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## Photovoltaic developments: CPVs drive Emcore spin-off CIGS technology update

NGST claims THz transistor • Cree buys LED Lighting Fixtures  
Austin joins LED City program • Nichia samples blue-green laser



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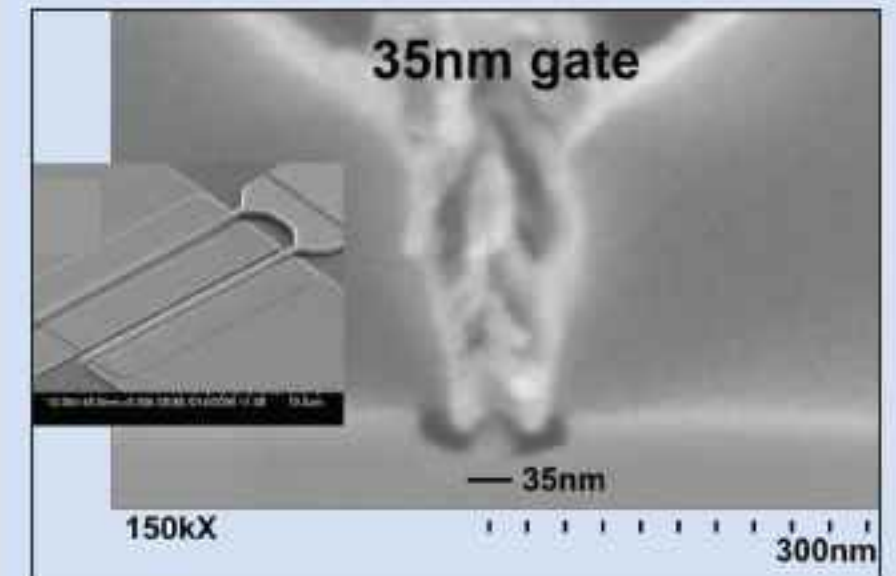
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# Concentrating on photovoltaics

In this issue we focus on developments in two types of thin-film photovoltaic cells. Firstly, in the feature article on page 52, we cover copper indium gallium diselenide (CIGS) PVs, from both the technical aspect (including the use of cadmium-free buffer layers by Honda Soltec and the incorporation of sulfur in the quaternary compound CIGSSe by Johanna Solar Technology to extend the range of absorption wavelengths) and the commercial aspect (with San Jose-based Nanosolar, for example, in late December producing what it claimed was the first printed thin-film solar cell in a commercial panel).


Secondly, on pages 46–49 we report news of the many burgeoning recent commercial developments in GaAs-on-Ge based terrestrial concentrator photovoltaic (CPV) solar cells. Spire (which this year rebranded its Bandwidth Semiconductor as Spire Semiconductor as part of its increasing focus on photovoltaic) now not only provides CPV systems but also contract cell design and manufacturing. Meanwhile, several CPV projects are ramping up around the world in the USA, Canada, Korea and Spain, involving CPV suppliers including SolFocus, Arima and Emcore. Emcore, in particular, has an order backlog dominated not by its fiber-optic products nor its traditional satellite solar cell business but by almost \$100m of orders for its terrestrial CPV cells and, most recently, systems (see page 46). There is also the prospect of supplying a further 700MW of systems to SunPeak Solar for utility-scale projects in south-western USA. Such rapid commercial growth is motivating Emcore to split itself into two firms: a fiber-optic firm and a spin-off CPV firm (targeting an IPO).

Solar business is also having a knock-on effect up the supply chain to the likes of AXT which, as we closed for press, reported revenue for germanium substrates (for solar applications) more than doubling year-on-year. AXT foresees it possibly surpassing semi-insulating GaAs substrate revenue for microelectronic applications within five years (to be detailed next issue).

Regarding GaAs RFIC makers, on pages 6–13 we report Q4/2007 results which show lower-than-expected revenue for RFMD due to temporary softness in the GSM/GPRS market in China (which represents as much as 10% of RFMD's total revenue). Excess inventory should also contribute to Q1/2008 revenue falling by 14–20%.

Likewise, despite a record 2007, TriQuint expects revenue to fall by a more-than-seasonal 10–14% in Q1 due to inventory corrections at tier-1 OEM customers (mainly in GSM, GPRS and EDGE-related handsets). However, both firms forecast a resumption of strong growth starting in the June quarter. TriQuint, in particular, ascribes Q1's expected dip in gross margin to its decision to maintain capital expenditure though Q1's revenue downturn on the basis of its confidence in strong growth subsequently. Such confidence bodes well for the whole supply chain.

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

#### Regular issues contain:

- news (funding, personnel, facilities, technology, applications and markets);
- feature articles (technology, markets, regional profiles);
- conference reports;
- event calendar and event previews;
- suppliers' directory.

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# Top 3 auto LED firms have half of market

Germany's Osram Opto Semiconductors was the largest supplier of LEDs for automotive applications in 2007 (with 23% market share), followed by the USA's Philips Lumileds and Japan's Nichia (16% each), estimates a report 'The Worldwide Market for LEDs in Automotive Applications' by IMS Research.

Despite this, Lumileds and Nichia do not compete with each other to a large extent. "Lumileds sells LEDs mainly for exterior applications while Nichia sells mainly for interior applications," says analyst Jamie Fox. "There are also geographical differences in the supply chain." Nichia does not sell much in Europe, where Osram is strong (in both interior and exterior applications).

The three firms pioneered LEDs for use in daytime running lights, and are now also pioneering LEDs for headlamps. The soon-to-be released Audi R8 will feature a full LED headlamp, supplied by Automotive Lighting, with power LEDs

supplied by Osram and Lumileds. This will be the second vehicle with LED headlamps, after the Lexus LS600h, which used Nichia LEDs. Also, in December, General Motors said that a special edition of its Cadillac Escalade Platinum will this year be the first production sports utility vehicle with LED headlamps.

These firms' experience in this sector, and the more challenging requirements for durability and brightness compared with mobile phones, MP3 players and TVs, make it difficult for other suppliers to challenge, says IMS. While many other suppliers (such as Toshiba, Avago and Everlight) sell LEDs into this sector, they sell far fewer.

But this may change in the next decade as LED headlamps flourish. Lumileds, Osram and Nichia supply LEDs of high brightness and quality suited to forward lighting. It will be interesting to see which of these, or any competitors, can win the biggest share of the headlamp market.

[www.imsresearch.com](http://www.imsresearch.com)

## Mobile WiMax market to grow at a compound annual growth rate of 198% to 2012

The mobile WiMAX market will enjoy a compound annual growth rate (CAGR) of 198% between 2008 and 2012, according to the study 'Telecom Application Report 2008' from Research and Markets, which forecasts the overall client-side RF chipset market.

"Shipments of IEEE 802.16.e chipsets will undergo strong growth over the next five years. However, WiMAX will also see strong competition from LTE [long-term evolution] and HSPA [high-speed packet access] by 2011," says principal analyst Kirsten West.

"Established cellular broadband technologies in this space are growing rapidly and it will be challenging for IEEE 802.16.e technology to displace much of the existing technology infrastructure," she adds.

With a CAGR of 198%, the report's author foresees a substantial advantage for WiMAX in the developing world, as it provides an ideal solution for greenfield deployments of basic voice and data services.

[www.researchandmarkets.com/reports/c81415](http://www.researchandmarkets.com/reports/c81415)

## Handset shipments rise 15.8% to 1.15bn in '07, but '08 forecast cut from 13.5% to 12%

Q4/2007 mobile device sales should reach the forecast of 342m devices, taking the yearly total to 1.15bn (up 15.8% on 2006), says ABI Research VP Jake Saunders in the report 'Mobile Devices Market Sizing and Share'. "Many economic sectors are struggling and there are fears that the global market might mimic the downturn in the USA, but virtually all the mobile device vendors experienced very festive cheer in Q4."

However, taking into account the growing sense of global economic uncertainty, ABI Research has cut its 2008 handset market growth forecast from 13.5% to 12%, adds research director Stuart Carlaw.

Motorola was the only vendor not to enjoy the fruits of 2007. By its own admission, Motorola's market share shrank 38% year-on-year from 23.3% to 12.4%. Nokia, Sony Ericsson, Samsung and LG were net beneficiaries.

Motorola says its market share in Q1/2008 looks set to fall further, but it is fighting back. It has been beefing up its portfolio, and some of its new handset models such as the ROKR E8 have received awards from key trade shows. Also, Motorola reduced its presence in a number of emerging ultra-low-cost handset markets, while Nokia, Samsung, LG, and Chinese vendors such as ZTE and Huawei are pulling out the stops to address them, says ABI.

The market research firm reckons that North America (and to a lesser extent South America) is the chink in Nokia's armor. North American carriers require more customization, exclusive sales periods, and personalization to appeal to their customers. Despite repeated declarations from senior management that Nokia will recover its position in the North American market, it has so far failed to do so, notes ABI.

[www.abiresearch.com/products/market\\_data](http://www.abiresearch.com/products/market_data)



# Handset growth slows in 2007

Cell-phone handset shipments were a record 334m in Q4/2007, up 15.3% on Q3, according to IDC's Worldwide Mobile Phone Tracker.

However, "Over the last three years, [year-on-year] growth in the industry during the holiday quarter has fluctuated from 18% to 30%, and this past quarter we saw it drop to 11.6%," says IDC's Ryan Reith. "The expectation that the market would maintain the level of growth it saw over the last three years was unrealistic. We expect growth to be in the single digits throughout 2008, and most likely for years to follow."

For full-year 2007, year-on-year growth slowed to 12.4%, to 1.14bn. Nokia once again led, but Samsung overtook Motorola into second place.

"For the past few years, Samsung's growth kept pace with the market, but in 2007 it beat the market almost by a factor of four," says Ramon Llamas. "Samsung capitalized on replacement handset opportunities in the USA and Europe with a steady stream of mid-range and high-end devices, while Motorola spent much of the year addressing inventory challenges across EMEA [Europe, Middle East and Africa] and Asia," he adds. "Now that Motorola is implementing a new

handset strategy, it will be interesting to watch the hotly contested number two position in 2008."

Nokia shipped more units in Q4 than the next three vendors combined, driven by entry-level products. Shipments could have been greater without component shortages.

Samsung's sixth consecutive quarter of shipment growth, and its third in second place, yielded double-digit profit margins due to focusing on its premium Ultra Edition phones and converged mobile devices.

Motorola saw continued slowing demand, missing out on growth areas (notably in 3G, China and emerging markets) due to gaps in its portfolio. Recent launches of its ROKR E8, Z10 and W series reflect attempts to revive business, but recovery is expected to continue into 2009.

Sony Ericsson shipped over 30m units for the first time. EMEA again represented most shipments, but it grew its presence in North America, Latin America, and Asia/Pacific. Even with greater attention and resources going on emerging markets, the firm still recorded the highest ASP among leading vendors.

LG Electronics closed further on the 25m mark and, with the success of

premium devices in developed markets and cost effectiveness, operating margin grew slightly. Key to success were several models launched in Q4. But LG's recent gains on Sony Ericsson were reversed as the gap grew to over 7m units.

[www.idc.com](http://www.idc.com)

Cell-phone shipments in Q4/2007 totalled 332m, up 13% year-on-year, according to market research firm Strategy Analytics in its report 'Q4 2007 Global Handset Market Share Update'. Demand remained strong in emerging markets, particularly Africa.

Nokia sold 134m handsets, taking a record 40% market share. "Despite fierce competition from ambitious rivals such as Samsung and Apple, Nokia still managed to gain ground last year," says Strategy Analytics' director Neil Mawston. "A famous brand, attractive handset lineup, strong technology portfolio and the industry's best logistics have enabled Nokia to achieve this impressive milestone."

Samsung held on to second position as 3G shipments surged.

Motorola's share has fallen sharply from 22.4% in Q4/2006 and 13.8% in Q2/2007 (falling behind Samsung into third place) to just 12.3% in Q4/2007, as it continued to suffer from a weak device portfolio (mainly a failure to replace the popular Razr model).

Sony Ericsson's annual growth rate continued to slow after plunging in recent quarters, to its lowest rate in almost three years. Sony Ericsson is starting to be impacted competitively by improved handset portfolios from Samsung, LG and Nokia.

Apple shipped 2.3m iPhones, taking a 0.6% share. Strategy Analytics predicts that Apple will be among the world's top ten vendors by the end of 2008.

For full-year 2007, cell-phone shipments totalled 1.12bn in 2007, up 12% on 2006's 1bn.

Analyst Bonny Joy expects the economic environment to be tougher in 2008, and forecasts slower growth of 10%, to 1.24bn units.

[www.strategyanalytics.net](http://www.strategyanalytics.net)

## Shipments (millions), market share and growth (IDC).

Vendor	Q4/07	Share	Q4/06	Share	Change
Nokia	133.5	40.0%	105.5	35.2%	26.5%
Samsung	46.3	13.9%	32.9	11.0%	40.7%
Motorola	40.9	12.2%	65.7	22.0%	-37.8%
Sony Ericsson	30.8	9.2%	26.0	8.7%	18.5%
LG Electronics	23.7	7.1%	17.7	5.9%	33.6%
Others	58.8	17.6%	51.5	17.2%	14.2%
<b>Total</b>	<b>334.0</b>		<b>299.3</b>		<b>11.6%</b>
Vendor	2007	Share	2006	Share	Change
Nokia	437.1	38.2%	347.5	34.2%	25.8%
Samsung	161.1	14.1%	113.7	11.2%	41.7%
Motorola	159.0	13.9%	217.4	21.4%	-26.9%
Sony Ericsson	103.4	9.0%	74.7	7.3%	38.4%
LG Electronics	80.5	7.0%	63.5	6.2%	26.8%
Others	202.9	17.7%	200.6	19.7%	1.1%
<b>Total</b>	<b>1144.1</b>		<b>1017.4</b>		<b>12.4%</b>

N.B. Branded shipments, excluding OEM sales for all vendors.



# RFMD loss follows dip in China

For fiscal Q3/2008 (to end-December 2007), RF Micro Devices Inc of Greensboro, NC, USA reported revenue of \$268.2m (up 4.8% on \$255.8m sequentially, but down 4.6% on \$281.1m a year ago). Excluding \$14.7m from Sirenza Microdevices Inc (acquired in mid-November for \$900m to expand beyond handset markets), RFMD revenue is 4% below the low end of guidance given in late October (of 4–9% growth to \$265–280m).

