SPDEI members, and representatives of trade union partners.

SPDEI assessed more than 115 manufacturers on several criteria,

Leveau with the SPDEI award.

such as partnership, products, resources and IP protection.

Osram says that its approach is characterized by sustainable development based on innovation. The firm supports customer development via its distribution partners. Its product portfolio fits industry's requirements. Indeed with a large portfolio covering all the needs concerning colors or power classes, long-term availability, observance of standards (from RoHs to PCN) Osram is a reliable partner for its customers by means of its dense distribution network — and provides at the same time all the advantages of a single supplier management for its customer teams like personal contacts or uncomplicated distribution channels. "With its design protection policy, Osram enables its distributors to secure the results of their work and investment," says Leveau. "The benefit, in turn, for the customer is consistent, continuous and high-level expertise on the products during the design phase."

www.osram-os.com

Bridgelux raises a further $21m

According to a filing with the US Securities & Exchange Commission (SEC), LED chip and lighting array maker Bridgelux Inc of Livermore, CA, USA has raised $20.74m of a planned $21m round of financing, led by existing investors Vantage Point Venture Partners and DCM.

Bridgelux has now raised total venture capital of $135m, including $2.5m in angel funding in 2002, $8.55m in May 2005, $23m in August 2007, and $80m in Series D financing, including $30m (plus a $10m line of credit from investors) in a first tranche in April 2008 — used to develop new products (some of which were rolled out in 2009) — and an extra $50m in January 2010. Other existing investors include Chrysalix Energy Venture Capital, El Dorado Ventures, Harris & Harris Group, and VentureTech Alliance.

After originally focusing on designing and making its power LED chips based on ITO/InGaN, Bridgelux launched its first LED array product line in January 2009, followed that May by a Lighting Services Group to offer a range of solid-state lighting design and support services, and in March 2010 by the 'plug-and-play' Helieon Sustainable Light Module (jointly developed with Molex Inc) for industrial and commercial building owners. Last October, Bridgelux also extended the standard 1-year and 3-year warranties on all its integrated LED arrays and light sources to 5 years.

In January 2010, the firm also recruited former Seagate CEO Bill Watkins as its CEO to assist in scaling up production. Last year, Bridgelux expanded by merging its two San Francisco Bay Area manufacturing operations in Sunnyvale into its new manufacturing & headquarters complex in Livermore (officially opened last October).

The latest funds are likely to be used to continue the scale-up of production, with the aim of lowering costs in order to target the residential lighting market with a product selling for less than $20 per unit (and nearer to $10, to compete with incandescent light bulbs costing $2–10 each).

● Bridgelux has created the new, global role of chief sales & marketing officer by recruiting David W. Plumer Jr, who has more than 30 years of multinational sales, marketing, operations, and general management experience across the information technology, clean tech, and energy management industries.

Plumer joins from American Power Conversion (APC), where he was president of the Asia Pacific/Japan Region and senior VP of its global IT business unit.

"The lighting industry is at an inflection point where the introduction of a disruptive technology, solid-state lighting, into a large, legacy market is presenting tremendous opportunities for the creation of new markets and applications," says CEO Bill Watkins. "David has spent his entire career with world-class corporations that successfully built entire businesses by introducing disruptive technologies into incumbent markets, owning those markets and then leveraging that technology into new applications," he adds. "He has an excellent track record of performance in the areas of strategic customer relationships, market penetration and expansion, team management and overall business operations."

www.bridgelux.com

Output, color temp & CRI range extended

Bridgelux has expanded its RS LED Array family (launched a year ago) to include what it claims is the industry's highest-performance LED products, designed for very high-lumen applications such as retail shop lighting, high-bay, roadway, exterior area and industrial lighting applications.

The new RS Arrays deliver 3500–8000 operational lumens (up from 3100–4500lm of the existing versions), an extended range of color temperatures including warm, neutral and cool white (2700, 3000, 4000 and 5600K color temperatures), and multiple color rendering indices (CRI) options, increasing choices for solid-state light (SSL) applications.

Bridgelux says that the new LED arrays both simplify and speed development of new high-lumen LED products, accelerating the ability for solid-state lighting to replace high-wattage high-intensity discharge (HID) luminaires, providing safer operation and reducing payback periods to as little as 2 years. The high-flux-density sources enable precision lighting previously impossible with lower-power solid-state lighting technology, opening up new markets, reckons Bridgelux.

"Leveraging the significant success of previous product generations, the RS Arrays are uniquely designed to help our customers quickly and cost-effectively introduce new products targeting an increasing number of lighting applications," says Jason Posselt, VP of global marketing.

"As we initiated the design of our NEVALO SSL System for interior lighting applications [launched at the end of January], the new additions to the Bridgelux RS Array series provided the best solution for the high-light-density versions of our new lighting module," says Bruce Pelton, chief technology officer for the Tyco Electronics Lighting Division. "The Bridgelux team not only worked with us to meet our initial LED light source requirements but also demonstrated a product roadmap to provide an increasingly broad range of light output, CRI and efficacy options to meet the future requirements of our lamp and luminaire customers," he adds.

IN BRIEF

Luminus powers tactical flashlights

At the Shooting, Hunting, Outdoor Trade Show and Conference (SHOT Show 2011) in Las Vegas (18–21 January), Luminus Devices Inc of Billerica, MA, USA, which develops and makes big-chip PhlatLight (photonic lattice) LEDs for illumination applications, announced it is collaborating with several manufacturers of tactical flashlights used by military, law enforcement, fire fighters, rescue personnel, campers and hunters. Manufacturers demonstrating new Luminus-powered flashlights at the SHOT Show include Jet-Beam, Lemax, Microfire, Olight, Thrunite, Trustfire, Ultrafire and Wolf-Eyes.

The flashlights use Luminus' SST-50 big-chip LEDs, which are rapidly being adopted by makers of lighting devices for both professional and personal use, says Luminus. As well as the tactical flashlight market, the firm's LEDs suit retail and residential track lighting, PAR/MR replacement lamps, high-bay/ low-bay commercial and industrial lighting, and outdoor area lighting (including roadway and acorn fixtures).

The SST-50 is a high-lumen-output single-source LED, with input power of 5W and has energy efficiencies in excess of 100lm/W, color temperatures of 3000–6500K and L70 lumen maintenance of 60,000 hours.

"SST-50 big-chip LEDs are superior to traditional high-intensity discharge lamp solutions being used in today's reflection systems," claims president & CEO Keith T.S. Ward. "Big-chip LEDs provide flashlight manufacturers with a new, long-lasting, solid-state lighting solution that is ideally suited for future innovative products currently in the research and design phase."

www.luminus.com

OIDA partners with OSA

The Optoelectronics Industry Development Association (OIDA) in Washington DC has established permanent organizational ties with The Optical Society of America (OSA).

Leaders of both the OSA and OIDA have approved the action, and the transition phase is underway. OIDA says that its activities, services and member benefits will continue without interruption while it prepares for a busy year of programming activities and the celebration of its 20th anniversary.

OIDA's members include providers of components and systems enabled by optoelectronics, as well as universities and research institutions. As a non-profit association, it serves as the voice of the optoelectronics industry to government and academia, acts as liaison with other industry associations worldwide, and provides a network for the exchange of ideas and information within the optoelectronics community.

Uniting over 106,000 professionals from 134 countries, the OSA aims to bring together the global optics community through its programs and initiatives. Since 1916 OSA has worked to advance the common interests of the field, providing educational resources to scientists, engineers and business leaders by promoting the technologies made possible by optics and photonics.

"This strategic partnership allows both OSA and OIDA to enhance their business and industrial programming to thousands of professionals in the optics community," says OSA's CEO Elizabeth Rogan. "The two organizations have successfully collaborated in the past and will continue to be a voice for their members and respective industries," she add. "We value the content and member services OIDA provides and we look forward to the important contributions they will make in the years ahead."

OIDA will remain a separate entity under the OSA umbrella. It will deliver programming and member services under the guidance of its voting members and board. This year's first OIDA Forum will take place on 7 March in tandem with the Optical Fiber Communication Conference & Exposition and the National Fiber Optic Engineers Conference (OFC/NFOEC 2011), 6–10 March. The workshop will conclude with a reception celebrating OIDA's 20th anniversary.

"OIDA will be in a stronger position to serve the optoelectronics industry through its advocacy efforts, technical meetings, publications and member services," says OIDA board chair Richard R. Grzybowski. "Now more than ever, associations such as OIDA are aligning with peer societies that share values and priorities," he adds. "This alliance with OSA will enable OIDA to securely build upon its past accomplishments as it works to develop valuable new services and products."

www.osa.org
www.oida.org

Epistar raising $280m in bond issue

Taiwan's largest LED chip maker Epistar Corp set a conversion price of NT$132.6 (US$4.57) — a 30% premium on 18 January's closing price of NT$102 — to raise US$280m from its euro convertible bond (ECB) issue (announced in a Taiwan Stock Exchange filing on 23 December).

The issue was 10–15-times oversubscribed, having received orders from over 180 institutional investors.

Proceeds from the issue (Epistar's third such undertaking) will be used to repay US dollar loans (in order to reduce interest payments) and to purchase manufacturing equipment, especially MOCVD reactors.

Epistar plans to expand capacity by 40% this year, including 25% in first-half 2011 alone, says Primasia Securities in a client note.

www.epistar.com.tw

IN BRIEF

CSTG ships millionth laser

Compound Semiconductor Technologies Global Ltd (CSTG) has now delivered 1 million laser diodes from its wafer fabrication plant in Hamilton Technology Park (near Glasgow), Scotland, UK, following full qualification of the facility at the end of September.

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

The Hamilton plant was acquired in January 2010 from Intense Photonics Ltd (a maker of monolithic laser array products and high-power laser diodes) and is now engaged in making a GaAs and InP foundry products, including high-power 650–1600nm lasers, 1310–1550nm single-mode lasers and gain elements, semiconductor optical amplifiers, super-luminescent LEDs, quantum cascade lasers, InGaAs detectors and custom monolithic chip solutions.

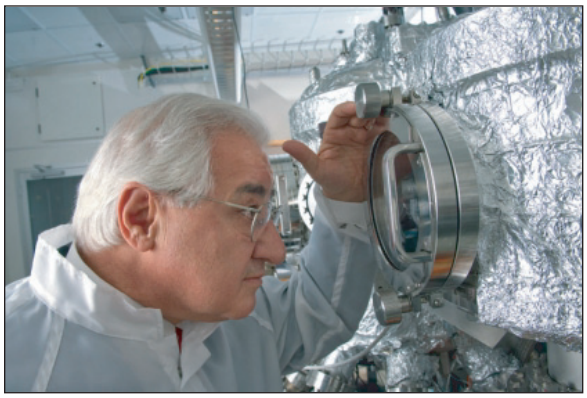
"Since full qualification of all foundry product lines in September, we have been focussed on ramping capacity to fulfil demand, particularly in industrial and telecoms applications," says CEO Neil Martin. "We are now engaged in expanding the capacity to deliver 1 million devices per month, which would position us as a leading European manufacturer of semiconductor laser sources," he adds. "In addition, we are aggressively expanding the portfolio of foundry processes and device technologies to capitalize on explosive growth in compound semiconductor applications."

www.compoundsemi.co.uk

Boston's Moustakas awarded $1.5m to develop handheld UV laser

Electron-beam pumping targets MBE-grown AlGaN-based alloys

Professor Theodore Moustakas of Boston University's Department of Electrical & Computer Engineering (ECE) has received a $1.5m, two-year subcontract from the US Defense Advanced Research Projects Agency (DARPA) to help develop a handheld electron-beam-pumped semiconductor laser that would be the first to operate in the ultraviolet (UV) region of the electromagnetic spectrum.



Professor Theodore Moustakas of Boston University, inspecting the growth of nitride-based semiconductor materials.

Because of its ultra-low emission wavelength and compact size, such a laser could be exploited for a wide range of defense and commercial applications, including non-line-of-sight communication in dense urban areas and other military theaters, via airborne particulates that propagate the signal; identification of biological and chemical substances used in potential terror attacks; and point-of-care chemical analyses of blood and other bodily fluids.

To develop the laser technology, Moustakas and two co-investigators (ECE associate professors Roberto Paiella and Luca Dal Negro) will fabricate ultraviolet laser materials and component devices; Applied Physics Technologies Inc of McMinnville, OR, USA and NASA's Jet Propulsion Laboratory (JPL) at the California Institute of Technology (Caltech) in Pasadena, CA will design miniature electron guns to pump the laser, and prime contractor Photon Systems Inc, which manufactures deep UV laser sources, will integrate everything into a prototype measuring less than 1 cubic inch.

"We plan to make a laser structure that, when bombarded with an electron beam, produces pairs of electrons and holes (positively charged particles), which recombine and produce the UV light," says Moustakas. "DARPA chose us because we have produced aluminum gallium nitride (AlGaN) alloys in which up to 68% of those electron/hole pairs are converted into light, a conversion efficiency of about 1000 times that of materials produced by other research groups," he claims.

Using molecular beam epitaxy (MBE), the Boston ECE team will produce the core AlGaN-based laser material and then construct component devices from multiple layers of the material. The researchers will evaluate the materials by directing electron beams at them in the lab.

In parallel with this project, Moustakas is working on a separate grant from NASA to develop a similar laser to perform chemical analyses of soil samples on future Mars expeditions. He is also advancing visible and ultraviolet LEDs and lasers for solid-state white lighting, water and air sterilization, and identification of biological and chemical agents; and indium gallium nitride (InGaN) quantum dots that boost solar cell efficiency.

www.bu.edu/nitrides

Soraa demos record 4W blue laser diode

450nm-wavelength devices target >500lm bulb-free projection displays

Soraa Inc of Fremont, CA, USA (formerly Kaai Inc), which is commercializing green and blue laser diodes (LDs), has demonstrated 4 watt blue laser diodes operating at a wavelength of 450nm, claimed to be the highest-power blue laser reported from a monolithic chip.

The devices are designed to enable >500 lumen bulb-free projection displays with dramatically reduced size, weight and power consumption compared with conventional bulb-based projectors used in venues such as boardrooms, education, home theater and cinema. The firm presented its latest results at the SPIE Photonics West 2011 conference in San Francisco.

Soraa also presented results of 750mW single-mode blue laser diodes (the highest single-mode power reported to date). The lasers operate with single spatial mode and multi spectral mode and are designed for smaller-format display applications such as micro projectors and pico projectors. The devices can be directly modulated at the high speeds required for high-resolution displays with minimal speckle.

Soraa's laser diodes are designed to be compatible with all available display generating technologies including LCOS, scanning MEMS mirrors, DLP, and other diffractive approaches. The blue LD devices complement Soraa's green laser diodes (announced in January).

The devices are designed to enable >500 lumen bulb-free projection displays with dramatically reduced size, weight and power consumption

Soraa was founded in 2008 (as parent firm to Kaai Inc) by University of California Santa Barbara (UCSB) professors Shuji Nakamura, Steve DenBaars, and Jim Speck. Management is led by ex-Intel and Samsung executive Eric Kim, and consists of commercial laser industry veterans. Soraa is funded by Khosla Ventures and NEA, and operates vertically integrated fabrication facilities in Silicon Valley and Santa Barbara.

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

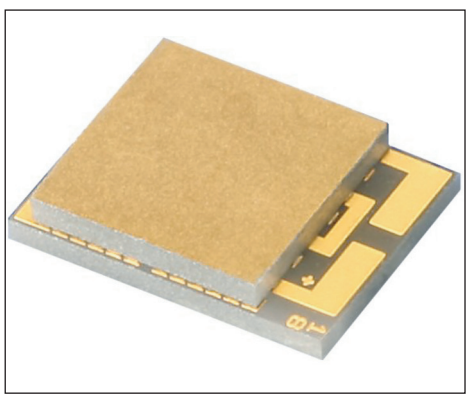
www.soraa.com

Nextreme launches thin-film thermoelectric cooler for high heat fluxes in photonics

At the Photonics West 2011 conference in San Francisco, CA, USA (25–27 January), Nextreme Thermal Solutions of Durham, NC, USA, which designs and manufactures microscale thermal and power management products, has launched the OptoCooler HV37 module, the next product in its high-voltage (HV) line of thin-film thermoelectric coolers (TECs) designed to address photonics cooling applications with larger heat pumping requirements.

At 85°C, the OptoCooler HV37 can pump 4.5W or 107W/cm^2 of heat in a footprint of just 6mm^2. The device is only 0.6mm high, making it one of the thinnest heat-pumping TECs in the photonics market, it is claimed.

Also, at 85°C, the HV37 can create a temperature differential (deltaT) of up to 60°C between its hot and cold sides, and operates at a maximum voltage of 7.7V, making it compatible with commonly found board-level currents and voltages. At 25°C, the device can create a deltaT of up to 50°C with a maximum voltage of 5.9V.



Nextreme's new OptoCooler HV37 high-voltage line of thin-film thermoelectric cooler modules.

The HV37 is RoHS-compliant and is manufactured using gold-tin (AuSn) solder, enabling assembly temperatures as high as 320°C, which makes it compatible with industry-standard processes for packaging photonics devices that require tight tolerances.

"Thermoelectric coolers made from thin-films are smaller and thinner than conventional TECs and can be embedded in the smallest of packages," says VP of engineering Dave Koester. "In addition to its high-heat pumping capability, the OptoCooler HV37 has a low mass, which enables a more rapid thermal response to changing temperatures for precise temperature control."

The HV37 module is available with an 8–10 week delivery lead time. Pricing is available upon request.

www.nextreme.com/optocooler

Opnext launches 60mW high-power 445nm blue laser for embedded device mini projector applications

At the Photonics West 2011 event in San Francisco (25–27 January), optical module and component maker Opnext Inc of Fremont, NJ, USA, which offers a family of high-power, low-operating-current red and infrared laser diodes, launched a high-power (60mW) 445nm blue laser diode. The first in a family of blue laser diodes being planned for development, the HL45023TG blue laser diode is designed for accessory or mobile pico projector applications as well as embedded device applications where a pico projector image capability is envisioned to be integrated into a mobile phone.

Using a unique and proprietary design, the HL45023TG provides 60mW of optical output power at a 445nm wavelength and consumes 30% less power than existing, commercially available blue lasers, it is claimed. The laser comes in a small 3.8mm package, suiting the growing market demand in embedded and mobile device applications. In addition, it has a small aspect ratio of 2.1, close to the same aspect ratio as the red, high-power laser diode that Opnext currently provides for pico projector applications. With the introduction of the blue laser, pico projector module manufacturers can now improve their RGB module by using both the red and blue laser diodes, the firm says.

Light Touch from Light Blue Optics projects bright, high-quality video images in WVGA resolution using Opnext laser diode technology.

"With the addition of a blue laser diode to our product portfolio, we anticipate manufacturers will be pleased with the power and image quality results they can deliver from their system," says Tadayuki Kanno, president of Opnext's devices business unit. "Opnext's focus continues to be on the development of diodes that are high power, high quality and high performance while consuming less energy."

Market research firm In-Stat forecasts that the market for pico projectors will reach 20 million units in 2014, driven mainly by tiny projectors embedded in mobile handsets, personal media players, cameras and camcorders ('Pico Projectors: One Reason Bigger Isn't Better', May 2010).

"Opnext is one of the key red laser diode suppliers for our Light Touch product, and they have consistently delivered on the quality we need," comments Chris Harris, CEO of projection system manufacturer Light Blue Optics of Cambridge, UK. "The introduction of Opnext's high-power blue laser is an important step in our roadmap towards embedded projection systems that deliver improved image quality and three times the brightness of a typical tablet screen using only half the power," he adds.

With more than 30 years of laser heritage, Opnext offers a broad spectrum of laser diode products that now span 404–850nm.

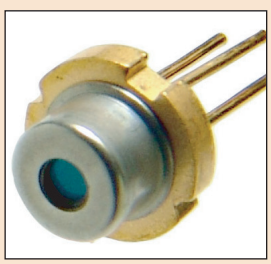
The HL45023TG will be shipping in sample quantities in February and is scheduled to be in mass production in April.

www.opnext.com

Opnext launches 500mW high-power 404nm violet laser diode for medical illumination systems

At Photonics West, Opnext also launched the HL40023MG, a high-power (500mW) 404nm violet laser diode for biomedical illumination applications, as well as direct imaging on PCB manufacturing surfaces.

Existing biomedical and direct imaging system manufacturers are using solid-state laser diodes that are large and consume tremendous amounts of power. Opnext says that the HL40023MG offers the option to use a high-power diode in a small 5.6mm package. With a typical operating current of 390mA, it provides 400mW of optical output power.



Violet laser diode.

"We believe cost-competitive, high-intensity sources like Opnext's 404nm lasers are critical to improving the capabilities of state-of-the-art instruments like high-performance illuminators," says Claudia Jaffe, VP of business development at light engine product maker Lumencor Inc of Beaverton, OR, USA, which is working with Opnext.

Lumencor is developing a medical illumination system that uses a light source to perform medical imaging tests and research. "As the industry trend moves toward using higher-power laser diodes, we will continue to develop innovative diodes with a low operating current," says Tadayuki Kanno, president of Opnext's devices business unit.

The HL40023MG is scheduled for mass production in February.

Opnext grows for 4th consecutive quarter to record $97m

Lower R&D spending enables return to positive adjusted EBITDA

For its fiscal third-quarter 2011 (to end-December 2010), optical module and component maker Opnext Inc of Fremont, NJ, USA has reported record revenue of $97.1m, up 12.4% on $86.4m last quarter and up 27.6% on $76.1m a year ago (representing the fourth consecutive quarter of growth).

Of total revenue, Alcatel-Lucent and Cisco Systems Inc each represented 10% or more (and 33% combined, compared to 34% last quarter).

Revenue from 40Gbps and above products was $27.4m, up 23.5% on $22.2m last quarter (due mainly to an increase in module sales) and up 63.3% on $16.8m a year ago. Revenue from 10Gbps and below products was $61.8m, up 9.3% on $56.5m last quarter (mainly as a result of increased sales of both SFP+ and X2 modules) and up 12.2% on $55.1m a year ago. Revenue from industrial and commercial products was $7.9m, up 2.7% on $7.7m last quarter and up 88.3% on just $4.2m a year ago.

Although up on 20.9% a year ago, non-GAAP gross margin has fallen from 22.2% last quarter to 21.5%, unfavorably impacted by lower average per-unit selling prices despite the higher sales volumes and higher mix of 40Gbps and above revenues.

Led by strong 40Gbps and above module sales, the growth was broad based across most product lines and, together with lower R&D spending, facilitated our return to positive adjusted EBITDA

Nevertheless, non-GAAP net loss has been cut from $12.7m and $10.7m last quarter to $5.5m. Also, adjusted EBITDA has improved from –$7.3m a year ago and –$4.4m last quarter to +$1.1m.

"Led by strong 40Gbps and above module sales, the growth was broad based across most product lines and, together with lower R&D spending [shrinking from $16m last quarter to $13.3m], facilitated our return to positive adjusted EBITDA," says president & CEO Harry Bosco. "We will continue to focus our efforts on returning to profitability as we continue to invest in our future," he adds.

For its fiscal fourth-quarter 2011 (to end March), although most of its product portfolio will be affected by calendar year-end price adjustments, Opnext expects revenues from sales of 40Gbps and above modules to continue to grow. The firm hence expects total revenue of $97–102m.

www.opnext.com

Modulight adds features and boosts FiberLight power

Laser manufacturer Modulight Inc of Tampere, Finland has launched new designs of its FiberLight product family addressing both power and functionality requirements of the medical, defense and industrial markets, including display and projection applications for visible lasers.

The new platform has improved coupling efficiency combined with a robust mechanical design, as well as a detachable fiber as a new feature.

The FiberLight product family comprises all Modulight's fiber-coupled laser array products, based on one- and two-laser arrays. The following wavelengths and power levels (single array and double array) are available as standard products: 635nm (3 or 5W; 7W), 650nm (7W; 12W), 1470nm (15W; 30W), 1550nm (15W; 25W). Other wavelengths and power levels are available on request.

Typical configurations includes a thermistor for temperature monitoring and a female SMA-905 connector designed for 400μm-core NA=0.22 fiber. Other fiber diameters and additional features including a monitoring photodiode, fiber sensor and aiming beam are available on request.

"The improved FiberLight platform along with recent developments in our laser bar products form a product line that is competitive in various markets such as medical, research, defense, and industrial applications,"

We have also focused on streamlining the manufacturing chain and pushing down the cost, despite added features and higher output power and efficiency

says Dr Tommi Hakulinen, product engineer responsible for Modulight's fiber-coupled products. "These upgrades in performance and features of FiberLight platform put us to the forefront of the fiber-coupled laser array technology in the visible red and eye-safe long-wavelength laser diodes," he reckons.

"We have also focused on streamlining the manufacturing chain and pushing down the cost, despite added features and higher output power and efficiency," Hakulinen continues. "Along with the FiberLight platform, we are making constant improvements in both array- and multiple single-emitter-based fiber-coupled lasers to accommodate needs in a range of applications from laser projection to surgery and illumination."

www.modulight.com

Oclaro highlights entry into new markets

At the Photonics West 2011 event in San Francisco (22–27 January), optical component, module and subsystem maker Oclaro Inc of San Jose, CA, USA announced new laser-based products and market expansion plans, highlighting its execution of a strategy to leverage its manufacturing operations to expand into adjacent markets.

"This year's Photonics West marks a significant milestone where we begin to see the successful results from our continued investment in technology, R&D and manufacturing operations, as well as strategic investments," says executive VP & division manager Yves Le Maitre. "Through our continued execution and a focus on technology innovation, Oclaro has transformed itself into a global manufacturing leader that can quickly meet the needs of new markets, such as the consumer space, that require high volume, low cost and exceptional reliability," he adds.

Of several new product announcements made both before and during Photonics West, some feature technology originally developed in the telecom space that is now being leveraged across new and adjacent high-growth markets, such as consumer electronics, medical and industrial lasers.

During Photonics West, Oclaro also presented six technical papers at the associated symposia BIOS and LASE 2011:

- 'Automated Assembly Processes for High-Power Single Emitter Diode Lasers';
- 'Bright Laser Source with High-Power Single Mode Emitting Diode Laser Stacked Array Assembly and Fiber Coupling';
- 'Compact Intracavity Frequency Doubled Diode Laser at 465nm';
- 'Versatile 1 W Narrow Band 976nm Light Source';
- 'Miniaturized High-Power Er:YAG Solid State Laser Pumped by a Single Laser Diode Bar';
- 'Low-Cost High-Reliability 830nm Single Mode Lasers for Consumer Electronics and CtP Applications'.

Oclaro launches 808nm laser diodes, demonstrating integration of former Spectra Physics' Tucson operation into Zurich facility

Oclaro has launched a new line of laser diodes that feature what is claimed to be the industry's highest level of efficiency and performance by combining the laser diode technology from its facility in Zurich, Switzerland with packaging technology from its Tucson site (part of the Newport Spectra Physics high-powered laser diode business acquired in July 2009).

Showcased at Photonics West in San Francisco (22–27 January), the new line represents Oclaro's first laser diodes to ship in volume into products originally developed in Tucson, including the collimated bar series and Prosario Series. Used primarily for diode-pumped solid-state lasers and direct medical applications, the new integrated platforms provide end-users and integrators with a more compact size, more efficient thermal management and increased power, says Oclaro.

"These new laser diodes demonstrate how we can take advantage of Oclaro's economies of scale and expertise to deliver the highest level of cost savings, operations efficiencies and manufacturing excellence — and then leverage the resulting technology across multiple Oclaro product lines," says executive VP & division manager Yves Le Maitre.

Targeted at solid-state laser pumping, direct-diode applications and medical markets, Oclaro's new line of 60W 27%FF (fill factor) bars and 80W 50%FF bars are developed for continuous-wave operation on a conductive heat-sink. The diode bars have an industry-standard CS-type assembly, which is fully compatible to previously released products. The increased brightness of the 60W product makes it most suitable for beam shaping and fiber coupling applications, while the 80W product suits pumping applications and line sources.

The laser diode bars represent the first Oclaro E2 facet passivated and hard-soldered bars to be incorporated in Oclaro's collimated bar series and fiber coupled Prosario series. By integrating this technology into these two series, Oclaro can improve their output power, efficiency and reliability in order to offer a higher-performing solution. This is an example of how Oclaro is taking its core technology and leveraging it across multiple product lines and markets.

The new Oclaro high-powered laser products feature the Oclaro E2 mirror passivation process which protects the front facet of the bar against catastrophic optical mirror damage. In addition, the telecom-grade AuSn (gold tin) hard solder suits industrial and defense applications in CW and hard-pulse operation mode. Oclaro says that these two manufacturing technologies significantly extend the life of its products by providing reliability and robustness even in the most demanding applications.

Oclaro claims to deliver the industry's most expansive line of high-powered laser diodes and to achieve lower costs and higher operating efficiencies through economies of scale, greater factory utilization and its assembly & test manufacturing capabilities in Asia. Its customer base, which includes top-tier firms in the medical and industrial markets, continues to grow as manufacturers steadily turn to lasers for new applications.

www.oclaro.com

Oclaro expands 1470nm single-emitter laser diodes to cosmetic skin treatment

Optical component, module and subsystem maker Oclaro Inc of San Jose, CA, USA says that its 1470nm laser diodes, which are already selling into the eye-safe laser market, are now being targeted at new high-volume skin treatment consumer markets.

Oclaro says that the 1470nm single-emitter lasers, which were showcased at the Photonics West 2011 event in San Francisco, CA (25–27 January), deliver the power, reliability and stable performance necessary in the cosmetic consumer market, while the firm's manufacturing capabilities is bring the technology down to mainstream price points.

"Oclaro continues to execute on its business strategy to bring proven technology into new high-growth markets that need the economies of scale and expertise that Oclaro can provide," says executive VP & division manager Yves Le Maitre. "Our extensive manufacturing infrastructure enables us to bring cutting-edge laser technology into the hands of consumers, and lasers for cosmetic skin treatment is just one example of the types of markets we can now effectively serve."

New consumer applications in the cosmetic skin treatment market, such as wrinkle reduction, are driving increased demand for cost-effective laser diode solutions. By leveraging its indium phosphide technology (which was developed for the telecom industry) into 1470nm single laser diodes, Oclaro says that it can also scale to volume quickly to meet the price points that are required in this market.

Our extensive manufacturing infrastructure enables us to bring cutting-edge laser technology into the hands of consumers, and lasers for cosmetic skin treatment is just one example

The 1470nm single-emitter laser diodes leverage proven technology that is currently being used in eye-safe applications in the defense, materials processing and medical markets. The laser diode emits 2W output power at 1470nm from a 90μm stripe and is available on a submount, a CMount or in a 105μm fiber-coupled configuration. The fiber-coupled version is built on Oclaro's widely used platform for single-emitter fiber-laser pump modules, and tailored configurations with fast- and slow-axis lenses for beam confinement address specific high-volume consumer applications. The laser diodes have also demonstrated reliability after being life-tested for more than 5000 hours at 10.5A without any fails, says Oclaro.

www.oclaro.com

Oclaro laser line filters cut background noise

Oclaro has launched a line of Clarity laser line filters designed to suppress amplified spontaneous emissions (ASE) in diode-pumped solid-state (DPSS) laser systems and improve the signal-to-noise performance of laser systems.

Oclaro says that the new filters are suited to the growing life sciences and analytical markets and, when combined with the firm's laser diodes, provide cost and time-to-market advantages by eliminating the need to work with multiple suppliers on critical components.

The firm says that the new filters can reduce the background noise on the laser and provide superior signal-to-noise performance for the laser manufacturers' customers. As a supplier of both laser diodes and filter products, Oclaro says that it can speed time-to-market, reduce development cost and simplify a customer's business by reducing the number of suppliers they have to manage in their design cycle. Furthermore, customers can benefit from Oclaro's manufacturing expertise from the telecoms industry, which is now being leveraged across a diverse set of industrial markets such as solid-state lasers.

"Customers not only benefit from having a single-source supplier for all their filter and diode needs, but also from Oclaro's world-renowned manufacturing excellence, ability to quickly scale to high-volumes and achieve attractive price points," claims executive VP & division manager Yves Le Maitre.

Oclaro's family of Clarity line filters uses proprietary Advanced Energetic Deposition (AED) high-energy reactive magnetron sputter technology to produce reliable hard-coated filters. The laser line filter combines high transmission (>90% at the laser line), sharp spectral edges, and deep out-of-band blocking (>OD6) optimized to meet the needs of high-performance laser systems. The firm's coating capabilities extend from 350nm to 2000nm, enabling laser line filters for a wide wavelength range. The filters are available for 488nm and 532nm laser systems and are currently sampling.

The new filters complement Oclaro's complete line of high-powered laser products. As a tier-one provider of high-power diodes to laser manufacturers, the new Clarity laser line filters represents significant design win opportunities, Oclaro reckons.

Oclaro's profit dips during investment and ramp-up

Advanced Photonic Solutions to bounce back after fab transfer

For its fiscal second-quarter 2011 (ended 1 January), optical component, module and subsystem maker Oclaro Inc of San Jose, CA, USA has reported revenue of $120.3m, up 29% on $93.6m a year ago but down slightly on $121.3m last quarter. "The surge in demand that we experienced coming out of the downturn is over," comments president & CEO Alain Couder.

Of total revenue, Huawei was 17%, CNA Nortel was 12%, and Alcatel–Lucent was 11%.

Telecom revenue was up slightly, from $107.8m last quarter to $108.3m, consistent with the inventory correction that was seen. In particular, products for data rates of 40Gb/s or higher comprised more than 30% of telecom revenue.

Advanced Photonic Solutions (APS) business was $12m (10% of total revenue), down from $13.5m (11% of revenue) last quarter. This is also down from 14% of revenue a year ago, which was before a decline due to: (i) tight inventories while completing the fab transfer from the former Newport Spectra Physics high-powered laser diode business in Tucson, AZ (acquired in July 2009) and the corresponding ramp-up at Oclaro's fab in Zurich, Switzerland, and (ii) an inventory correction at the APS division's biggest customers.

Non-GAAP gross margin has risen from 26.8% a year ago and 29% last quarter to 30%. This was despite the mix of: (i) high-margin APS products declining; and (ii) revenue rising from 40Gb/s products of the former Mintera business (prior to implementing cost improvements that should transition these products to above-average margins in the future).

Adjusted EBITDA was $10.1m, up on $4.3m a year ago but down on $10.9m last quarter. Net income was $5.9m, up on $0.9m a year ago but down on $6.6m last quarter.

During the quarter, cash, cash equivalents and restricted cash fell from $94m to $78.1m since, while Oclaro continues to generate positive operating earnings, it is also in investment and growth mode. Capital expenditure rose from $6.9m last quarter to $11.4m, in order to both close capacity gaps and ramp up businesses acquired over the last year.

"We are entering a new phase following the integration of our past acquisitions," says Couder. "After successfully maintaining design momentum, we are now focused on ramping new products across many of our key markets," he adds. "Consistent with those priorities, we have enhanced our organizational structure to simplify our customer interface and to strengthen our execution."

Oclaro has consolidated its five divisions into two primary business units, led by two of its experienced optical industry executives. Former chief operating officer Jim Haynes has been appointed president & general manager of the new Photonic Components business unit (which includes APS). Former executive VP of the Transmission Systems Solutions division Terry Unter (former CEO of Mintera) has been named president & general manager of the new Optical Networks Solutions business unit. Oclaro has also added two senior executives to the management team: Gray Williams (former VP of Worldwide Supply Chain at Logitech) as executive VP, Supply Chain Operations and Quality (leading all backend operations, located mostly in Asia); and Bob Quinn as chief information officer (formerly VP of Operation and Technology at RagingWire Enterprise).

We are entering a new phase following the integration of our past acquisitions... we are now focused on ramping new products across many of our key markets

"Market conditions remain strong, and we are expecting revenue growth in the seasonally softer March quarter," says Couder. For its fiscal third-quarter 2011 (ending 2 April), Oclaro expects revenue to rise to $123–131m, helped by APS revenue starting to bounce back (both from a recovery in VCSEL sales and getting over the fab transfer). Non-GAAP gross margin should be 27–31% (consistent with the December quarter, even while absorbing the impact of new pricing, most of which takes effect at the start of the quarter). Adjusted EBITDA should be $6–11m.

In the upcoming few quarters, CapEx should remain level. Also, Oclaro does not expect any significant capacity issues, other than those associated with improving yields for APS laser diode products as the firm continues to ramp production in Europe.

Chief financial officer Jerry Turin reckons that gross margins could be back in the targeted 35% range by the end of 2011, due to the ramp-up of products like the high-margin tunable XFP as well as the bounce-back in APS, and completing cost improvements for Mintera 40G products (for which revenues are currently doing very well).

www.oclaro.com

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- Photonic integration technologies

Plenary Speakers:

Andre Geim (Nobel Laureate in Physics 2010) - University of Manchester: „Graphene"

Connie Chang-Hasnain - University of California, Berkeley: „Novel Nanophotonic Devices"

Meint Smit - Technical University Eindhoven: „A new era for InP-based photonics"

Rump session:

Semiconductor Quantum Dots for Electronics and Photonics: Promises and Accomplishments

organized by Dieter Bimberg, Technical University Berlin

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Oclaro ships 100 millionth VCSEL

Optical component, module and subsystem maker Oclaro Inc of San Jose, CA, USA has shipped its 100 millionth vertical-cavity surface-emitting laser (VCSEL) chip from its facility in Zurich, Switzerland. The firm says that it was able to achieve this by delivering high reliability and tight process control at the volumes and cost levels demanded by leading optics and electronics manufacturers.

Oclaro is now expanding this proven manufacturing capability into other high-volume applications for diode lasers, such as optical interconnects, optical illumination and other emerging consumer applications. The firm's VCSEL team has been commercializing VCSELs for demanding industrial and consumer applications, accumulating expertise in all aspects of VCSEL design and manufacturing.

"The ability to scale to high volume reliably and cost-effectively is a strength that Oclaro perfected in the telecom space and is now leveraging in emerging high-volume markets," says executive VP & division manager Yves Le Maitre.

"Oclaro's unique expertise and manufacturing capability is driving the adoption of lasers into adjacent and diverse photonics markets," he adds. "As a result, Oclaro diode lasers are now being incorporated into a wide range of products being used by home consumers across the globe."

Oclaro diode lasers are now being incorporated into a wide range of products being used by home consumers across the globe

Oclaro VCSELs are currently powering high-volume consumer electronics devices such as computer mice and finger navigation engines for mobile devices. In addition, VCSEL-based optical cables are emerging as a replacement for existing electrical cable technology in mainstream computing devices because electrical solutions are approaching their practical limits for speed and length, whereas VCSEL-based optical interconnects do not have the same limitations.

Wavelength launches low-noise QCL driver

Wavelength Electronics Inc of Bozeman, MT, USA, which manufactures laser diode drivers and temperature controllers, has launched the QCL Series of low-noise quantum cascade laser drivers, offering sub-microamp RMS noise (0.7μA RMS over 100kHz bandwidth with the QCL1000 1A driver) for improved chemical sensor performance. Designed as an OEM controller, it can be used in field-deployed systems or on a benchtop. The bandwidth is 2–3MHz, with rise and fall times of 250/200ns.

The QCL Series drives up to 2A of low-noise current with core safety features — current limit, slow start, brownout/reverse voltage/overvoltage protection, remote or local current enable. Despite being lower cost than an instrument, it is smaller and offers better performance, says the firm.

Application notes and free technical support can help users to minimize noise in particularly demanding applications.

www.teamwavelength.com

VCSEL delivered for first miniature atomic clock available in volume

Optical component, module and subsystem maker Oclaro Inc of San Jose, CA, USA says that it has developed single-mode vertical-cavity surface-emitting lasers (VCSEL) for atomic clocks, and that the lasers are being used by Symmetricom, a designer and manufacturer of frequency standards, in its SA.35m miniaturized rubidium atomic clock. Featuring ultra-high stability, low noise and a wavelength of 795nm, Oclaro claims that the single-mode VCSELs signify a new direction in the industry by enabling the world's first miniature atomic clock available in volume.

While atomic clocks are recognized as extremely precise timekeeping devices, they have been limited in size and reliability due to their traditional gas lamp. By replacing the gas lamp with a laser, manufacturers such as Symmetricom can improve the reliability and power consumption of atomic clocks and begin targeting applications that require smaller devices, says Oclaro.

"A core part of Oclaro's strategy is to expand into adjacent markets where we can leverage our optical technology and solutions," says executive VP & division manager Yves LeMaitre.

The firm says that its single-mode VCSELs enable advances in physics miniaturization, resulting in reduced size and power consumption while providing stable reference frequencies that are immune to standard environmental perturbation. The lasers power Symmetricom's SA.3Xm rubidium atomic frequency reference, a miniature atomic oscillator component used by network equipment manufacturers to ensure reliable wireless infrastructure.

"Oclaro's breadth of technology is enabling us to deliver a new generation of laser-based atomic clocks," says Symmetricom's director of engineering Jeff Dansereau. "The ability to bring atomic oscillators to newer, small form factors enables a variety of end systems to achieve performance previously unattainable," he adds.

www.oclaro.com

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TU Berlin demos 980nm VCSELs on IQE material capable of high performance at elevated temperatures

A team of researchers led by Dieter Bimberg at the Technical University of Berlin in Germany has reported the demonstration of record data transmission rates from an oxide-confined 980nm vertical-cavity surface-emitting laser (VCSEL) operating at 85ºC.

The VCSEL devices fabricated on wafers produced by IQE's optoelectronic facility in Cardiff, UK are capable of operating at 25Gb/s at elevated temperatures, suiting very-short-reach optical links within high-performance computers.

"Since temperatures inside computers are as high as 85ºC, or even higher, good temperature stability is indispensable for robust, inexpensive optical links," says Dieter Bimberg, head of the research team at the TU Berlin.

Most short-reach optical links and local and storage-area networks currently operate at a wavelength of 850nm, but Bimberg believes there is a strong case for 980nm sources in all these applications. "980 nm has the crucial advantage of transparency of the GaAs substrate, so one can easily realize bottom-emitting devices, increasing and simplifying packaging density," he says. "This is very important, for example, in the case of a large number of VCSELs for parallel optical links."

The VCSEL wafers are produced by IQE's MOCVD reactors at its facility in Cardiff, UK. The epitaxial structure contained 24 pairs of $Al_{0.12}Ga_{0.88}As$ and $Al_{0.9}0Ga_{0.10}As$ layers for the bottom mirror, and a further 37 pairs for the top mirror. Sandwiched between these mirrors is an active region with five compressively strained 4.2nm-thick $In_{0.21}Ga_{0.79}As$ quantum wells interlaced with 6nm-thick $GaAs_{0.88}P_{0.12}$ tensile-strained barriers.

Output from a 10μm-diameter oxide aperture VCSEL is 4.3mW at 20ºC and 2.6mW at 85ºC. This relatively small reduction in power stems from an intentional red-shift detuning of 15nm between the quantum well gain peak and the cavity resonance. The devices have bit error rates (BER) at 25Gb/s of less than 10^{-12}.

Future targets for the team are to speed the 980nm VCSELs to 40Gb/s and maintain this rate at 100ºC.

http://apl.aip.org/resource/1/applab/v97/i15/p151101_s1
www.iqep.com

HiTrans project develops 40G VCSEL components

As part of the HiTrans research consortium funded and managed by Berlin-based bank IBB, VI Systems GmbH of Berlin, Germany (a fabless spin-off of the Technical University of Berlin and the A. F. Ioffe Physico-Technical Institute in St Petersburg, Russia that provides laser and photo-detector chips and modules) has reported completion of a project to develop ultra-high-speed vertical-cavity surface emitting laser (VCSEL)-based optical transmitters and PIN photodetector (PD) receivers for up to 40Gb/s short-reach data transmission. Product samples are now available.

The consortium also involved Europe's leading GaAs epiwafer foundry, a foundry for silicon-germanium-based BiCMOS ICs, a high-volume manufacturing partner with expertise in flip-chip and wire bonding process steps, and the German technical universities of Berlin (TUB) and Dresden (TUD).

In the project, VI Systems coordinated and led efforts to develop serial 40Gb/s fiber-coupled small-form-factor TO-can receiver and transmitter modules including several related electro-optic components. In particular, the project developed and prototyped driver ICs for current or electro-optically modulated lasers, as well as limiting transimpedance amplifier ICs for the PDs. High-frequency (40GHz) transmitter and receiver packaging (with a TO-can form factor) based on the proprietary integrated-packaging approach of VI Systems for flip-chip and wirebond sub-assemblies was also completed.

Using the latest high-frequency test equipment and microwave and optical characterization techniques, data transmission at ultra-high data bit rates was characterized. Using the electro-optical subassemblies and fiber-coupled modules that were developed, the project partners demonstrated error-free data bit transmission over multi-mode fiber at 40Gb/s.

The power consumption of the receiver and transmitter modules (including driver and amplifier ICs) is below 150mW, allowing integration into standard commercial SFP (small-form-factor pluggable) transceivers. The small size (less than 6mm x 6mm) and low power consumption of the new prototype modules also allows integration into QSFP (quad small-form-factor pluggable) transceivers with serializer/de-serializer (SerDes) ICs, with expected total power consumption for the module below 3W. The production of both single- and multi-mode fiber versions of the QSFP transceiver is possible.

Together with follow-on involvement of an industrial partner, the project should enable scalable mass production at a low cost, says VI Systems. Active optical cable (AOC) applications and IEEE 802.3bg standard extensions towards low-cost, low-power applications can be targeted for follow-on product exploitation, the firm adds.

www.v-i-systems.com


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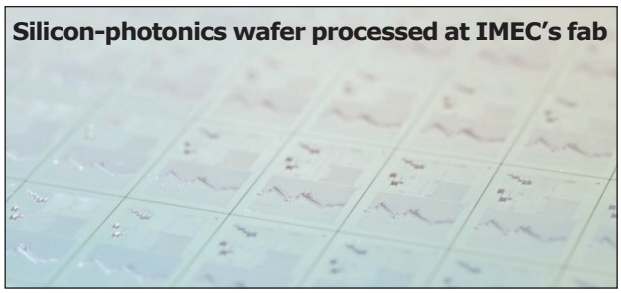
Multi-junction CPV Cells

IMEC launches industrial affiliation program for research on high-bandwidth optical input/output

Silicon photonics targeted at 100Tb/s off-chip communication by 2020

The IMEC research center in Leuven, Belgium has announced the launch of a new industrial affiliation program (IIAP) on high-bandwidth optical input/output (I/O). The primary objective, which is part of IMEC's research platform on deep-submicron CMOS scaling, is to explore the use of optical solutions for realizing high-bandwidth I/O between CMOS chips.

According to the International Technology Roadmap for Semiconductors (ITRS), the aggregate data rate for off-chip communication is expected to exceed 100Tb/s by 2020. However, no known manufacturable solution for achieving such bandwidth density is currently available. Silicon photonics has been identified as a prime candidate to deliver a technology solution for enabling cost-effective short-range optical links. The main benefits of silicon-based optical interconnects are their high speed, compact footprint, low power consumption and low cost, enabling the realization of a scalable interconnect solution. Moreover, the compatibility with existing CMOS processing infrastructure as well as the possibility of co-integration with CMOS circuits are additional key assets of silicon photonics technology.



Silicon-photonics wafer processed at IMEC's fab

IMEC and its associated lab INTEC at Ghent University have a proven track record over the past ten years in demonstrating the outstanding performance of silicon-based optical devices for high-speed data transmission, using silicon-on-insulator (SOI) substrates. IMEC's new optical I/O program builds on this expertise and aims to further develop a silicon-photonics solution for addressing the upcoming scaling challenges in interconnecting CMOS chips, in close collaboration with IMEC's industrial partners.

The program includes a two-fold path-finding effort. First, the complete electrical-to-optical-to-electrical (E-O-E) transmission path will be modeled for various technological implementations and benchmarked against the requirements for various applications, as well as against existing solutions. This benchmarking effort will focus on optimizing bandwidth density, power consumption, thermal robustness and cost at the system level.

Second, demonstrators of the full optical link will be realized in silicon, including all required components such as optical modulators, germanium-based photodetectors, and thermally robust optical multiplexers, as well as their CMOS-based driving and receiving circuits.

The optical I/O IIAP is part of IMEC's core program in which it works together with leading IC companies on future CMOS technologies. In this framework, core partners will actively participate in the IIAP at IMEC. Such on-site participation enables partner companies to have early access to new technology insights, processes and equipment, says the research center.

www.imec.be

Nokia Siemens joins EC's 100GbE transponder project

Nokia Siemens Networks of Espoo, Finland has joined the European Commission's GALACTICO project to develop compact, cost-efficient, silicon-based photonic circuits for Gigabit Ethernet (GbE), focused on coherent optical communications systems.

The three-year research program (launched last October) aims to uniquely blend three of the most established integration materials — indium phosphide, gallium arsenide and silicon — on a common silicon-based platform to address the high-performance, volume production and low-cost requirements of the next generation of GbE, and eventually Terabit, optical transponders. The total budget of the project is €4.02m, with €2.9m of that coming from the European Commission (EC) via its Seventh Framework Program (FP7), Information and Communication Technologies (ICT).

"Currently system vendors require their own photonic integration technology to deliver a practical and economically feasible 100GbE system solution," says GALACTICO project coordinator Lars Zimmermann. "Our project aims to develop low-cost and small-size 100GbE interfaces, and provide integrated coherent transmitters and receivers that deliver a massive amount of aggregate bandwidth," he adds.

"We have been at the forefront of the transition from 10 and 40Gbps networks to 100G and beyond," says Uwe Fischer, head of optical networks product management at Nokia Siemens Networks. "With our expertise in the optical transport domain, we will provide specifications for the components to be developed as well as participate in the ensuing lab demos and field trials," he adds.

www.ict-galactico.eu

www.nokiasiemensnetworks.com

Photonic integrated circuit firm CyOptics raises $50m

Indium phosphide-based optical chip and component maker CyOptics Inc of Lehigh Valley, PA, USA has raised $50m in a funding round led by Israel's JVP (Jerusalem Venture Partners, a global venture capital firm with over $820m under its management) and joined by other existing investors Sprout Group, Birchmere Ventures and Eurofund. The transaction entailed the secondary purchase of shares from several existing shareholders and the financing of additional growth capital.

Founded in 1999, CyOptics has InP design, fabrication and packaging operations in Lehigh Valley, PA; a silica photonic lightwave circuit (PLC) fab in South Plainfield, NJ; and planar automated packaging & testing in Matamoros, Mexico. "CyOptics is uniquely positioned to bring together all of the critical technologies required to design and manufacture high-performance optical devices," claims CEO Ed Coringrato.

In 2010, CyOptics surpassed more than $100m in revenue and ended the year with a strong sales backlog, giving good visibility into 2011. The firm serves more than 100 customers worldwide, including telecom system OEMs, module level suppliers, and major defense contractors. In particular, CyOptics supplies to the high-volume consumer fiber-to-the home (FTTH) market, the US defense market, and next-generation photonic integrated circuit applications.

CyOptics believes that, driven by demand from wireless backhaul, cloud computing, data-center congestion, video downloading and social networking, the photonics industry is once again entering a growth phase. Bandwidth demands are doubling every 18 months, and the optical transmit and receive sub-components designed and manufactured by CyOptics are enabling this growth.

"This incremental investment will help to fund the working capital needed to bolster near-term revenue growth and to support R&D required to deliver the next-generation products and services our customers require," says Coringrato.

"As the relative share of web traffic comprising media and video continues to grow, our communications networks will be required to deliver unprecedented levels of bandwidth," says JVP's founder & managing partner Erel Margalit, who serves as chairman of CyOptics' board. "CyOptics' high-speed, high-performance solutions will increasingly enable the fulfillment of consumer demand for evolving entertainment, educational, and gaming applications. The company's accelerated growth over the past 12 months is a clear testament to this," he believes.

"Over the past decade, we have worked closely with the CyOptics' management to build the company into a leading independent global organization," Margalit continues. "The firm's strong underlying technology, broad portfolio of products, and successful acquisition and integration capabilities position it for continued growth."

Following the latest funding transaction, JVP will nominate an additional member to CyOptics' board.

www.cyoptics.com

NeoPhotonics' initial public offering raises $82.5m

NeoPhotonics Corp of San Jose, CA, USA raised $82.5m in its initial public offering of 7.5 million shares of its common stock at $11 per share (at the top end of the originally planned $9–11 price for 7 million shares). The firm granted underwriters an option to purchase up to an additional 1.125 million shares at the IPO price to cover overallotments. The common stock began trading on the New York Stock Exchange under the symbol 'NPTN' on 2 February, closing its first day of trading up 20.45% at $13.25.

Founded as NanoGram Corp in 1996 before changing name in 2002, principal stockholders are funds affiliated with Oak Investment Partners, Draper Fisher Jurvetson, Concord Investments Co, ATA Ventures and International Finance Corp.

NeoPhotonics is a vertically integrated designer and manufacturer of photonic integrated circuit (PIC)-based components, modules and subsystems for bandwidth-intensive, high-speed communications networks. Products include active semiconductor, passive PLC (photonic lightwave circuit) and MEMS multi-dimensional switching functions in a single product, with integration enabled by nanomaterials and nanoscale design and fabrication. The firm has ISO 9001:2000 certified engineering and manufacturing facilities in both Silicon Valley and Shenzhen, China.

Clients include ADVA, Alcatel-Lucent, Ciena, Cisco, FiberHome, ECI, Telefonaktiebolaget LM Ericsson, Fujitsu, Harmonic, Huawei, Mitsubishi Electric, NEC, Nokia Siemens and ZTE.

For the first nine months of 2010, NeoPhotonics reported net income of $2.8m on revenue of $132.9m (improving on full-year 2009's net loss of $6.8m on revenue of $155m, and 2008's net loss of $28m on revenue of $134m).

NeoPhotonics originally filed a registration statement with the US Securities and Exchange Commission (SEC) last April for an IPO to raise $115m, but filed a Form S-1 amendment on 18 January.

The firm plans to use the net proceeds of the IPO for working capital, to continue to expand its existing business (including possibly acquiring complementary businesses, products, services or technologies), and for general corporate purposes.

www.neophotonics.com

High-speed optical IC firm GigOptix to acquire high-frequency RF firm Endwave

Merger to strengthen GaAs and SiGe IC design capabilities

GigOptix Inc of Palo Alto, CA, USA, which designs modulator drivers, laser drivers and transimpedance amplifier (TIA) ICs based on III-V materials as well as polymer electro-optic modulators for high-speed fiber-optic communications systems, has signed a definitive merger agreement to acquire Endwave Corp of San Jose, CA, which designs and manufactures high-frequency RF solutions and semiconductor products for the wireless mobile backhaul communications, satellite communications, electronic instruments, and defense and security markets.

Retaining the name GigOptix Inc, the combined firm will provide high-speed, high-frequency products for optical and wireless communications. Subject to regulatory approval and approval by Endwave's stockholders, the merger is expected to close in second-quarter 2011.

All outstanding shares of Endwave common stock (including those issuable upon settlement of outstanding restricted stock units) plus outstanding in-the-money Endwave stock options will be converted into shares of GigOptix common stock so that, immediately after the merger, such shares represent about 42.5% of all outstanding GigOptix common stock. Based on the number of shares outstanding as of end-January, about 9.1 million shares of GigOptix common stock will be issued to holders of Endwave common stock, registered stock units and stock options. Issuance will be made pursuant to an effective registration statement on Form S-4 to be filed with the US Securities and Exchange Commission (SEC).

GigOptix's chairman & CEO Dr Avi Katz will maintain his positions as chairman of the board of directors, CEO & president of the combined firm. Endwave's chief financial officer Curt P. Sacks will be CFO. GigOptix's chief technology officer Andrea Betti-Berutto will be CTO. Other key executives from both firms will serve on the management team. The new board will consist of all five of GigOptix's existing directors plus two directors to be recommended by Endwave's board (subject to the approval of GigOptix's chairman), one of which will be Endwave's president & CEO John Mikulsky.

"We are set to offer solutions to both the optical and microwave RF front ends that will drive continued growth," says Katz. "Responding to the core issue of increasing bandwidth to meet customer demand has shaped the technology advancements for both companies," he adds. "By combining Endwave's extensive point-to-point microwave radio system knowledge and monolithic microwave IC (MMIC) product portfolio with GigOptix's portfolio of optical modulators and broadband amplifiers, it positions us to not only expand our market opportunities, but also enables us to increase our penetration of the existing customer bases and market segments," Katz continues. "The combined company will be able to leverage Endwave's manufacturing and GigOptix's high-speed fiber-optic front-end technology to provide cutting-edge solutions for next-generation 100G and 400G drivers and electro-optic sub-systems."

We are set to offer solutions to both the optical and microwave RF front ends that will drive continued growth... It positions us to not only expand our market opportunities but also enables us to increase our penetration

It is reckoned that the merger will enable the combined firm to:

- address growing demand for high-speed solutions in both wireless mobile backhaul and optical networks by providing a one-stop-shop with a comprehensive portfolio to consolidate and simplify supply chains;
- strengthen financial performance (with estimated post-merger consolidated cash of about $16m, after payment of closing expenses and severance) and enhance revenue and deliver operational cost savings (beginning this year, and reaching about $1m per quarter in 2012);
- strengthen the combined firm's high-speed design capabilities in both point-to-point radio and optical networks while providing low-cost assembly, testing and production through Endwave's facility in Chiang Mai, Thailand;
- leverage GigOptix's high-speed broadband ICs, mixed-signal technologies and Thin Film Polymer on Silicon (TFPS) technology together with Endwave's MLMS system-on-chip technology to further increase the level of integration of electro-optical front ends;
- develop electro-optical systems-on-a-chip (such as integrated drivers and modulators), electro-optical transceivers on a chip, and microwave photonic transceivers for base stations;
- consolidate GigOptix's microwave products with Endwave's MMIC product line for commercial and military applications (with the potential for expansion into the high-speed instrumentation market);
- strengthen the combined firm's

IC design capabilities in both gallium arsenide (GaAs) and silicon germanium (SiGe) manufacturing processes, enabling additional integration, functionality and cost reductions for products targeting microwave/millimeter-wave and broadband fiber optic applications; and

- strengthen 40G, 100G and next-generation 400G surface-mount technology (SMT) packaging capabilities by leveraging Endwave's expertise in millimeter-wave SMD packaging.

"Together, we can deliver the most extensive and comprehensive product portfolio in the industry, providing customers with the highest-quality yet cost-effective technology solutions," believes Mikulsky.

"The acquisition of Endwave, an acknowledged leader in high-frequency point-to-point radio communication systems, confirms GigOptix's continuous commitment to support new-generation communication networks," says Betti-Berutto. "In addition to the many technical synergies between high-speed RF microwave and millimeter-wave radio and fiber-optic network electronic designs, we see exciting growth opportunities for wireless mobile backhaul to build out the broadband communication infrastructure," he adds. "Driven by increasing use of bandwidth-intensive smartphones and services, the same market demands that force network operators to upgrade their optical equipment from 10Gb/s to 40Gb/s and 100Gb/s and next-generation 400Gb/s force operators to upgrade their mobile backhaul equipment to higher frequencies into the 71–95GHz E-band to support the increased bandwidth generated from cellular networks," Betti-Berutto continues.

"As with all transactions based upon our initial 2007 Strategic Plan of inorganic and organic growth [including the acquisitions of amplifier and modulator driver IC maker iTerra Communications LLC in 2007, TIA, limiting amplifier and VCSEL driver maker Helix Semiconductors AG of Zurich, Switzerland and polymer electro-optic modulator maker Lumera Corp of Bothell, WA, USA in 2008, and ASIC designer ChipX Inc of Santa Clara, CA, USA in 2009], this merger with Endwave is the next step in our long-term vision of building the industry's premier supplier of front-end solutions for high-speed optical and microwave RF communication links, based on solid financial foundations," says Katz. "We look forward to furthering our leadership position as the only pure-play provider of electronic devices for high-speed fiber-optic and wireless communications covering all applications, all speeds and all distances," he adds.

"Adding Endwave's products and manufacturing capabilities to the GigOptix catalog will further simplify our customers' supply chain as we become the one-stop shop for solutions that address the demands of both the optical core and the mobile backhaul networks," Katz continues. "The combined company will have a strong balance sheet (with about $16m of cash), a significant revenue base and — together with the optimization of the sales, marketing, and operations teams — we have a clear short-term path to profitability."

Both GigOptix and Endwave will formally announce their respective fourth-quarter and 2010 year-end financial results on 24 February. However, according to preliminary results, GigOptix expects Q4 revenue of more than $8m (up more than 10% on Q3's $7.2m, exceeding guidance of 7–10%) and adjusted EBITDA of more than $1.1m (up $0.3m on Q3). For full-year 2010, GigOptix expects revenue of $26.9m (up 81.2% on 2009's $14.8m) and adjusted EBITDA of $1.9m. Cash and investments as of end-2010 are estimated at $4.3m.

Endwave expects Q4 revenue of $4.1m (level with Q3) and adjusted EBITDA of –$1.8m. For full-year 2010, revenue should be $16.7m (down 14.3% on 2009) and adjusted EBITDA –$6.7m. Cash and investments as of the end of 2010 are estimated at $23.5m.

www.endwave.com
www.gigoptix.com

GigOptix appoints corporate controller as acting CFO

GigOptix has announced the resignation (effective 1 February) of Ron Shelton, chief financial officer since December 2009. "I would like to thank Ron for his contributions over this past year with GigOptix," says Dr Avi Katz, CEO & chairman of the board for GigOptix.

Corporate controller Jeff Parsons has been appointed acting CFO and will assume financial responsibilities for the firm.

Parsons joined GigOptix in January 2010. Previously, from 2006–2009, he was a consultant for various high-tech firms. From 2002 to 2005, he was corporate controller and later CFO at Alliance Semiconductor. From 2000 to 2001, Parsons served as the director of finance at Lara Networks. Prior to that, he held senior financial positions at Cirrus Logic, Cypress Semiconductor, and Cadence. He holds a Masters in Industrial Administration from Carnegie-Mellon and a BA in Economics from Vanderbilt University.