Gross margin has fallen from 35.8% a year ago and 32.2% last quarter to 26.2%, due to lower production volumes and a high reliance on outsourcing pHEMT production to Filtronic (about a \$7m drag on gross margin). Compared to net income of \$59.3m a year ago and \$14.5m last quarter, RFMD made a net loss of \$15.1m.

The results are consistent with updated guidance that RFMD gave in mid-January and reflect late-quarter reductions in demand, mainly for GSM/GPRS cellular front-ends (down \$20m sequentially).

Cellular Handset Products Group (CPG) revenue was \$232.8m (down from \$238.3m last quarter). Sequential growth in EDGE and WCDMA was offset by reduced GSM/GPRS demand from customers in China (which represents more than 10% of RFMD's total revenue) and the high concentration of top-tier customers using inventory hubs.

RFMD started EDGE front-end shipments to a leading top-tier handset maker and expects the volume ramp to contribute to the diversification of its revenue base in handsets. The firm also completed the expansion of its Beijing facility (doubling RFMD's assembly capacity), which should boost gross margin improvement throughout fiscal 2009.

Multi-Market Products Group (MPG) revenue was \$35.4m. Record sales of wireless LAN front-ends were driven by RFMD's leading position in WLAN-enabled handsets and shipments of 802.11n front-ends

for notebook computers, offsetting weakness in infrastructure, broadband and consumer markets. MPG also started shipping from its Shanghai production facility, contributing to gross margin improvement.

"While we were disappointed by the weakened demand environment experienced late in December, we made progress during the quarter executing on our strategies to drive diversification, grow earnings per share and generate free cash flow," says president & CEO Bob Bruggeworth. "We improved margins on Polaris 3, and we expect this trend to continue." Also, Sirenza should be accretive to non-GAAP earnings from the current quarter, a quarter ahead of schedule.

Also in fiscal Q3, RFMD agreed the acquisition (due to close in March) of Filtronic Compound Semiconductor for £12.5m. This should expand RFMD's installed capacity by 30% [excluding a possible doubling in Filtronic's available cleanroom space], cut GaAs pHEMT manufacturing costs significantly and improve gross margins throughout fiscal 2009. Especially since the fab is currently under-utilized, and after transfer of RFMD's 'much simpler' pHEMT process, the fab should support RFMD's expected capacity demand with significantly reduced capital expenditure, says Bruggeworth.

For the March quarter, RFMD expects revenue of \$215–230m (down 14–20% sequentially). CPG will be down more than seasonally due to excess GSM/GPRS front-end inventory in China and delay in the ramp-up of a top-tier customer's new low-cost platform, offset by relative strength in EDGE and WCDMA. But, after excess inventory is consumed and the platform ramp starts in March, CPG should rebound to sequential growth in the June quarter.

MPG is expected to be flat to up, as a result of strength in WLAN front-ends, wireless infrastructure and broadband/consumer components, including WiMAX and CATV.

"In the March 2008 quarter, we expect the MPG product mix and supply chain synergies will result in higher margins, and we anticipate quarter-over-quarter growth in sales of Polaris 3 as the high-volume ramp continues," says Bruggeworth. "March guidance reflects improving market dynamics for MPG and relative softness in CPG as GSM/GPRS front-end inventories are consumed in a seasonally down quarter. EDGE and WCDMA are expected to be less-than-seasonal," he adds.

"RFMD projects gross margin improvement in the March 2008 quarter, driven by our diversification strategy, and continued gross margin improvement in the June 2008 quarter, supported by the closing of the pending Filtronic acquisition," says CFO Dean Priddy. "Synergies associated with the Sirenza acquisition are currently ahead of plan."

Indeed, now that the first quarter of partial revenues from Sirenza has

**The Cellular Handset Product Group should rebound to sequential growth in the June quarter**

been completed, for MPG in fiscal 2009 RFMD forecasts revenue of \$250m (up 10–12%), with gross margin of 50% (recovering from 26.2% last quarter, compared to 35.8% a year ago). RFMD is also still target-

ing gross margin of 35% for CPG. Overall, for fiscal 2009, based on customer forecasts, RFMD expects strong year-over-year growth, beginning in the June quarter.

"RFMD anticipates strong cash flow in fiscal 2009 [which should be one of the lightest years for capex], giving the company the flexibility to continue to drive diversification and execute on our announced share repurchase program [the firm's first, of up to \$150m over the next 24 months] in order to improve our capital structure," says Priddy.

[www.rfmd.com](http://www.rfmd.com)



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## SoCs boost GPRS shipments past 750m

By expanding its position in GPRS front-end modules (FEMs) through strategic engagements with system on chip (SoC) suppliers, Skyworks has now shipped over 750 million GPRS power amplifiers (PAs) and FEMs, supporting the increasing demand for entry-level handsets in emerging markets.

Part of Skyworks' InterLite portfolio, the low-cost and small-form-factor FEMs are now in volume production with several SoC providers, including Infineon, MediaTek, Texas Instruments and NXP Semiconductors.

"InterLite FEMs complement our existing EDGE and 3G portfolio, furthering our partnerships with baseband suppliers and OEMs who leverage SoC architectures as part of their low-end handset strategy," said Liam K. Griffin, senior VP, sales & marketing.

Integrating a PA, PA controller and a switch, the FEMs reduce the RF footprint and overall bill-of-materials for low-cost phones. Given its high-power efficiency, these solutions also maintain overall thermal performance and improve battery life.

The InterLite portfolio is led by three key devices:

- the SKY77318 module for quad-band cellular GSM850/900, DCS1800 and PCS1900 handset applications (supporting GPRS multi-slot operation);
- the SKY77518 Tx-Rx FEM with integrated PA control (iPAC) for dual-band cellular handsets comprising GSM900 and DCS1900 operation (supporting GPRS multi-slot operation);
- the SKY77531 high-power efficiency Tx-Rx quad-band FEM with iPAC (now in volume production), which contains a quad-band GaAs HBT PA, a 1P6T switch to enable flexible phone layout, and an integrated CMOS-based controller to manage the PA and switch.

## Skyworks grows quarterly revenue a higher-than-expected 11%

For its fiscal first-quarter 2008 (ended 28 December 2007), Skyworks Solutions Inc of Woburn, MA, USA, which manufactures linear products, power amplifiers, front-end modules and radio solutions, has reported revenue of \$210.5m, up 7% on \$196m a year ago and up 11% on the previous quarter's \$190.5m (better than its guidance of 9%).

On a non-GAAP basis, operating income was \$28.6m, up from \$22.7m the previous quarter. Net income was \$27.9m, up from \$23.0m. Diluted earnings per share was a record \$0.17 (\$0.01 ahead of consensus estimates). Skyworks also generated a record \$55m of cash flow from operations.

"Skyworks delivered solid results in the December quarter, with operational execution translating into improved profitability," says president and CEO David J. Aldrich.

"Our linear products momentum, share gains at key handset OEMs and increased multimode sales fueled double-digit top-line growth and both record earnings per share and cash flow generation."

During the quarter, Skyworks: introduced custom RF solutions for

automatic meter reading applications; increased shipments of GSM and WCDMA base-station RF ICs to network infrastructure maker Huawei; ramped multimode front-end solutions at Samsung; enhanced multimode front-end module (FEM) market position by increasing EDGE and WCDMA shipments with a new tier-one OEM; launched front-end modules with Research in Motion; and extended the partnership with China's MediaTek (one of the world's fastest-growing solution providers) to include power amplifiers and front-end modules.

Skyworks also acquired Freescale Semiconductor's power amplifier and front-end module product line.

For its fiscal second-quarter 2008, Skyworks expect to largely offset the seasonally low March quarter for handsets with growth from its linear products portfolio and multimode handset content gains, says VP and chief financial officer Donald W. Palette. "Accordingly, we anticipate delivering \$200m in revenue [down just 5% on fiscal Q1 and up 10% on \$180.2 m a year ago] and diluted earnings per share of \$0.15 on a non-GAAP basis."

[www.skyworksin.com](http://www.skyworksin.com)

## McLachlan replaces Decker as chairman

Skyworks says that Dwight W. Decker will retire as the chairman of its board of directors, effective with the annual shareholder meeting in March. David J. McLachlan, currently chairman of the board's audit committee, will serve as the new chairman.

"Dwight Decker has been instrumental in guiding Skyworks to its leadership position in mobile connectivity semiconductors," says president and CEO David J. Aldrich. "We thank Dwight for his strong commitment to our business and his many contributions over the years."



**Dwight Decker.** Decker has been chairman since June 2002. He has also been chairman of the board of Conexant Systems Inc since December 1998 and a director since 1996.

McLachlan has been a Skyworks director since 2000. He was executive VP and chief financial officer of Genzyme Corp from 1989 to 1999 and was later a senior advisor to Genzyme's chairman and CEO. McLachlan also serves on the board of directors of Dyax Corp.



## Anadigics' record sales boosted by 3G and WLAN/WiMAX

For Q4/2007, Anadigics Inc of Warren, NJ, USA, which makes GaAs-based wireless and broadband communications components and modules, reported its 11th consecutive quarter of revenue growth, to a record \$67.6m. This is up 13.5% on \$59.5m last quarter and 39.4% on \$48.5m a year ago (near the top end of October's guidance of 10–14% and 35–40%, respectively).

Broadband revenue was \$25.3m, up 13.6% year-on-year but down 1% sequentially. However, wireless revenue was \$42.3m, up 24.5% sequentially and 61.3% year-on-year. "Momentum in 3G and WLAN/WiMAX continued to accelerate at a solid pace, with sequential revenue growth in the fourth quarter of 37.9% and 19.5%, respectively," says Dr Bami Bastani, president & CEO. Top customers included Samsung, Intel, LG Electronics, and Huawei.

Net income was \$2.9m, up from \$2.4m last quarter and a net loss of \$0.1m a year ago.

"We demonstrated continuous improvements in our manufacturing operation, leading to higher-than-anticipated gross margins [36.1%, up from 35.1% in Q3/2007]," says chief financial officer Tom Shields. "Our production capacity plans continue to progress through equipment expansion in our New Jersey fab, qualifying external foundries and building our next fab in China," adds Bastani. Cash generated of \$19.5m offset capital expenditure of \$19m.

Full-year 2007 sales were a record \$230.6m (up 38% on \$166m in '06). Broadband revenue was \$101.6m (up 35%), including WiFi and WiMAX revenue up 52% (with WiMAX power amplifier revenue doubling). Wireless revenue was \$129m (up 41.4%), driven by 3G PAs (after exiting the commoditized, low-margin 2G GSM/GPRS market early in 2007). In particular, demand for Anadigics' third-generation of HELP PAs doubled for WCDMA HSPA during 2007, says Bastani.

Gross margin rose from 31.2% to 35.7%. Compared with 2006's net loss of \$8.8m, 2007 yielded the first net profit (\$6m) since 2000.

For Q1/2008, Anadigics expects revenue to rise again, by 1–4% on Q4/2007 to \$68–70m (unaffected by industry seasonality: the third consecutive year of Q1-over-Q4 sequential growth). This is also up 37–41% year-on-year. Growth will be led by 3G wireless and WLAN. "We are expecting to buck seasonality in Wireless in the first quarter while working to build further market share with our top-tier customers," says Bastani.

However, net income per share is expected to fall from Q4/2007's \$0.05 to \$0.02–0.03, due to boosting funding for manufacturing in the New Jersey fab to meet demand, increased R&D investment, and lower cable infrastructure revenue. "In the first quarter, we are expecting an unfavorable product-mix shift related to lower revenue from cable [CATV] infrastructure and increased investments in manufacturing, which will lower gross margins from the fourth quarter," says Shields.

However, cable infrastructure may resume growth in Q2/2008, for which orders and forecasts are stronger. "We believe this shift is temporary, and therefore we expect that we are better positioned to resume quarterly gross margin expansion in Q2," reckons Shields.

In addition, Bastani highlighted new products launched at the 2008 GSMA Mobile World Congress in Barcelona, Spain, including the 5mm x 5mm AWT6155 3G quad-band polar EDGE PA module (half the size of current-generation EDGE PA modules) for use with Qualcomm's WCDMA and HSPA chipsets, and the 4.5mm x 4.5mm AWM6422 PA for 2.3–2.4GHz WiMAX and WiBro, which can be operated at not just 3.3V but also supply voltages up to 4.2V.

[www.anadigics.com](http://www.anadigics.com)

## Anadigics' board gains retired senior VP of TI's wireless terminals unit

Anadigics has appointed Gilles Delfassy, the retired senior VP of Texas Instruments Inc's worldwide wireless terminals business unit, to its board of directors.

A veteran with over 28 years of experience in global business development and wireless technology, Delfassy had been at the helm of TI's wireless terminals business unit since its inception in 1995, growing it into a multi-billion dollar operation.

"Gilles has been a champion of mobile communications worldwide for several decades and brings a wealth of sophisticated business acumen and technical wireless expertise to our next generation of enabling semiconductor technology," says president & CEO Bami Bastani. Delfassy should be invaluable in helping to shape the future of Anadigics as it continues to grow and expand in the wireless market and explore new, yet untapped applications for its broadband wireless and wireline communication technology, Bastani adds.

"As the industry addresses the ever-increasing complexities of next-generation wireless networks, Anadigics' leading-edge technology will continue to morph and evolve to meet the future needs of our wireless and broadband customers in 3G, 4G and beyond," says Delfassy.

Apart from Bastani, Anadigics' board now consists of chairman Ronald Rosenzweig, Paul Bachow (senior managing director, Bachow & Associates Inc), David Fellows (executive VP of Comcast Cable), Harry Rein (general partner, Foundation Medical Partners), Lewis Solomon (co-founder & CEO, Broadband Services Inc), and Dennis Strigl (president and chief operating officer, Verizon Communications Inc).



# TriQuint expects strong rebound from Q1 dip after record 2007

RF front-end component maker TriQuint Semiconductor Inc of Hillsboro, OR, USA has reported full-year 2007 revenue of \$475.8m (up 18% on 2006's \$401.8m, and exceeding its previous record in 2000).

Q4/2007 revenue was \$128.5m (up 12% on \$114.3m a year ago and up 4.5% on Q3's \$122.9m). Revenue came from handsets, 53%; networks, 36%; and military, 11%. For the sixth quarter in a row, Samsung comprised over 10% of revenue (boosting Asia to 65% of the total).

By standard, handset revenue was 47% GSM/GPRS, 30% CDMA, and 23% WCDMA/EDGE/other. Growth in transmit modules was 44% (10% in CDMA; 59% in GSM). 3G growth was 59%. In particular, EDGE product revenue grew five-fold.