"I am confident in Jeff Parsons' ability to serve in the role of acting chief financial officer to maintain continuity of our financial management and controls," says Katz. "Jeff offers a wealth of industry experience and has become an integral part of the senior management team and is well suited to lead our financial team."

Infinera revenue dips 10% in Q4, but up 30% year-on-year

Infinera Corp of Sunnyvale, CA, USA, a vertically integrated manufacturer of digital optical network systems incorporating its own indium phosphide-based photonic integrated circuits (PICs), has reported revenue of $454.4m for 2010, up 47% on $309.1m in 2009. However, this included revenue of $117.1m for the fourth quarter, up 30% on $90.2m a year ago but down 10% on $130.1m on the prior quarter.

Nevertheless, on a non-GAAP basis, quarterly gross margin of 51% was level with the prior quarter and up from 40% a year ago. Gross margin for the year rose from 2009's 36% to 47%.

Quarterly net income was $7.6m, down from $18.7m the prior quarter but compared with a net loss of $6.5m a year ago. Net income for the year was $22., compared to a net loss of $45.4m in 2009.

"2010 was a year of strong growth in bandwidth demand worldwide, and our customers saw growth in their networks, driven by a number of applications, notably video, mobility, and cloud computing," says president & CEO Tom Fallon. "We have been able to participate in this growth, showing strong year-over-year performance in revenues and market share, improved profitability and progress toward achieving our long-term business model," he adds. "Service providers continue to look for ways to improve the economic performance of their networks through both efficiency and rapid response to their revenue-creating opportunities. With our digital optical architecture, we enable them to do so with the unique combination of world-class optics and digital network intelligence," he continues.

"In fiscal 2011, we will continue to focus on meeting the needs of our customers and on addressing market expansion opportunities," says Fallon. "In addition, we will focus on expense management, while at the same time ensuring that we invest appropriately to enable the successful launch of our PIC-based 100G product in 2012," he adds.

"We remain on track to ship our differentiated 40G solution with FlexCoherent technology for our current DTN networks later this year. In the meantime, we will meet customer needs today with what we believe is the industry's most cost-effective and flexible portfolio of network solutions — our differentiated PIC-based DTN network and our ATN metro solution," Fallon concludes.

www.infinera.com

Infinera co-founder Welch to receive 2011 John Tyndall Award

Infinera executive VP & chief strategy officer Dr David F. Welch has been awarded the 2011 John Tyndall Award by The Optical Society (OSA) and IEEE Photonics Society for "seminal contributions to photonic integrated circuits (PICs) and semiconductor lasers deployed in fiber-optic communication systems around the world".

Welch will receive the award in the plenary session of March's Optical Fiber Communication Conference and Exposition/National Fiber Optic Engineers Conference (OFC/NFOEC) in Los Angeles.

The award recognizes Welch's contributions to the optical communication systems field, including in the development and manufacture of PICs, the development and commercialization of high-power semiconductor lasers, high-efficiency Nd:YAG lasers, fiber lasers and amplifiers, and devices associated with non-linear optical materials. Welch was also involved in the development of materials and fabrication techniques used in semiconductor laser systems.

Welch co-founded Infinera in 2001. The goal was the development of large-scale PICs integrating multiple DWDM channels on a single chip (viewed as impossible or impractical by many in the industry at that time, Infinera says). The firm's first product in 2004 was the DTN, a long-haul and metro DWDM optical system based on 100Gbps PICs. By 2006, Infinera was number one in the long-haul DWDM market in North America, according to analysts' reports. The firm plans to begin shipping its next generation of PICs (with data capacity of 500Gbps per chip) in 2012.

Welch received his BSEE from the University of Delaware and a Ph.D. in electrical engineering from Cornell University. He then went on to Spectra Diode Labs (SDL), working as a research scientist and eventually VP of research. As chief technology officer and VP for corporate development at SDL, he was responsible for the development of laser and optical technologies as well as the execution of six corporate acquisitions. In 2001, SDL and JDS Uniphase merged in what was then the largest ever technology acquisition. Welch has more than 250 published articles and 125 patents to his name. He received the Adolph Lomb Award from OSA in 1992, the Engineering Achievement Award from LEOS in 1998, and the OSA Joseph Fraunhofer/Robert M. Burley Award in 1999. He is also a fellow of the OSA and IEEE, and is on the board of directors of OSA and of Infinera.

Inaugurated in 1987, the Tyndall Award recognizes an individual who has made pioneering, highly significant or continuing technical or leadership contributions to fiber-optics technology. Corning Inc endows the award (a glass sculpture signifying total internal reflection). The award is named for the 19th century scientist who was first to demonstrate internal reflection.

Advanced Photonix's December-quarter revenue up 68% year-on-year

Fiscal-year revenue guidance raised from 25% to 35% growth

For its fiscal third-quarter 2011 (to end-December 2010), Advanced Photonix Inc of Ann Arbor, MI, USA (which designs and makes silicon, InP- and GaAs-based APD, PIN, and FILTRODE photodetectors, high-speed optical receivers, and terahertz instrumentation for telecom, homeland security, military, medical and industrial markets) has reported revenue of $7.7m, up 68% on $4.6m a year ago and up 10% on $7m last quarter (with revenue down in only one of the firm's five markets).

Gross margin of 40% is down on 42% last quarter but up on 34% a year ago. Operating expenses were $3.3m, up slightly on $3.1m both last quarter and a year ago. Compared to net loss of $922,000 a year ago, non-GAAP net profit was $259,000, up on $209,000 last quarter.

"Building upon the momentum of the revenue growth driven by our telecommunications market, we are continuing to experience accelerating growth for our fiscal year," says chairman & CEO Richard (Rick) Kurtz. "Year-to-date results exceeded the raised guidance we gave last quarter of a minimum of 25% year-over-year growth," he adds. Year-to-date revenue of $21m is up 32% on $16m for the first nine months of fiscal 2010.

"Based on the performance of the first three quarters, and the outlook for the fourth quarter [with increasing demand globally for the firm's high-speed optical receivers and increasing revenue in the terahertz product platform], we are again raising our guidance [from 25%] to 35% revenue growth for the year," Kurtz says.

www.advancedphotonix.com

IN BRIEF

API raises $4.6m in share offering

Following a registration statement filed with the US Securities and Exchange Commission (SEC) on 23 December and declared effective on 5 January, Advanced Photonix entered into an underwriting agreement offering 2,702,703 shares of its Class A Common Stock at a purchase price of $1.48 per share ($1.391 per share, net of an underwriting discount of $0.089 per share).

The agreement included an overallotment option for the purchase of up to an extra 405,405 shares. This was exercised by the underwriter on 10 January.

Net proceeds of $4.6m (after underwriting discounts and transaction expenses) are to be used for general corporate purposes including reducing outstanding indebtedness, increasing working capital and expanding the firm's product range.

Advanced Photonix to supply 40Gb/s high-speed optical receiver for long-haul communications to China OEM telecom systems provider

Advanced Photonix Inc says that its subsidiary Picometrix LLC will supply BR-40D 40Gb/s high-speed optical receivers (HSORs) for long-haul communications to a leading China OEM telecom systems provider.

This initial purchase commitment (to be delivered over the next three months) exceeds $625,000 and has the potential to bear significant additional revenue during the coming fiscal year, with follow-on commitments to purchase the 40Gb/s optical receivers, says the firm.

"This design win with a major OEM based in China, who is a key supplier to the rapidly growing BRIC [Brazil, Russia, India and China] markets, confirms that our efforts at penetrating the China OEM market are beginning to bear fruit and could provide significant future revenue," believes Rob Risser, chief financial officer of API and general manager of Picometrix.

Our efforts at penetrating the China OEM market are beginning to bear fruit and could provide significant future revenue

"This design win is only one of several design wins with tier 1 OEMs based in China that were are pursuing," he adds. "We anticipate additional design wins in both 100Gb/s and 40Gb/s products that will move to volume production status during the next fiscal year."

Picometrix offers what is claimed to be the industry's most complete line of 100Gb/s and 40Gb/s HSOR solutions for both client-side and line-side modulation formats, including NRZ, RZ, DPSK, DQPSK, ODB, DP-QPSK and DP-BPSK.

The new design win is for 40Gb/s long-haul communications in dense wavelength division multiplexing (DWDM) systems that use 40Gb/s DPSK (differential phase-shift keying) modulation. The receiver uses the firm's patented photodiode arrays to limit timing skew, which is important for DPSK modulation schemes that are used in DWDM systems. DPSK modulation takes advantage of phase modulation to extend transmission distances with high tolerance to crosstalk, lowering cost for systems implementation and reducing power consumption.

JDSU reports record revenue and profit margins

Target operating margin raised from 11–14% to 14–17%

On a non-GAAP basis, for its fiscal second-quarter 2011 (ended 1 January), JDSU of Milpitas, CA, USA has reported net revenue of $477.2m, up 16% on $411.3m last quarter and up 38.8% on $343.8m a year ago (and well above the expected $425–450m). Of total net revenue, the Americas represented 51%, EMEA 26% and Asia-Pacific 23% (with all regions growing sequentially).

Advanced Optical Technologies (AOT) revenue was $54.7m (11.5% of total revenue), down 9.6% on $60.5m (15% of total revenue) last quarter. AOT gross margin was 48% (down from 50.4% last quarter) and operating margin was 32.4%.

Communications Test & Measurement revenue was $231.4m (48.5% of total revenue), up 26.6% on $182.8m (44% of total revenue) last quarter. CommTest gross margin was 60.9% (up slightly on last quarter) and operating margin was 19.4% (up from 11.9%, and above guidance).

Communications & Commercial Optical Products (CCOP) revenue was $191.1m (40% of total revenue), up 13.8% on $168m (41% of total revenue) last quarter and up 70.2% on $112m (just 33% of total revenue) a year ago.

Within CCOP, Commercial Lasers revenue was $22.7m, down 9.2% after an atypically strong $25m last quarter (when customers replenished their inventories). However, Optical Communications revenue was $168.4m, up 17.8% on $143m last quarter and up 76.2% on $95.6m a year ago.

CCOP gross margin was 34.4% (including Commercial Lasers steady at 45.5%, and Optical Communications rising from 29.5% last quarter to 32.9%, driven by product mix, better factory utilization and cost-reduction activities). CCOP operating income was $34m (an operating margin of 17.8% of revenue), up from $24.2m last quarter and just $3.2m a year ago.

Overall company gross margin has risen from 44.6% a year ago and 47.4% last quarter to a record 48.8%, due mainly to the higher CommsTest revenue. Operating margin has risen from 8.2% a year ago and just 10.8% last quarter to a record 15.3%.

"JDSU reported record revenues, gross margin and operating margin, which exceeded our operating model target [of 11–14%]," says president & CEO Tom Waechter. "Our market drivers are strong, our innovation engine and pipeline for new products is robust, and we continue to increase our operating leverage," he adds.

Net income has risen from $26.6m a year ago and $44.8m last quarter to $67m, driven by higher gross profit and operating expense leverage. After generating $60.7m of cash from operations (up from $35.7m last quarter) and following capital expenditure of $28.3m, during the quarter JDSU's total cash and short-term investments hence rose from $620m to $655.3m.

For fiscal third-quarter 2011 (ending 2 April), JDSU expects AOT revenue to grow by 3% and CCOP revenue to grow by 6–10% (despite Optical Communications ASP decline expected to be slightly above JDSU's quarterly sequential range of 2–4% due to just-completed annual pricing negotiations). However, for the March quarter CommTest revenue is historically seasonally lower as the December-quarter revenue includes calendar year-end budget flush spending from telecom carriers (a greater-than-expected $20m), and carrier budgets are typically released in the second half of the March quarter. Based on current visibility, JDSU hence expects CommTest revenue (after adjusting downwards for the budget flush) to fall by 6–12% sequentially.

JDSU therefore expects total net revenue to fall back slightly to $440–460m and operating margin to fall to 11–13% (including AOT falling to 29–32%, and CommTest to 13–16% due to lower revenue).

However, given current revenue levels, JDSU now targets operating margin of 16–20% for CCOP when the segment's revenue is above $190m. The firm also targets operating margins of 20–23% for CommTest and 32–35% for AOT. JDSU is hence also raising its targeted overall company operating margin from 11–14% to 14–17% when quarterly revenue is $460m or more and gross margin is 49%.

www.jdsu.com

Frost & Sullivan recognizes JDSU as fiber-optic test market leader

JDSU has earned Frost & Sullivan's Global Market Share Leadership Award in fiber-optic test. It was recognized by the independent research firm as the leading supplier of fiber test solutions critical to the build out of high-capacity fiber networks and the quality delivery of video and other high-bandwidth services.

Frost & Sullivan also named JDSU as the market leader in the next-generation SONET/SDH test category, which included JDSU's optical transport network (OTN) and Ethernet (jitter/wander) test capabilities.

"JDSU's extensive and innovative product portfolio, brand loyalty, global solutions, and ability to identify upcoming market trends were key factors in the company's success," says Sujan Sami, industry manager at Frost & Sullivan.

www.frost.com

Emcore's revenue falls 4% due to ITC ruling

Tunable XFPs and Suncore CPV to contribute in second-half 2011

For its fiscal first-quarter 2011 (to end-December 2010), Emcore Corp of Albuquerque, NM, USA has reported revenue of $52.1m, up 23% on $42.4 a year ago but down 4% on $54.1m last quarter.

Photovoltaics revenue was $20.3m (39% of total revenue), up 21% on a year ago and 3% on last quarter, driven by record revenue for space solar power generation products. However, Fiber Optics revenue was $31.8m (61% of total revenue), up 24% on a year ago but down 8% on $29.2m last quarter. The drop was driven mainly by lower shipments of digital products, particularly related to the International Trade Commission (ITC) last July banning Emcore from importing parallel-optical modules (made by contract manufacturer Fabrinet Co Ltd in Thailand) that were found to infringe patents belonging to Avago Technologies.

Gross margin has risen from 22% a year ago and 23.6% last quarter to 24.3%. This was due mainly to Photovoltaics gross margin rising from 22.1% a year ago and 29.3% last quarter to 33.1%. However, Fiber Optics gross margin has fallen from 21.9% a year ago and 20.4% last quarter to 18.7%, due mainly to an unfavorable product mix shift and higher material costs associated with the Telecom and Datacom divisions as customers began moving towards newer technology platforms. "This evolution will cause margins in this division to be under pressure until our new products begin to ramp in the latter part of this year," says chief financial officer Mark Weinswig.

Despite being a big improvement on $12.1m, the net loss of $3.6m is up from just $0.8m last quarter. But compared with cash consumption of $1.2m a year ago, Emcore generated $3.9m in cash from operations due to improved operating performance and strong working capital management. During the quarter, cash and cash equivalents and restricted cash rose from $21.2m to $25.4m.

At the end of the quarter, order backlog was $57.3m, down 20% on $71.3m last quarter. In particular, Photovoltaics backlog fell 32% from $52.9m to $36.1m due to certain contracts that are now complete. However, Fiber Optics backlog rose 15% from $18.4m to $21.2m, driven by tunable lasers penetrating 40G and 100G markets.

For fiscal Q2/2011 (to end March), Emcore expects revenue to fall to $46–49m. Fiber Optics should be flat to slightly up as cable TV business improves and next-generation telecom products begin to ramp. Photovoltaic revenue will fall due to completion of a few large satellite orders over the last couple of quarters plus a delay from an international customer for a new program.

"We are confident that our business fundamentals are still very strong," says president & CEO Dr Hong Hou. "In the past month after we closed the Q1 December quarter, we have added a couple of program wins into our backlog, and there's been additional significant booking opportunities in the very near future."

Also, Emcore believes parallel-optical module business will recover over the next few quarters as it begins to ship new solutions.

"We'll continue to solidify our strong market positions in our more established satellite Photovoltaic and broadband Fiber Optics businesses," says Hou. In particular, telecom Fiber Optics revenue has nearly doubled in the past 4–5 quarters, driven by sales of tunable lasers and integrable tunable laser assemblies (ITLAs) for 40–100Gb/s applications. "In the meantime, we will be focusing on the capacity buildup of tunable XFP production [at both Emcore's fab in Newark, CA and Fabrinet in Thailand], so that we'll be positioned for a significant revenue ramp up in the second half of the year," Hou adds. The tunable XFP product is shipping in small volumes to multiple tier-one OEMs for qualification. The targeted production output of the line in Thailand (starting in mid June) is 5000 parts per month. But as the market for tunable XFPs is forecast to grow at nearly 120% annually over the next four years, this will satisfy only about half or a third of demand, so Emcore is planning to expand with a third line, in either Thailand or its facility in China.

Also, Emcore's Suncore Photovoltaics terrestrial concentration photovoltaic (CPV) joint venture with China's San'an Optoelectronics has received its business license and regulatory approval to establish manufacturing in Huainan City. "We plan to break ground for the new manufacturing facility later this month and expect the JV manufacturing alliance to be up and running for producing CPV components and systems in September," says Hou. Emcore is due to contribute $12m in capital to the JV this quarter.

Order backlog for CPV systems at Suncore is now 15MW. With the JV taking on manufacturing CPV receivers, modules and systems plus business development in China, Emcore can now focus on developing its next-generation CPV product plus solar business development activities in North America and Europe (including completing two projects in New Mexico and Arizona totaling 3MW this year).

"This year we expect to expand our solar project development capability as well. This will drive additional sales of our CPV products and also remove margin backing by distributors and the project developers," says Hou. "We are in the process of adding necessary skill set to expand our business development," he adds. "We are ramping up to win new project opportunities with competitively priced product from our joint venture in China. Terrestrial solar opportunities should add to our revenue substantially over the next couple of years."

www.emcore.com

Cyrium's QDEC CPV cells deployed in 200kW China plant

Cells installed in modules designed and made by Suntrix

Cyrium Technologies Inc of Ottawa, Ontario, Canada, a fabless developer and supplier of multi-junction concentrator photovoltaic (CPV) cells for the terrestrial solar energy market, has announced the opening of a 200kW HCPV (high-concentrating photovoltaic) power station owned and operated by China's Qingdao HG Solar Energy Co Ltd.

The HCPV systems are powered by Cyrium's QDEC (quantum dot enhanced cell) high-efficiency triple-junction CPV cells installed in modules manufactured by Shanghai-based Suntrix Co Ltd (which makes HCPV systems for utility-scale and rooftop applications) and mounted on tracking systems designed by Suntrix and produced by Qingdao HG Solar Energy. Suntrix's SCPV-500 HCPV panel has a concentration ratio of 576, and has been deployed at different locations in China.

"Cyrium has been working for more than a year to establish a presence in the Chinese market," says CEO & president Harry Rozakis. "Our relationship with a great company like Suntrix is just the first step in our efforts to bring Cyrium's patented QDEC concentrator PV technology to the Chinese market," he adds.

"The plant is operating with a system efficiency of 25%, which means this station is not only the highest scale of HCPV in production, but also the highest efficiency for photo-electric conversion in China," believes Suntrix CEO Guy Rong.

Collaboration between Suntrix and Cyrium on this demonstration project began several months ago and highlights the opportunity that exists in China for HCPV systems, reckons Cyrium. Construction of the power station started last November and was completed this month, demonstrating the ease and speed with which HCPV systems can be deployed for utility-scale solar energy projects, it adds.

Cyrium's portion of the project received support from Environment Canada's Asia Pacific Partners (APP) program, as part of the Canadian government's effort to bring Canadian and China-based firms together to foster cross-border collaboration on cleantech projects.

During the opening ceremonies, Xu Dingming (counselor of the State Council, chairman of the National Energy Expert Advisory Committee, and former director of the National Energy Bureau) congratulated each of the project's contributors on the success of the power plant and requested the parties to continue to work toward China's cleantech effort by accelerating the development of China-based PV power. Also, Wu Dacheng (deputy director of the China Photovoltaic Society) commented that he foresees a bright future for the development of HCPV in China.

HCPV is considered to the third generation of PV technology, making use of low-cost, light-concentrating optical systems and group III-V semiconductor materials for the solar cell. Cyrium says that the photo-electric conversion efficiency is twice that of silicon technology and requires much less land area than other technologies for deployment. It also has the highest possibility of reducing power-generation cost to the level of using coal, which is of great importance in China. The firm says that completion of the 200kWp project is a key event in moving China towards greater deployment and application of HCPV systems to meet its rapidly growing energy needs.

www.suntrix.cn

Cyrium opens Hong Kong office; appoints general manager/Asia

Cyrium Technologies Inc of Ottawa, Canada has opened an office in the Hong Kong SAR, China, and named Nelson Fan as general manager of its Asian operations.

Fan is an 18-year veteran of the semiconductor industry, who most recently was R&D director at Traxon Technologies Ltd of Hong Kong. Previously he was a founder and VP of engineering at CT Electronics Ltd in Hong Kong and, before that, held positions as general manager Hong Kong manufacturing and VP of packaging development for subcontract semiconductor assembly & test firm ASAT Holdings Ltd. Fan is also the holder of a series of US patents for QFN packaging as well as many other semiconductor packaging related patents.

"He is an executive with demonstrated technical talent and superior management skills," says CEO & president Harry Rozakis about Fan. "Having recently installed Cyrium QDEC [quantum dot enhanced cell] solar cells in a major CPV installation in eastern China, Nelson's appointment represents the continued expansion of our efforts in China and Asia."

Fan's position is designed to allow him to focus on working with Cyrium's supply chain, pursuing technology options and supporting Chinese and other Asian customers.

"Nelson's technical qualifications will make him an invaluable person to expand our business in Asia as he will be able to help design and implement solutions that work both for Cyrium and our customers," Rozakis says.

www.cyriumtechnologies.com

Concentrix system in Jordan confirms CPV's readiness for large-scale deployment in hot, arid regions

Soitec Group of Bernin, France, which makes engineered substrates including silicon-on-insulator (SOI) wafers (as well as III-V epiwafers through its Picogiga International division) has reported results for its concentrated photovoltaic (CPV) system connected to Jordan's national electrical grid.

The system — which was made by Soitec's Concentrix Solar division of Freiburg im Breisgau, Germany, and jointly installed with Azur Space Solar Power — ran continuously through the extremely hot summer and fall months, demonstrating full reliability under the most demanding conditions, Soitec says.

Concentrix CPV systems are also running at other sites in the MENA (Middle East and North African) region. The technology, which is designed for use by large-scale solar power plants in hot and arid regions, provides the highest efficiency of all solar technologies available, it is claimed. The systems are modular, flexible and have ultra-low water consumption. Proven robustness demonstrates their readiness for competitive electricity production and large-scale deployment in the MENA region, the firm adds.

Soitec says that, after more than six months of operation, the system in Jordan has confirmed the performance of CPV technology in conditions of extreme heat, sunshine and dust:

- Average solar-to-grid efficiency reached 21%, with daily peak efficiencies regularly reaching 25% and beyond (2–3 times higher than standard photovoltaic installations, even in ambient temperatures of up to 45°C).
- The system has been running on a continuous basis, with 100% uptime, demonstrating reliability in a harsh environment.
- The measurement data confirm that annual specific electricity yield will be as high as 2500kWh/kW of installed nominal AC power. This high value is a result of the site's high level of direct solar irradiation in combination with the performance of the system, says the firm.

Apart from the Jordanian system, Soitec also has five CPV systems installed in Egypt (in the Wadi El Natrun desert valley, near Cairo) as well as a system connected to the grid in Oman (at the Ar Rusayl industrial park near Muscat). The firm is also involved in Abu Dhabi's Masdar initiative to demonstrate the value of CPV technology for the region.

High performance even under very high temperatures, and the fact that the systems require no water for cooling, are two advantages for the MENA region, highlights Hansjörg Lerchenmüller, senior VP Customer Group of Soitec's Solar Energy business unit. "We have proven with real systems that our technology is best suited for the region, and we are ready for high-volume deployment."

Especially at sites with extremely hot ambient temperatures, CPV systems perform better than conventional solar systems and hence guarantee high and constant power production throughout the day, Soitec claims. Due to the very low temperature coefficient of their III-V multijunction concentrator solar cells, CPV system performance is much less affected by temperature than any other PV technology, particularly those that are silicon-based, adds the firm. In extreme heat, silicon-based PV systems suffer from three times greater loss in efficiency compared with systems such as Concentrix CPV technology, it is claimed. The technology hence shows best performance even during summer, when electricity demand is particularly high due to air-conditioning demand — all without needing cooling water (suiting power plant installations in arid regions such as MENA).

Soitec says that, due to CPV technology's high scalability, power plants can be commissioned in phases, shortening the time to operation. The first units installed and connected to the grid can start to produce energy immediately, even while the installation of subsequent systems is in progress. Also, once operational, CPV's peak production hours align with the region's peak electricity demands from air conditioning, adds the firm.

Soitec exhibited Concentrix CPV technology in the French Pavilion at the World Future Energy Summit in Abu Dhabi, United Arab Emirates (17–20 January).

www.soitec.com

OPEL Solar designated member of 2011 TSX Venture 50

OPEL Solar International Inc of Toronto, Ontario, Canada, which makes high-concentration photovoltaic (HCPV) panels, has been made a member of the '2011 TSX Venture 50', a ranking of strongly performing firms listed on Toronto's TSX Venture Exchange.

The 2011 TSX Venture 50 consists of ten companies from each of five sectors (Clean Technology, Mining, Oil & Gas, Diversified Industries, and Technology & Life Sciences), chosen on basis of: share price appreciation, trading volume, market capitalization growth, and analyst coverage.

"We look forward to expanding our offering to additional consumer, commercial and industrial applications," says CEO Leon M. Pierhal.

Awards will be presented to the Top 50 firms on 31 March at The TMX Broadcast Centre in Toronto.

www.opelinc.com

Solar Junction's commercial-ready CPV cell hits 41.4%

Shortlisting for Loan Guarantee prelude to 250MW fab commissioning

Just one month after achieving 40.9% efficiency, Solar Junction of San Jose, CA, USA, a developer and manufacturer of III-V multi-junction solar cells for the concentrated photovoltaics (CPV), has reached 41.4% on a standard commercial-ready production cell (rather than a 'champion' cell). Both milestones have been validated by the US National Renewable Energy Laboratory (NREL).

"As the debate over PV versus CPV continues, we contend that, with double the efficiency of traditional photovoltaics, the CPV sector is entering a high-growth period," says CEO Jim Weldon. "These recent NREL results reflect our continued commitment to efficiency gains and validate the advantages of our A-SLAM technology for the CPV sector."

Founded in 2007, Solar Junction says that its cell, which incorporates proprietary adjustable spectrum lattice-matched A-SLAM technology, is accelerating the rise in multi-junction cell efficiencies in a customer-integrable and commercial form factor: in both a 5.5mm x 5.5mm aperture area form factor (the dominant cell for CPV module makers) as well as in a variety of other larger and smaller sizes.

The firm says that it is also the only CPV cell supplier to advance to a short list of finalists chosen for post-selection due diligence within the Department of Energy's (DOE) Loan Guarantee Program (LGP). The grant would support the commissioning of Solar Junction's high-volume, 250MW-capacity manufacturing facility, co-located with its headquarters in San Jose. Solar Junction expects to begin shipping commercial cells this year.

LGP post-selection due diligence comes just over a year after Solar Junction announced receipt of a $3m contract from NREL as part of the US Department of Energy's Photovoltaic (PV) Incubator Program. The efficiency gains of the firm's solar cells relate to the work as part of the Incubator subcontract with NREL. Once the LGP post-selection due diligence process is complete, Solar Junction will ramp its in-house manufacturing capacity to meet the needs of CPV module makers.

The PV Incubator contract was followed last March by a $13.3m Series C round of funding from prior investors Draper Fisher Jurvetson, Advanced Technology Ventures and New Enterprise Associates.

www.sj-solar.com

EPIR hits 77.6% fill factor for CdTe single-junction cell

Efficiency record on commercial glass substrate raised to 15.2%

EPIR Technologies Inc of Bolingbrook (a suburb of Chicago), IL, USA, which develops infrared sensor, biosensor and solar photovoltaic products, says that it has repeatedly fabricated high-efficiency polycrystalline single-junction cadmium telluride (CdTe) solar cells on commercial glass substrates.

The firm was founded in 1997 by CEO Dr Sivalingam Sivananthan who, at the University of Illinois at Chicago, pioneered the growth of single-crystal II-VI materials such as mercury cadmium telluride (HgCdTe) on silicon for infrared night-vision applications. EPIR is now building on this to also develop and manufacture high-efficiency, low-cost multi-junction solar cells for concentrated photovoltaic (CPV) applications.

"EPIR has been collaborating closely with a team of scientists from National Renewable Energy Laboratory (NREL)," says Sivananthan. "The combination of EPIR's expertise in CdTe materials and NREL's expertise in CdTe solar cell device technology has empowered us to achieve these excellent results in a short timeframe," he adds.

"Our champion-cell efficiency was officially verified by NREL at 15.2%. The high efficiency was driven by a fill factor of 77.6%, which is one of the highest fill factor values ever recorded for this type of solar cell," says EPIR's CdTe Solar Cell Technical Lead Dr Chollada Gilmore. "These results are significant because our solar cells were fabricated using inexpensive commercial TEC-series glass substrates as opposed to technical-grade glass which is commonly used in champion cell fabrication," he adds.

"This achievement elevates EPIR to the very small group of solar companies and research facilities that have reproducibly fabricated CdTe solar cells with greater than 15% efficiency," comments Dr Timothy Coutts, NREL Fellow Emeritus and founder of the Device Development Group at NREL. "This clearly validates EPIR's expertise in CdTe solar cell growth and fabrication," he adds.

"This is an important advancement for CdTe thin-film PV technology because it not only surpasses the previous best result that was published for commercial soda-lime glass by a clear margin (14.4% was the previous best result on commercial soda-lime glass), but all the layers incorporated into this new device structure are consistent with present commercial manufacturing processes," notes Dr Timothy Gessert, principal scientist & group manager of the NREL CdTe Research Group.

www.epir.com

First Solar's second German factory to start production ahead of schedule in June

First Solar Inc of Tempe, AZ, USA, which manufactures thin-film photovoltaic (PV) modules based on cadmium telluride (CdTe), has taken a step towards doubling its production in Germany by celebrating completion of the roof on its new manufacturing plant in Frankfurt (Oder), which will draw some of its energy from a PV power plant on the roof.

After construction lasting just a year and an investment of €173m, the new production site will start operations by June, ahead of schedule. Spread across 50,000m^2, it will produce modules with a collective annual capacity of more than 238MW. The expansion represents a doubling in the firm's production capacity in Frankfurt to 477MW just four years after First Solar began producing modules for commercial-scale solar power plants there in 2007. The expansion is part of First Solar's global plan to boost its total production capacity to more than 2.7GW by 2012.

"Germany remains a key solar market and manufacturing base for First Solar," says president Bruce Sohn. "The stability of the political framework here is an important factor in our investment and supports our mission to reduce the cost of solar energy to grid parity. The government's decision to steadily reduce support schemes rather than put a cap on the market is necessary and encourages our efficiency improvements," he adds. "Doubling our capacity in Frankfurt will enable us to satisfy the growing demand for clean, affordable, renewable energy not just in Germany, but throughout Europe and around the world."

"We welcome this additional investment in Brandenburg by First Solar, which has been a leading employer in our region," notes Matthias Platzeck, Prime Minister of the state of Brandenburg. "Their investment not only creates 500 new jobs for our skilled workforce, but also supports further opportunities for the renewables industry and local businesses," he adds.

Katherina Reiche, state secretary in the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, sees the investment as an endorsement of the federal government's renewable energy policies: "The fact that a globally leading solar company such as First Solar is expanding its investment in Germany is clear evidence that our economic and environmental policies are successful."

The expansion is part of First Solar's global plan to boost its total production capacity to more than 2.7GW by 2012

"Almost every second solar panel in Germany comes from Brandenburg," notes Ralf Christoffers, Minister for Economics and European Affairs in Brandenburg. "Expansion and investment by well-known companies has built an entire value chain in the region," he adds.

Frankfurt (Oder) mayor Martin Wilke welcomes the push that the new plant will give to First Solar's closed-loop manufacturing, which includes a pre-funded collection and recycling program. "First Solar is a pioneer in recycling, and offers a real and cost-effective alternative to conventional energy generation," he said. "For every job created in the plant, an equivalent number of jobs will be created among suppliers and service providers, which multiplies First Solar's investment across the economy."

www.firstsolar.com

IN BRIEF

Abound gains MCS certification and enters UK market

Abound Solar of Loveland, CO, USA has received UK MCS (Microgeneration Certification Scheme) certification for its AB1-series of cadmium telluride (CdTe) thin-film photovoltaic (PV) modules. MCS certification enables PV systems using Abound modules to qualify for UK solar feed-in-tariffs.

The certification was awarded to Abound following a demanding assessment of its production process and materials as well as the rigor of quality controls over its manufacturing operations. Abound's modules have already received certifications under Underwriters Laboratories 1703, TÜV (IEC 61646, IEC 61730, IEC 61215) and the California Energy Commission (CEC).

"Total installed solar power capacity is growing significantly in the UK," says senior VP of sales & marketing Julian Hawkings. Abound says it is expanding on new and existing relationships with system integrators and project developers in the region.

Since being founded in 2007, Abound has raised about $260m in venture capital and private equity, built its first production line in Longmont, CO and began full-scale commercial operations in November 2009. Since securing a $400m loan guarantee from the US Department of Energy (DOE) last December, it plans to expand capacity at both Longmont (where it has already begun construction of a second manufacturing line to boost its annual capacity to 200MW per year by the end of 2011) and at a second site to be constructed in Tipton, IN, boosting the firm's total annual capacity by 640MW to more than 840MW.

www.abound.com

IN BRIEF

Southern California Edison agrees 250MW PV deal

Edison International company Southern California Edison (SCE) of Rosemead, CA, USA has signed a power purchase agreement with First Solar for 250MW AC of electricity (equivalent, in greenhouse-gas terms, of removing 30,000 cars from the road annually). The contract is subject to California Public Utilities Commission approval.

The solar panels will be ground-mounted on about 2500 acres of public land near Primm, NV. First Solar is developing the Silver State South project, which will interconnect with SCE's proposed Eldorado–Ivanpah 220kV transmission line. The project is expected to begin producing electricity as early as 2014 and be fully operational by May 2017. It should create about 300 construction jobs, and the solar panels will be recycled after their useful lifespan.

"When we get projects of this magnitude, we make great progress toward our renewable energy goals," says Marc Ulrich, SCE's VP, Renewable and Alternative Power. "This agreement represents another important milestone toward our goal of grid parity," says Frank De Rosa, First Solar's senior VP of North American project development.

www.firstsolar.com

Enbridge acquiring 20MW of solar projects from First Solar

Toronto-based energy distributor Enbridge Inc of Calgary, Canada is to invest CDN$90m to acquire two new solar energy projects in Ontario with a collective annual generating capacity of 20MW from cadmium telluride (CdTe) thin-film photovoltaic (PV) module maker First Solar Inc of Tempe, AZ, USA:

- the 5MW Tilbury Solar Project (on which First Solar completed construction in December); and
- the Amherstburg II Solar Project, about 70km from Tilbury (two separate facilities totaling 15MW, for construction beginning in March and completing in third-quarter 2011).

The 87 acre (35 hectare) Tilbury project has 89,000 panels covering 15 acres (6.1 hectares) and yielding about 7 million kWh annually (equal to the consumption of about 800 homes, and saving 2500 tonnes of CO_2 per year). The estimated peak workforce is about 300.

The 154 acre (62 hectare) Amherstburg II project has 244,000 panels area covering 43 acres (17 hectares) and yielding about 23 million kWh annually (equal to the consumption of about 2400 homes, and saving 7500 tonnes of CO_2 per year). The estimated peak workforce is 300–400.

Immediately prior to the transaction, First Solar had acquired the Amherstburg II Solar Project from Helios Energy Inc of Toronto, Ontario (one of Canada's leading independent solar energy firms, founded in 2006 to develop large-scale ground-mounted and rooftop solar projects).

"Following closely on the heels of the successful completion of our 80MW Sarnia Solar Project, we're pleased to add another 20MW of solar generating capacity to our renewable energy portfolio," says Al Monaco, president, Gas Pipelines, Green Energy & International, at Enbridge. "The fundamentals of the renewable energy business are strong as electricity demand will continue to grow, and renewable energy is well positioned to meet a significant portion of the demand," he adds.

"These agreements demonstrate continued momentum in First Solar's project development business," says Frank DeRosa, senior VP of North American project development. "We are very pleased to extend our relationship with Enbridge that began with Sarnia, and to work together to increase renewable energy generation in Canada."

Under the terms of the agreements, First Solar constructed (and, in the case of Amherstburg II, will construct) the projects under fixed-price engineering, procurement and construction (EPC) contracts. First Solar will also provide operations and maintenance services to Enbridge under long-term contracts. Enbridge will sell the facilities' power output to the Ontario Power Authority pursuant to 20-year power purchase agreements under the terms of the Ontario Government's Renewable Energy Standard Offer Program.

www.enbridge.com

Environmental permitting final for AV Solar Ranch One

First Solar says that the Environmental Impact Report for the 230MW AV Solar Ranch One photovoltaic solar project in Los Angeles County has become final and non-appealable.

The milestone occurred on 7 January, 30 days after the county Board of Supervisors unanimously rejected an appeal from an earlier decision of the Los Angeles Regional Planning Commission approving the Conditional Use Permit and related Environmental Impact Report for the project. Parties had 30 days from the Board of Supervisors action within which to initiate a lawsuit in Los Angeles Superior Court challenging the Board's decision, pursuant to the California Environmental Quality Act. No legal actions were filed.

Construction is expected to begin in 2011, with completion by the end of 2013. During construction, the project will employ up to 400 workers.

First Solar-built Cimarron Solar Facility starts commercial operation

The Cimarron Solar Facility in northern New Mexico has begun commercial operation. At 30MW, Cimarron is among the nation's largest solar photovoltaic plants.

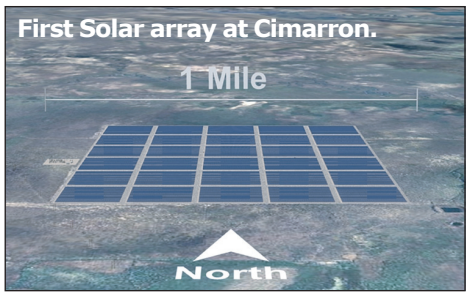
First Solar Inc of Tempe, AZ, USA, which makes thin-film photovoltaic modules based on cadmium telluride (CdTe), developed and constructed the facility. The firm sold the project last March to Southern Company and Turner Renewable Energy (a subsidiary of Turner Enterprises Inc with a focus on the development of commercial-scale solar projects), but will provide operation and maintenance services under a long-term contract.

The facility is the first resulting from the partnership between Atlanta-based Southern Company (the premier energy company serving the southeast USA) and Ted Turner. Using about 500,000 2'x 4' photovoltaic modules, the facility will supply power to about 9000 homes (or 18,000 residents) via the member electric cooperatives of Denver-based Tri-State Generation and Transmission Association, displacing over 45,000 tons of CO_2 per year.

Initially expected to go on line by the end of 2010, the facility was completed in eight months and began commercial operation in early December, nearly a month ahead of schedule. More than 300 workers were employed to construct the plant.

"The Cimarron Solar Facility demonstrates First Solar's capabilities in utility-scale projects... integrating technology, manufacturing, project development and engineering, procurement and construction expertise," says Frank De Rosa, First Solar's senior VP of project development, North America.

"This is a key milestone for Southern Company as we steadily incorporate more renewables into our energy portfolio," says Southern Company's chairman, president & CEO Tom Fanning. "Renewables,



along with new nuclear, increased energy efficiency, 21st century coal technology and additional natural gas, all will be crucial to meeting this nation's growing energy demand."

Fanning also notes that New Mexico, with its abundant solar resources, was an ideal location to establish the company's first commercial-scale solar operation. The 364-acre plant site is located within the service territory of Tri-State member system Springer Electric Cooperative in Colfax County, NM and is adjacent to Turner's Vermejo Park Ranch.

"Large-scale solar generation is among the fastest growing energy sources in the world, and we're pleased that we can be a part of that growth," says Turner.

Electricity generated by the plant will serve a 25-year power purchase agreement with Tri-State Generation and Transmission Association, a not-for-profit wholesale power supplier to 44 electric cooperatives serving 1.5 million consumers across Colorado, Nebraska, New Mexico and Wyoming. The project further expands Tri-State's focus on providing renewable generation for its members, as the association also announced late last year that its Kit Carson Windpower Project began commercial operation in eastern Colorado. "The Cimarron Solar Facility is another example of our ability to harness and utilize the abundant natural resources that are available to us in the West," says Ken Anderson, Tri-State's executive VP & general manager.

www.southerncompany.com

5N Plus extends long-term CdTe recycling & supply deals with First Solar

New recycling plant to be built in Malaysia

5N Plus Inc of Montreal, Canada, a producer and provider of high-purity metals, compounds and wafers for electronic applications, has signed a new recycling agreement as well as three new supply agreements with First Solar Inc of Tempe, AZ, USA, which makes thin-film photovoltaic (PV) modules based on cadmium telluride (CdTe).

The new agreements, which run until the end of 2015, replace the original recycling and supply agreements between 5N Plus and First Solar, the world's leading thin-film solar module manufacturer.

Under the new agreements, First Solar has agreed to increase the minimum prescribed quantities of CdTe that it will order from 5N Plus, initially by 30% and then 60% by 2013 compared with the minimum quantities prescribed in the original agreements.

Also, in order to meet growing customer demand, 5N Plus has announced plans to build a new recycling plant in Malaysia. To be operational by mid-2012, the new plant is intended to expand 5N Plus' recycling presence in Asia and to provide recycling services for various solar cell manufacturing by-products, including those produced by First Solar.

"Our new agreements with First Solar will provide us with a solid and predictable revenue stream for the next five years and allow us to enhance our presence in the rapidly growing Asian market," says 5N Plus' president & CEO Jacques L'Écuyer.

www.5nplus.com

DOE offers loan guarantee for 290MW First Solar-built Arizona PV project

Energy Secretary Steven Chu has announced the US Department of Energy's offer of a conditional commitment for a loan guarantee of up to $967m to Agua Caliente Solar LLC, a 290MW solar project in Yuma County, AZ acquired by power generation firm NRG Energy Inc of Princeton, NJ in December from First Solar Inc of Tempe, AZ, which makes thin-film photovoltaic (PV) modules based on cadmium telluride (CdTe) as well as providing engineering, procurement and construction (EPC) services.

The loan guarantee will support the facility's construction, which began last year and is expected to be complete by 2014 (creating 400 construction jobs). The plant will use CdTe PV panels made by First Solar. NRG Solar estimates that, when completed, the project will be the world's largest photovoltaic generation facility.

"The public–private partnership between NRG Solar, First Solar and the Department of Energy will be instrumental in adding an unprecedented amount of emission-free solar power to America's energy portfolio," said Tom Doyle, president of NRG Energy subsidiary NRG Solar LLC.

"The DOE Loan Programs Office is important to enabling the deployment of utility-scale renewable energy resources such as Agua Caliente, supporting financing terms commensurate with the long-lived nature of a photovoltaic solar power plant," said Frank De Rosa, First Solar's senior VP of Project Development, North America. "These cost advantages allow renewable energy sources to scale faster towards grid parity," he added.

"Solar projects like this are helping the US to compete globally for the clean energy jobs of today and the future," said Chu. "The Obama Administration is committed to bringing innovative renewable energy technologies to the market to support the country's transition to a clean energy economy."

NRG expects the project to offset about 237,000 metric tons of greenhouse gas emissions per year (equivalent to taking more than 40,000 cars off the road annually). Also, at full capacity, the project should provide electricity for about 100,000 homes.

The Agua Caliente Solar project will deploy fault ride-through and dynamic voltage regulation, technologies that are new to solar power plants in the USA. These technologies should improve the reliability and predictability of electricity generated by solar power plants and supplied to the grid. Under a 25-year power purchase agreement, Pacific Gas & Electric Company will deliver electricity generated by the project to consumers in California.

The Department of Energy, through the Loan Programs Office, has issued loan guarantees or offered conditional commitments for loan guarantees totaling more than $17bn to support 17 clean energy projects, which together will produce more than 37 million MW-hrs (sufficient to power about 3.5 million homes).

www.nrgenergy.com
http://lpo.energy.gov/?p=2046

Moser Baer to use 25MW of First Solar CdTe PV modules

First Solar has announced that Moser Baer Clean Energy Ltd (MBCEL), the solar subsidiary of Moser Baer Projects Private Ltd (MBPPL) of New Delhi, India, will procure 25MW DC of its CdTe thin-film photovoltaic modules for its solar power generation projects. Delivery is expected to take place by the end of June.

MBCEL was established in 2008 to undertake development of renewable power projects worldwide, and owns and operates solar power projects globally. It is currently India's largest solar power development company, with a presence in key international markets. MBCEL has about 500MWp under development across multiple states in India and a project portfolio of over 200MWp in Europe to be developed by 2012. The firm has already commissioned a 5MWp PV project in Tamil Nadu and 13MWp of PV projects in Germany (the first of which was completed in December 2009 in Nordendorf).

"We are very happy to have selected First Solar for meeting part of the requirement for our projects," says Lalit Jain, MBCEL's chief operating officer, International Operations. "MBCEL is developing over 300MWp of solar power projects in Germany, Italy, US, Australia and India, and this marks the beginning of a mutually beneficial relationship in the long run," he adds.

"We are pleased to collaborate with a leader like MBCEL to contribute to India's development of clean, affordable, sustainable solar electricity, providing our advanced thin-film technology and expertise in large-scale solar PV systems," says TK Kallenbach, First Solar's executive VP of marketing & product management. "India's rich solar resource, unique energy needs and commitment to solar energy represent a tremendous opportunity for First Solar as we expand our global reach into emerging solar markets."

www.firstsolar.com
www.moserbaerprojects.com

DOE PV Incubator program invests $7m in fourth round of projects

Stion's CIGSSe and Solexant's CZTS among four technologies funded

The US Department of Energy (DOE) has announced the investment of up to $7m in total funding through its National Renewable Energy Laboratory (NREL) of Golden, CO, USA to support the development and commercialization of emerging solar energy technologies.

Launched in 2007, the Photovoltaic (PV) Technology Incubator program has the primary goal of advancing the timeline and commercial potential of new manufacturing processes and products with the potential for dramatic price improvements.

"The startup companies awarded under the Incubator program will truly benefit the manufacturing processes and products in the US through rapid commercialization of these innovative technologies," says NREL incubator manager Martha Symko-Davies.

This is the fourth installment of the PV Incubator program where companies benefit from close partnership with the national laboratories. Previous awardees, including Calisolar and Abound Solar, have developed new PV technologies with DOE support and are now scaling their domestic manufacturing operations while creating jobs in their communities. Cadmium telluride (CdTe) thin-film photovoltaic (PV) module maker Abound Solar of Loveland, CO, USA currently has about 350 staff in Colorado and 65MW of manufacturing capacity, with plans to expand to 775MW via a recently announced $400m federal loan guarantee.

In this current round, firms were selected in one of two categories: Tier 1, representing the development of commercially viable prototypes (receiving up to $1m over 12 months); and Tier 2, representing the development and manufacturing scale-up of pilot-scale processes (receiving up to $4m over 18 months). Funding will be issued through NREL.

The Tier 1 projects (subject to negotiation) include:

- Caelux of Pasadena, CA, which is developing a flexible solar cell manufacturing process and design that could reduce production costs by minimizing the amount of semiconductor material used while also having the potential to surpass standard device efficiency.
- Solexant of San Jose, CA, which is developing a new thin-film material comprised entirely of materials that are non-toxic and abundant on Earth, including copper, zinc, tin, selenium and/or sulfur (CZTS). Devices will be constructed with a non-particle ink that can be printed and should result in commercially viable efficiencies using scalable, low-cost processes.
- Stion of San Jose, CA, which is developing copper indium gallium sulfide-(di)selenide (CIGSSe) technology that should allow two high-efficiency thin-film solar devices to be stacked, allowing better absorption of light. Devices are constructed in a way that can reduce cost, simplify manufacturing and reduce material utilization over traditional designs.

The Tier 2 project (subject to negotiation) is:

- Crystal Solar of Santa Clara, CA, which is developing a new technology for the fabrication, handling, processing and packaging of very thin single-crystal silicon wafers (four times thinner than standard cells). This uses much less silicon, eliminating many of the wasteful and expensive wafer-processing steps and addressing the problem of handling very thin wafers.

www1.eere.energy.gov/solar/pv_incubator.html

IN BRIEF

Glass-like diffusion barrier boosts CIGS PV efficiency by 13%

INM — Leibniz Institute for New Materials in Saarbrücken, Germany has developed a barrier layer that separates the metal carrier from the absorber film and thus increases the solar energy conversion efficiency of metal-based CIGS thin-film photovoltaic cells.

The INM's 'Optical Materials' program division presented the development for the first time in the German Pavilion at the 'nano tech 2011' trade fair in Tokyo, Japan (16–18 February) as well as the upcoming Hannover Messe 2011 in Germany (4–8 April).

Using glass as carrier material can prevent flexible application of CIGS solar cells in the automotive industry, for example. However, corrosion and poor isolation between a metal carrier and the substrate can reduce efficiency for CIGS.

The new barrier layer is glass-like. "It works as iron diffusion barrier and thus prevents corrosion and oxidation of the carrier," explains Peter William de Oliveira, head of the program division. "At the same time, the barrier works as insulating layer and reduces unintentional electrical currents from the absorber to the carrier." Both functions increase the efficiency of metal-based CIGS solar cells by up to 13%.

The glass-like diffusion barrier is applied on the metal carrier via a sol-gel process. It is transparent and flexible and has a thickness of just a few microns. INM has developed both the layer and the up-scaled process. Using dip coating and slot coating they have produced foils in a DIN A3 size. The traditional roll-to-roll printing process allows the production of continuous layered foils up to 50m long and about 0.5m wide.

www.inm-gmbh.de/en

Veeco receives $4.8m DOE grant to speed multi-stage CIGS PV tool development as part of SunShot project

Epitaxial deposition and process equipment maker Veeco Instruments Inc of Plainview, NY, USA has been awarded $4.8m by the US Department of Energy (DOE) to accelerate R&D, integration and commercialization of its thin-film copper indium gallium diselenide (CIGS) multi-stage thermal deposition systems for the manufacturing of cost-efficient photovoltaic (PV) solar cells.

The award was granted as part of the DOE's 'SunShot' High-Impact Supply Chain R&D Program, the goal of which is to strengthen the US solar manufacturing industry, improve manufacturing efficiencies, and reduce costs (in order to achieve price parity between solar electricity and fossil-based electricity by the end of the decade, without additional subsidies). Total funding of $20.3m for five projects includes support for companies across the solar energy supply chain, including US material and tool suppliers and companies that are developing technologies that can be adopted directly into current manufacturing processes.

The award to Veeco will help it to speed up efforts at the Veeco Solar Equipment unit in Lowell, MA, USA to commercialize multi-stage thermal deposition production systems used to manufacture cost-efficient CIGS solar cells.

"Developing new, clean, home-grown sources of energy is a vital part of our economic recovery," comments Senator Kirsten Gillibrand (D-NY). "This federal investment will help drive research and development of new solar power technology, helping make solar power more efficient. By making solar power more effective and affordable over the long term, we can cut emissions, improve our environment, lower our energy bills, and create good-paying green jobs," he adds.

"Investments in our growing clean technology industry are critical to both our economic recovery and our national security," says Representative Steve Israel (D-NY). "This DOE funding will bolster our efforts to compete globally as a clean energy leader," he adds.

"I strongly supported Veeco's grant application because this major investment in Lowell will help create jobs in our community by developing the clean energy technology that can reduce household energy bills while promoting reliable domestic sources of power," comments Representative Niki Tsongas (D-MA).

www.veeco.com
www1.eere.energy.gov/solar/sunshot

SoloPower receives $197m DOE loan guarantee

SoloPower Inc of San Jose, CA, USA, which makes flexible, lightweight copper indium gallium di-selenide (CIGS) thin-film photovoltaic (PV) cells and modules on stainless-steel materials using a proprietary roll-to-roll electro-deposition process, has received a conditional commitment from the Department of Energy (DOE) Loan Programs Office for a $197m loan guarantee. The funds will support construction of a $340m manufacturing plant in Wilsonville, OR that, when completed and at full capacity, should produce 400MW of modules annually.

"Oregon is already an epicenter for renewable energy projects," says Senator Ron Wyden. "A loan guarantee to help companies such as SoloPower get important projects off the ground is the right approach."

"This backing allows us to rapidly ramp up our production and to promote the spread of clean, distributed solar power to the rooftops and on the ground, while providing hundreds of quality manufacturing jobs," states SoloPower's CEO Tim Harris.

In January, SoloPower said that it had agreed to construct its first high-volume manufacturing plant in Wilsonville, as the Small Scale Energy Loan Program (SELP) Advisory Committee recommended approval to the Oregon Department of Energy for a $20m loan to the firm. The firm also applied for a Business Energy Tax Credit (BETC) of $20m from the State of Oregon. The State funding supplements $51.575m in fourth-round equity and warrant/option financing raised last December from existing investors Crosslink Capital, Convexa A/S and Hudson Clean Energy Partners LP in order to expand SoloPower's existing 109,000ft^2 small-scale production plant in San Jose and to finance construction of the new plant. Previously, SoloPower (which was founded in 2005) raised $230m in 2008 alone, followed by $44.9m in debt financing in February 2010.

Retrofit of an existing building in Wilsonville is scheduled to begin in second-quarter 2011. The plant is expected to provide direct employment to about 500 people at full capacity. About 270 construction jobs will be created to build the plant, and additional jobs are also likely to be generated in the local supply chain.

The new plant's ultimate annual capacity was originally announced in January as 300MW. Although SoloPower intends to build four 75MW lines (with the first phase creating 170 jobs), the firm reckons it has efficiencies that will enable it to produce 100MW off each line, yielding the 400MW capacity.

SoloPower's family of lightweight flexible modules are certified to both UL and IEC standards with up to 260Wp per panel, and are being sold in small volumes to leading customers in five countries.

www.solopower.com

Avancis raises monolithic thin-film PV module efficiency record to 15.5%

ZnO electrode and improved process for CIS PV boosts record from 15.1%

Avancis GmbH of Torgau, Germany (a subsidiary of Saint-Gobain of Courbevoie, France since autumn 2009) has boosted the photovoltaic (PV) conversion efficiency of its copper indium selenide (CIS) thin-film PV modules from the record of 15.1% that it claimed in January 2010 to a new record of 15.5% for a monolithic thin-film solar module measuring 30cm x 30cm, as verified by the US National Renewable Energy Laboratory (NREL) in Golden, CO, USA.

"The increase in efficiency was achieved by using a zinc oxide (ZnO) front electrode with higher conductivity," says chief technology officer Dr Franz Karg. "We also improved the structuring process, thereby enlarging the active area of the module," he adds. "This enabled us to optimize the width of the individual cells once more, allowing us to increase efficiency as a result."

So that the findings of the research department could be implemented in industrial applications as quickly as possible, Avancis says that its engineering department worked exclusively with processes and materials that are actually in use in series production. The firm plans to implement many of the improved processes in the new factories that it is currently building.

Avancis is adding to its first 20MWp/a-capacity plant by building a second plant in Torgau with a production capacity of 100MWp/a, while preparing to establish a third plant in South Korea (also with a capacity of 100MWp/a) after forming the joint venture Hyundai Avancis with South Korea's Hyundai Heavy Industries Co Ltd (HHI) last October.

Efficiencies are also evident in series production: modules in Avancis' PowerMax range are already delivering 12% in the 130W class.

www.avancis.de/en

Honda Soltec to boost CIGS PV module efficiency to 13%

Honda subsidiary Honda Soltec Co Ltd says that this year it will launch a new copper indium gallium diselenide (CIGS) thin-film photovoltaic (PV) solar module in which the performance of the photosensitive CIGS layer has been improved. This results in an increase of about 10% in module conversion efficiency compared with the current HEM130PCA model (from 11.6% to more than 13% for the new prototype), making it among the world's most efficient CIGS-based thin-film solar cells, it is reckoned.

Also, the surface area of the surrounding frame and other non-photosensitive portions has been reduced. The more compact design than the current model (measuring 926mm x 738mm x 37mm, just two-thirds of the surface area of the current 1417mm x 791mm x 37mm model), as well as the lighter weight (8.7kg versus 14.3kg) therefore allows efficient installation of more thin-film solar cells in limited space on a wide range of roof shapes in a variety of locations. This results in more power generated from the same installed surface area.

Honda notes that it is working to improve the module conversion efficiency further while it brings the product to market.

www.honda.co.jp/soltec

Q-Cells' CIGS PV modules outperform competitors at Australian desert test site

Q-Cells SE of Bitterfeld-Wolfen, Germany says that its copper indium gallium diselenide (CIGS) thin-film solar module Q.SMART and prototype polysilicon solar modules Q.PRO and Q.BASE have achieved peak performance under extreme climate conditions at a test field in Alice Springs in Central Australia run by the independent, Australian government-financed Desert Knowledge Australia Solar Centre (DKASC). Due to the dry desert climate, test conditions are among the most demanding worldwide.

At the test field, the performances of more than a dozen leading European, Asian and American manufacturers are tested under identical conditions. Q-Cells is the only German firm represented with its modules in the Australian desert.

During the six-month period from August 2010 to January 2011, the power output of the Q.SMART module was measured at the test field, along with several similarly sized thin-film systems. The firm says that its module emerged as one of the leading performers during the test period, with an average energy yield of 5.8 kilowatt-hours per installed kilowatt-peak per day (kWh/kWp/day), compared with averages of 5.1–5.3kWh/kWp/day for systems from leading international manufacturers with a similar system configuration.

Q-Cells claims that, due to cost-effective production and high efficiency, its CIGS modules have excellent performance under various geographic conditions and, due to their appealing aesthetics, are suited to architecturally demanding applications. The firm produced its first Q.SMART module as early as June 2010, achieving what was claimed to be record efficiency of 13%.

www.dkasolarcentre.com.au
www.q-cells.com

DayStar agrees $5m securities purchase with Socius and extinguishes $3.6m in debt

DayStar Technologies Inc of Milpitas, CA, USA, which is developing copper indium gallium diselenide (CIGS) thin-film photovoltaic products, has entered into a $5m securities purchase agreement with Socius CG II Ltd (a subsidiary of Socius Capital Group).

Daystar has the right over a term of two years (subject to certain conditions) to require Socius to purchase up to $5m of redeemable Series B Preferred Stock. With each purchase, Socius will receive two-year warrants to purchase shares of common stock valued at 35% of the Preferred Stock amount. The exercise price of the warrants will equal the closing bid price of the common stock on the preceding day. In addition, Socius will be entitled to exercise an additional investment right for 60 days after each sale of Preferred Stock to purchase common stock valued at 100% of the amount of the Preferred Stock, at a per-share price equal to the exercise price of the warrants associated with the sale of Preferred Stock.

"This flexible financing arrangement, with a proven partner in Socius Capital, will strengthen our balance sheet and will better position us as we continue our discussions with potential strategic partners," says CEO Magnus Ryde. "The partnerships we are pursuing, if consummated, could include joint ventures, licensing agreements, contract manufacturing agreements, a reverse merger with or an acquisition of DayStar," he adds.

DayStar has also extinguished an additional $3.6m in debt from its balance sheet through the conversion to equity of certain convertible notes payable, as well as agreements with vendors to settle their liabilities in exchange for shares of DayStar's common stock. This follows a prior series of agreements with vendors (announced at its 2010 Annual Shareholder meeting on 30 December) to eliminate $5m in debt. Previously, in October, Socius entered into agreements with 14 of DayStar's vendors to purchase about $1m of DayStar's debt, settling the resulting amounts owed in exchange for free-trading shares of the firm's common stock.

"We appreciate the continued support of our vendors and other stakeholders," says Ryde. "We have nearly completed our balance sheet restructuring and other activities to enhance our ability to pursue strategic transactions."

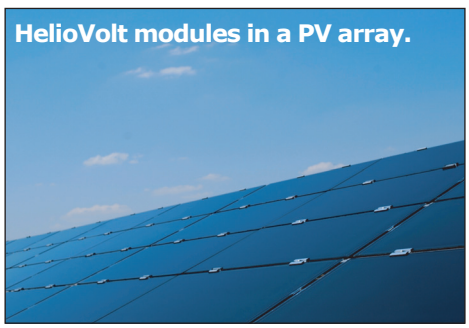
www.daystartech.com

HelioVolt's CIGS PV module completes lifetime testing

HelioVolt Corp of Austin, TX, USA says its first commercial thin-film copper indium gallium diselenide (CIGS) photovoltaic (PV) modules have completed rigorous accelerated lifetime testing, with results showing degradation rates 1–2 orders of magnitude lower than typical module performance required to pass UL and IEC certification.

Modules are based on HelioVolt's proprietary CIGS manufacturing process. The US National Renewable Energy Laboratory (NREL) recently confirmed the firm's conversion efficiency of 11.8% for its monolithically integrated 1.2m x 0.6m module size (current HelioVolt cell efficiencies are 14–15%).

HelioVolt said it has invested great resources in providing module reliability and field performance. The products demonstrate what is claimed to be a new benchmark required to maximize energy generation over the module's lifetime, minimizing the ¢/kWh energy cost.



HelioVolt modules in a PV array.

"[CdTe module maker] First Solar has shown that thin-film modules can deliver utility-scale solar power at a compelling cost," says HelioVolt's CEO Jim Flanary (formerly First Solar's chief operating officer). "As the next generation of monolithic thin-film products enters the market, we need to continue to build on the high-efficiency and low-cost promise of CIGS and drive towards higher field performance and higher reliability standards," he adds.