In networking markets, wireless LAN revenue was up year-on-year by 143% (driven by demand for laptop connectivity), point-to-point radio product revenue was up 20%, and GPS revenue was up 173%.

Defense-related revenues were roughly flat on a strong Q4/2006, but up 10% sequentially. Full-year 2007 military revenue rose 7%.

Driven by fab utilization of 85% in Hillsboro as well as improved yields and favorable product mix (with new products — launched in the last two years — back to about 50% of revenue), gross margin has grown from 29.4% a year ago and 32.2% last quarter to 36.7%, taking 2007 to 31.8% (up from 30.8% in 2006).

Net income has risen from \$1.9m last quarter to \$13.8m, taking 2007 to \$23.4m (up from 2006's \$21.8m).

For Q1/2008, TriQuint is over 89% booked, but revenue should fall to \$110–115m (versus \$110.6m a year ago) with utilization falling to nearly 70% (and gross margin to 30%). This is due not only to seasonality but also to inventory corrections at specific tier-1 OEM customers

(mainly for GSM, GPRS and EDGE-related handsets): over-ordering in Q4 in one case, and a new policy to reduce material on hand in the other.

However, president and CEO Ralph Quinsey says these issues represent neither an impact beyond Q1 nor any general softness in the market. "I expect solid growth in Q2, accelerating in the second half of the year," he adds. "I expect strong growth to come from our recently announced products and have focused the company on preparing to meet the growing demand," he continues.

"I am committed to the successful ramp of these large programs in support of Q2 and beyond. We intend to maintain our spending level in support of these important opportunities."

"We are continuing to invest on the premise of a very strong 2008, where alternatively we could have backed off," confirms chief financial officer Steve Buhaly. "We are maintaining our investment levels in the first quarter [compared to Q4/2007's CapEx of \$8.4m] despite relatively disappointing top-line performance."

"TriQuint continues to penetrate the high-volume mobile phone market and expand our leadership position in the military and networks markets," says Quinsey. "Our handset strategy leverages the broadest technology portfolio in the industry, providing our customers with better performance and lower cost in their applications. As the world transitions from mobile voice to mobile data, TriQuint supplies the market with some of the most highly integ-

rated front-end modules," he claims. "This is simplifying our customers design effort, yielding faster time to market and reduced board space requirements for the RF section in the phone." Due to upgrades from 2G phones, 3G phones are the fastest growing portion of the market, and hence dollar content is increasing. Quinsey expects TriQuint's 3G business to continue to grow rapidly in 2008.

In addition, the mobile data market (e.g. laptops) is now TriQuint's second largest RF market. Similarly to handsets, RF content is increasing due to the popularity of new standards that provide greater bandwidth, higher data rates, and better quality of service. The transition to 802.11n is well underway, and TriQuint recently announced a platform representing its strategy to integrate component content (LNAs, PAs, switches, and some filtering) on to a single GaAs die in a 6mm x 4mm module solution for dual-band MIMO. Three of these high-end front-end modules provide a complete RF front-end for the 3/3 MIMO architecture (now shipping to a major chip maker). Executing this product roadmap raises TriQuint's content in laptops from less than \$1 (prior to TriQuint becoming a module integrator) to over \$4 (and maybe \$5–6). Quinsey expects significant near-term revenue growth, starting to pick up in Q2/2008 and ramping to a peak in Q4 (or maybe a year from now).

"Our two largest markets, cellular phones and wireless LAN are growing in unit demand with expanding RF content," Quinsey says. The strategy of replacing components with highly integrated RF front-end modules across all markets will accelerate in 2008, he continues. The RF space is seeing expansion of demand based on multi-mode,

**We are continuing to invest on the premise of a very strong 2008, where alternatively we could have backed off.**



multi-band phones in the transition from 2G to 3G, and the transition from single-band WLAN to multi-band WLAN (802.11n).

So, despite the economic concern in North America, for full-year 2008 TriQuint expects revenue to grow 18% on 2007 to \$540–580m (driven by strong WLAN opportunities in its network business and market share growth in its handset business) and earnings per diluted share of \$0.30–0.40. Non-GAAP earnings are expected to be \$0.35–0.45 (up 43% on 2007).

"I am confident 2008 will be another record revenue year, with solid improvements in margin structure, operating income, and earnings," says Quinsey. "We have good visibility into several large opportunities ramping in Q2 and beyond."

In 2008, Quinsey foresees growing revenue in the networks and military

markets (first with WLAN module integration, then new defense opportunities); solid revenue growth from 3G Quantum and Tritium modules for the handset market (including Quantum II and Tritium III modules, which were launched in mid-February and should ramp in second-half 2008); focused and disciplined R&D spending; expanding product strength, and steady execution of the firm's roadmap to margin expansion.

"We are adhering to our strategic model where we intend to spend about 25% OpEx as a percent of revenue, and strive to obtain 40% gross margins [at \$160–170m quarterly revenue]," adds Buhaly.

**We are adhering to our strategic model where we intend to spend about 25% OpEx**

"I am not sure we'll quite get there during this year, but we will definitely make progress over 2007."

"Our target is to get closer to about 95% utilization," comments Quinsey. Also, TriQuint has the ability to expand the Oregon fab about another 20–25% with some investment. "Based on demand, it's likely we'll do that... It's a relatively small CapEx in the numbers that we have been talking about," he adds.

"Incrementally, this is probably the cheapest capacity we'll ever buy, because it's really bottleneck remediation."

Quinsey adds that TriQuint's fab in Richardson, TX is fairly large, with very low space and equipment utilization, but it's already facilitated and is largely staffed with the overall engineering superstructure. This would allow TriQuint to probably more than double its existing capacity relatively inexpensively.

## TriQuint unveils optical lithography foundry process for high-volume, commercial millimeter-wave products

TriQuint Semiconductor, the world's largest GaAs foundry supplier, has unveiled TQP13-N, its latest process technology for designing and manufacturing cost-effective, high-frequency millimeter-wave products for the commercial marketplace. Designed using its patented transistor technology, which replaces traditional electron-beam gate lithography with optical gate lithography, the firm claims that its TQP13-N process offers dramatic cost savings over current millimeter-wave technologies.

Historically, millimeter-wave applications, which operate at frequencies up to 95GHz, have been limited to military and other low-volume products due to high cost. TriQuint says that the TQP13-N process can broaden the market for higher-frequency applications, such as mobile satellite TV, WirelessHD and adaptive cruise control (ACC), by offering a cost-effective solution for high-volume millime-

ter-wave products. Market research firm Gartner notes that the global penetration rate for ACC is currently just 1%, but it expects that by 2015 more than half of all new cars will be fitted with ACC or some variant.

"Over 40% of all minivans, full-size sports-utility vehicles (SUVs) and luxury SUVs manufactured in the last two years featured rear-seat entertainment systems or LCD screens, providing a broad customer base capable of integrating aftermarket mobile satellite TV systems," adds Frost & Sullivan program manager Sandeep Kar.

"High-frequency applications have been considered too expensive for use in commercial markets. With TQP13-N, TriQuint is offering a disruptive new technology at a price point that can drive the volume needed to be successful," says Mike Peters, director of marketing for TriQuint's Commercial Foundry. TQP13-N, together with TriQuint's

design tools, application support and GaAs foundry services, offers manufacturers the opportunity to broaden their presence in existing markets and develop innovative new uses for millimeter-wave applications, reckons Peters.

TriQuint says that TQP13-N is enabled by a unique, low-cost 150mm GaAs wafer manufacturing process that incorporates a highly repeatable optically defined 0.13µm self-aligned gate pHEMT field-effect transistor (FET) using a highly reliable refractory gate metal system, coupled with high-density capacitors, epitaxial and nichrome resistors, and two layers of gold interconnect. The use of optically defined gates greatly reduces the cost of production compared to similar processes based on electron-beam gate lithography.

The firm says that the process is in production, and device samples and design kits are now available.

[www.triquint.com](http://www.triquint.com)



## TD-SCDMA chipset order for China

WJ has received an initial production order worth \$0.5m for its first TD-SCDMA multi-chip module (MCM) chipsets, for delivery in Q1/2008 to a Chinese telecom equipment and network provider. Further deliveries are expected later in 2008 to support roll-out of China's TD-SCDMA 3G standard.

"Over the past several years, we have strategically focused our product roadmap on providing semi-custom system-level, highly integrated MCM and RFIC solutions," says president and CEO Bruce Diamond.

For TD-SCDMA, WJ also offers small-signal solutions consisting of mixers, 5V drivers, and 28V power amplifiers.

## Catalog and Internet sales channel deal

WJ has signed a global catalog and Internet sales channel partnership agreement with electronic component distributor Mouser Electronics Inc of Mansfield, TX, USA, focused on the rapid introduction of new products and technologies to electronic design engineers.

Mouser will stock RF amplifiers, mixers, and frequency converters. "Our new partnership with Mouser Electronics will complement our existing sales channel by leveraging their strength in catalog and online sales outreach, thus expanding our presence into universities and developing opportunities early in the sales cycle," says Haresh Patel, WJ's senior VP of sales & marketing.

According to Mike Scott, Mouser's VP of Active Products, the sales channel agreement capitalizes on Mouser's core competences of fast introduction, extensive stocking, and promotion of the newest products to the design engineering community as well as its educational institution customer base.

[www.mouser.com](http://www.mouser.com)

## WJ raises Q4/2007 estimates again and re-engages with key customer

WJ Communications Inc of San Jose, CA, USA, which designs and supplies RF products for wireless infrastructure, RFID and WiMAX markets, now expects Q4/2007 revenue of \$10.5–10.6m, above the updated estimate of \$10.2–10.5m that it gave on 8 January (which itself was up on November's guidance of \$9.3–10.3m, due to strength within the distribution side of the business). The new estimate is 7–8% up on Q3.

Together with an improvement in working capital, WJ also expects to be profitable on a non-GAAP basis for the third consecutive quarter (since closing its fab last March) and to generate \$3.5m in cash (up from the last estimate of \$3.3m). Cash reserves are expected to be \$16.7m (at the end of 2007).

Also, a customer that had delayed qualification of several cost-reduced parts during 2007 has now awarded WJ a substantial portion of their next procurement, which will allow WJ to re-engage with what it describes as a key customer. Shipments are expected to begin in Q2/2008 at the rate of about \$400,000 per quarter.

"We are pleased with the effectiveness of our cost-savings initiatives implemented over the course of the last year, which will result in a lower-cost business model and provide significant leverage on revenue and operational improvements," says president and CEO Bruce Diamond.

WJ expects to report Q4 and year-end 2007 results in late February.

[www.wj.com](http://www.wj.com)

## High-linearity driver amps & PAs for WiMAX

WJ has launched a new series of four products targeted at high-performance WiMAX/WiBro customer premise equipment (CPE) and/or base transceiver stations (BTS). The AH314/AH315 high-linearity 2W two-stage driver amplifiers are available in a 5mm x 5mm QFN20 package; the AP561/AP562 high-performance 8W single-stage power amplifiers are sampling (with production starting in March) in a 5mm x 6mm DFN14 package.

The amplifiers are suited to use in WiMAX/WiBro applications at the commonly targeted sub-bands within the 2.3–2.9 and 3.3–3.8 GHz frequency ranges. All four are based on InGaP/GaAs HBT technology, and incorporate proprietary bias circuitry to compensate for variations in linearity and current draw over temperature. An internal active bias allows the AH314/5 to operate at a single voltage of +5V, and the AP561/2 to operate at +12V with an added +5V power-down control pin.

The AH314 two-stage amplifier has 23dB gain operating at 2.3–2.9GHz;

the AH315 has 25dB gain operating at 3.3–3.8GHz. Both offer +25dBm linear output power with less than 2.5% error vector magnitude (EVM) and >2W of compressed 1dB power. Key characteristics are very low EVM at high power backoff conditions as well as good gain flatness (<0.2dB over a 100MHz window). The AH314/5 are suited to WiMAX/WiBro BTS applications requiring linearity margin prior to the system's final-stage amplifiers (as the driver amplifier immediately after the direct modulator or transceiver chipset).

The AP561 and AP562 offer 12dB gain and operate at 2.3–2.9GHz and 3.3–3.8GHz, respectively. The amplifiers deliver >1W of linear power at <2.5% EVM with +39dBm of 1dB compressed output power. At 1W, the amplifiers also have 13% of power-added efficiency, meeting the needs for ultra-efficient systems. High output linear power and efficiency suit outdoor CPE applications (for single-ended or balanced configurations to achieve higher output power levels).



## Hittite continues growth, but profit falls short of forecast

Hittite Microwave Corp of Chelmsford, MA, which designs and supplies RF, microwave and millimeter-wave ICs, modules and subsystems, has reported Q4/2007 revenue of \$42.5m (at the top end of October's forecast of \$41.5–42.5m). This is also up 6.4% on \$39.9m last quarter and up 20% on \$35.4m a year ago.

Gross margin was 70.8%, level with both 71% last quarter and a year ago. Net income was \$13.4m, up on \$12.1m a year ago but down 2.4% on \$13.7m last quarter (and slightly short of October's forecast of \$13.7–14m). Nevertheless, cash and short-term investments rose by \$3.3m to \$164.7m.

"Our fourth quarter was an excellent finish to the year," says chairman & CEO Stephen Daly. For full-year 2007, revenue was \$156.4m, up 20% on 2006's \$130.3m, and net income was \$51.2m, up 20% on \$42.7m. Order backlog rose from \$34.6m to \$36.5m. Hittite strengthened its business during the year by increasing the breadth of its product portfolio, says Daly.

"For 2008, we will remain focused on growing our revenue by further penetrating our target markets and continuing to invest in research and new product development," he adds.

For Q1/2008, Hittite expects revenue to be steady at \$42–43m, and net income to be \$12.9–13.3m.

[www.hittite.com](http://www.hittite.com)

## Hittite creates chief technology officer role

Hittite has promoted Michael Olson to VP of Engineering, responsible for managing worldwide engineering resources and design centers.

Olson has been at the firm for 12 years and recently served as director of IC Engineering and director of New Product Development.

Former VP of Engineering Michael Koechlin has been appointed to

the newly created post of chief technology officer, responsible for continuing to develop Hittite's long-term technology strategy.

"I am pleased to expand the structure and leadership in our engineering organization to support the growth in the company's business and technology," says chairman and CEO Stephen Daly.

## Mimix's 13.5–17/27–34GHz MMIC doubler integrates gain, doubler and driver stages

Mimix Broadband has introduced an active doubler that delivers +20dBm output saturated power and 35dBc fundamental suppression.

Using 0.15 $\mu$ m gate-length GaAs pHEMT technology, the XX1007-QT doubler covers the 13.5–17/27–34GHz frequency bands and integrates a gain stage, passive doubler and driver amplifier in a single device.

Also, on-chip ESD protection and an integrated bypassing capacitor eliminate the need for any external components. In addition, the device has a self-bias configuration, requiring only a +5V supply.

The high level of integration, coupled with a standard 3mm x 3mm plastic QFN package, saves board area and component count. "Eliminating the need for negative voltage supply and external bypassing elements simplifies our customers' PCB layout and reduces their time to market," says product manager Amer Droubi. The high output power of the XX1007-QT suits use as a driver stage to the final output power amplifier in VSAT transmit systems." The device is also suited to millimeter-wave point-to-point radio, LMDS or SATCOM applications.

## Receiver and transmitter MMICs complete first 38GHz SMT chipset

Mimix Broadband Inc of Houston, TX, USA has launched surface mount technology (SMT) packaged, gallium arsenide monolithic microwave integrated circuit (MMIC) receiver and transmitter devices that cover the 35–45GHz and 36–42GHz frequency bands, respectively.

The XR1008-QB receiver integrates an image-reject mixer, an LO doubler/buffer amplifier, and a low-noise amplifier and is offered in a 7mm x 7mm SMT package. The XU1006-QB transmitter integrates a balanced, image-reject mixer, an LO doubler/buffer amplifier, and an output RF amplifier consisting of a series of gain and attenuation stages to achieve linear gain control with a fixed IF input level.

The image-reject receiver has a noise figure of 3.5dB and 10dB conversion gain with +5dBm IIP3. The transmitter has a +17dBm output OIP3 and 5dB conversion gain across the band.

The receiver/transmitter pair is suited to wireless communications applications such as millimeter-wave point-to-point radio, local multipoint distribution services (LMDS), SATCOM and VSAT applications.

The devices come in 7mm x 7mm QFN surface-mount laminate packages. "The receiver and transmitter pair, along with our XP1031-QK power amplifier, complete the industry's first 38GHz SMT chipset," claims product manager Paul Beasley. "By offering highly integrated devices in surface mount packaging technology, we enable our customers to greatly simplify their designs and improve time-to-market at a lower cost."

[www.mimixbroadband.com](http://www.mimixbroadband.com)



## Axiom shipped 10m CMOS PAs in 2007

Axiom Microdevices Inc of Irvine, CA, USA shipped more than 10m units of its AX502 quad-band GPRS CMOS power amplifier (PA) in 2007.

Cellular handsets containing the PA, made by Taiwanese foundry TSMC, are now available to consumers in Asia, Europe, and Australia.

Axiom reported shipment of its first million units only in Q2/2007, then shipment at more than 1m per month in August. "More customers are starting to enjoy the benefits of a simpler CMOS supply chain after years of being locked into proprietary process technologies with complex supply chains," says CEO Brett Butler.

In 2007 a shortage of PAs impacted shipments of handsets in China.

"This tends to happen regularly due to the small-scale manufacturing capabilities of the leading PA suppliers relative to the silicon CMOS industry and TSMC," adds Butler.

"By leveraging mainstream CMOS-based process technologies, we have been able to insulate our customers from supply shortages through a very steep production ramp."

"Axiom puts the power amplifier on a silicon CMOS cost curve through the use of economies of scale and supply chain simplicity that TSMC's 0.13 $\mu$ m RF-CMOS provides," says Ken Chen, TSMC's director mainstream technology marketing.

The PA uses a 0.13 $\mu$ m silicon CMOS process to integrate all functions between transmitter output and transmit/receive switch. Power gain stages, small-signal control circuitry and 50 $\Omega$  matching are integrated on a single die, achieving what was previously only viable with devices using proprietary GaAs process technology and assembled in multichip module packaging, claims Axiom.

The reliability of the quad-band GPRS PA has been proven through thousands of hours of life testing and high-volume shipments to top Asian handset manufacturers which have, to date, reported zero field failures, adds Axiom.

[www.axiom-micro.com](http://www.axiom-micro.com)

## Infineon ships first CMOS RF switch on silicon with GaAs performance

Infineon Technologies of Neubiberg, Germany is shipping in volume what it claims are the world's first RF switches manufactured in a CMOS-based process on silicon wafers offering equivalent performance to RF switches manufactured using GaAs process technology. Previously, CMOS-based RF switches had to be manufactured on dedicated, much more expensive sapphire wafers to reach the performance of GaAs switches.

The first product in a whole new family of CMOS-based RF switches, the BGS12A, comes in a fine-pitch wafer-level package (WLP) with dimensions of 0.79mm x 0.54mm, which is about 60% less PCB space compared to the smallest packaged GaAs RF switch on the market, Infineon claims. In many wireless products (including cell phones, WLAN, WiMAX, GPS navigation systems, Bluetooth accessories or remote-keyless entry), RF switches are typically used to implement switching functions for receiving and transmitting (Rx/Tx) data, band select or antenna diversity applications as well as enabling worldwide roaming. On average, mobile devices typically have one RF switch, but some multi-band multi-mode phones have up to four.

"Infineon's CMOS-based RF switches come in a tiny chip-scale package and require no further external components, such as level shifters, offering more space savings for various board designs," says Michael Mauer, senior director of Silicon Discretes at Infineon. "With the increasing complexity of modern mobile devices, RF switches are expected to substitute today's PIN diodes in the next five years."

According to market research firm Strategy Analytics, the market for RF switches comprised about 2bn pieces in 2006 and is expected to double to about 4bn by 2011.

Infineon's new RF switches are manufactured in a unique RF CMOS



The 0.79mm x 0.54mm BGS12A.

technology, combining the benefits of CMOS with what is claimed to be outstanding RF performance (low insertion loss, low harmonic distortion, good isolation and high power levels). CMOS advantages include high integration capabilities, cost effectiveness and ESD robustness. Compared to existing solutions, the CMOS-based RF switches offer the highest integration capabilities; are less expensive than GaAs devices; and allow higher battery life than PIN diodes, since current consumption is much reduced. All Infineon RF switches require no external DC blocking capacitors and integrate all control logic. CMOS-compatible logic levels (1.4–2.8V) eliminate the need for external level shifters.

The BGS12A is a general-purpose single-pole double-throw (SPDT) RF switch designed for power levels of up to 20dBm, with a  $P_{-1dB}$  above 30dBm. The new RF switch offers RF performance with an insertion loss of only 0.3dB at a frequency of 1.0GHz, low harmonic distortion, isolation of 34dB at 1.0GHz, and a switching time of less than 4 $\mu$ s. The BGS12A is suited to use in low- and medium-power applications of up to 3GHz.

In second-half 2008, Infineon aims to start volume production of more members of the new RF switch family with further package options including a thin small leadless package (TSLP) with up to 16 pins, higher power levels of 38dBm, and up to nine Tx/Rx ports for a broad range of wireless applications.

[www.infineon.com](http://www.infineon.com)



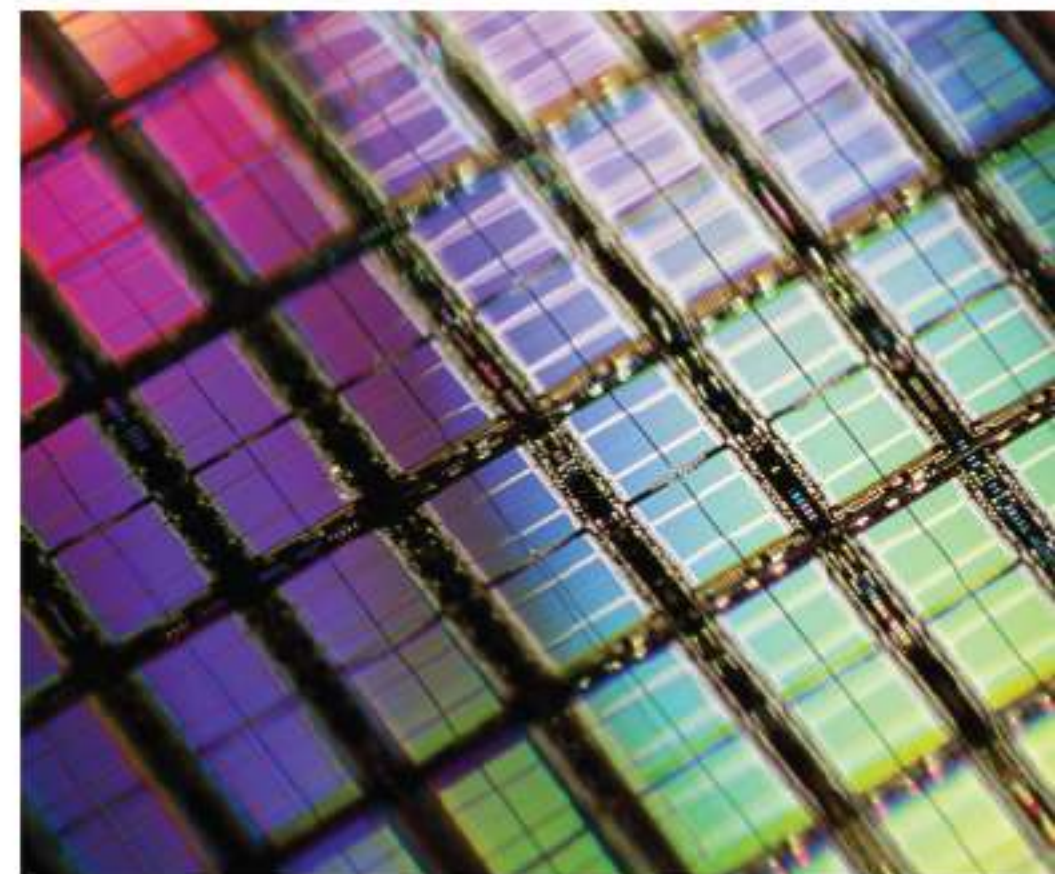


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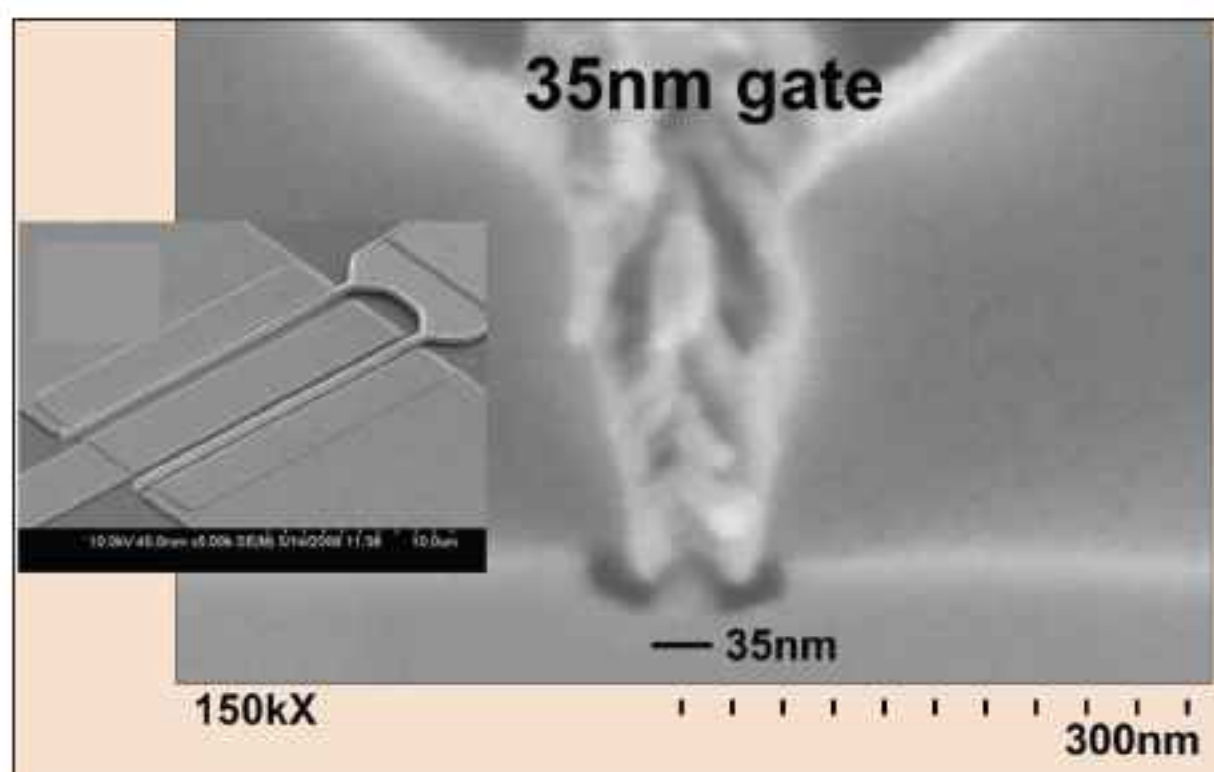


# NGST reports 1THz transistor

A record maximum frequency of operation for a transistor of more than 1000GHz (1THz) was reported by Northrop Grumman Space Technology (NGST) of Redondo Beach, CA, USA at December's 53rd annual IEEE International Electron Devices Meeting (IEDM 2007) in Washington DC.

By fabricating a sub-50nm InGaAs/InAlAs/InP HEMT device structure on an InP substrate, researchers led by Richard Lai were able to extrapolate a maximum frequency of oscillation of above 1THz with unilateral gain to 1.2THz and maximum stable gain (MSG) to 1.1THz. "This represents, to the best of our knowledge, the state of the art in high-frequency transistor capability," says Dwight Streit, NGST's VP of Technical Development and Microelectronics Technology.

To demonstrate the capabilities, in tests conducted by NASA's



NGST's 35nm-gate InGaAs/InAlAs/InP HEMT.

Jet Propulsion Laboratory the InP HEMTs were installed in a three-stage common-source low-noise MMIC amplifier. The device achieved 6dB gain per stage at 300GHz and 5dB gain per stage at 340GHz.

To improve performance further, device modifications of the baseline NGST InP HEMT process were applied, including reducing the transistor's gate length from 70nm to less than 50nm using electron-beam lithography.

Following the refinements, on-wafer measurements made on the low-noise MMIC amplifiers yielded 21dB total amplifier gain at 285GHz, and 18dB at 300GHz and 15dB at 340GHz. These closely match computer simulated values and are consistent with extrapolations based on measured S-parameter data through 110GHz.