In addition to the rigorous accelerated lifetime testing of HelioVolt's modules, the firm has invested in a rooftop test site at its factory, serving as a model for in-the-field performance. The outdoor testing facility compares the performance of traditional multi-crystalline silicon modules alongside state-of-the-art thin-film modules from a variety of manufacturers. Monitoring module electrical and physical characteristics in step with irradiance, ambient temperatures and humidity, HelioVolt has been tracking its module performance against its competition.

HelioVolt says that the test site is a demonstration of its diligence to ensure delivery of reliable, competitive thin-film modules. The data is available to its partners for installation and solar project financial planning purposes. Company representatives presented additional updates at the SPIE's Optoelectronic Integrated Circuits XIII Conference at Photonics West (26–27 January) as well as at Photon's 3rd Thin Film Conference (16 February), both in San Francisco.

www.heliovolt.com

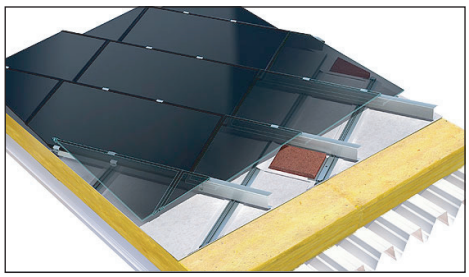
Sulfurcell gains €18.8m for CIGSe PV module production expansion and launch

Transition from sulfur- to selenium-based CIGS targets 14% efficiency

Sulfurcell of Berlin, Germany, which manufactures both sulfur-based CIGS and selenium-based CIGSe thin-film photovoltaic (PV) solar modules, has secured €18.8m ($25m) in equity funding.

The financing round was led by Intel Capital (the global investment arm of Intel Corp) and joined by other existing investors — London-based Climate Change Capital Private Equity and Zouk Ventures, Copenhagen-based Bankinvest Group, New York-based Masdar Clean Tech Investments (a partnership between Abu Dhabi's Masdar and Swiss bank Credit Suisse Group AG) and Paris-based Demeter — all of which had previously contributed to a €85m equity funding round in July 2008. Sulfurcell's long-term investors (since its first financing round in 2002) — led by the BEU fund (supported by Berlin-based Vattenfall Europe and Berlin/Paris-based GdF Suez) — also contributed substantially, joined by Ventegis Capital AG, IBB Beteiligungsgesellschaft and others.

Founded in 2001 as a spin-off of the Helmholtz Centre for Materials and Energy (previously the Hahn-Meitner Institute), Sulfurcell says that it has developed unique, comprehensive solutions for the building-integrated photovoltaic (BIPV), solar construction and commercial rooftop sectors. Since producing and shipping its first modules to customers in 2005, the firm has commercialized on a mass scale, employing 250 staff. "In the last five years, Sulfurcell has become an important provider of solutions for solar construction and building-integrated photovoltaics," comments Intel Capital investment director Heiko von Dewitz.



Sulfurcell's rack-mounted PV system for flat roofs.

The funding follows Sulfurcell recently manufacturing full-scale thin-film modules with an efficiency of 12.6%. "The financing is the result of our great progress in 2010, in which we developed an industrial manufacturing process delivering thin-film modules with efficiencies over 12%, while also ramping up our brand new 35MW production plant and fully automated manufacturing facility," says CEO Dr Nikolaus Meyer. "This additional funding from our existing investors is a vote of confidence that will allow us to accelerate our technological progress."

Sulfurcell is migrating its production from sulfur-based CIGS cells to higher-efficiency selenium-based CIGSe cells. Instead of using sulphur in the CIS absorbers for its new product line, Sulfurcell is relying on selenium and is using CIGSe instead of CIGS (copper-indium-gallium-selenide or sulfide). Both belong to the CIS family of chalcopyrite semiconductors. The potential efficiency for CIGSe is considerably greater than CIGS (as has been shown via record-breaking cells made of CIGSe with efficiencies greater than 20%). Sulfurcell is basing part of its own production on co-evaporation processes (as has been used for achieving record efficiencies at various scientific institutes). CIGSe layer properties can be precisely configured, which enables efficiencies to be continually improved, says the firm.

Investors have already funded the acquisition of additional CIGSe equipment as well as ongoing R&D work targeting 14% efficiency within the next 12–18 months. Sulfurcell will use the new funds for the expansion and market introduction of its second-generation thin-film PV technology.

"The investment will allow Sulfurcell to continue the successful development of its leading-edge CIGSe technology," says von Dewitz. "The company's efforts align well with Intel's focus on investing in the design, development and delivery of new technologies to address sustainability challenges," he adds.

Commercial CIGSe module confirmed at 12.6% efficiency

Full-scale 0.8m², 94W module to ship to customers by Q3/2011

Sulfurcell says that product safety and quality certification firm TÜV Rheinland has confirmed the 12.6% efficiency of its full-scale (0.8m^2) second-generation 94W module, which will begin shipping to customers as soon as third-quarter 2011. The firm is currently setting up a network of partner installers and integrators in North America.

"Sulfurcell has achieved momentum over the last year, with major supply agreements, financing, and now validation of our 12.6%-efficiency CIGS modules," comments CEO Dr Nikolaus Meyer.

www.sulfurcell.com

Nazca completes second Solyndra installation in France

Solyndra Inc of Fremont, CA, USA, which makes cylindrical copper indium gallium diselenide (CIGS) photovoltaic (PV) systems consisting of panels and mounting hardware for commercial rooftops, says that fully integrated engineering, procurement and construction (EPC) contractor Nazca (a Platinum Solyndra Solution Provider) has completed a 1.2MW solar system installation on the rooftop of the food conditioning facility AZ Méditerranée in Cavaillon, in the South of France. The firm, which conditions and imports fruit and vegetables, wished to renovate its 17,500m^2 (188,000ft^2) rooftop and ensure maximum waterproofing.

Nazca was founded by GSE Group of Avignon, France in late 2007, and has since developed and implemented PV systems in excess of 4MW. Their project portfolio exceeds 30MW, currently exclusively in the French market. The latest installation is Solyndra's second for Nazca in France (after completing a 1.28MW installation on a large warehouse close to Toulouse) and one of Solyndra's largest worldwide.

"Having experienced the speed and efficiency of the first Solyndra installation, choosing Solyndra for this second project was a no-brainer," says Nazca's general manager Julien Puel. "Much like the first installation, the excellent support and unique Solyndra product made it simple to install the panels and complete the project quickly," he adds. For this turnkey project, developed for a third-party investor, Nazca completed the installation and the grid-connection process in just 11 weeks.

The building installation concept exploits Solyndra system advantages including the light weight. The non-penetrating mounting, with no ballast, allowed Nazca to design a system that generated significant power without requiring additional engineering. Installed on a new white reflective PVC membrane, the system consists of more than 6800 Solyndra panels and will generate 1500MWh/year of electricity. According to the EPA carbon calculator, this is equivalent to powering 662 households.

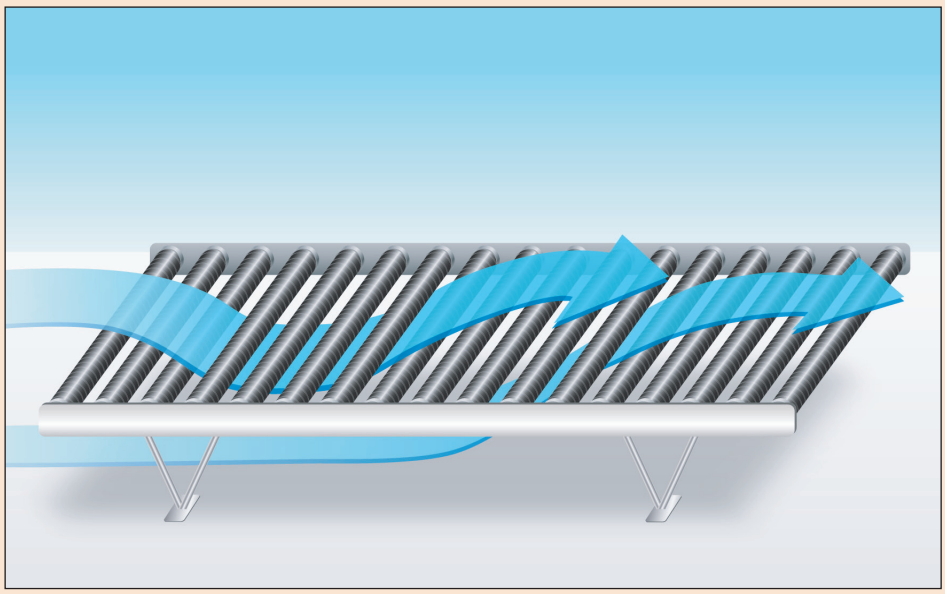
"Our partnership will lead to several more successful installations," believes Clemens Jargon, president EMEA & corporate senior VP, Solyndra. "This particular Solyndra system provides more than 77% net PV roof coverage and maximizes power density," he adds. "We are seeing more and more leading companies like Nazca invest in innovative and high-value rooftop installations."

www.solyndra.com
www.gsegroup.com

Marglen adopts Solyndra PV system for plastic bottle recycling plant

Marglen Industries has recently commissioned a 95.2kW solar photovoltaic (PV) array on the rooftop of its plastic bottle recycling plant in Rome, GA, USA. The system was installed by commercial, turn-key solar project developer United Renewable Energy LLC of Alpharetta, GA, and is the largest in the Southeast USA to use the thin-film solar system of Solyndra Inc of Fremont, CA, USA, which makes cylindrical copper indium gallium diselenide (CIGS) photovoltaic (PV) systems consisting of panels and mounting hardware for commercial rooftops.

The plant yields a post-consumer recycled PET resin that is used in manufacturing sustainable food-grade packaging. It also produces a polyester fiber that is used in manufacturing sustainable flooring and other textile products. Marglen has commissioned the solar system as part of it's overall sustainable mission to recycle materials.



Solyndra's panel design, showing how it allows wind to flow through it.

The installation's 476 cylindrical solar modules capture sunlight across a 360º photovoltaic surface (both direct sunlight and light reflected off the roof surface). The electricity generated will offset energy demands from 10 average American homes. "Marglen Industries has again demonstrated their commitment to the environment, while making a solid business investment," says United Renewable Energy's president William Silva.

www.u-renew.com

Ascent's CIGS modules to be marketed and installed by Green Earth in Benelux & Germany, SW Solarwatt in Greece & Cyprus, Polymeur Sun in Singapore & Malaysia

Ascent Solar Technologies Inc of Thornton, CO, USA has announced three new distributors for its lightweight, flexible thin-film copper indium gallium diselenide (CIGS) photovoltaic modules.

SW Solarwatt Ltd of Nicosia, Cyprus will act as a distributor for building-integrated photovoltaic (BIPV) applications in Greece and Cyprus.

SW Solarwatt designs and installs solar arrays throughout Cyprus and Greece, specializing in grid-connected and off-grid photovoltaic systems for residential and commercial applications.

"This relationship will enable integration of Ascent Solar's flexible, lightweight CIGS modules in a variety of applications, from grid-connected rooftop installations to portable power and other off-grid standalone solutions," says Ascent's president & CEO Farhad Moghadam.

Ascent says that Singapore-based Polymeur Sun will act as an authorized reseller of its CIGS modules for BIPVs and portable power solutions in Singapore and Malaysia.

Polymeur Sun is a designer and installer of grid-connected and off-grid photovoltaic systems, specializing in integration of flexible solar modules.

Ascent says that the SW Solarwatt and Polymeur Sun agreements give it access to multiple segments in the rapidly developing Eastern Mediterranean and Southeast Asian solar markets, respectively, including direct application to building materials for both grid-connected and off-grid solutions.

Ascent adds that Green Earth Energy and Technology of Kortrijk, Belgium is to distribute its CIGS modules for BIPVs and portable power solutions in Belgium, Netherlands, Luxembourg (Benelux) and Germany.

Green Earth Energy and Technology is a distributor of renewable energy technologies, solar modules and complete PV systems, with a focus on construction and management of industrial solar parks and large-scale solar arrays.

Ascent says the agreement gives it access to multiple segments in Europe's solar market including direct integration into building materials for residential and commercial solutions.

"This relationship will give us access to new and emerging market opportunities in BIPVs that could provide significant opportunity in Europe over the coming years," says Moghadam.

Green Earth Energy and Technology participated at the Intersolution Solar Energy Expo 2011 in Ghent, Belgium (27–29 January).

Ascent also expects other products in its lineup of flexible, lightweight CIGS modules to be marketed via the new distributor relationships.

www.polymeur.com
www.solarwatt.com.cy
www.green-earth-energy.com
www.ascentsolar.com

CIGS system to provide power and teaching tool to school

Irving Independent School District in Irving, TX, USA has selected GridPoint Inc of Arlington, VI to design, engineer and install a 582kW solar panel system on Lady Bird Johnson Middle School using the cylindrical thin-film copper indium gallium diselenide (CIGS) photovoltaic (PV) panels of Solyndra Inc of Fremont, CA, USA. Set to open in August, the school will be the largest net zero-energy school in the USA.

By using the most energy efficient materials and on-site power generation, the building's energy consumption will be about half the consumption of a typical middle school building. "The zero-energy school will reinforce teaching and learning as it becomes an extended classroom," says Scott Layne, assistant superintendent for support services. "With the use of efficient materials and cutting-edge renewable energy technology, the building transforms into a three-dimensional learning space," he adds.

Designed specifically for commercial rooftops, Solyndra's solar panels offer a low weight, non-penetrating mounting system, and superior wind and soiling performance. The system will maximize the 150,000ft^2 school's entire roof space to ensure that generation exceeds consumption. Each panel consists of 40 individual modules, wired in parallel for high current, which capture sunlight across a 360º photovoltaic surface capable of converting direct, diffuse and reflected sunlight into electricity.

"Every aspect of Lady Bird Johnson Middle School is an opportunity for its students to learn first-hand the value of renewable energy and energy conservation," says GridPoint senior VP Jeff Ross.

The roof-mounted solar energy system will also feature an intelligent monitoring solution to record and display the current and historical energy production. This information will allow Irving Independent School District to closely monitor system performance through a web-interface.

Other key contributors to the project include architectural firm Corgan Associates, general contractor Charter Builders and IEG Consulting.

www.gridpoint.com
www.solyndra.com

Self-aligned Ni-InGaAs as source–drain for InGaAs MOSFET

Nickel-InGaAs alloy reduces source–drain resistance to fifth of value for n-type InGaAs MOSFETs.

Researchers in Japan have developed a self-aligned nickel-indium gallium arsenide (Ni-InGaAs) alloy source/drain (S/D) process for application in InGaAs n-type metal-oxide-semiconductor field-effect transistors (nMOSFETs) [SangHyeon Kim et al, Appl. Phys. Express, vol4, p024201, 2011]. The scientists are variously based at University of Tokyo, the National Institute of Advanced Industrial Science and Technology (NAIST), and the firm Sumitomo Chemical Co Ltd.

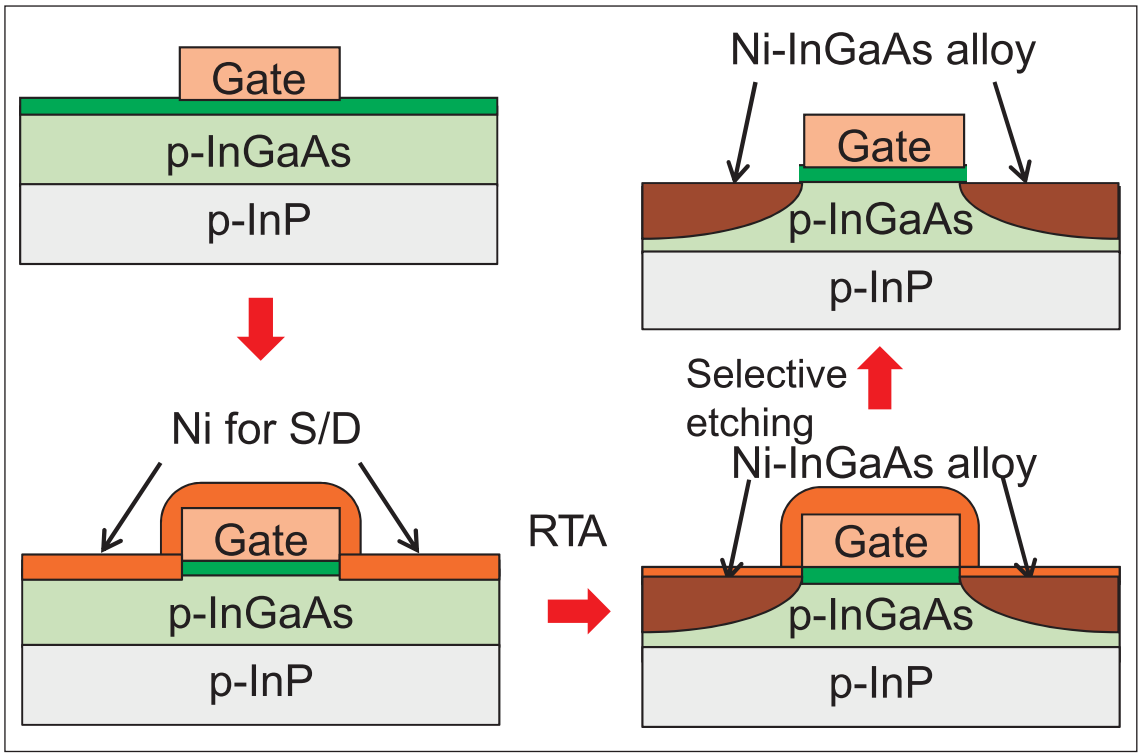


Figure 1. Fabrication process for InGaAs MOSFET with self-aligned metal S/D structure.

The self-aligned process is seen as an important potential ingredient of a manufacturable device. Silicon complement MOSFET (CMOS) processes presently use a self-aligned silicide ('SAlicide') S/D process. The self-alignment refers to using previously patterned structures rather than a separate lithographic process (that would require precise alignment) to form the S/D contact regions.

InGaAs devices are being developed with a view to enhancing the performance of the CMOS logic circuits that are at the base of present day electronics. In particular, as these devices become smaller, the electronic properties of silicon are not sufficient to overcome a series of 'short-channel effects'. InGaAs is attractive because it has a much higher mobility than silicon (but also has other problems that are being intensively worked on by researchers).

The Tokyo/NAIST/Sumitomo process starts with metal-organic chemical vapor deposition (MOCVD) of p-type InGaAs on indium phosphide substrates (Figure 1). This is followed by atomic layer deposition (ALD) of 10nm aluminum oxide (Al_2O_3) insulating material. A nickel gate is then formed by electron-beam deposition and lithographic patterning.

After the gate has been formed, a further 30nm of nickel is deposited to create the S/D regions. Ni-InGaAs alloying is achieved through a rapid thermal anneal at 250°C for 1 minute. Hydrochloric (HCl) acid solution was used to remove unreacted Ni, leaving just the Ni-InGaAs alloy.

Aluminum metal was used for the S/D electrodes. A back contact electrode of gold-zinc was also applied.

The device had a gate length of 5μm and a width of 150μm. These figures are a way off from today's 32nm

(~ 5μm/150) technology and future devices seeking gate lengths less than 18nm.

With an $In_{0.7}Ga_{0.3}As$ channel (Figure 2a), the device achieved on/off current ratio of 10^4 and subthreshold slope of 147mV/dec (a low figure indicates a desirable sharp turn-on of current). Other III-V devices have achieved 120mV/dec and better. Silicon CMOS achieves around 70mV/dec.

Before producing MOSFETs, the Tokyo/NAIST/Sumitomo team characterized Ni-InGaAs as an S/D material. This meant finding ways to reduce its sheet resistance and its Schottky barrier height with the InGaAs channel.

The researchers performed a rapid thermal anneal (RTA) of Ni on InGaAs over a range of temperatures, finding that above 250°C a Ni-InGaAs alloy is formed with a sheet resistance of around 25Ω/square. The ability to use RTA in such a way to create Ni-InGaAs is reported as 'a new finding'. This is around a third of the value of maximum conductivity n-type InGaAs (~80Ω/square).

Transmission electron microscopy (TEM), transmission electron (TED) and x-ray (XRD) diffraction were used to study the crystal properties of the alloy. Higher RTA temperatures were found to result in structures with a smaller lattice constant.

In order to operate as S/D material, Ni-InGaAs alloy needs to make ohmic contact with the p-type InGaAs channel. The researchers studied the electrical properties of Schottky diode formations of Ni-InGaAs alloy on n- and p-type InGaAs with various In contents (In = 40%, 53%, 60%, 70%, 80%). Schottky diode behavior was weakest at the higher indium concentrations, and temperature dependence studies extracting the Schottky barrier height revealed that the barrier was zero above 70% In.

Schottky diode behavior was weakest at the higher indium concentrations, and temperature dependence studies extracting the Schottky barrier height revealed that the barrier was zero above 70% In

The researchers produced a number of MOSFETs with different In content channels (53% and above), along with controls with n-type InGaAs S/D regions. The S/D resistances of the various devices were 38.7, 17.6, 5.72 and 2.73kΩ-μm for InGaAs channels with In contents of 53%, 60%, 70% and 80%, respectively. The S/D resistance of the best devices is about a fifth of that for the control devices. The mobilities were also determined (Figure 2b), with the 70% and 80% devices respectively achieving peak values of 2000 and 1810cm²/V-s. The researchers suggest that Schottky barrier effects (increasing the S/D resistance) reduce the effective mobility values for InGaAs channels with lower In content. ■

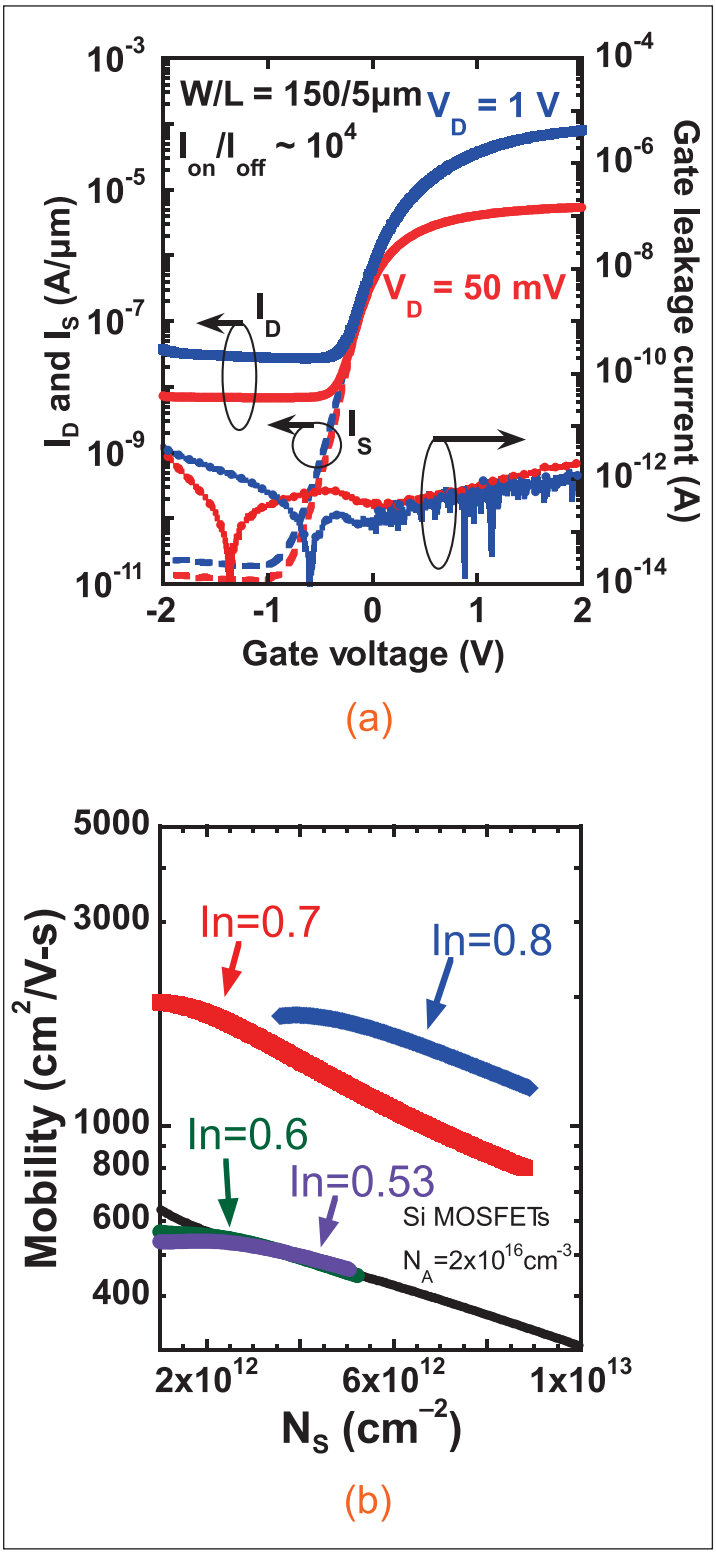


Figure 2. (a) I_D and I_S versus V_G characteristics of an $In_{0.7}Ga_{0.3}As$ MOSFET with self-aligned metal S/D. (b) Electron mobility versus the channel electron sheet density (N_S) characteristics in $In_xGa_{1-x}As$ MOSFETs. The Si electron mobility is also shown. The enhancement for InGaAs over Si is up to 3.8x at N_S of $8x10^{12}/cm^2$.

http://apex.jsap.jp/link?APEX/4/024201

Author: Mike Cooke

Two-dimensional hole gas with increased density and mobility

Improved characteristics could lead to ultra-low-loss power devices.

The UK's University of Sheffield and Japanese firm Powdec KK have developed a technique based on the polarization in nitride semiconductors to create two-dimensional hole gases (2DHGs) with increased carrier density and mobility [Akira Nakajima et al, Appl. Phys. Express, vol3, p121004, 2010].

Two-dimensional electron gases (2DEGs) are the basis for high-electron-mobility transistors (HEMTs). In nitride semiconductors, these 2DEGs arise at the interface between aluminum gallium nitride (AlGaN) and gallium nitride (GaN) due to positive polarization charges.

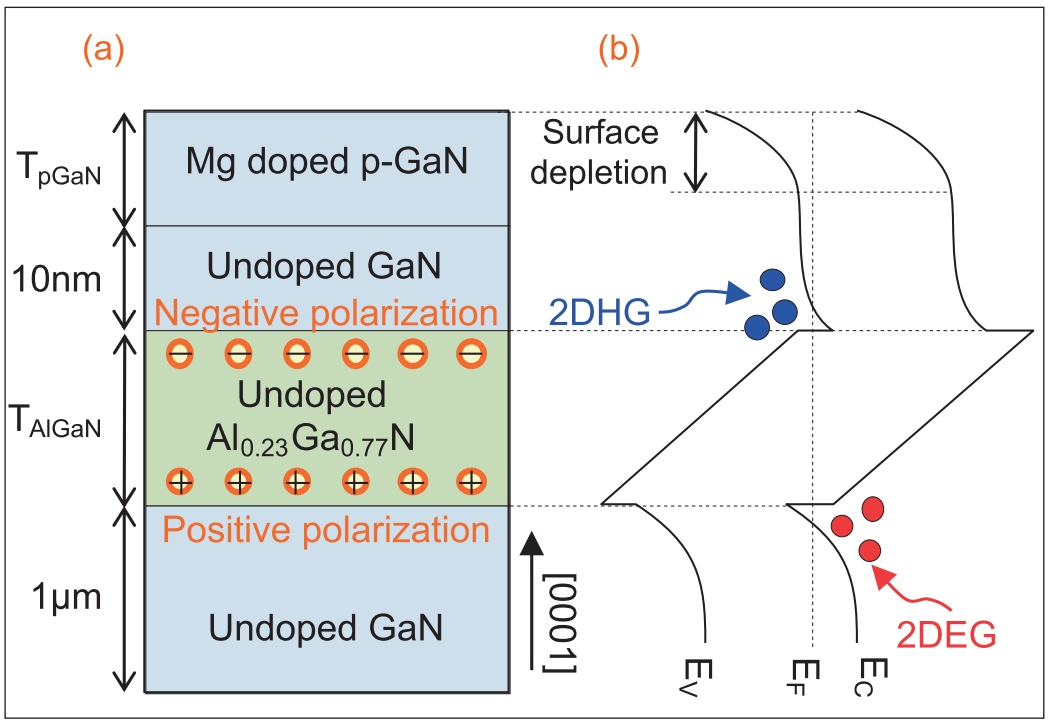


Figure 1. Schematics of (a) layer structure and (b) band diagram.

These HEMTs are seen as having potential in power electronics for both high frequencies (cut-off and oscillation frequencies in the hundreds of gigahertz have been achieved) and high voltage (~2000V breakdown was recently reported for one structure).

The Sheffield/ Powdec researchers see possibilities for applying such 2DHGs in creating p-channel heterostructure field-effect transistors (HEMT is the name for n-channel HFETs) and in creating 'super-junction' devices that use both 2DHGs and 2DEGs. These possibilities could lead to ultra-low-loss power devices.

Two-dimensional electron gases typically have carrier densities of more than $10^{13}/cm^2$ and mobilities greater than $1000cm^2/V\text{-}s$. Until now, reported 2DHGs have had densities of less than half this; further, mobility only up to $5cm^2/V\text{-}s$ had been observed. These factors combine to give very high sheet resistances for 2DHGs compared with what is obtained with 2DEGs.

Using simulations of the GaN/AlGaN/GaN double heterostructures (Figure 1), the researchers designed a circular p–n junction diode (Figure 2a) in order to perform C–V measurements. It was expected that both 2DHGs and 2DEGs would be formed. The simulation was used to optimize the thickness of the various layers.

The structure was grown on sapphire using metal-organic chemical vapor deposition (MOCVD). The top p-GaN (magnesium-doped) layer was 30nm thick. The AlGaN (23% Al) layer was 47nm thick. In normal HEMTs, the AlGaN layer is usually ~20nm thick.

The ohmic contacts of the diode's anode and cathode were nickel-gold and titanium-aluminum-titanium-gold, respectively. The diameter of the anode was 600µm.

The capacitance (C) of the structure was determined at various bias conditions (V) by using a small 0.1V alternating current modulation at 250kHz. The experi-

ments were carried out at temperatures of 96K, 198K and 298K (Figure 2b). The calculated depletion width of 51–52nm is described as being in good agreements with the AlGaN layer thickness of 47nm determined using x-ray diffraction (XRD).

The C–V measurements suggest the presence of 2DHG and 2DEG either side of the AlGaN layer, as predicted from the group's simulation (Figure 1). The results are almost temperature independent, so the 2DHG does not freeze out. This behavior is different from that of p-GaN layers where hole carrier densities are strongly temperature dependent due to the high activation energy of the Mg-acceptors.

Hall-effect measurements using the Van der Pauw method at room temperature were carried out on samples with nickel-gold contacts on the p-GaN layer. This gave a sheet resistance of 35kΩ/square, 2DHG carrier density of $1.1x10^{13}/cm^2$, and a hole mobility of $16cm^2/V\text{-}s$.

"This is the first report of experimentally obtained high-density 2DHG over $10^{13}/cm^2$," the researchers comment.

The researchers attribute only $9x10^{11}/cm^2$ of the carrier density to holes arising from the Mg-doping of the 30nm p-GaN layer, an order of magnitude lower than the measured value. Also, the mobility is $10cm^2/V\text{-}s$ larger than those of typical Mg-doped layers. The researchers conclude that the majority of holes are induced by polarization charge and not the Mg-doping.

The researchers believe that further improvement of the 2DHG mobility could be achieved through optimization of the layer structure and growth conditions. This is based on a bulk hole mobility of $100cm^2/V\text{-}s$. The degradation to $16cm^2/V\text{-}s$ is explained as being due to diffusion of Mg from the p-GaN layer into the undoped GaN beneath.

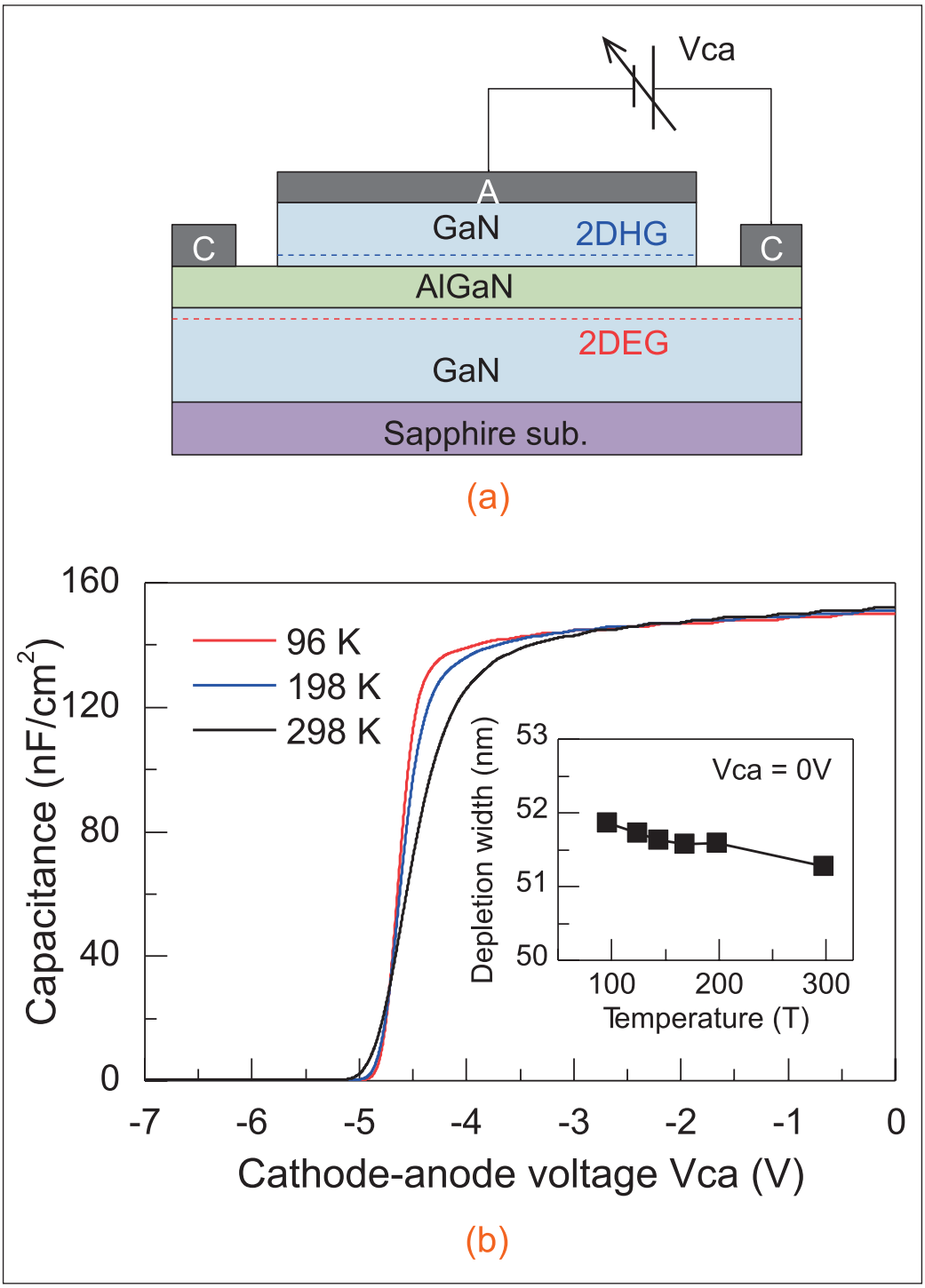


Figure 2. (a) Simplified schematic of fabricated p–n junction diode. (b) C–V results at different temperatures under reverse bias. Inset: calculated depletion width at zero bias, assuming linear interpolation value of the dielectric constant of AlGaN layer of 8.8Å$_0$.

The work was supported by a variety of UK funding sources under the Newton International Fellowship Scheme of the Royal Society of London, the British Academy and the Royal Academy of Engineering. ■

http://apex.jsap.jp/link?APEX/3/121004

www.powdec.co.jp/e/index.html

The author Mike Cooke is a freelance technology journalist who has worked in the semiconductor and advanced technology sectors since 1997.

Germanium doping option for gallium nitride on silicon substrates

Germanium used to create n-type conductivity without cracking.

Researchers at Otto-von-Guericke-Universität Magdeburg propose the use of germanium (Ge) doping as an alternative to the usual silicon (Si) for n-type nitride semiconductor layers on silicon substrates [Armin Dadgar et al, Appl. Phys. Express, vol4, p011001, 2011]. The aim of the switch would be to produce better-quality nitride layers that could even be used for creating light-emitting devices on silicon.

Presently, nitride semiconductors are being widely developed on Si substrates for electronics application, but reports of light-emitting devices are rare. Electronics applications include power and high-frequency devices.

Producing thick gallium nitride (GaN) layers on silicon needs careful strain engineering as the growth process proceeds in order to avoid cracking. This is because the thermal expansion coefficients are mismatched in an unfavorable manner. For example, layers are introduced to incorporate compressive stress to counteract the tensile stress that would normally arise in GaN on Si.

For reasons that are not entirely clear, silicon doping of the GaN layer to produce n-type conduction increases the unwanted tensile stress through the induction of edge-type dislocation climb, reducing the effectiveness of the engineered compressive stress. When the Si doping concentration exceeds 10^{18}/cm^3, typical edge-type dislocation densities are 10^9/cm^2. These dislocation levels increase the tensile stress significantly.

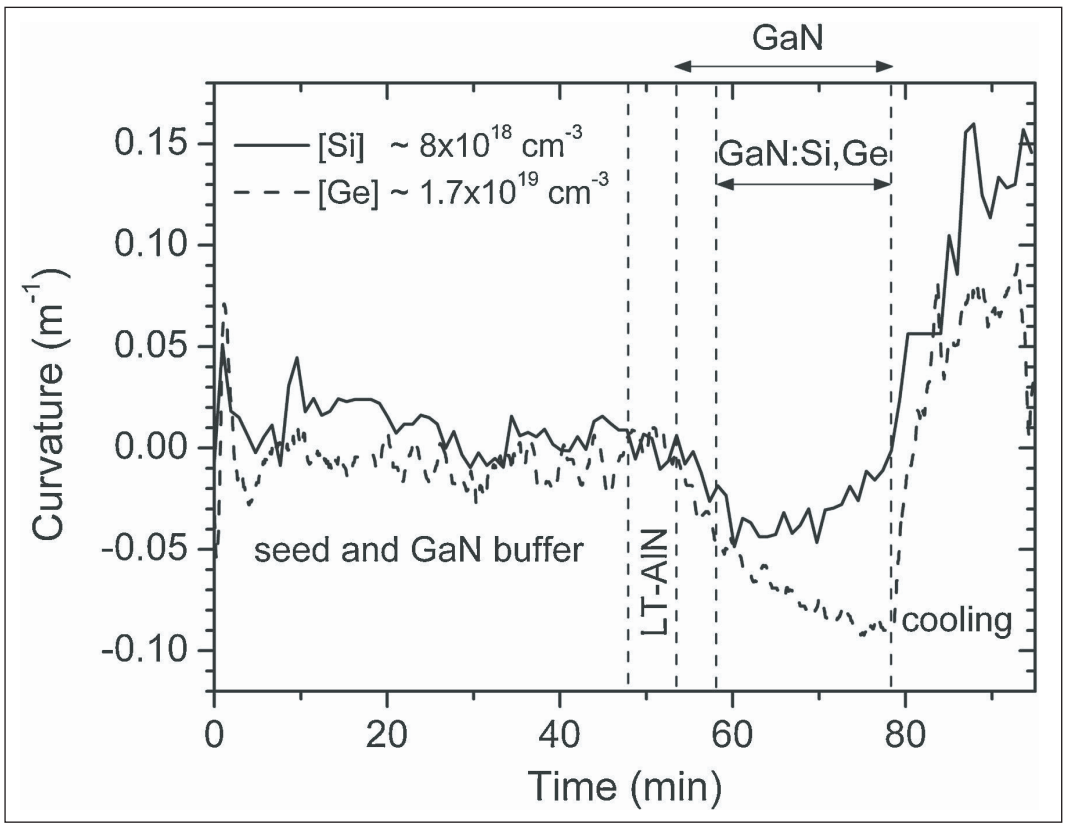


Figure 1. In-situ curvature measurement of Magdeburg's Si/AlN/2x(GaN/LT-AlN/)GaN/GaN:Si,Ge layer stack.

These factors currently limit the ability to create thick (>1μm) n-type conducting layers in nitride semiconductor on silicon devices.

The Magdeburg researchers investigated whether the use of Ge doping might alleviate these problems. Metal-organic chemical vapor deposition (MOCVD) in an Aixtron reactor was used to grow the nitride layers on silicon using standard nitride semiconductor precursor/sources. The doping was supplied either by silane (SiH_4) for silicon or by germane (GeH_4) for germanium, with hydrogen (H_2) carrier gas. The concentration in the H_2 was 100 parts per million for silane and 10% for germane. The higher concentration of germane was needed due to its lower doping efficiency compared with silane.

The growth began with aluminum nitride (AlN) seed and buffer layers. This was followed by a two-period system of a 400nm GaN layer (~400nm) and a low-temperature AlN layer (~10nm) to create compressive stress for the final 800nm GaN layer. The final layer consisted of 150nm of undoped GaN, with the remainder doped with Si or Ge.

The development of the curvature of the wafer during growth (Figure 1) was determined using an in-situ optical system supplied by LayTec. The curvature indicates the stress development in the nitride semiconductor layers. While the compressive stress induced by the GaN/AlN layers turns tensile during silicon doping, the compressive trend continues with germanium doping. The germanium-doped sample stress only turns tensile during cooling, as expected. Cracks develop in the Si-doped sample, but not in the Ge-doped material (Figure 2).

For the Ge sample, the carrier concentration ($1.7x10^{19}/cm^3$) was determined using C–V measurements. Due to the cracks, the Si sample electron concentration could not be measured in this way. Instead, identical conditions were used to grow a Si-doped GaN layer on sapphire, which had a C–V carrier concentration of $8x10^{18}/cm^3$.

X-ray diffraction analysis revealed the tensile stress of the Si-doped GaN to be $4.4x10^{-3}$, while that in the Ge-doped sample was $2.7x10^{-3}$. The full-width at half maximum (FWHM) of the x-ray (0002) diffraction peak was 400arcsec for Ge-doped GaN and 700arcsec for Si doping. The narrower peak for the Ge-doped sample indicates superior crystal quality.

The photoluminescence of the Ge-doped sample was a factor of two more intense than that of the Si-doped material.

The Magdeburg researchers suspect that silicon nitride forms the cores of the dislocations that lead to tensile stress and eventually cracking. The team observes that the germanium analog, Ge_3N_4, is not stable under MOCVD GaN growth conditions (near the compound's melting point of 900°C).

Although germanium-doping is applicable to AlGaN layers, the ionization increases with increasing Al content, reducing the material's doping effectiveness.

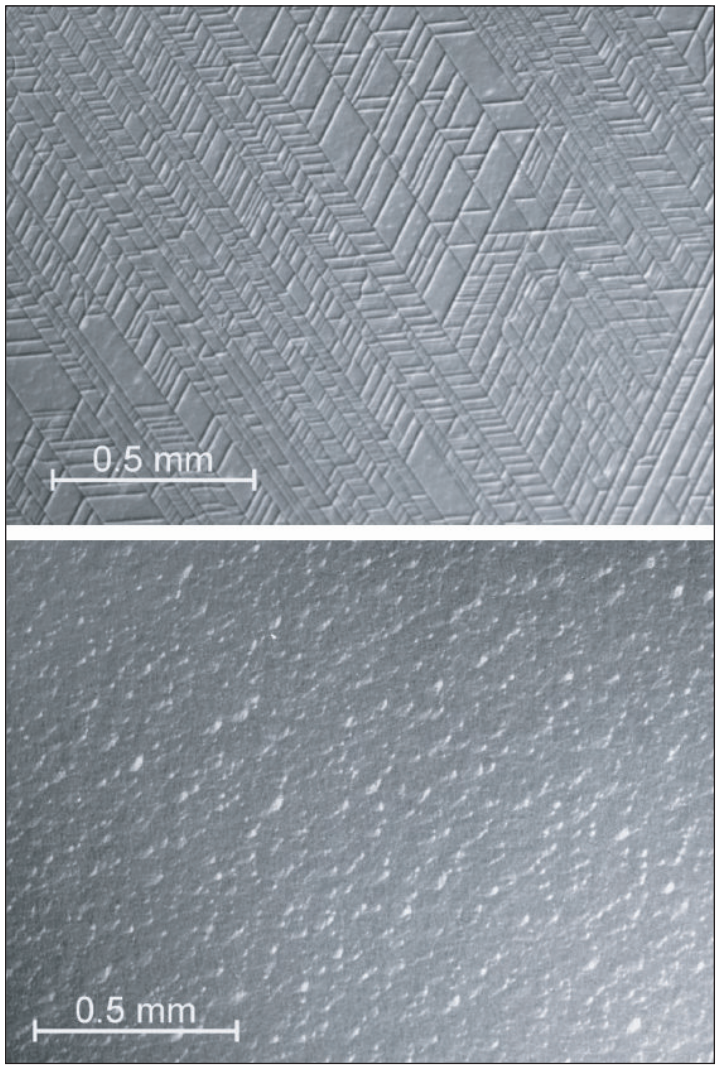


Figure 2. Nomarski microscopy images of Si (top, $8x10^{18}/cm^3$) and Ge (bottom, $1.7x10^{19}/cm^3$) doped samples.

The researchers believe that the technique could also be applied to hydride vapor phase epitaxy (HVPE), which is used to create very thick GaN layers.

Germany's Bundesministerium für Bildung und Forschung (federal education and research ministry) provided some funding for the work within its GaNonSi project. ■

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Author: Mike Cooke

Free-standing GaN from lateral overgrowth and chemical etch

Surface texturing from etch could boost nitride LED light extraction.

Researchers from Gwangju Institute of Science and Technology and Samsung LED in Korea have developed a technique to chemically separate laterally overgrown gallium nitride (GaN) crystal from its sapphire substrate [Chu-Young Cho et al, Appl. Phys. Express, vol4, p012104, 2011]. Such 'free-standing' GaN is an attractive substrate for growing more efficient light-emitting structures.

Commercial nitride semiconductor light-emitting diodes (LEDs) are generally produced by growing epitaxial layers on sapphire substrates. Since sapphire is electrically insulating, one has to put the device contacts on the nitride semiconductor side of the device. This creates lateral current flows that suffer from current crowding, which reduces efficiency. By removing the sapphire substrate, one is able to put the contacts on both the top and bottom of the device, enabling 'vertical' current flow.

Laser-lift off techniques have been developed to remove the sapphire, but can cause strain-induced cracking and other damage of the device structure, impacting performance. Another approach is chemical, where defects are not expected to be generated since physical and thermal damage are avoided.

The Gwangju Institute of Science and Technology and Samsung LED combined chemical lift-off and lateral epitaxial overgrowth (LEO, also known as epitaxial lateral overgrowth/ELOG). LEO uses a mask to block threading dislocations in certain parts of the GaN template, creating regions of near-damage-free crystal from material that grows over the mask.

The technique begins with growing GaN seed layers on c-plane sapphire using metal-organic chemical vapor deposition (MOCVD). A 25nm GaN nucleation layer (grown at 550°C) was followed by 2μm-thick undoped GaN (1020°C).

The LEO process was performed using silicon dioxide coated tungsten as a mask that consisted of a series of lines 6μm wide with 6μm gaps (Figures 1a and b).

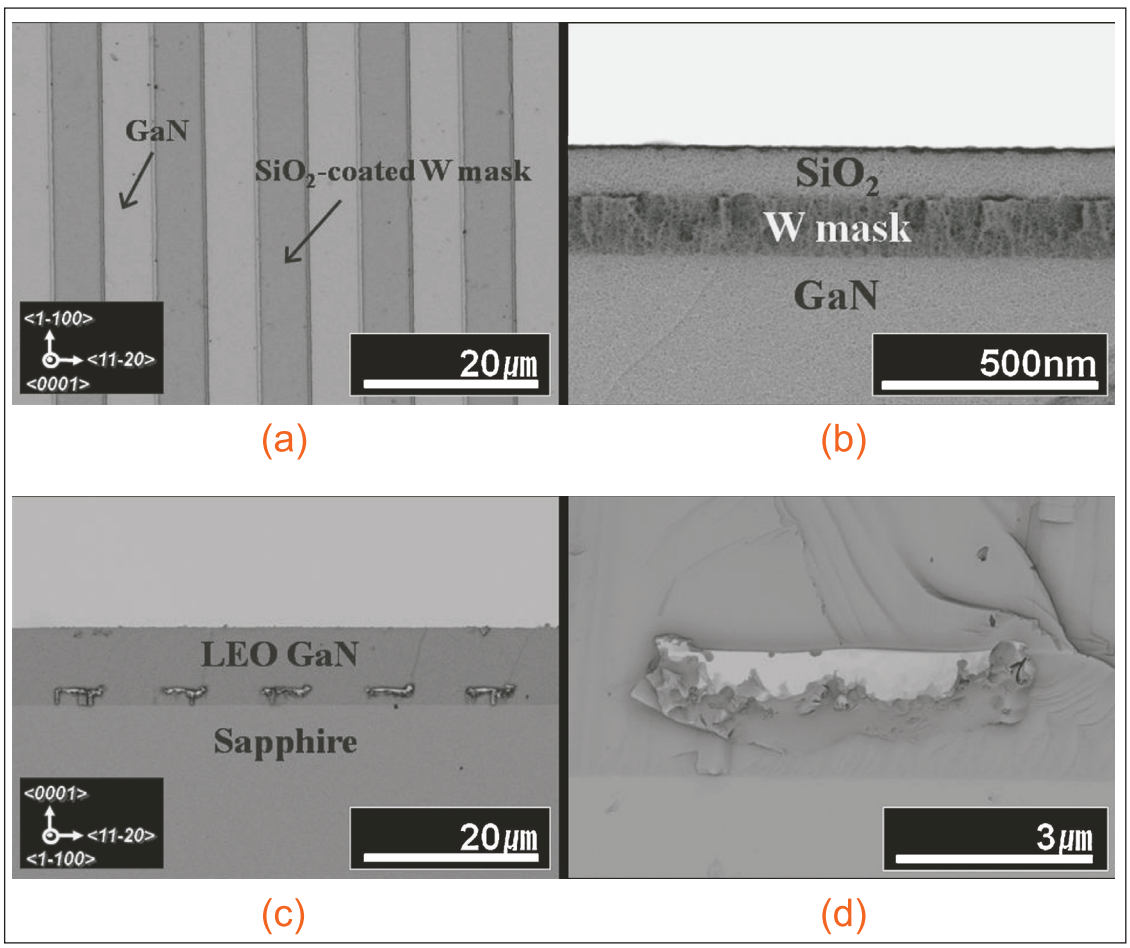

Figure 1. (a) Plan-view and (b) cross-sectional SEMs of SiO_2-coated W mask. (c), (d) Cross-sectional SEMs of LEO GaN epilayer grown on the SiO_2-coated W mask.

The 8μm-thick LEO GaN layer was grown at 1020°C (Figures 1c & d).

The voids that are seen under the LEO mask are attributed to GaN decomposition reactions involving GaN, tungsten, and the hydrogen gas that was used as carrier during the MOCVD growth.

The LEO GaN was separated from the sapphire using a molten potassium hydroxide (KOH) etch (150°C for 10–60 minutes) of the GaN between the voids (Figure 2). The researchers believe that the KOH penetrates the voids and then etches the remaining template GaN.

The etched surface was covered with inverted pyramids (Figure 2f). Such surface texturing has been used in GaN LEDs to reduce total internal reflection effects where photons are reflected back into the device at air–GaN interfaces.

Various analyses of the separated GaN were performed to check the material quality. Transmission electron micrography (TEM) showed that the SiO_2/W mask had effectively prevented propagation of the threading dislocations from the lower template layers. By contrast, threading dislocations were seen in the gaps/windows in the mask. AFM (atomic force microscopy) showed reduced surface roughness above the mask (0.37nm root mean square) compared with the window region (0.52nm RMS). Surface pits formed from threading dislocations had a density of $5x10^7/cm^2$ in the mask regions, which increased to $2x10^9/cm^2$ in the window regions.

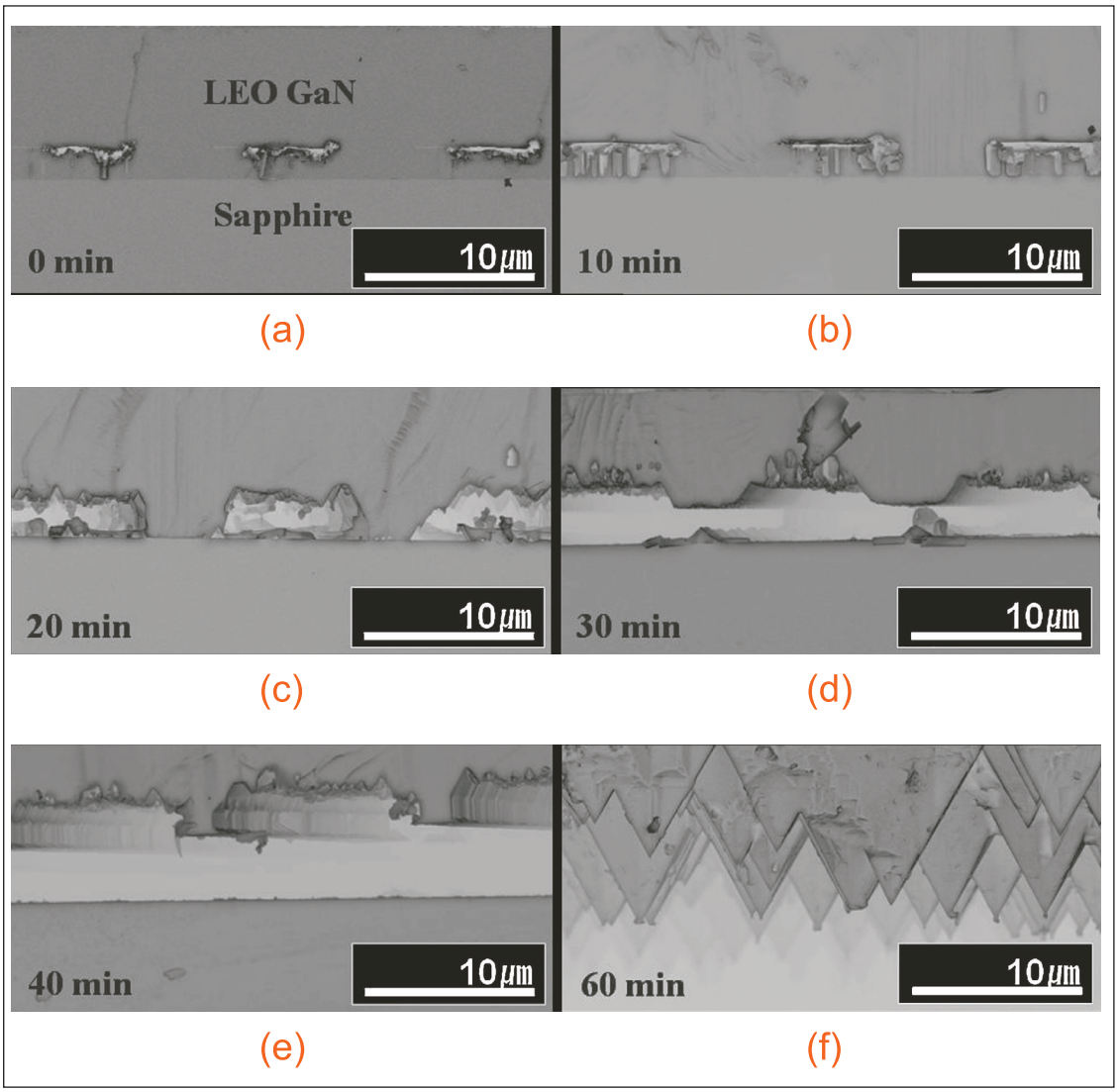

Figure 2. Cross-sectional SEMs of (a) LEO GaN epilayer before etching process; and (b–f) LEO GaN epilayers etched in the KOH for 10–60 minutes.

TEM showed that the SiO_2/W mask had effectively prevented propagation of the threading dislocations from the lower template layers. By contrast, threading dislocations were seen in the gaps/windows in the mask. AFM showed reduced surface roughness above the mask (0.37nm RMS) compared with the window region (0.52nm RMS)

Photoluminescence (PL) and Raman spectroscopy measurements were also performed. The PL intensity for the LEO GaN was increased by 63% compared with as-grown samples without LEO. The improvement is attributed to reduced dislocation densities.

Raman spectroscopy probes the phonon spectrum, which is related to vibration modes of the lattice through energy shifts in photon scattering. Vibration modes are affected by changes in strain.

The LEO GaN had a Raman peak red-shifted relative to the as-grown material. The value obtained (1.2/cm in wavenumbers) suggests a compressive stress relaxation of 0.285GPa. This relaxation is attributed to the void formation process. ■

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Author: Mike Cooke

Light output increased 116.7% at 20mA over conventional LED structure

Substrate removal and reflector layer boost red LED output.

Researchers based at National Cheng Kung University and WuFeng University in Taiwan have developed techniques to boost the output from red light emitting diodes constructed using aluminum gallium indium phosphide (AlGaInP) semiconductor structures. [Der-Ming Kuo et al, Appl. Phys. Express, vol4, p012101, 2011].

Although AlGaInP LEDs can achieve 90% internal quantum efficiency, high extraction efficiencies are hampered by absorption in the gallium arsenide (GaAs) substrate used to grow these devices.

The researchers did use GaAs substrates to grow the epitaxial structure using metal-organic chemical vapor deposition. However the substrate was later removed using a wet etch employing ammonium hydroxide/hydrogen peroxide solution ($NH_4OH:H_2O_2:H_2O$, 1:4:2 for two hours). The epitaxial structure consisted of n-GaAs buffer (300nm), InGaP (200nm), n^+-GaAs (50nm), n-AlGaInP (2μm), n-AlInP cladding (50nm), AlGaInP/InGaP multi-quantum well active layer, p-AlInP cladding (50nm), and p-GaP contact (9μm).

On top of these layers plasma-enhanced chemical vapor deposition was used to create a silicon dioxide diffusion barrier (0.5μm thick) that was then patterned into 280μm x 280μm squares. The metal part of the p-contact consisted of gold-beryllium alloy (150nm) and gold (350nm) covering a 300μm x 300μm area. Then a 450°C anneal was used to achieve ohmic behavior with high reflectivity (85%).

The purpose of the silicon dioxide barrier was to restrict the region of contact between the metal and the p-GaP. To make an ohmic contact the metal has to be thermally annealed and this causes some metal to diffuse into the p-GaP, roughening the interface and reducing reflectivity.

To prepare for nickel electroplating, an adhesive/seed layer consisting of chromium, titanium and gold (100nm each) was deposited using electron-beam evaporation. The nickel substrate was grown to a thickness of 80μm to serve as substrate for the final device (Figure 1a).

It was at this point that the GaAs substrate was removed, along with the InGaP layer (using hydrochloric/phosphoric acid solution), exposing the thin n^+-GaAs layer.

The n-contact consisted of 10μm-diameter ohmic-contact metal dots of germanium-gold alloy (95nm) and gold (200nm). After the metal dots were annealed at 360°C, 300nm of indium zinc oxide (IZO) was applied using sputtering, to create a transparent conducting layer with transmittance above 87%. The researchers found that IZO on its own formed a Schottky contact with n^+-GaAs, but that adding the metal dots created an ohmic contact for the system. Presumably the dots provide a low resistance conduction path between the n^+-GaAs/IZO materials.

The 300μm x300μm device mesas separated by 25μm were then wet etched down to the p-GaP layer using hydrochloric/phosphoric acid solution. A metal pad for the p-contact and passivation were finally deposited.

Two other LEDs were created for comparison purposes (Figure 1b): an LED using a similar process to that already describe, but without the transparent conducting layer; and, an LED produced conventionally with GaAs substrate. The peak emission wavelength was around 624nm (red) for all three devices.

Voltage and light output power dependence on current was determined (Figure 2). The nickel/IZO contact devices had a 0.02V increase in forward voltage at 20mA compared with the regular LED. This is attributed to the presence of the resistive silicon dioxide diffusion barrier needed to improve the reflectivity of the p-contact. The IZO contact improved the forward voltage at 20mA by about 0.03V, compared with the device without such a contact (LED-B). This improvement is attributed to the IZO reducing current crowding effects, hence reducing the resistance of the contact.

Despite the reduced electrical performance, the nickel/IZO devices (LED-A) increase light output power (4.225mW) significantly by 116.7% at 20mA and 168.9% at 100mA over the regular device (1.95mW). Even without the IZO layer, LED-B (3.75mW) showed a 92.5% in light output at 20mA over the regular device.