The transistors should provide much higher frequency and bandwidth capabilities for future military communications, radar and intelligence applications. Development was supported by DARPA's Sub-millimeter Wave Imaging Focal-plane Technology (SWIFT) program and the US Army Research Laboratory. "These advancements will enable a new generation of military and commercial applications that operate at higher frequencies with improved performance," adds Streit.

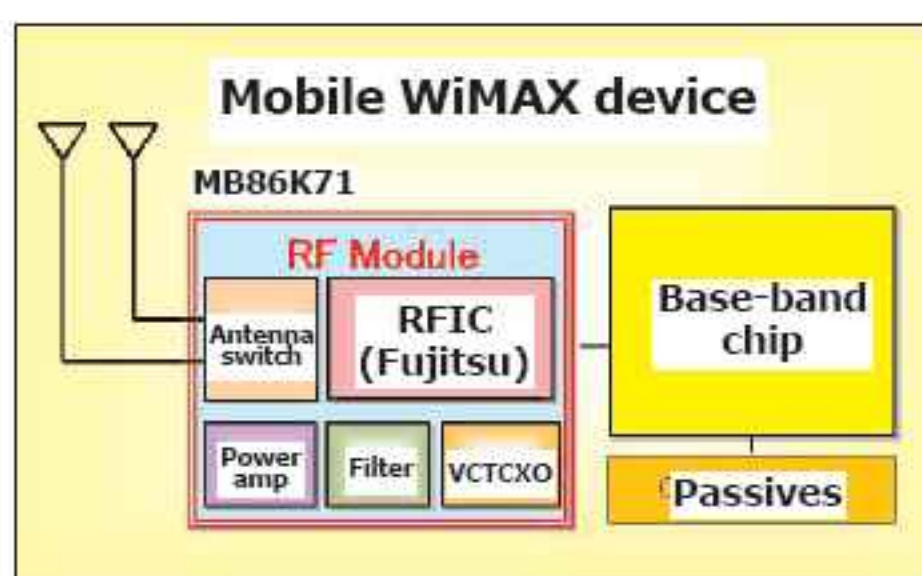
[www.northropgrumman.com](http://www.northropgrumman.com)

## CMOS yields smallest RF module for mobile WiMAX

At February's GMSA Mobile World Congress 2008 in Barcelona, Spain, Tokyo-based Fujitsu Ltd launched what it claims is the world's smallest RF module to feature all of the RF circuitry necessary for the mobile WiMAX standard (IEEE 802.16e-2005), including an RFIC, antenna switches, a power amplifier, filters, and an oscillator circuit.

Co-developed with Fujitsu Laboratories Ltd, the MB86K71 module was designed using 90nm CMOS process technology for the RFIC, has 94 pins (with a pitch of 0.5mm), and measures just 15mm x 15mm x 1.5mm, enabling a significant reduction of the form-factor of mobile WiMAX devices.

Operating in the 2.496–2.69GHz RF band, the new module supports multiple input, multiple output (MIMO) technology, which uses multiple antennas at both the



RF module in mobile WiMAX device.

transmitter and receiver to achieve high-speed and reliable wireless connections (essential for mobile WiMAX devices, says Fujitsu). The module also supports the WiMAX Forum's Wave 2 specifications (for certification testing for mobile WiMAX equipment using MIMO).

The firm has also verified that the module can be connected to its existing MB86K21 mobile WiMAX baseband chip, speeding development and time to market for devices.

Mobile WiMAX service is scheduled to start in the USA and Taiwan this year, followed by Japan in 2009. With the ramp-up of WiMAX, opportunities for new markets and services are expected to be created.

Samples of the MB86K71 are scheduled to start shipping at the end of February for ¥5000. Fujitsu is targeting accumulated revenues of ¥5bn by the end of fiscal 2010 (to end-March 2011).

Fujitsu says that it will continue to pursue the integration of baseband chips and RF modules and, as well as adding products to its line-up that will feature even lower power consumption and smaller form-factors, it aims to contribute to the expansion of the mobile WiMAX market through the further miniaturization of RFICs.

[www.fujitsu.com](http://www.fujitsu.com)



# Nitronex raises \$7.5m in funds

Nitronex Corp of Durham, NC, USA, which manufactures gallium nitride on silicon (GaN-on-Si) RF power transistors for the commercial wireless infrastructure, broadband and military markets, has raised \$7.5m in new venture capital. This brings total funding to more than \$80m since the firm was spun off from North Carolina State University in 1999, including \$39.1m in previous venture rounds.

The latest funding comes from the same investors (Alloy Ventures, Arch Venture Partners, Intersouth Partners and Diamondhead Ventures) that participated in Nitronex's previous \$21.8m 'Series A-1' fundraising round in June 2006 (which allowed the firm to expand its headquarters and manufacturing last year from Raleigh to a 69,000ft<sup>2</sup> facility in Durham, NC on property that it leased in 2002).

According to director of finance Jim Devivo, funds will be used for:

- completion of Nitronex's transition from an R&D company to a volume production, ISO-certified company;
- internal systems needed to expand production capabilities;
- new product roadmaps and new process capabilities;
- recruitment of production, engineering, customer support and administrative staff.

In March 2007, Nitronex received a \$100,000 grant from the Durham County commissioners for employee training. In negotiating the grant, Nitronex said it would invest \$24m in the Durham facility and create 200 jobs over five years. Since moving to Durham, the firm has raised its headcount from 55 to more than 60, spokesperson Ray Crampton told the web-based publication WRAL Local Tech Wire.

However, the Triangle Business Journal reports that, in December,

the North Carolina Institute for Constitutional Law of Raleigh, NC (which campaigns against corporate tax incentives) filed a lawsuit claiming that the grant (for a private company moving from one county to another) violates a requirement of the North Carolina State Constitution that any spending of public funds must be for a public purpose. Also, it claims that the incentives were unnecessary because Nitronex had already signed a lease for the property (in 2002).

According to an interview with Nitronex's president and CEO Charles Shalvoy in the Raleigh News & Observer at the time the grant was made, before choosing Durham, Nitronex had been considering incentives from local and state leaders in California to relocate to Silicon Valley.

The lawsuit was filed on behalf of former North Carolina house representative Russell Capps and Sean Haugh (head of the North Carolina Libertarian Party).

[www.bizjournals.com/triangle](http://www.bizjournals.com/triangle)

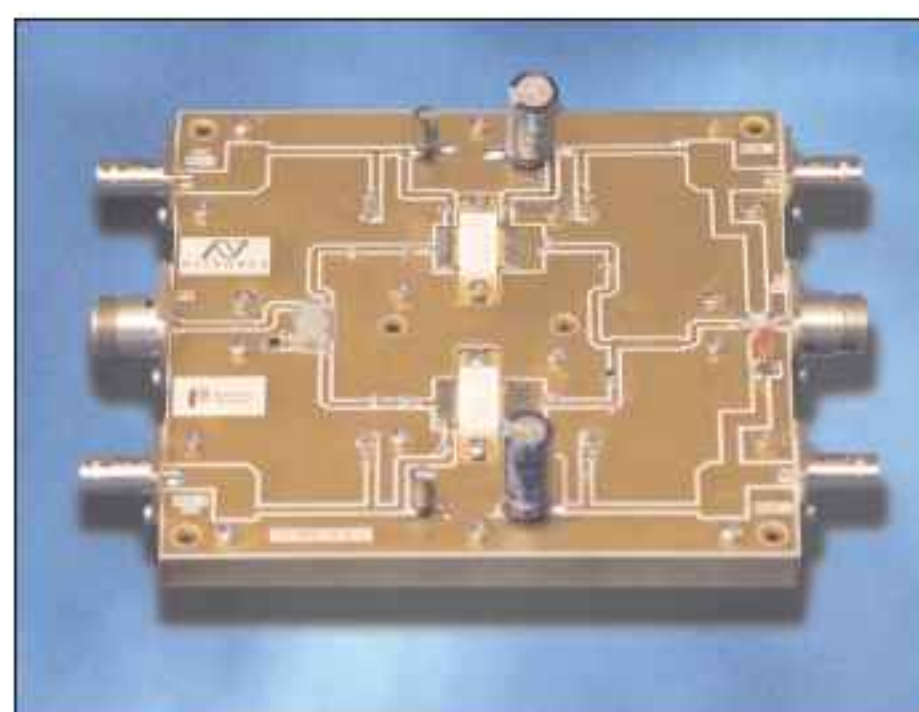
## Prescient partners on 20W WiMAX Doherty amplifier

Nitronex has partnered with Prescient Wireless of Itasca, IL, USA, a supplier of RF products and design services to the wireless and avionics industries, to develop a broadband Doherty power amplifier for WiMAX applications based on its NPT25100.

The design provides 20W of linear power from 2.5 to 2.7GHz while achieving over 30% efficiency, and 2% EVM (error vector magnitude) with digital pre-distortion.

Previously, last September, the firms partnered to design a Doherty power amplifier with 6W of linear output power from 2.5 to 2.7GHz, based on Nitronex's NPT25015 power transistor.

"Customers asked us to increase our power levels while further reducing our industry-leading price



**Doherty design based on NPT25100.**

point for WiMAX power amplifiers," says marketing director Ray Crampton. "Prescient Wireless' expertise in power amplifier design allows us to deliver a reference design with instant credibility in the wireless infrastructure field."

Typical performance numbers were taken using a mobile WiMAX

waveform defined as single-carrier OFDMA (orthogonal frequency-division multiplexing access) 64-QAM 3/4, 10MHz channel bandwidth, and 9.5dB peak/average ratio (PAR) @ 0.01% probability during the transmit portion of a 50% duty cycle TDD signal.

The reference design consists of the schematic, bill of materials, circuit board layout files, detailed performance data, and other documents describing the design. Built and tested Doherty application boards are available for a suggested resale price of \$1950.

Both the reference design and the Doherty design based on the NPT25015 were shown at the Radio & Wireless Symposium in Orlando, FL (22-23 January).

[www.prescientwireless.com](http://www.prescientwireless.com)



## ISE sets PV inverter efficiency record using SiC MOSFETs

Fraunhofer Institute for Solar Energy Systems (ISE) in Freiburg, Germany has achieved a maximum DC-AC conversion efficiency rating of 98.5% for photovoltaic (PV) inverters in a test using prototype silicon carbide-based MOSFETs manufactured by Cree Inc of Durham, NC, USA.

These are record efficiency results for PV inverters, Fraunhofer ISE claims, as well as representing the first test of SiC MOSFETs for this application. The researchers also reduced the inverter's power dissipation by 30-50% compared with results obtained using traditional silicon-based transistors.

"SiC components switch faster and have a smaller forward-bias power loss than traditional silicon-based transistors," says Dr Bruno Burger, head of the Power Electronics Group.

Inverters transform direct current generated by PV systems into alternating current and feed it into the public power grid. The higher the efficiency rating of the inverter, the greater is the energy yield of the entire PV system. To achieve the highest energy output over time, the efficiency rating should remain high over a wide range of power levels. During testing, the inverter with Cree SiC components also set a new performance precedent across a wide range of power output values, Fraunhofer ISE says.

"Our work involved characterizing the components and integrating them into existing inverters," adds Burger. "If, in a further step, the inverter circuitry is optimized specifically for SiC, then even greater efficiencies could certainly be achieved."

The Fraunhofer team achieved the record with a single-phase inverter using their patent-pending HERIC topology and a nominal power rating of 5kW. The team also increased the efficiency of a three-phase inverter with a nominal power rating of 7kW from 95.1% to 97.5%.

[www.ise.fhg.de](http://www.ise.fhg.de)

## SemiSouth adds CEO and shifts HQ to Austin for sales, marketing and design

SemiSouth Laboratories Inc, which designs and manufactures silicon carbide-based discrete microelectronic power devices and epiwafer materials, has opened its new corporate headquarters in Austin, TX.

SemiSouth was spun off from SiC R&D activities at Mississippi State University (MSU) in 2000, and since August 2006 has been based at its 20,000ft<sup>2</sup> MSU-owned manufacturing facility in Starkville, MS. Complementing this, the new headquarters in Austin will provide the office space to support the firm's infrastructure and business needs for growth over the next 12 months. SemiSouth has moved sales & marketing to Austin and is currently adding a design center.

The move comes after SemiSouth appointed MSU alumnus and Austin resident Vess Johnson as president & CEO, superceding co-founder Jeff Casady (now chief operating officer).

Austin is a vibrant high-tech community, says Johnson. As well as being the capital of Texas and the 16th largest city in the USA, Austin is home to the main campus of the University of Texas (the USA's fifth largest university) as well as many semiconductor and computer firms. "This will enhance our ability to expand and to attract key talent," reckons Johnson.

Johnson will leverage his 18 years of industry experience to drive execution, build image and awareness for the firm, and grow business says the firm. "Vess has a proven record of success with venture-funded start-ups," says board member and co-founder Dr Mike Mazzola.

Previously, he was president and CEO of Nascentric, a supplier of high-speed circuit simulation products, where he established early partner relationships with firms such as Infineon, ST Microelectronics, ARM, TSCM, Chartered and AMD.

Johnson was also president and CEO of Silicon Metrics Corp, which provides characterization and modeling of foundation IP for IC design (continuing as general manager when it became the Silicon Correlation Division of Magma Design Automation in October 2003).

He also has executive management experience at Omniview Design Automation and Xynetix as well as co-founding Cellular Sessions.

Johnson brings a fresh vision for leading the company to the next level, says Mazzola. "This is the culmination of a multi-year plan," adds Casady. "We have produced very advanced SiC JFETs and epitaxy in our new fab... Now is the time to increase our market footprint."

[www.semisouth.com](http://www.semisouth.com)

## SemiSouth awarded patents for SiC JFETs

SemiSouth has been awarded two US patents for work led by Dr Igor Sankin and Dr Mike Mazzola. Patents 7,294,860 ('Monolithic Vertical Junction Field Effect Transistor & Schottky Barrier Diode Fabricated From SiC & Method of Fabricating the Same') and 7,274,083 ('Semiconductor Device w/ Surge Current Protection & Method of Making') cover power management topics, such as the integration of SiC JFET, diodes, circuits, and process designs for SiC power JFETs. The firm now owns

or has exclusive license to 11 patents in SiC power electronics.

SemiSouth says its SiC JFETs can replace silicon MOSFETs, IGBTs or BJTs and eliminate more than 50% of the energy loss in power converters used in applications such as solar power, computing, motor drive, automotive and military aerospace.

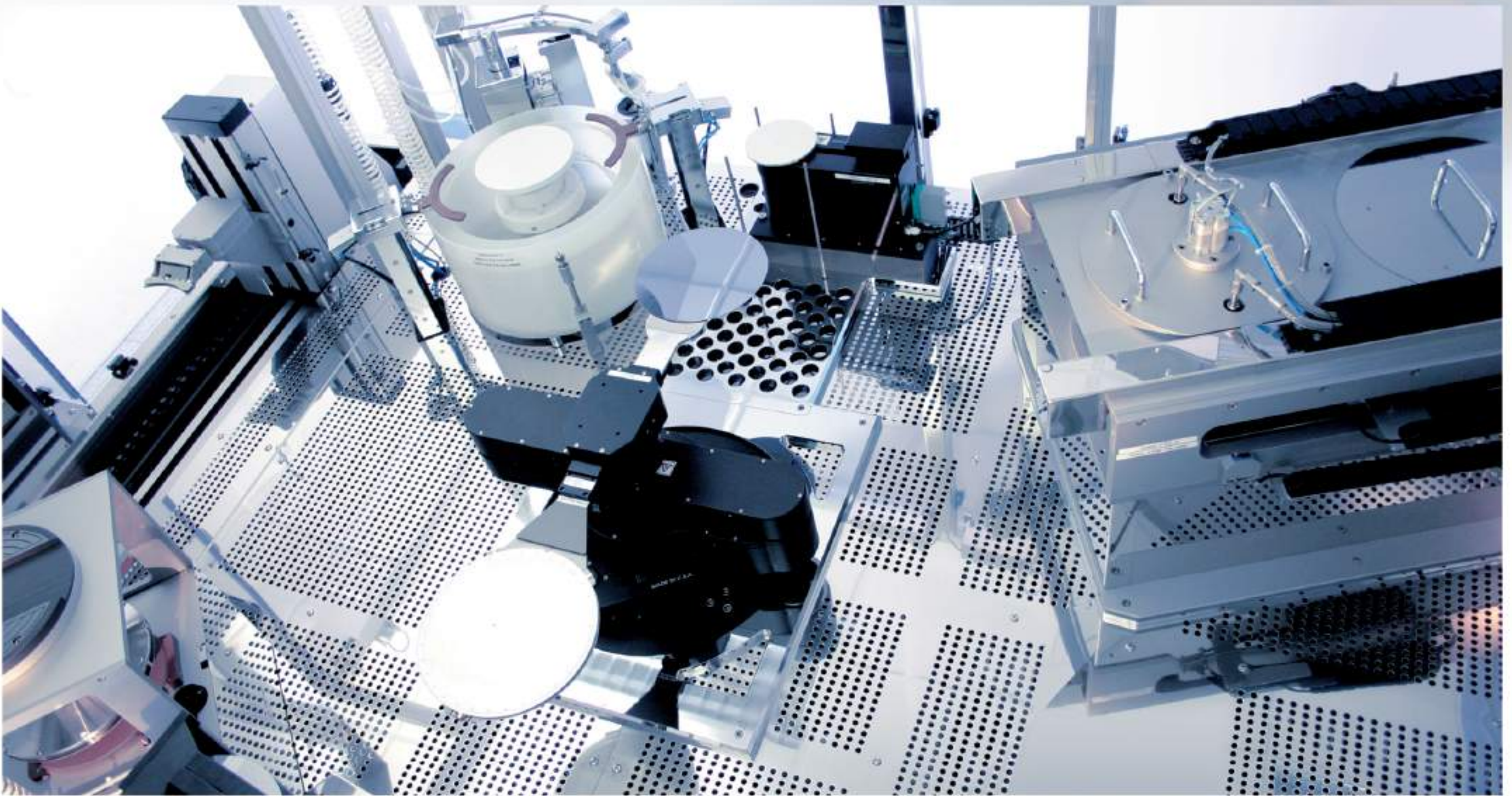
"Our qualification partners have provided very positive feedback on our rugged, reliable, and very power-efficient SiC power JFET," said chief operating officer Jeff Casady.



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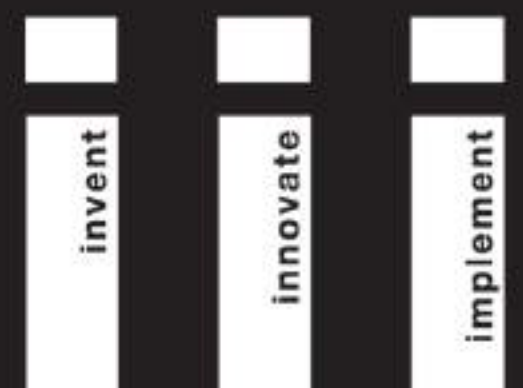


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## IN BRIEF

**Nasdaq extends Kopin deadline again**

Nasdaq has extended the deadline from 11 February to 17 March for Kopin Corp of Taunton, MA, USA, which makes GaAs-based HBTs and liquid-crystal CyberDisplays, to file all delayed periodic reports with the US Securities and Exchange Commission (SEC), necessary to regain compliance with Nasdaq Marketplace Rule 4310(c)(14). Nasdaq had already extended the deadline once from 17 December.

Kopin has previously received Nasdaq warnings for failing to file its Q3/2006 Form 10-Q, 2006 Form 10-K, and Q1, Q2 and Q3/2007 Form 10-Q reports. The delays are due to an investigation into the firm's past stock option granting practices by a special investigative committee.

Last May, the committee recommended that financial statements for 1995 through 2006 should be restated. Kopin is working to complete any necessary restatements.

If Kopin files its reports by 17 March, then it will be remanded back to Nasdaq's Listing Qualifications Panel for its failure to solicit proxies and hold an annual meeting. Otherwise, its securities will be suspended and a notification of delisting will be filed with the SEC.

[www.kopin.com](http://www.kopin.com)

**ISO9001 certification for EpiWorks**

EpiWorks Inc of Champaign-Urbana, IL, USA has received ISO9001:2000 certification from Quality System Registrars Inc. The certification covers the design and manufacture of compound semiconductor epitaxial wafers, including all of EpiWorks' products (i.e. InP- and GaAs-based microelectronic and optoelectronic wafers).

[www.epiworks.com](http://www.epiworks.com)

**IQE expects '07 sales up 65% year-on-year**

In a mid-January trading update, substrate and epiwafer supplier IQE plc of Cardiff, UK said that it expects revenues of about \$100m for 2007, up 65% in dollar terms on 2006 (which had been £32.4m in sterling). This is the third consecutive year of sequential revenue growth (averaging about 50% annually).

Trading in December was very strong following the qualification of products and tools with various customers across the group, resulting in record monthly revenue. These and additional qualifications in progress secure the foundation for significantly more production capacity in 2008, says IQE.

As a result of the good growth in revenue coupled with high operational gearing and tight cost control, earnings before interest, taxes, depreciation and amortization (EBITDA) continued to increase from first-half 2007 and is expected to be in line with market expectations, despite the adverse effect of the sterling/dollar exchange rate.

Sales of wireless products have been particularly strong as a consequence of the firm expanding its customer base, product portfolio and geographical reach during 2007.

In particular, the acquisitions made during 2006 (the epiwafer foundries MBE Technology Pte Ltd of Singapore and IQE RF LLC of Somerset, NJ, USA, formerly Emcore's Electronic Materials & Device division) have performed extremely well, says IQE. Most customers are focussed on products for the advanced upgrade smart phone market, WiFi (802.11n), WiMAX, GPS and other high-speed wireless markets, which have all continued to show strong growth.

IQE says that it has also made substantial progress in developing additional future high-volume products, including for advanced solar

cells and solid-state lighting. The firm reckons that it has also established a leadership position in advanced materials combinations for ultra-high-speed integrated electronics applications.

IQE's board says it expects markets to remain strong, particularly those linked to high-speed wireless applications, as evidenced by the myriad of new and emerging applications at the 2008 International CES consumer electronics show in Las Vegas, NV, USA (7-10 January).

IQE will issue preliminary results for 2007 in the week starting 17 March.

● IQE has appointed Lloyds TSB Corporate Markets as its principal banker and agreed new, significantly increased banking facilities that provide funding of up to £15.5m (a term loan of up to £8.5m and a working capital facility of up to £7m). This replaces existing UK loans of £3.7m and a UK overdraft facility of £4m, representing additional headroom of almost £8m to fund continued growth. Also, IQE retains its overseas working capital facility of £1m.

"Given current macro economic conditions, this new funding facility demonstrates the confidence that exists in IQE's business model, its markets and its management team," says chief financial officer Phil Rasmussen.

"We view IQE as a high-performing business that has established an enviable position within the international compound semiconductor wafer market," says Andrew Hunter of Lloyds TSB's Fast Growth Team.

"Through careful acquisition, the management of IQE has established a market-leading business which is very well placed for continued growth," adds Jason Evans, area director and head of Lloyds TSB Corporate Markets for South Wales.

[www.iqep.com](http://www.iqep.com)



## AXT retains Elliot to extend R&D to Cz/LEC growth

Substrates and raw materials manufacturer AXT Inc of Fremont, CA, USA says that it has retained the services of Dr Grant Elliot (who was previously a consultant to the R&D team) in order to extend R&D activities under chief technology officer Chia-Li Wei, mainly in vertical gradient freeze (VGF) technology enhancement and Czochralski (Cz) and liquid-encapsulated Czochralski (LEC) crystal growth.

Elliot has more than 40 years of R&D and engineering experience in materials ranging from oxides and high-temperature inter-metallic compounds to III-V semiconductors, including 18 years developing and augmenting the crystal growth capabilities of Hewlett Packard's Optoelectronics Division. His main area of expertise is the LEC growth of both gallium arsenide (GaAs) and gallium phosphide (GaP).

Elliot obtained his bachelor's of science degree in ceramic engineering

from the University of California, Berkeley and started his career in R&D with Lockheed Missiles and Space Co Inc's Palo Alto

Research Labs. **Grant Elliot.**

After a master's degree in materials science from San Jose State University, he was awarded a Graduate Study Fellowship from Lockheed to pursue a doctorate in materials science at Stanford University. Following a postdoctoral fellowship in the Physics Department at Southampton University, UK, he returned to Stanford to study liquid phase epitaxy (LPE) growth of GaAs on various substrate materials.

Elliot has 33 publications and one patent to his name. He served one



term as vice president of the American Association for Crystal Growth and several terms as president of the American Association for Crystal Growth/Western Region.

"We are very pleased to have retained the services of Dr Elliot, a leading scientist in the area of LEC growth of both gallium arsenide and gallium phosphide," says chairman and CEO Phil Yin. "We are very committed to developing world-class Cz and LEC capabilities in order to broaden our product offering into areas that we do not currently participate in and to improve our manufacturing cost structure for certain current products, in which these technologies offer the most appropriate level of performance," he adds. "We continue to focus on our internal competencies with an eye towards providing a more comprehensive product offering."

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## IN BRIEF

## Nanometrics names Toho as Japan distributor

Process control metrology system maker Nanometrics Inc of Milpitas, CA, USA has named Nagoya-based Toho Technology Corp as its exclusive distributor in Japan for six compound semiconductor and materials characterization product lines (the RPM2000, Vektor, Vertex, ECV Pro, NanoSpec 3000 and NanoSpec 6100 systems), primarily serving the high-brightness LED (HB-LED), wafer substrate and solar photovoltaic (PV) metrology sectors.

As exclusive distributor, Toho will support these products with its local sales & service network. Toho will also open a dedicated demonstration facility in the Tokyo area to facilitate product sales & marketing in Japan.

"This partnership with Toho to support our Materials Characterization products will greatly improve our corporate presence in the region and enable Nanometrics to focus on its growing fab business," says Tom Ryan, director of Nanometrics' Materials Characterization business unit. Nanometrics will continue to sell its 200mm/300mm fab tools through its Nanometrics Japan subsidiary.

The agreement follows the sale of Nanometrics' Flat Panel Display (FPD) business unit to Toho in December 2005.

● As a result of its strategy to operate reduced sensitivity to revenue level, Nanometrics is cutting staffing by about 7% worldwide, to achieve its goals of improved profitability, cash flow and predictability.

The firm will record about \$600,000 in restructuring charges in Q1/2008, but expects cost savings to be fully realized in Q2.

[www.tohototechnology.com](http://www.tohototechnology.com)  
[www.nanometrics.com](http://www.nanometrics.com)

## Lam receives further Nasdaq notice

Etch and wafer-cleaning equipment maker Lam Research of Fremont, CA, USA has received a further Nasdaq Staff Determination letter saying that it is not in compliance with the filing requirements for continued listing set forth in Nasdaq Marketplace Rule 4310(c)(14). The letter was issued due to the delayed filing of Lam's report on Form 10-Q for the quarter ended 23 December.

This follows similar letters received on 27 August and 7 November due to Lam's delayed filing of its Form 10-K report for the year ended 24 June and its Form 10-Q report for the quarter ended 23 September, respectively. After a hearing on 11 October, at which Lam's management presented its plan to regain compliance, the Nasdaq Listing Qualification Panel granted the firm's request for continued listing on the Nasdaq Global Select Market, provided that it files delayed reports with the Securities and Exchange Commission by 13 February.

As Lam has previously disclosed, a committee composed of two independent board members is conducting a review of its past stock option practices and related accounting, as a result of the independent fiscal year-end 2007 audit.

Working with outside legal counsel, the committee has reached a preliminary conclusion that the actual measurement dates for financial accounting purposes of certain stock option grants differ from the recorded grant dates, but that there was no intentional misconduct by management.

On 18 December, the board's audit committee concluded that the firm's financial statements for 1997 through 2005 should no longer be relied upon. Lam expects to restate certain financial statements to record non-cash charges for compensation expenses relating to past stock option grants. Most of the measurement date changes result from grants prior to fiscal 2003.

Lam said it would not be in a position to file the delayed reports until after the completion of the review and until it can determine the non-cash adjustments to compensation expense. Because it could not complete that by 13 February, on 6 February Lam requested that the Nasdaq Listing and Hearing Review Council call for a review of the Listing Qualification Panel's 15 January decision and grant a stay of delisting beyond 13 February.

[www.lamresearch.com](http://www.lamresearch.com)

## Datacon receives Skyworks' Best Supplier Award for Capital Equipment

Chip-assembly equipment maker Datacon Technology GmbH of Radfeld, Austria, a part of the Besi group since 2005, has received the 2007 Best Supplier Award for Capital Equipment from Skyworks Solutions Inc of Woburn, MA, USA, which manufactures gallium arsenide-based linear products, power amplifiers, front-end modules and radio solutions.