The further improvement in using an IZO film is attributed to reduction in total internal reflection at due

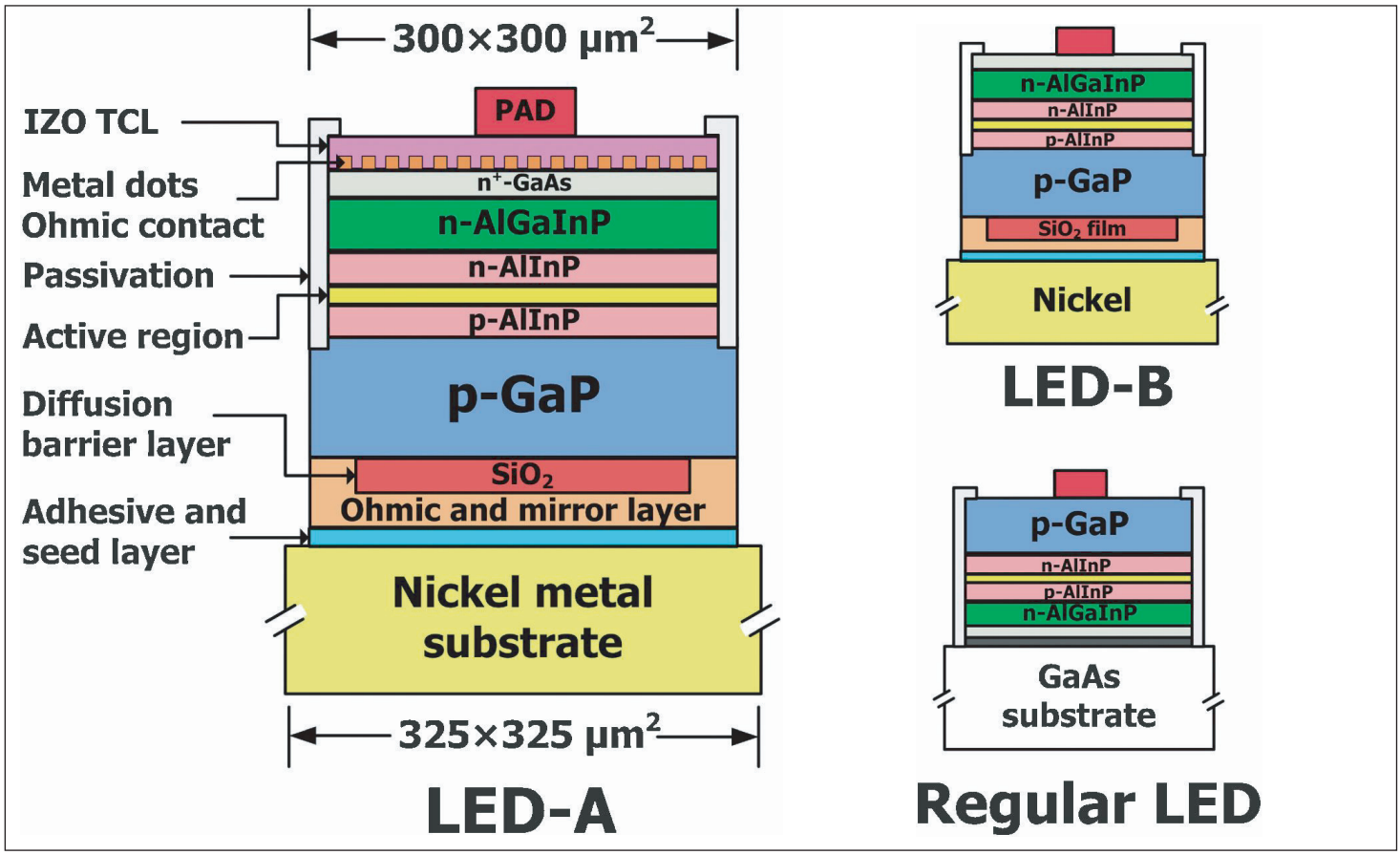

Figure 1.(a) LED-A, which has Ni substrate and IZO TCL. (b) LED-B, which has Ni substrate but without IZO TCL (top) and a regular LED with a GaAs absorbing substrate (bottom). All devices have same chip size of 300μm x 300μm.

to its refractive index (2.1) being closer to that of air (1), compared with GaAs (3.8). The lower refractive index increases the critical angle that determines which photons can leave the structure.

The researchers note that their devices do not reach the external quantum efficiency (EQE) of commercial devices. The full device achieved an EQE of 10.5% at 20mA. The comparison device without IZO had an EQE of 9.3% at 20mA, and the regular device 4.9%. These low values are attributed to the low material quality of the epitaxial wafers, compared with those available commercially (EQE up to ~50%).

'Nevertheless, results obtained from the comparisons of current–voltage and light output power characteristics of the prepared samples still clearly reveal the effectiveness of the proposed technology for AlGaInP LEDs,' the researchers maintain. ■

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Author: Mike Cooke

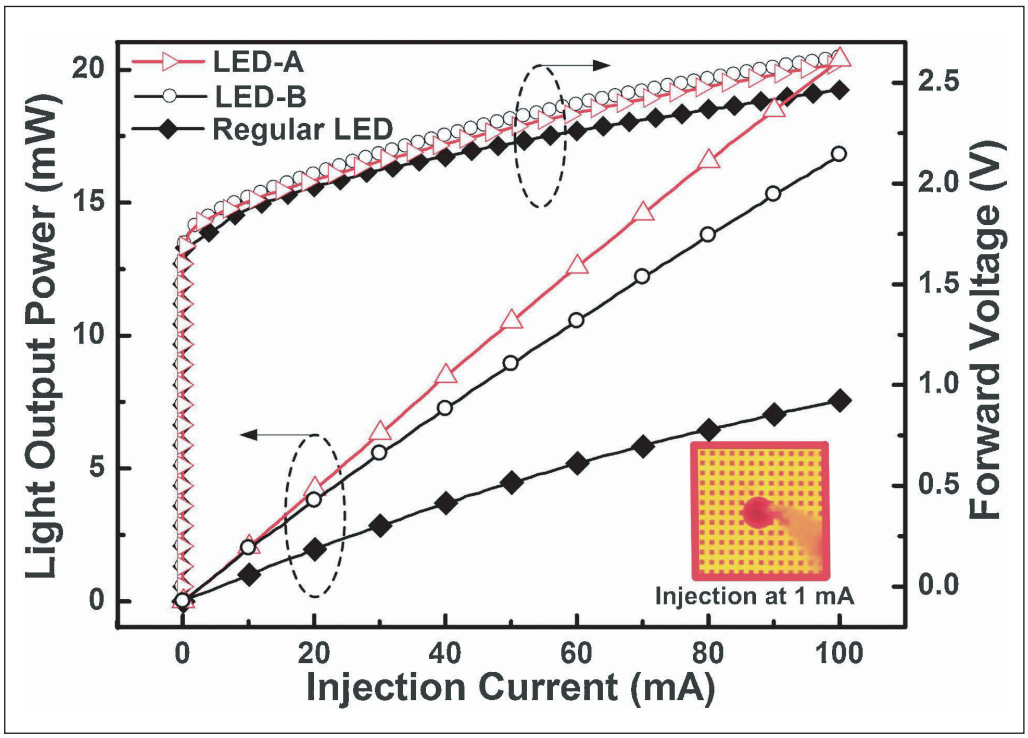

Figure 2. Comparisons of current-voltage and light output power-current characteristics between LED-A, and comparison devices (LED-B, and regular LED). Inset shows photo of light emission from LED-A at injection current of 1mA.

Taiwan research allows use of AlGaAs optical confinement/ cladding with InGaAsN

Improving InGaAsN laser diodes with antimony passivation.

Researchers based in Taiwan have developed a passivation technique using antimony (Sb) that improves laser diodes that have indium gallium arsenide nitride (InGaAsN) quantum wells and aluminum gallium arsenide (AlGaAs) optical cladding/ confinement [Hsin-Chieh Yu et al, Appl. Phys. Express, vol4, p012103, 2011]. The team contained researchers from National Cheng Kung University, National Taitung University, and Kun Shan University.

InGaAsN quantum wells (with GaAs barriers) provide a simple way to tune emission wavelengths that fall within the 1.3–1.55μm range needed for fiber optic transceiver modules. This is achieved by varying the amount of N incorporation.

Unfortunately, InGaAsN is very sensitive to the presence of aluminum (Al) that is needed to create high refractive index contrasts for optical cladding/ confinement in other parts of GaAs-based lasing devices. Effects of Al-containing layers on subsequent InGaAsN material quality include optical deterioration and surface roughness that hamper the development of laser diodes with low threshold currents.

These problems have been seen in both molecular beam epitaxy and in metal-organic chemical vapor deposition. During such processes, Al-containing layers grow on the reaction chamber walls that can decompose and redeposit Al on the epitaxial structure later. Such redeposition seems to be encouraged by the presence of nitrogen in the chamber. Attempts to avoid this situation are complicated, discouraging development of commercial processes.

The epitaxial layers (Table 1) of the various devices were grown using metal-organic chemical vapor deposition (MOCVD). The InGaAsN sources were trimethyl-indium (TMIn), triethyl-gallium (TEGa), tertiarybutylarsine (TBAs), and dimethylhydrazine (DMHy), respectively. For AlGaAs cladding layers, TMAl, TMGa, and arsine (AsH_3) were the sources. Zinc and silicon doping for p-type and n-type conduction were provided by DM-zinc (DMZn) and disilane (Si_2H_6), respectively. The antimonide treatment was supplied by TMSb. High temperature (HT) and low temperature (LT) GaAs layers were grown at 725ºC and 510ºC, respectively. The TMSb passivation was carried out for 7 minutes at 510ºC.

The InGaAsN is used as a quantum well, surrounded by GaAs barriers. Structures with and without AlGaAs cladding were created. One of the AlGaAs samples was subjected to the TMSb treatment before the LT-GaAs layer.

Table 1. Structures of (a) sample Q1: InGaAsN on GaAs, (b) sample Q2: InGaAsN on AlGaAs and (c) sample Q3: InGaAsN on GaAs with TMSb passivation.

(a)		(b)		(c)	
GaAs	20nm	GaAs	20nm	GaAs	20nm
InGaAsN	7nm	InGaAsN	7nm	InGaAsN	7nm
GaAs	20nm	GaAs	20nm	GaAs	20nm
InGaAsN	7nm	InGaAsN	7nm	InGaAsN	7nm
GaAs buffer		LT GaAs	20nm	LT GaAs	20nm
GaAs substrate		HT GaAs	120nm	TMSb treatment	
		$Al_{0.3}Ga_{0.7}As$	1500nm	HT GaAs	120nm
		GaAs buffer		$Al_{0.3}Ga_{0.7}As$	1500nm
		GaAs substrate		GaAs buffer	
				GaAs substrate	

InGaAsN quantum wells (with GaAs barriers) provide a simple way to tune emission wavelengths that fall within the 1.3–1.55μm range needed for fiber optic transceiver modules. Unfortunately, InGaAsN is very sensitive to the presence of aluminum that is needed to create high refractive index contrasts for optical cladding/confinement in other parts of GaAs-based lasing devices

Photoluminescence (PL) and atomic force microscopy (AFM) were used to analyze the structures. In the PL studies, the peak emission wavelengths were 1221nm, 1216.5nm and 1213.5nm for the devices without AlGaAs cladding (Q1, Table 1a), with AlGaAs cladding (Q2, Table 1b), and with AlGaAs cladding and TMSb passivation (Q3, Table 1c), respectively. The AlGaAs sample Q2 without TMSb passivation showed a 70% decrease in PL peak intensity compared with Q1. The passivation step giving sample Q3 recovers the intensity lost by Al-contamination in sample Q2. The surface roughness derived from AFM measurements give root mean square values of 0.42nm in Q1, 0.97nm in Q2 (Al cladding) and 0.57nm in Q3 (Al cladding and TMSb passivation). The passivation thus improves the surface morphology over that of the Al cladded sample.

The effect of the Sb is explained as being due to pyrolysis (decomposition of organic material at high temperature in the absence of oxygen) and surfactant effects. The pyrolysis temperature of TMSb is 500ºC. The researchers believe this effect of the treatment carries over from the introduction as TMSb up to the deposition of the InGaAsN well, since Sb atoms are not only deposited on the epitaxial structure, but some also stick to the walls of the reactor. The presence of Sb can block residual Al from reacting with the nitrogen sources. Also the surfactant effect of Sb may be continued beyond the treatment layer with effect lasting up to the AlGaAsN layer, improving crystal quality, optical characteristics and surface morphology.

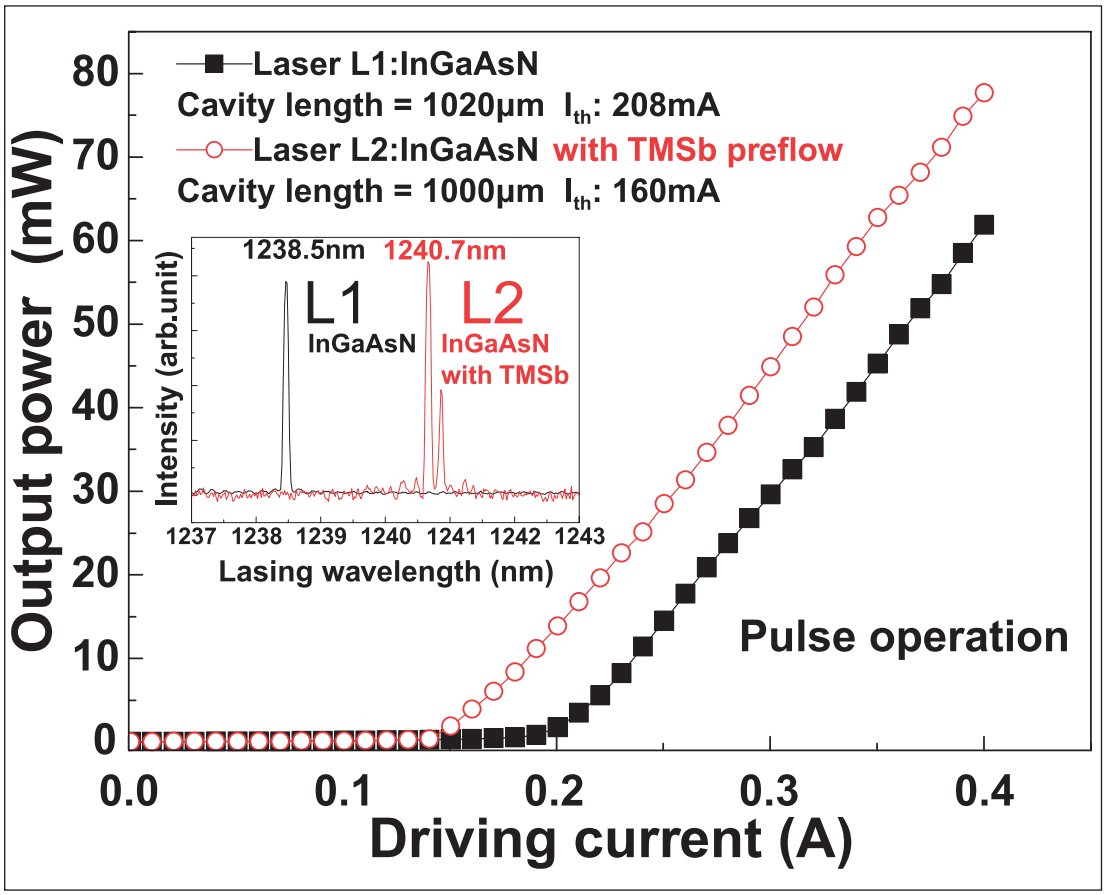

Figure 1. Light output power vs. current curves of InGaAsN single quantum well (SQW) lasers with (L2) and without (L1) TMSb passivation. Inset shows electroluminescence (EL) lasing spectra of the two samples.

TMSb passivation was varied. Higher levels gave increased PL intensity and narrower linewidths. The Sb-treated sample had a narrower linewidth than the sample without Al cladding... this might be due to Sb incorporation in the GaAs barrier, which forms a strained GaAsSb layer before the highly strained InGaAsN well, improving optical quality and device characteristics

The amount of TMSb passivation was varied. Higher levels gave increased PL intensity and narrower linewidths. In fact, the Sb-treated sample had a narrower linewidth than the sample without Al cladding. Apart from surfactant effects, the researchers suggest that this might be due to Sb incorporation in the GaAs barrier, which forms a strained GaAsSb layer before the highly strained InGaAsN well, improving optical quality and device characteristics.

Broad area lasers (50μm wide) were produced from the Al cladded materials Q2 and Q3. The cavity lengths were ~1mm. The threshold currents (Figure 1) were, respectively, 208mA and 160mA for the devices without (L1) and with (L2) TMSb passivation. These correspond to densities of 407A/cm^2 and 320A/cm^2, respectively. The lower threshold current for the passivated device is attributed to better crystal quality. The peak wavelengths were 1238.5nm (L1) and 1240.7nm (L2). ■

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Author: Mike Cooke

Short- and long-reach of new VCSEL applications

Vertical-cavity surface emitting laser (VCSEL) technology has established itself in the short-range optical data link and optical mouse markets. New applications such as very-short-range data and bio-analysis beckon. Mike Cooke reports.

Much of the recent development in VCSEL technology has been driven by short- and very-short-range optical data link opportunities (Table 1). Companies such as Google, Intel, HP and IBM have been among the leaders in developing optical data interconnects, and it seems likely that intra-rack systems will be standard within a year. In a few years, chip-mounted VCSEL arrays could be used for high-speed data communications at even closer quarters.

In terms of performance, VCSELs can deliver a near-circular output beam with a small full-divergence angle and a fundamental mode with near-Gaussian intensity profile. The smaller divergence angle compared with other technologies allows for better coupling efficiency with optical fiber.

VCSELs also have low threshold current and power consumption, along with high output power and high slope efficiency. The low threshold enables direct modulation of these devices at high frequency. Further desirable features include thermal stability at milliwatts of peak output power.

The production advantages of the VCSEL format include simplified packaging and small size compared with edge-emitting lasers. The devices are produced in a planar process that allows testing and characterization at an earlier stage in the production process, even on-wafer, giving tighter production control at low cost. These features enable high-reliability products and packaging versatility.

Further, low-cost parallel devices are possible with the VCSELs produced in 2D-arrays. Among the attractive applications of VCSEL arrays is optical interconnects for future high-performance computer architectures.

Researchers are seeking to build on these characteristics and find ways to increase the modulation bandwidth while simultaneously improving device reliability, power efficiency, modal and spectral characteristics, thermal management, and so on.

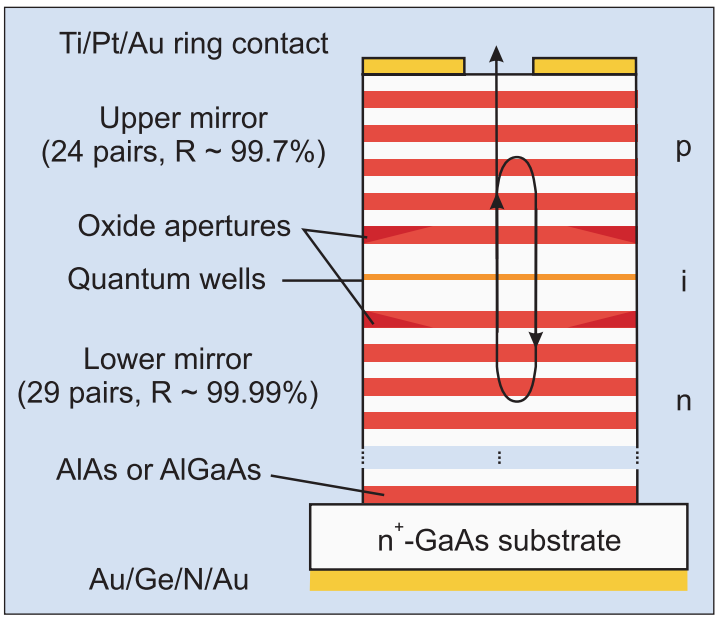

Figure 1. Schematic of distributed Bragg mirrors and quantum well structures found in typical 850nm oxide-confined VCSEL.

Table 1. Some recent achievements in VCSEL modulation at various wavelengths.

Wavelength	Distance	Room temp.	High temp.	Demonstration parameters
850nm	up to 300m	40Gb/s	25Gb/s @ 85°C	40Gb/s @ RT with ~3m fiber, 35Gb/s @ RT, 25Gb/s @ 85°C with 100m fiber
980nm	several meters	35Gb/s	25Gb/s @ 85°C	35Gb/s @ RT with ~1 m, 25Gb/s @ 85°C with ~3m fiber
1100nm	several meters	40Gb/s	25Gb/s @100°C	both with ~3m of fiber
1300nm	~100km	10Gb/s		
1550nm	~100km	35Gb/s	25Gb/s @ 55°C	

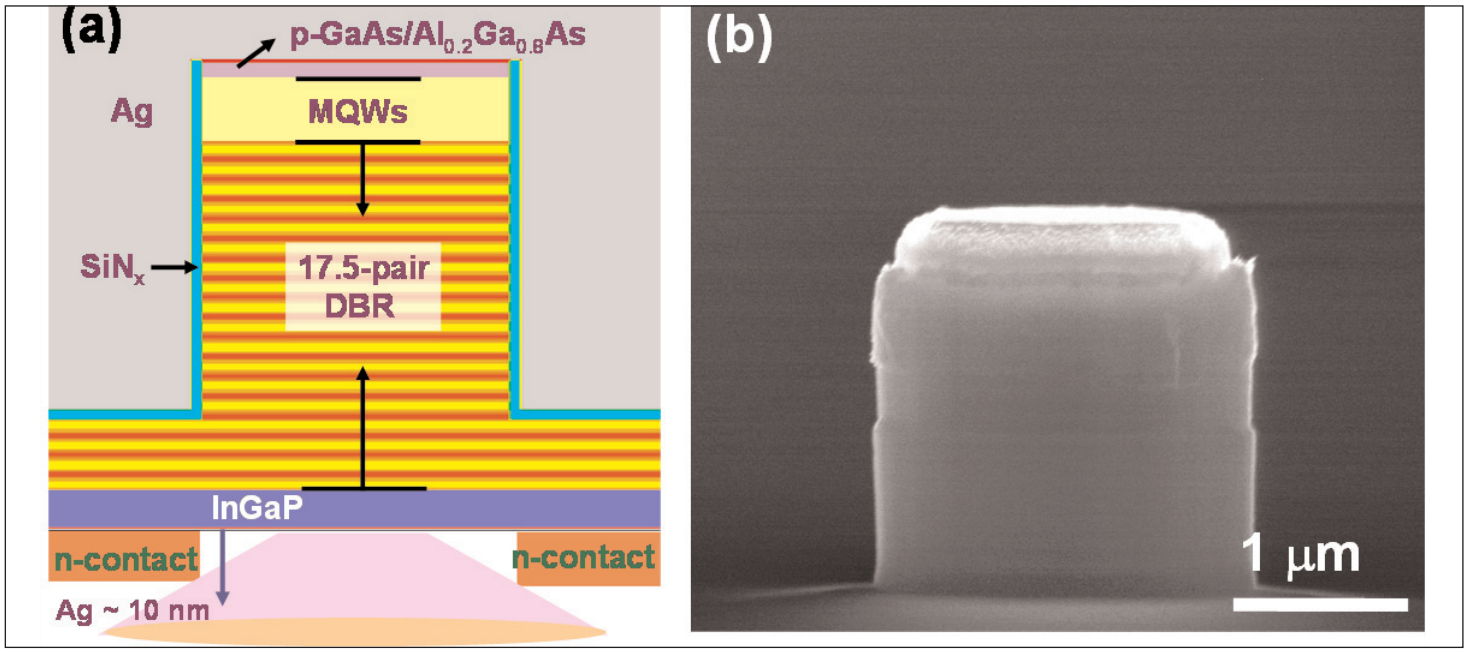

Figure 2. (a) University of Illinois at Urbana-Champaign/TU Berlin metal-cavity surface-emitting laser device flip-chip bonded to silicon that supports the contact and serves as heatsink. The physical size of the device is 1.0μm radius and 2.5μm total thickness. (b) SEM of a metal cavity after silver metallization. (From [1].)

The 850nm wavelength VCSEL presently constitutes the largest volume, with tens of millions of diodes being produced per month. The main applications for these devices are short-range (up to 300m) high-speed high-capacity optical data links (multi-mode optical fiber in data centers and computer clusters) and optical computer mice.

Local (LAN) and storage (SAN) area networks already exist that use 850nm VCSEL illumination. Further protocols for 850nm VCSELs are being developed such as Fiber Channel FC32G, InfiniBand, and universal serial bus (USB).

The monolithic 850nm VCSEL (Figure 1) depends on a particularly fortuitous combination of refractive index/bandgap in the aluminum gallium arsenide (AlGaAs) system. In particular, the top and bottom mirrors are created as distributed Bragg reflectors (DBRs) consisting of a large number of AlAs/GaAs quarter-wavelength pairs.

Fabrication processes have been developed for both molecular beam epitaxy (MBE) and metal-organic chemical vapor deposition (MOCVD). These processes need to deliver up to 100 layers of different material compositions with better than 2nm thickness control.

Production techniques for 850nm devices have tended to be MOCVD, since it is far easier to grow graded material compositions as needed for the DBR interfaces. However, recent developments have enabled MBE to produce multi-step grading. Also, large platens capable of holding a number of substrates have increased throughput. MBE also has advantages for growing a wider range of compound semiconductor compositions on GaAs substrates, as needed for moving away from the 850nm wavelength.

The technology that makes monolithic devices at 850nm possible is not directly transferable to other wavelengths. Non-monolithic approaches (wafer bonding, dielectric mirrors, metamorphic mirrors, MEMS) are more difficult and, therefore, expensive.

Extending the monolithic nature of the 850nm technology to a wider band of wavelengths (650–1550nm) is therefore very attractive. And, with a broader wavelength palette, new applications come into view: fiber-to-the-home, biomedical sensors for tracking the efficacy of medical therapies, ultra-high-density optical storage, large-area, nano-scale inspection, and so on.

AlAs/GaAs DBRs suffer from a smaller refractive index contrast at shorter wavelength. Varying the 850nm design to accommodate shorter wavelength requires a larger number of quarter-wavelength layers in the DBRs, and the p-DBR is particularly difficult to create with low enough resistance. Also, the thermal conductivity of the graded AlGaAs interfaces decreases, creating thermal management problems for these devices.

Long-wavelength VCSELs have been enabled by the development of GaInNAsSb and InAs quantum dots, allowing 1300–1550nm devices to be created. However, DBR limitations arise here also, along with free-carrier absorption and high series resistance of devices.

Longer wavelengths such 1550nm are particularly attractive due to lower voltage operation and hence lower power consumption, resulting from the narrower bandgap used in the active layers. Also, the transmission of 1550nm in silicon is particularly favorable. Intra-chip connections with silicon waveguides could take advantage of this. Plus, the 1550nm range has

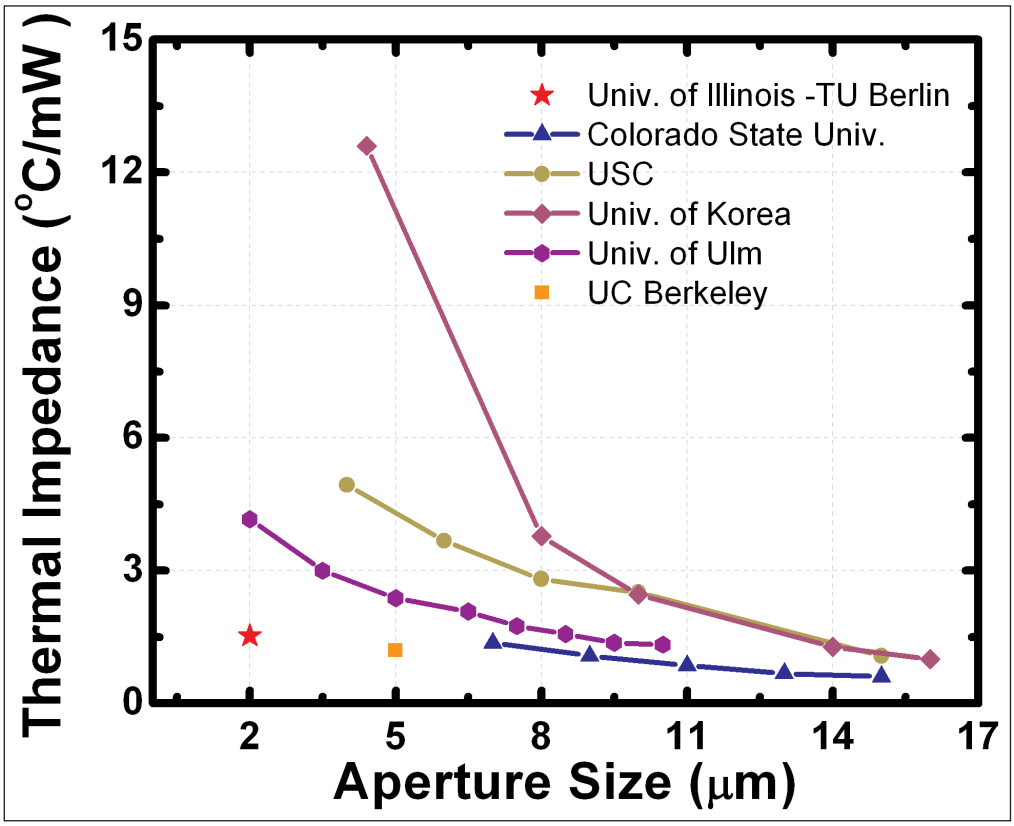

Figure 3. Comparison of thermal impedance as a function of aperture (diameter) size for various VCSELs presented in the literature and for TU Berlin's metal-cavity surface-emitting laser (star). The thermal impedance of 1.327ºC/mW for the metal-cavity device is comparable with those of VCSELs having apertures as large as 10μm.

already been widely developed for 1550nm (1.55μm) with metro-range links of 10–20km and, of course, the best performance of long-distance (hundreds of kilometers) silica-based optical fiber is often centered on this wavelength. Other 1550nm possibilities include free-space optical data transmission and light detection and ranging (LIDAR or 'laser radar').

Fiber-to-the-home is based on 1310nm (upstream) and 1490nm or 1550nm (downstream) lasers. To be cost effective, these devices must avoid complicating factors like cooling systems, optical isolators or external modulation. To compete with mobile network offerings, these systems will need to handle HD TV, high-resolution imagery, etc.

Apart from telecoms, VCSELs could be monolithically combined with other optical or optoelectronic elements such as detectors, thin-film filters and gratings. One area where integrated devices could be used is biomedical analysis (bio-defense, drug development, in-vivo imaging, diagnostics, etc.). Here one needs miniature, disposable device arrays.

Wide-ranging portfolio

Institut für Festkörperphysik und Zentrum für Nanophotonik at Technische Universität Berlin (TU Berlin) has perhaps one of the widest-ranging portfolios of high-performance VCSELs and metal-cavity surface emitting lasers, developed in conjunction with a number of other organizations.

In their latest joint work, University of Illinois at Urbana-Champaign and TU Berlin have produced metal-cavity devices (Figure 2) that are flip-chip bonded to a gold-coated silicon substrate [1]. Metal-cavity devices are a variation on the VCSEL that have attractive features including shielding of neighboring devices from cross-talk and efficient heat removal due to the use of high-thermal-conductivity metal, enabling better thermal management. This latter quality is especially important for ultra-small devices under high current injection.

Thermal effects limit modulation speed and cause gain saturation in short-cavity devices such as VCSELs. Also, the smaller-aperture devices allowed with metal cavities should lead to higher modulation bandwidth.

The metal cavities consisted of silicon nitride (SiN) dielectric coated with silver and then gold (to prevent oxidation). The optical confinement comes in the form of surface-plasmon waves in a thin skin at the metal/dielectric interface. To reduce thermal effects to a minimum, the substrate was removed from these devices.