The award was presented at the Skyworks Supplier Day Meeting at the Hyatt Hotel in Irvine, CA on 8 January. Key suppliers in both the front-end and back-end segments were present at the award

ceremony, which was attended by about 200 representatives of participating companies.

To receive the Best Supplier Award, companies were measured for their performance in fulfilling Skyworks' stringent supply chain requirements during 2007. Datacon was recognized for "excellent quality performance, strong technical support and alignment with Skyworks' supply chain requirements," said Skyworks' president and CEO David J. Aldrich.

[www.datacon.at](http://www.datacon.at)  
[www.skyworksinc.com](http://www.skyworksinc.com)



## QuantumClean expands MBE parts cleaning services after rising demand in eastern USA

Quantum Global Technologies LLC of Dublin, PA, USA, which provides outsourced parts cleaning, process tool part restoration surface treatment and analytical engineering services, has expanded its molecular beam epitaxy cleaning capabilities to its Advanced Technology Cleaning Center (ATCC) in Portland suburb Scarborough, ME.

QuantumClean says it designed the dedicated treatment facility at the Maine ATCC to handle large MBE chambers and related components after seeing demand for the service increase dramatically in the Eastern region of the USA. The firm finished the segregated MBE decontamination area in December.

"We believe we are the only outsourced parts cleaning service provider with the ability to clean to the high level of standards that this industry segment requires," says president, CEO and chairman Scott Nicholas. "Unlike other providers,"

he claims, "we have dedicated areas, equipment and facilities that support the MBE process."

The firm's Colorado ATCC supported all MBE cleaning in the past, but that facility will now focus solely on cleaning traditional semiconductor process tool parts and smaller MBE components, while larger-scale MBE projects will be processed in Maine. The expansion of MBE capabilities to the Maine ATCC is a natural progression in ongoing efforts to invest in supporting emerging markets such as MBE, solar, nano, and other microelectronics segments, says QuantumClean.

Founded in 2000, QuantumClean has cleaning centers across the USA and Asia, including Advanced Technology Cleaning Centers in the Silicon Valley, Pacific Northwest, Arizona, Colorado, Texas and New England regions.

[www.quantumclean.com](http://www.quantumclean.com)

## Riber expects rebound in 2008

MBE equipment maker Riber of Bezons, France has reported 2007 revenue of €17m, down 15% on 2006's €20.1m due to a drop in production reactor shipments (from five to three) and a 22% drop in sales of components and accessories (owing to fewer machine-refurbishing sales).

Unaudited net loss is over €9m (€4m from operations; €5m from impairment and non-recurring provisions due to updated risks regarding surplus metal inventory, a joint research contract, and litigation). Given the order backlog and sales negotiations, revenue in 2008 should be more than €18m.

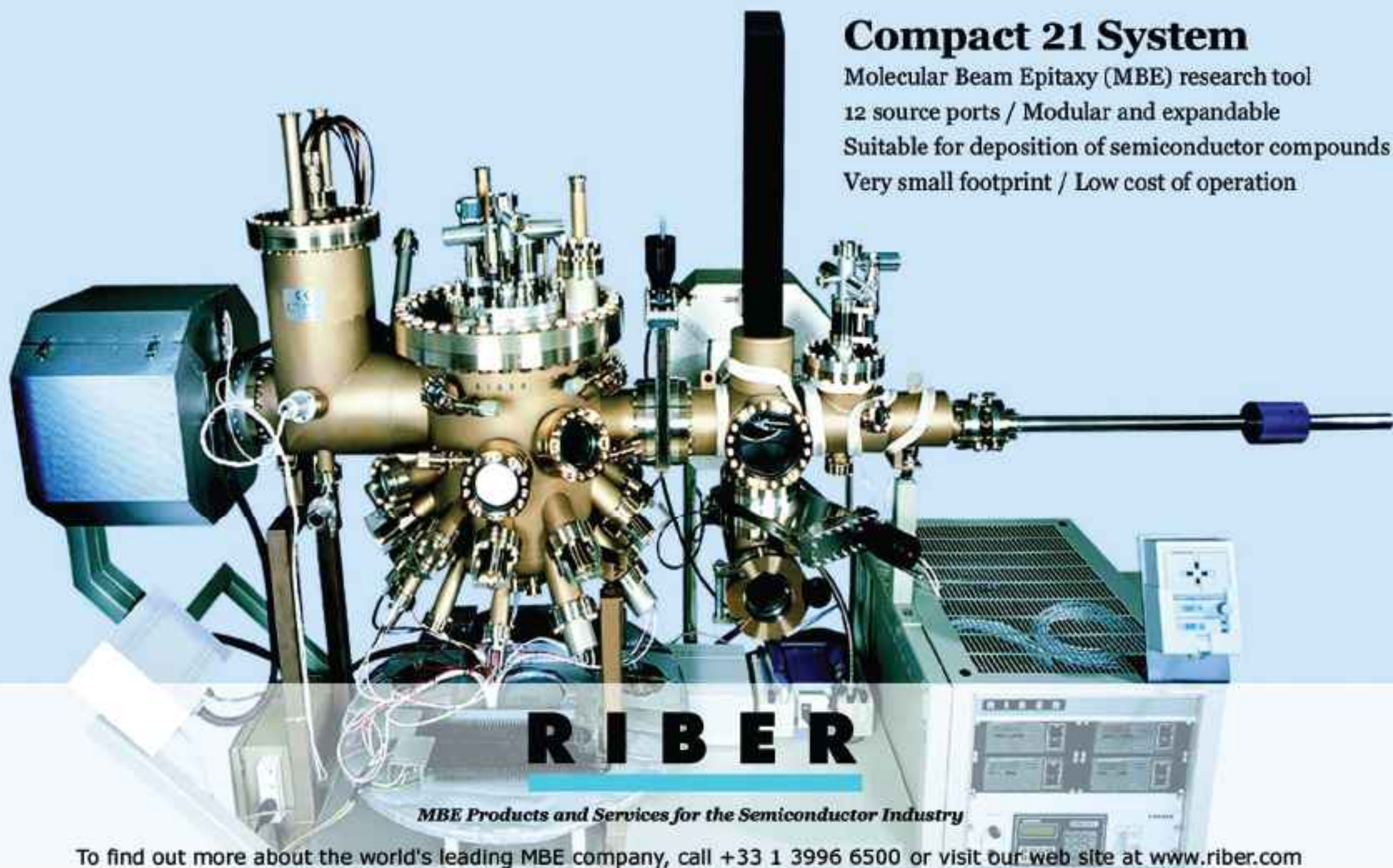
Cash reserves should grow in Q1 with the receipt of significant billings from Q4/2007 and the launch of an extensive cost-cutting plan aimed at achieving a positive operating result in 2008.

[www.riber.com](http://www.riber.com)

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# HB-LEDs and PVs boost Veeco

Veeco Instruments Inc of Woodbury, NY, USA has reported Q4/2007 revenue of \$106.8m. This is down 13% on \$123.1m a year ago (due to a 22.4% drop in metrology sales, mainly automated AFM products for the semiconductor market), but up 9% sequentially.

Including \$10.6m in restructuring and other charges, net loss was \$9.4m, compared to net income of \$7.6m a year ago.

Despite data storage orders of \$36m being flat sequentially (with cancellations of \$16.2m, due mainly to discontinued products), overall bookings were \$114.9m, up 5% on \$109.1m a year ago (and at the high end of the \$105–115m guidance). "We received orders of over \$40m from HB-LED/wireless and solar customers for our MOCVD systems and thermal deposition sources [up 35% on a year ago]," says CEO John R. Peeler. As well as multi-unit orders and orders from several new customers in Asia, this included \$5m for solar applications.

"Veeco made significant progress on our profit improvement programs," says Peeler. "We completed a 7.5% reduction in force [by about 100 staff in July to 1216 at the end of 2007], representing annualized savings of nearly \$12m. We are on track to consolidate corporate headquarters into our Plainview, NY site, which we anticipate will save \$1.8m annually," he adds. "While we will continue to rigorously focus on cost-containment activities, we are investing in our global field sales and service organization, strengthening our management team, and aligning our R&D spending to growth opportunities in LEDs, solar and nanotechnology."

For full-year 2007, revenue fell 9% from 2006's \$441m to \$402.5m. However, this was due to data storage and semiconductor being down 25% and 35% respectively, offset by growth of 23% in MOCVD and MBE equipment for HB-LED/wireless (from \$94m to \$116m). During

2007, Veeco launched the TurboDisc K-series of MOCVD platforms for GaN-based blue-green LEDs (with the first K465 systems now receiving customer field acceptance) and the E475 As/P system for red, orange and yellow (ROY) LEDs and triple-junction solar cells.

Net loss was \$17.4m, compared with net income of \$14.9m in 2006. However, gross margin for MOCVD and MBE business improved significantly, from 30.4% in 2006 to 37.8%.

Overall bookings fell by 8.5% from \$493.8m to \$451.6m. However, MOCVD and MBE orders for HB-LED/wireless rose 37%, from \$120m in 2006 to

\$164m (including as much as \$20m in MOCVD tools for solar applications, of which about half have been shipped).

"We have increased our MOCVD market share (based on orders) from 20% to about 35% during 2007," says Peeler. "While we remain the number-two supplier, we have penetrated several top-tier accounts where our competitor [Aixtron] holds the installed base," he adds. "We continue to enhance our MOCVD systems, and develop new products to improve throughput efficiency." Peeler reckons that the E475 offers 50% more throughput than competing systems being used for III-V solar cell manufacturing.

For Q1/2008, Veeco forecasts revenues of \$98–105m and bookings of \$105–112m (down sequentially due to the normal seasonality in the scientific research market).

Although first-half 2008 is starting off slowly (due to a trough in data

**MOCVD and MBE orders for HB-LED/wireless rose 37% (including as much as \$20m in MOCVD tools for solar)... We have increased our MOCVD market share from 20% to about 35%**

storage revenue), Veeco expects 2008 to be a recovery year in growth and profitability. "While we always face unpredictability in our served markets, our 2008 goal is for revenue growth at a minimum of 10% [20–25% in LED and solar process equipment; 0–5% in data-storage equipment; 5–7% in metrology] and for operating spending to decline as a percentage of sales," says Peeler.

"While we are cautious about macro-economic issues, we are currently experiencing positive growth trends for Veeco's MOCVD and MBE technologies in the HB-LED/wireless market, as well as early penetration in solar applications," he adds. In LED and solar process equipment, the firm has an exceptional multi-year growth opportunity, he reckons. "We expect continued strong order patterns in the LED market, given the broadening adoption of LED. The overall LED market is forecasted to grow from \$4.2bn in 2006 to \$9.4bn in 2011, which is an 18% compounded annual growth rate." However, some applications are forecasted to grow at much higher rates (e.g. nearly 40% over the next several years for LEDs for architectural and retail lighting).

"Our customers are seeing increased penetration in exterior as well as interior automotive lighting, and a recent Strategy Analytics survey estimated that this market alone could be worth \$1bn by 2014," Peeler adds. LEDs are also experiencing increased adoption in laptop backlighting, with industry players expecting growth at the expense of traditional CCFL solutions.

"Given the tremendous growth opportunities we see in LED and solar, we will increase our R&D spend in MOCVD and MBE technology by about 40% in 2008," says Peeler.

[www.veeco.com](http://www.veeco.com)

**We will increase our R&D spend in MOCVD and MBE technology by about 40%**



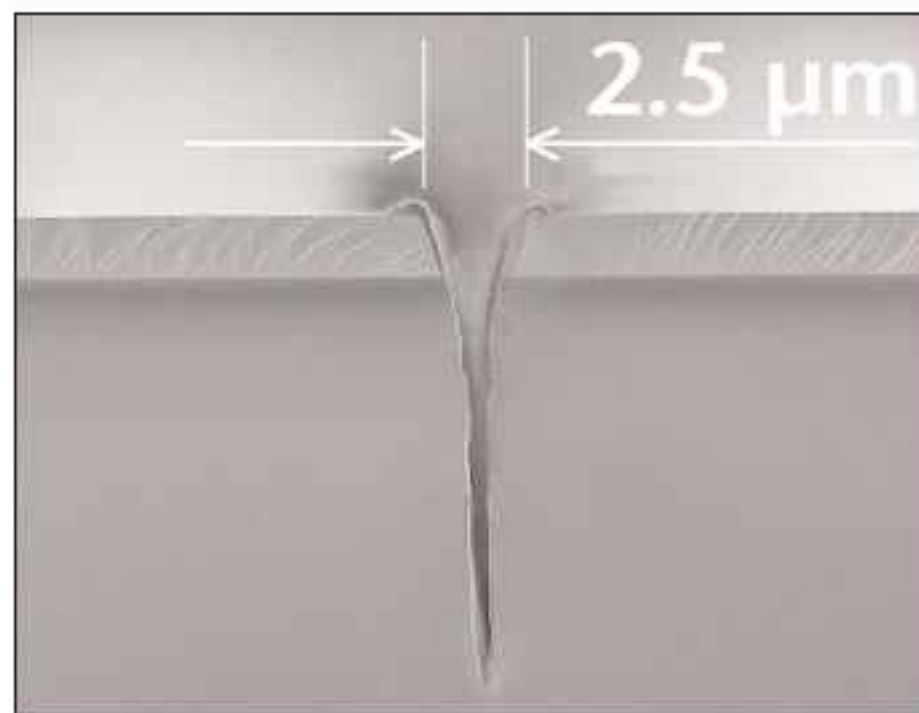
## LED wafer scribing process patent

J. P. Sercel Associates Inc (JPSA) of Manchester, NH, USA, a designer, supplier, and systems integrator of laser-based materials processing workstations, has been awarded a patent, applicable in Korea, for its front-side laser scribing technique for sapphire LED wafers.

The technique involves the use of a unique laser energy distribution method that allows extremely narrow kerf widths (2.5µm wide), resulting in faster processing and higher yields. Narrower kerfs also yield more die per wafer.

JPSA developed the LED sapphire wafer dicing capability with its IX-200 Chromadice DPSS UV laser wafer singulation system. "Our Chromadice system, using this patented process, can process fifteen 2" wafers per hour," says president Jeffrey P. Sercel. "That represents a dramatic increase in throughput compared to diamond scribing and conventional laser techniques," he claims.

The IX-200 ChromaDice DPSS is



SEM showing 2.5µm width.

also suitable for wafer trimming and scribing applications. Its UV diode-pumped solid-state (DPSS) laser system delivers high-speed wafer dicing and cutting with typical yields of greater than 99% at less than \$2 per wafer. The process is tolerant of wafer warp and bow and suitable for all wafer types, JPSA says. The system is also available in an excimer laser version for via drilling, micromachining, thin-film patterning and other packaging applications, including LED liftoff.