A 1μm device had a thermal impedance value as low as 1.327ºC/mW and a small thermal wavelength shift of 4.367×10^{-2}nm/ºC. VCSELs have higher values (Figure 3), with a recent 10μm aperture device managing to exhibit a thermal impedance of 2ºC/mW.

Although the quality factor of metal-cavity devices is lower than that for the dielectric confinement of VCSELs, the metal devices tend to have shorter photon relaxation times, allowing for greater modulation speeds.

TU Berlin has also worked with Berlin-based firm Vertically Integrated Systems (VI Systems) on 980nm VCSELs [2]. The longer wavelength has advantages for very-short-reach applications such as next-generation board-to-board, module-to-module and chip-to-chip interconnects.

In particular, the 980nm wavelength is absorbed more readily by silicon photodetectors, compared with 850nm illumination. Such devices could also be used

with active optical cables (AOCs) designed for the 980–1100nm wavelength range.

Other favorable features include lower operating voltage and greater transparency of the GaAs substrate at 980nm. These attributes allow greater freedom in device design and packing density of VCSEL arrays powering high-density interconnects. The 980nm light can be used with polymer waveguides because of absorption and dispersion properties at these wavelengths.

However, there are problems operating at 980nm, such as strict control of doping to avoid excessive free-carrier absorption, as well as strain effects in the active layers. Since 980nm devices are likely to be used in very-short-reach data links that could be located near hot microprocessors, thermal management is again a particular concern.

TU-Berlin/VI Systems have increased error-free ($<10^{-12}$ bit error rate) bit rates at 85ºC from less than 20Gbit/sec to 25Gbit/sec, bringing these devices up to the achievements of 850nm and 1100nm VCSELs at high temperature.

The 85ºC tests were performed without adjusting the drive current or peak-to-peak voltage. Such adjustments complicate drive circuitry and increase total power consumption. The devices were grown

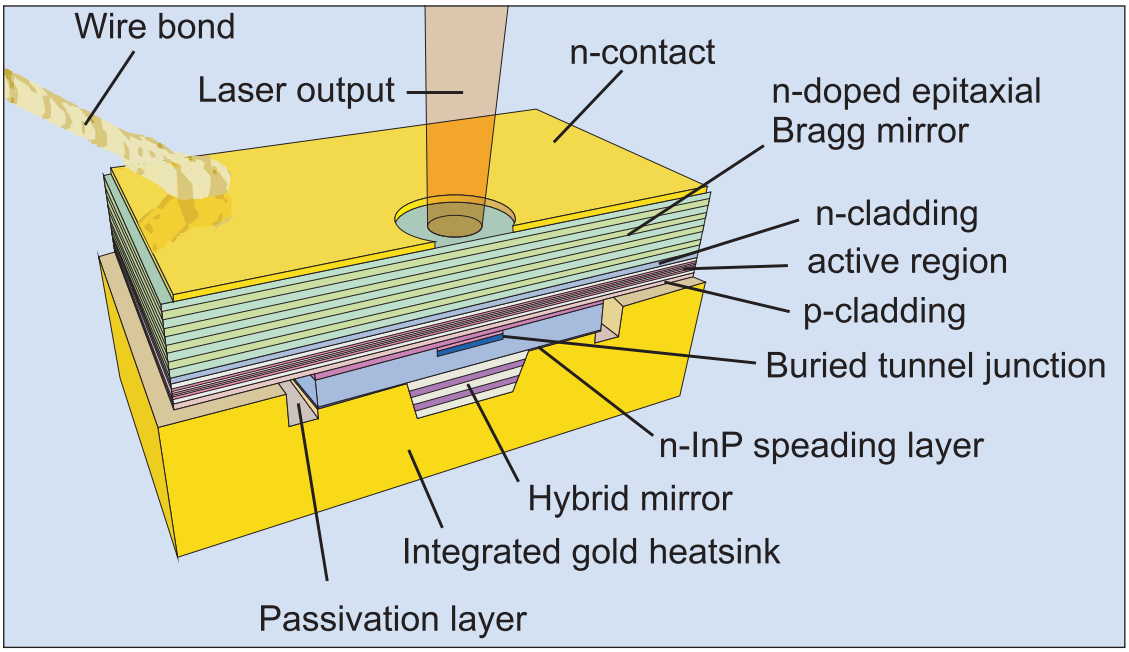

Figure 4. Indium phosphide-based long-wavelength (LW) VCSEL. A buried tunnel junction (BTJ) serves as a current aperture. Gold is used as a bottom reflector (within a hybrid mirror) and a heatsink. A wavelength range of 1.3–2.3μm can be covered by this technology. The device was optimized for continuous wave (CW) operation.

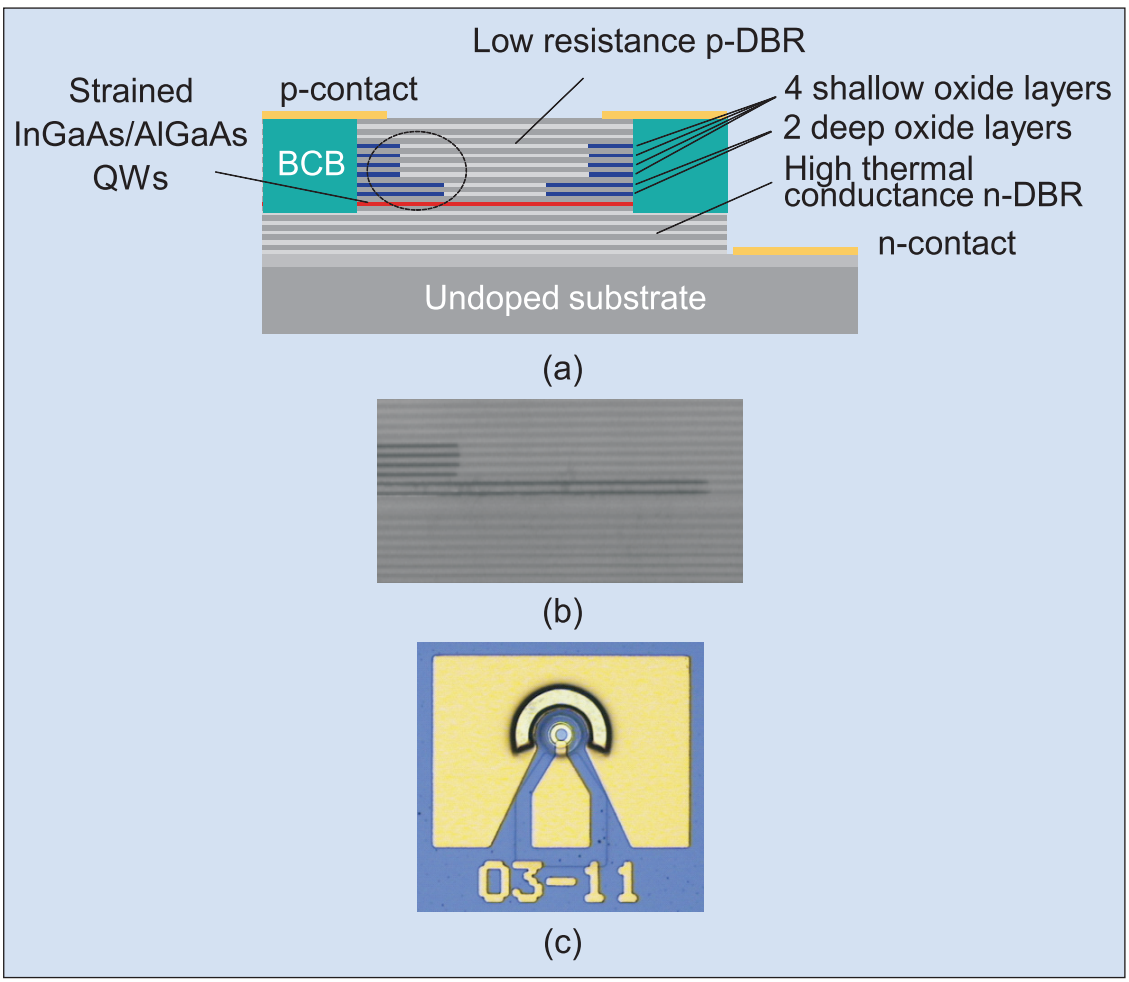

Figure 5. (a) Cross section of Chalmers 850nm VCSEL design, indicating several of the design features for high speed. (b) SEM of the oxide layers (within the area indicated in (a)). (c) Microscope image of the high-speed VCSEL chip showing the ground–signal–ground contacts for high-frequency probing.

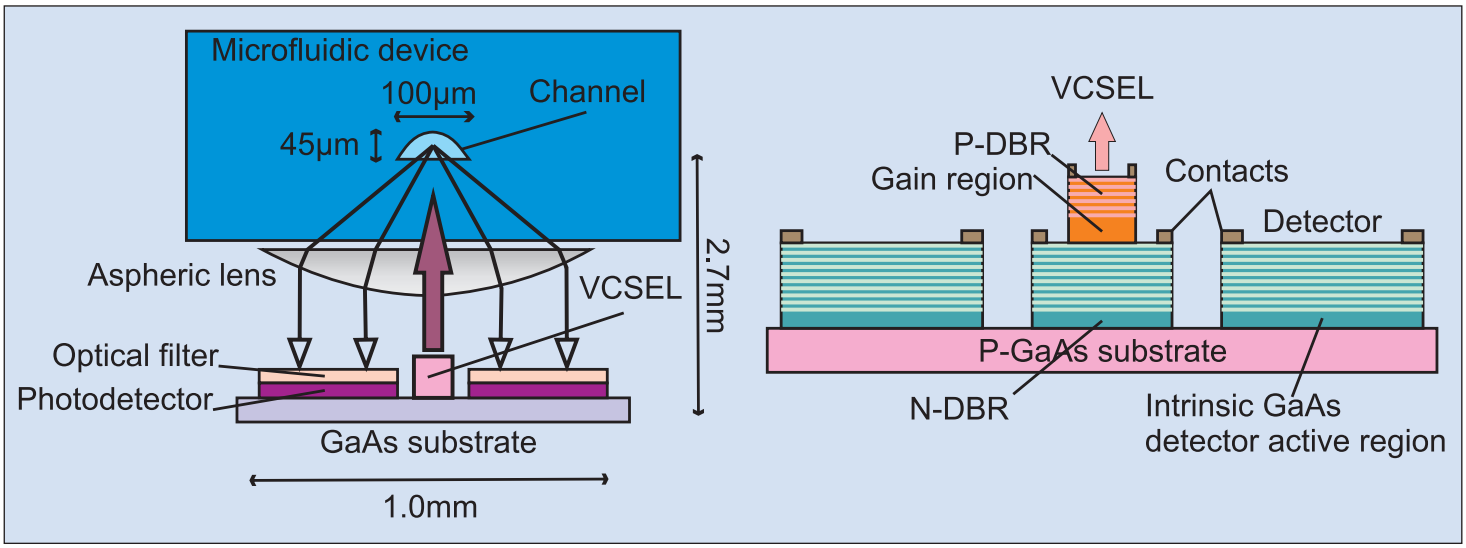

Figure 6. Stanford sensor architecture for 773nm integrated sensor designed for microfluidic applications (left), and the monolithic epitaxial structure to realize such a sensor with the VCSEL bottom DBR used as a fluorescence emission filter (right).

using mature and proven mass-production MOCVD and conventional quantum well designs.

Among the features used to make the VCSEL insensitive to temperature shifts was to detune the quantum well photoluminescence peak and cavity resonance by 15nm. This was designed to compensate for gain decreases at high temperature. As a result, the minimum threshold current was observed at 50ºC. In the 20–85ºC range, the threshold deviates from the minimum by less than 16%. The low threshold current contributes to maintaining the large differential gain that is needed for high-speed operation.

The maximum bandwidth at 20ºC was 15.3GHz, decreasing by only 2GHz to 13.2GHz at 85ºC. The received optical power for the lowest bit-error rate was less than –1dBm (794μW). The power penalty for working at 85ºC (rather than 25ºC) is 0.8dB (1.2x).

Analysis suggests that the dominant speed-limiting factors for the present devices were limited heat dissipation and damping effects. The 980nm research was carried out as part of the European Commission's framework 7 (FP7) project Vertically Integrated Systems For Information Transfer (VISIT) [3].

TU Berlin researchers have also produced 1530nm VCSELs capable of 40Gbit/sec modulation, based on indium phosphide technology [4]. The error-free data rate was somewhat lower at 35Gbit/sec at room temperature (25Gbit/sec at 55ºC). This improved on a design that achieved error-free 25Gbit/sec data rates.

To achieve the 35Gbit/sec performance, the top mirror design was optimized and the manufacturing process improved to give higher yields. The resulting chip has coplanar contact pads, low internal chip capacitance, reduced cavity length, and high single-mode power (2.5mW with 5μm aperture).

Higher data transmission rates of 40Gbit/sec were possible for short pseudo-random bit-sequences (PRBSs) of 2^7-1. But for longer sequences, bit-error rates increased; this is attributed to very thin epitaxial layers very close to the active region with poor thermal conductance and thermal time-constants in the low GHz-range.

Another approach being followed at TU Berlin is using buried tunnel junctions to create lower-resistance p-type contacts [5]. The tunnel junction allows a p-type contact to be connected with lower-resistance n-type material (Figure 4).

40Gbit/sec error-free at 850nm

Chalmers University of Technology in Sweden is among the many other organizations developing VCSELs. Among its latest achievements has been a high-speed multi-mode 850nm VCSEL with 40Gbit/sec error-free operation with less than 0dBm (1mW) of received optical power and small-signal modulation bandwidth of 23GHz [6]. The researchers comment: "This is the first demonstration of 40Gbit/sec error-free operation of an 850nm VCSEL."

The Chalmers team turned to TU Berlin for help with the 40Gbit/sec measurements. The Tyndall Institute in Ireland contributed expertise to the active region design. IQE Europe supplied the epitaxial material.

The bandwidth was maximized through a series of factors affecting the active region, mirrors and oxide layers (Figure 5). The active region (5x strained InGaAs/AlGaAs quantum wells) was designed with a large differential gain and small gain compression (non-linearity). A low-reflectivity top-mirror (22-pair DBR) reduced the photon lifetime. The oxide layers were used to reduce parasitic capacitance, along with providing optical confinement. Bond capacitance was

controlled by putting benzocyclobutene (BCB) under a small bond pad. To reduce resistance, graded interfaces and modulation doping were used in the AlGaAs DBRs.

The resulting VCSEL (with photon lifetime of 3.3psec) had 0.43mA threshold current and 0.98W/A slope efficiency. Increasing the photon lifetime to 6.4psec (by varying the top layer thickness of the p-DBR) gives a lower threshold of 0.28mA but also a lower slope efficiency of 0.46W/A.

The series resistance of the device (130Ω) is described as being relatively high. An 'accidentally high contact resistance' is blamed. The researchers believe that the performance of the device could be improved with lower series resistance to give a few extra GHz of modulation bandwidth.

Widening the application net

Stanford University researchers see a number of possible applications for VCSEL outside of data comms [7]. For example, Stanford has developed plasmonic nano-apertures to produce high optical intensity near-field illumination for sub-wavelength ultra-high-density optical storage, single-molecule spectroscopy, high-resolution imaging and high-throughput inspection.

In one application for such devices, the Stanford team has developed in-vivo monitoring devices for use in small animals (Figure 6). Presently, the VCSEL excitation sources operate in the near-infrared (NIR) range 750–1000nm, but it would be useful to cover a wider range of wavelengths.

Stanford's first in-vivo device (a fluorescence sensor) had a 773nm VCSEL monolithically integrated with a photodetector. The bottom-reflecting DBR of the VCSEL was also used to filter out the excitation light at the photodetector, allowing it to concentrate on fluorescence from the sample. The side lobes of the DBR transmit roughly 40% of the fluorescence from the fluorophore used (IRDye800 phosphoramidite in ethanol). Optical blocking layers were used to prevent cross-talk between VCSEL and sensor.

A more recent fluorescence sensor was based on a 675nm VCSEL (Figure 7) for deep red and NIR applications using fluorescent proteins and fluorophores. This device reversed the growth order between the VCSEL (first) and detector (second). This was to ensure a high-quality material structure for the more challenging shorter-wavelength AlGaInP VCSEL layers.

A further problem for in-vivo systems at shorter wavelength is thermal management, since it is not possible to include heat sinks. The 675nm device achieved 2mW multi-mode output power. The photodetector had a dark current density of less than 5pA/mm^2 with a reverse bias of up to 1V, and an internal quantum efficiency of more than 75%. The fluorophore Cy5.5 was sensed in concentrations as low as 5nM (5x10^{-9}Moles/liter) in vitro and 50nM in-vivo (limited by autofluorescence of animal tissue).

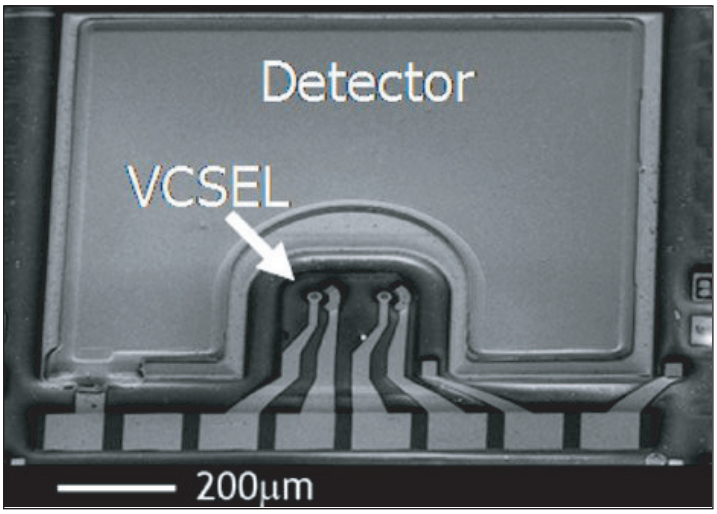

Figure 7. SEM of a single-pixel monolithically integrated fluorescence sensor with 675nm VCSELs and a thin-film emission filter, developed at Stanford.

Although LEDs could be used, VCSELs have higher output intensity and the directional nature of the beam reduces cross-talk. Also, the narrow spectral linewidth of VCSELs enables easier separation between fluorescence excitation and emission wavelengths.

Stanford has also combined 780–850nm VCSELs with photonic crystals and biomolecule capture layers, in efforts to create sensing without fluorescent labeling. The analyte is detected through changes in the index of refraction, affecting the guided resonance of the photonic crystal. Further scanning detection capabilities can be obtained by varying the VCSEL wavelength using changes in temperature or current.

Another possible way forward to more VCSEL applications has emerged in the past few years: high-power light sources (~100W) based on arrays of devices. The 100W level makes possible the use of brute laser power in applications such as cosmetics (hair/wrinkle removal), military/surveillance infrared light sources, pumping power sources for other solid-state/fiber lasers, production of green light through second-harmonic generation (SHG) frequency-doubling, and machining (cutting, drilling, ablation, engraving). ■

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7. J.S. Harris et al, Semicond. Sci. Technol., vol26, p014010, 2011

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1-2221I, Milpitas,
CA 95035,
USA
Tel: +1 408 875 3000
Fax: +1 408 875 4144
www.kla-tencor.com

LayTec GmbH
Seesener Str.
10–13,
10709 Berlin,
Germany
Tel: +49 30 39 800 80 0
Fax: +49 30 3180 8237
www.laytec.de
LayTec develops and manufactures optical in-situ and in-line metrology systems for thin-film processes with particular focus on compound semiconductor and photovoltaic applications. Its know-how is based on optical techniques: reflectometry, emissivity corrected pyrometry, curvature measurements and reflectance anisotropy spectroscopy.

Optical Reference Systems Ltd
OpTIC Technium,
St Asaph Business Park,
St Asaph, LL17 0JD,
UK
Tel: +44 (0)1745 535 188
Fax: +44 (0)1745 535 186
www.ors-ltd.com

WEP (Ingenieurbüro Wolff für Elektronik- und Programmentwicklungen)
Bregstrasse 90, D-78120
Furtwangen im Schwarzwald,
Germany
Tel: +49 7723 9197 0
Fax: +49 7723 9197 22
www.wepcontrol.com

12 Inspection equipment

Bruker AXS GmbH
Oestliche Rheinbrueckenstrasse 49,
Karlsruhe, 76187,
Germany
Tel: +49 (0)721 595 2888
Fax: +49 (0)721 595 4587
www.bruker-axs.de

13 Characterization equipment

J.A. Woollam Co. Inc.
645 M Street Suite 102,
Lincoln, NE 68508,
USA
Tel: +1 402 477 7501
Fax: +1 402 477 8214
www.jawoollam.com

Lake Shore Cryotronics Inc
575 McCorkle Boulevard,
Westerville, OH 43082, USA
Tel: +1 614 891 2244
Fax: +1 614 818 1600
www.lakeshore.com

14 Chip test equipment

Keithley Instruments Inc
28775 Aurora Road,
Cleveland, OH 44139,
USA
Tel: +1 440.248.0400
Fax: +1 440.248.6168
www.keithley.com

SUSS MicroTec Test Systems
228 Suss Drive,
Waterbury Center, VT 05677,
USA
Tel: +1 800 685 7877
Fax: +1 802 244 7853
www.suss.com

15 Assembly/packaging materials

ePAK International Inc
4926 Spicewood Springs Road,
Austin, TX 78759, USA
Tel: +1 512 231 8083
Fax: +1 512 231 8183
www.epak.com

Gel-Pak
31398 Huntwood Avenue,
Hayward, CA 94544, USA
Tel: +1 510 576 2220
Fax: +1 510 576 2282
www.gelpak.com

Williams Advanced Materials
2978 Main Street, Buffalo, NY 14214,
USA
Tel: +1 716 837 1000
Fax: +1 716 833 2926
www.williams-adv.com

16 Assembly/packaging equipment

Ismeca Europe Semiconductor SA
Helvetie 283, La Chaux-de-Fonds, 2301,
Switzerland
Tel: +41 329257111
Fax: +41 329257115
www.ismeca.com

J P Sercel Associates Inc
220 Hackett Hill Road,
Manchester, NH 03102,
USA
Tel: +1 603 518 3200
Fax: +1 603 518 3298
www.jpsalaser.com

Kulicke & Soffa Industries
1005 Virginia Drive,
Fort Washington, PA 19034,
USA
Tel: +1 215 784 6000
Fax: +1 215 784 6001
www.kns.com

Palomar Technologies Inc
2728 Loker Avenue West,
Carlsbad, CA 92010, USA
Tel: +1 760 931 3600
Fax: +1 760 931 5191
www.PalomarTechnologies.com

TECDIA Inc
2700 Augustine Drive, Suite 110,
Santa Clara, CA 95054, USA
Tel: +1 408 748 0100
Fax: +1 408 748 0111
www.tecdia.com
Tecdia is a manufacturer of single-layer chip capacitors, chip resistors, DC boards, bias-Ts, diamond scribing tools and dispensing nozzles.

17 Assembly/packaging foundry

Quik-Pak
10987 Via Frontera,
San Diego, CA 92127, USA
Tel: +1 858 674 4676
Fax: +1 8586 74 4681
www.quikicpak.com

18 Chip foundry

Compound Semiconductor Technologies Ltd
Block 7, Kelvin Campus,
West of Scotland, Glasgow,
Scotland G20 0TH, UK
Tel: +44 141 579 3000
Fax: +44 141 579 3040
www.compoundsemi.co.uk

United Monolithic Semiconductors
Route departementale 128,
BP46, Orsay, 91401, France
Tel: +33 1 69 33 04 72
Fax: +33 169 33 02 92
www.ums-gaas.com

19 Facility equipment

MEI, LLC
3474 18th Avenue SE,
Albany, OR 97322-7014, USA
Tel: +1 541 917 3626
Fax: +1 541 917 3623
www.marlerenterprises.net

20 Facility consumables

W.L. Gore & Associates
401 Airport Rd,
Elkton, MD 21921-4236, USA
Tel: +1 410 392 4440
Fax: +1 410 506 8749
www.gore.com

21 Computer hardware & software

Ansoft Corp
4 Station Square, Suite 200,
Pittsburgh, PA 15219, USA
Tel: +1 412 261 3200
Fax: +1 412 471 9427
www.ansoft.com

Crosslight Software Inc
121-3989 Henning Dr.,
Burnaby, BC, V5C 6P8, Canada
Tel: +1 604 320 1704
Fax: +1 604 320 1734
www.crosslight.com

Semiconductor Technology Research Inc
10404 Patterson Ave., Suite 108,
Richmond, VA 23238, USA
Tel: +1 804 740 8314
Fax: +1 804 740 3814
www.semitech.us

22 Used equipment

Class One Equipment Inc
5302 Snapfinger Woods Drive,
Decatur, GA 30035, USA
Tel: +1 770 808 8708
Fax: +1 770 808 8308
www.ClassOneEquipment.com

23 Services

Henry Butcher International
Brownlow House, 50–51
High Holborn,
London WC1V 6EG, UK
Tel: +44 (0)20 7405 8411
Fax: +44 (0)20 7405 9772
www.henrybutcher.com

M+W Zander Holding AG
Lotterbergstrasse 30,
Stuttgart, Germany
Tel: +49 711 8804 1141
Fax: +49 711 8804 1950
www.mw-zander.com

TECDIA Inc
(see section 16 for full contact details)

24 Consulting

Fishbone Consulting SARL
8 Rue de la Grange aux Moines,
78460 Choisel,
France
Tel: + 33 (0)1 30 47 29 03
E-mail: jean-luc.ledys@neuf.fr

25 Resources

SEMI Global Headquarters
3081 Zanker Road,
San Jose,
CA 95134,
USA
Tel: +1 408 943 6900
Fax: +1 408 428 9600
www.semi.org

Yole Développement
45 rue Sainte Geneviève,
69006 Lyon,
France
Tel: +33 472 83 01 86
www.yole.fr

event calendar

If you would like your event listed in *Semiconductor Today*'s Event Calendar, then please e-mail all details to the Editor at mark@semiconductor-today.com

6–10 March 2011
OFC/NFOEC 2011 (Optical Fiber Communication Conference and Exhibition/ National Fiber Optic Engineers Conference)
Los Angeles Convention Center, CA, USA
E-mail: info@ofcconference.org
www.ofcnfoec.org

13–17 March 2011
OTST 2011: International Workshop on Optical Terahertz Science and Technology
Santa Barbara, CA, USA
E-mail: support.otst@gmail.com
http://otst2011.itst.ucsb.edu

15–17 March 2011
LASER World of PHOTONICS CHINA
Shanghai New International Expo Centre (SNIEC), China
E-mail: laser@mmi-shanghai.com
www.world-of-photonics.net/en/laser-china/start

15–17 March 2011
SEMICON China 2011
Shanghai New International Expo Centre (SNIEC), China
E-mail: semichina@semi.org
www.semi.org/scchina-en

20–23 March 2011
Euro-MBE 2011: 16th European Molecular Beam Epitaxy Workshop
Alpe d'Huez, France
E-mail: embe2011@grenoble.cnrs.fr
http://embe2011.neel.cnrs.fr

21–23 March 2011
SEMATECH Surface Preparation and Cleaning Conference (SPCC 2011)
Austin, TX, USA
E-mail: spcc@sematech.org
www.sematech.org/meetings/spcc

21–24 March 2011
GOMACTech-11: 36th annual Government Microcircuit Applications and Critical Technology conference
Orlando, FL, USA
E-mail: john.franco@dtra.mil
www.gomactech.net

28 March 2011
3rd Thin Film Solar Summit Europe
Berlin, Germany
E-mail: matt@thinfilmtoday.com
www.thinfilmtoday.com/europe

4–6 April 2011
CPV-7 International Conference on Concentrating Photovoltaic Systems
Las Vegas, NV, USA
E-mail: info@cpv-conference.org
www.cpv-conference.org

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13–15 April 2011
11th Fiber Optics Expo (FOE 2011)
Tokyo Big Sight, Japan
E-mail: foe@reedexpo.co.jp
www.foe.jp/en

14–15 April 2011
3rd Photovoltaics Thin-Film Week, including:
— International Workshop on CIGS Solar Cell Technology
— 3rd Thin-Film Industry Forum (TIF 2011)
Berlin, Germany
E-mail: info@solarpraxis.de
www.solarpraxis.de/en/conferences

16 – 21 April 2011
54th Society of Vacuum Coaters Annual Technical Conference (2011 SVC TechCon)
Chicago, IL, USA
E-mail: svcinfo@svc.org
www.svc.org

18–20 April 2011
Semiconductor and Integrated Opto-Electronics Conference (SIOE'11)
Cardiff University, Wales, UK
E-mail: K.A.Shore@bangor.ac.uk
www.astro.cardiff.ac.uk/research/pm/events/?page=sioe

18–21 April 2011
SPIE Optics & Optoelectronics
Prague Congress Centre, Czech Republic
E-mail: customerservice@spie.org
http://spie.org/x25077.xml

18–21 April 2011
Photonica — Lasers, Optics & Application 2011:
6th International Specialized Exhibition for Laser, Optical & Optoelectronic Technologies
ZAO Expocentre, Moscow, Russia
E-mail: ak@expocentr.ru
www.photonics-expo.ru/en

25–29 April 2011
SPIE Defense, Security, and Sensing 2011
Orlando, FL, USA
E-mail: customerservice@spie.org
http://spie.org/defense-security.xml

25–29 April 2011
MRS 2011 Spring Meeting
Moscone West and San Francisco Marriott, CA, USA
E-mail: info@mrs.org
www.mrs.org/spring2011

26–28 April 2011
ISSTT 2011: 22nd International Symposium on Space Terahertz Technology
Tucson, AZ, USA
E-mail: info@nrao.edu
www.nrao.edu/meetings

27–28 April 2011
Advanced Manufacturing in Semiconductors Asia 2011
Kuala Lumpur, Malaysia
E-mail: enquiry@iqpc.com.sg
www.semicon-manufacturing.com

1–6 May 2011
219th Electrochemical Society (ECS) Meeting
Montreal, Canada
E-mail: meetings@electrochem.org
www.electrochem.org/meetings/biannual/fut_mtgs.htm

9–13 May 2011
E-MRS 2011 Spring Meeting
Congress Center, Nice, France
www.emrs-strasbourg.com

10–12 May 2011
Strategies in Light China 2011
Kowloon, Hong Kong, China
E-mail: lubah@pennwell.com
www.sil-ledchina.com

10–12 May 2011
SEMICON Singapore 2011
Suntec, Singapore
E-mail: cchan@semi.org
www.semiconsingapore.org

15–19 May 2011
LIGHTFAIR International (LFI 2011)
Pennsylvania Convention Center, Philadelphia, PA, USA
www.lightfair.com

16–18 May 2011
International Symposium on Photonics and Optoelectronics (SOPO 2011)
Wuhan, China
E-mail: sopo@scirp.org
www.sopoconf.org/2011

16–19 May 2011
2011 CS MANTECH (International Conference on Compound Semiconductor Manufacturing Technology)
Palm Springs Hyatt Grand Champion hotel, CA, USA
E-mail: csmantech@csmantech.org
www.csmantech.org


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