[www.jpsalaser.com](http://www.jpsalaser.com)

### IN BRIEF

#### JPSA appoints customer service manager

JPSA has appointed Bob Bowman as customer service manager, responsible for customer satisfaction and field service.



"Due to JPSA's rapid growth and worldwide expansion, more emphasis has been placed in our service department to better support our customer base; so Bob has moved from manager of our Applications Laboratory to focus his efforts in Customer Service," says president Jeffrey P. Sercel.

"Bob has broad engineering experience, a high level of technical expertise as JPSA's Electrical Engineering Manager and Applications Lab Manager," Sercel added. Bowman has been working at JPSA for five years.

## Epistar places further order

As part of its ongoing expansion of LED manufacturing capacity, in Q4/2007 Epistar Corp of Hsinchu, Taiwan placed a third multiple order for MOCVD systems from Aixtron of Aachen, Germany, again including both multiple CRIUS Close Coupled Showerhead (CCS) reactors and AIX 2800G4 HT Planetary Reactor systems (Aixtron's flagship products for large-scale GaN-based LED manufacturing — claimed to be the world's highest-capacity proven reactors for GaN LED production — for both of which Epistar was the launch customer).

The latest order (for delivery later this year), along with a multiple order announced last October, made Epistar Aixtron's largest individual system investor in Q4/2007.

[www.aixtron.com](http://www.aixtron.com)

## Aviza targets emerging markets

For its fiscal Q1/2008 (ended 28 December 2007), deposition and etch equipment maker Aviza Technology Inc of Scotts Valley, CA, USA reported sales of \$34m. Operations loss was \$7.9m, due to difficult market conditions and a weak business climate globally throughout the industry, says president & CEO Jerry Cutini. "While Aviza was not immune to the protracted reduction in DRAM capital spending that closed out 2007, we did make significant inroads during the quarter, particularly in the atomic layer deposition (ALD) market, where we shipped our first logic tool into Japan."

Strategic initiatives include broadening its product offerings and diversifying further into 3D-ICs and emerging markets.

[www.aviza.com](http://www.aviza.com)

## GPT supplies purifier for Chinese LED maker HBTH

Via its China distributor Gentech International, Johnson Matthey Gas Purification Technology group (GPT) of West Chester, PA, USA has supplied a Model PSH-30 hydrogen purifier, capable of flowing 30Nm<sup>3</sup>/hr, to China's HBTH for the manufacture of LEDs.

GPT says its PSH Series bulk hydrogen purifiers are capable of providing 99.9999999%-pure hydrogen for wafer fabrication.

The latest sale follows the supply in November of a Model PSH-30 to Chi Mei Entech Co Ltd (CMLT) of Taipei, Taiwan, which makes LEDs for backlighting LCD screens, and in December of two Model PSH-60 purifiers to HB-LED wafer and chip maker Tekcore Co Ltd of Nantou, Taiwan.

[www.pureguard.net](http://www.pureguard.net)



## TDI mourns loss of nitride materials pioneer Dmitriev

It is with great sadness that we learnt of the sudden death from a heart attack on 6 January of Dr Vladimir Dmitriev (52), president and CEO of nitride material manufacturer Technologies and Devices International Inc (TDI) of Silver Spring, MD, USA, while traveling from the USA to Japan.

After a masters of science degree at Leningrad Electrotechnical Institute in 1978, Dmitriev gained a PhD in 1986 and a Doctor of Science degree in 1996 in semiconductor physics from Russia's Ioffe Institute. He worked on developing hydride vapor phase epitaxy (HVPE) technologies for UV and visible LEDs and power electronic devices including, from 1992-96, directing the Eastern European Division of Cree of Durham, NC, USA.

In August 1997, Dmitriev founded TDI in Gaithersburg, MD to develop manufacturing technology for the wide-bandgap semiconductor materials GaN, AlN and SiC. The firm expanded to Silver Spring in 2002.

Firsts claimed by TDI include (in 1998) HVPE-grown GaN p-type materials and pn diodes; (in 2000) large-area (30mm x 30mm) free-standing AlN wafers, as well as stimulated emission from HVPE-grown AlGaIn/GaN double heterostructures;



**Vladimir Dmitriev.** AlN material; and HVPE-grown AlGaIn/GaN HEMTs; (in 2004) HVPE-grown AlGaIn/AlGaIn UV LEDs, and 6" GaN epiwafers; and (in 2006) 4" AlN/SiC semi-insulating substrates for high-power HEMTs, GaN quantum well structures by low-deposition-rate HVPE, and high-quality HVPE-grown InN and InGaIn.

Currently, TDI uses its patented HVPE technology and equipment manufacture 2", 3" and 4" (100mm) GaN-on-sapphire, AlN-on-sapphire, AlGaIn-on-sapphire, InN/GaN-on-sapphire, and AlN-on-SiC epiwafers.

"Vladimir was known throughout the industry for his tireless pursuit of innovative technology for semiconductor processing," said TDI (Dmitriev published more than 100 scientific papers and co-authored 27 US patents). "He entered the New Year on a high with TDI having just been awarded an important US Patent covering novel HVPE

(in 2001) true bulk GaN crystal; (in 2003) free-standing AlGaIn wafers, a stress-control HVPE process for producing crack-free thick

production equipment for manufacturing of low defect nitride semiconductor materials," added the firm. "His vision of reliable low-cost deposition equipment has been gaining widespread appeal and several important customers have been targeted for installation of TDI's first commercially available machines [expecting to announce a major partner that will be working jointly with the firm to refine and help with introduction of the equipment]."

R&D director Dr Alexander Usikov has taken over Dmitriev's technical responsibilities, while Tatiana Dmitriev has assumed much of the managerial role. Assisting each of them are Mark Fine, former president of Epichem Inc, and Rick Stall, former CTO for Emcore Corp.

Fine, who had been working with Vladimir and TDI in a senior business advisory role, said: "The loss of our close friend is a shock to all of us. His energy and enthusiasm for this business and for life in general was and will always be an inspiration to everyone who knew him. Though his passing is tragic, we are confident this company will pull together and work even harder to carry on with his vision and keep his dream alive."

[www.tdii.com](http://www.tdii.com)

## Rubicon appoints business expert to board of directors

Rubicon Technology Inc of Franklin Park, IL, USA, a vertically integrated manufacturer of sapphire material, wafers and components, has appointed Raymond Spencer, CEO of Capgemini's Financial Services Strategic Business Unit, as a member of its board of directors.

Spencer has more than 30 years experience spanning international business, management planning, technology, finance, and mergers & acquisitions. As founder, chairman and CEO of Kanbay International Inc (a provider of IT services to the financial-services industry) he led the firm from its inception,

through its initial public offering (one of the top five performing IPOs on Nasdaq in 2004), to its acquisition last year by Capgemini. Spencer also serves as a board member of the Information Technology Association of America (ITAA).

"Our business is global and our product-line is growing. Raymond brings outstanding experience and insight to our organization," says Rubicon's president and CEO Raja Parvez.

Last September, Rubicon recruited William F. Weissman (Kanbay's former chief financial officer) as CFO, treasurer and secretary. In Novem-

ber, the firm raised \$93.8m in its IPO on the Nasdaq Global Market, partly to fund capital expenditure. Rubicon had previously said in May that it was expanding its manufacturing capacity by 25% for Q1/2008 and by 40% by the end of 2008, with the addition of a new 30,000ft<sup>2</sup> production facility in the Chicago area (complementing the firm's existing 80,000ft<sup>2</sup> operation). The expansion should enable Rubicon to address the growing demand from LED makers for both small-diameter and large-diameter (4-inch and above) sapphire wafers.

[www.rubicon-es2.com](http://www.rubicon-es2.com)



## BluGlass makes its first quantum well LED structures

BluGlass Ltd of Sydney, Australia says that it is on-track in all key areas of the commercialization plan for its low-cost manufacturing technology for GaN-on-glass material for LED lighting devices.

In mid-January, construction of its prototype commercial-scale RPCVD reactor was completed at equipment maker EMF Semiconductor Systems Ltd in Ireland (overseen by BluGlass's equipment design and development manager Conor Martin) and first-stage commissioning is underway there and on schedule for completion by March.

The results of initial trials have exceeded expectations, reports EMF director Jim Dixon. "Initial plasma tests look very promising. The automated wafer handler has been integrated into the tool, making it a truly competitive production system," he adds. "These advances will lead to improved product yield and reduced reagent costs."

BluGlass's Manufacturing Demonstration Facility at Silverwater in Sydney is on track to accept delivery of the commercial reactor early in second-quarter 2008, when full commissioning of the facility will also take place.

In addition, chief technology officer Dr Scott Butcher and his team have made their first ultra-thin-layered (quantum well) device structures (the basis of high-brightness LEDs). The structures, consisting of 4nm-thick indium gallium nitride (InGaN) layers embedded in GaN (and aluminium gallium nitride), are a significant advance on the 6"-diameter 'GaN on glass' wafers that the firm reported in mid-2007. This keeps BluGlass on track for its primary 2008 technical goal of demonstrating a working HB-LED, the firm reckons.

BluGlass believes that the ability of its patented RPCVD process to grow nitrides at low temperatures

has also created new opportunities for hybrid technologies with significant commercial prospects in areas such as oxide-nitride mixed structures, photovoltaics (solar technology) and silicon.

The firm is also in advanced negotiations with Canada's Lakehead University to develop a research program around its R&D reactor, with BluGlass's first unit on track to be installed there in 2008. It adds that there has also been interest in the product from other universities, research institutes and companies in Asia, North America and Europe for joint development programs that may provide early revenue opportunities as well as further exploration of other materials and device development using RPCVD.

Interim CEO and commercial manager Giles Bourne confirms that the firm is proactively seeking additional partnerships.

[www.bluglass.com.au](http://www.bluglass.com.au)

## Jordan steps down as CEO but continues as advisor

BluGlass, which is developing low-cost GaN-on-glass blue LED technology, says that CEO David Jordan has resigned slightly ahead of his contract expiry in mid-2008, citing personal reasons.

Jordan has agreed to continue to act in an advisory role to assist the firm in expanding its commercial and strategic activities, construction of the manufacturing demonstration plant and the design, build and commissioning of the commercial and research reactors, due in late first-quarter 2008. Jordan will also continue as a director in a non-executive role.

During Jordan's tenure, BluGlass transitioned from spinning off from Macquarie University in mid-2005 to listing on the ASX (Australian Securities Exchange) in September 2006. Collaborations were established with leading players in the semiconductor manufacturing industry to enable the commercial

demonstration of the BluGlass technology.

The executive and technology teams were also strengthened to add support to technology development and commercial equipment design, and to focus on health & safety issues and business development.

BluGlass also created the world's first blue LED on glass, demonstrated the technology's cost savings and scalability, secured an AusIndustry support grant of AUS\$5m (US\$4.3m), and put into action a plan to deliver BluGlass' proprietary manufacturing process.

"David has made an invaluable contribution in taking BluGlass from R&D to pre-commercialization," says Dr Michael Taverner,



David Jordan.

BluGlass' chairman. "This solid foundation he has built will enable a new CEO to take the company to its next level of development and revenue generation."

Taverner has initiated a global executive search for a new CEO. In the interim, Giles Bourne (recruited last July as commercial manager) will be CEO. "Bourne is well positioned to drive BluGlass' commercial and strategic activities over the coming months," says Taverner. Bourne is a specialist in developing offshore business opportunities for Australian corporations, he adds. "He has over 12 years experience working with multinationals and SMEs [small and medium enterprises] in Australia and overseas, focussing on growing businesses through securing inward investment, setting up domestic and international partnerships, joint ventures and licensing deals."



# Austin joins LED City program

The City of Austin has joined the LED City program, an international community of government and industry parties initiated by LED maker Cree Inc of Durham, NC, USA to evaluate, deploy and promote LED lighting for municipal infrastructure. Austin is the fourth city to join the program following Raleigh, NC (last February), Toronto, Canada (July) and Ann Arbor, MI (October), in which cities evaluate and deploy LED lighting technology across their municipal infrastructures. According to the US Department of Energy, 22% of electricity used in the USA powers lighting.

In December, the City of Austin (the capital of Texas) and Austin Energy (the USA's 10th largest community-owned electric utility) retrofitted a floor of the One Texas Center Parking Garage with 47W LED fixtures from Beta LED (a brand of Beta Lighting of Sturtevant, WI). LED fixtures have also been installed in a hallway at Austin Energy headquarters, in streetlights on Barton Springs, in the Palmer Events Center marquee sign and in the water fountain at the new Palmer Events Center Park. Additional test installations are planned throughout the city, including a portion of

the lights surrounding the Lady Bird Lake Hike and Bike Trail. Austin Energy aims to install LED lighting throughout the city.

"One of the workhorses in the city's lighting inventory is the 250W high-pressure sodium [HPS] cobra-head roadway fixture. We plan to evaluate LED solutions that have the potential to reduce energy consumption by 47-90% over traditional lighting solutions," says mayor Will Wynn. "Just by retrofitting 5000 streetlights — a mere portion of all of the streetlights within the city — the city could realize savings of up to \$500,000 a year. And that doesn't include additional maintenance and labor cost savings if we won't be sending out a worker in a boom truck an additional 6-7 times just to change a light bulb," he adds.

"The total wattage of the LED garage light installation is about 30% below the allowable wattage as required by the Energy Code Allowance. This represents a saving of \$6795 a year in utility costs," says Wynn. "Because LEDs typically last 5-7 times longer than the prior fixture bulbs, the city anticipates it could achieve additional savings of \$27,000 in replacement lamp costs over the life of the LEDs."

The combined annualized savings to the city could be \$10,178 per year with a simple payback of 6.5 years. "This lighting strategy is part of our efforts to achieve Energy Star and LEED Accreditation for City of Austin buildings," adds Wynn.

"Austin Energy has a \$17m per year rebate program that encourages commercial and home energy customers to purchase and use products that provide significant energy savings," says Roger Duncan, Austin Energy's interim general manager. "Our LED lighting rebate of \$300 per-kilowatt-of-capacity-reduced aims to cover about 30% of the upfront cost of LEDs to help businesses explore the benefits of this new technology."

In 2003, the City of Austin retrofitted over 5200 traffic signals and 3700 pedestrian signals with LEDs. The wattage of the traffic signals was reduced from 135W to 11-15W each (a 90% reduction). The award-winning retrofit has realized savings of 7.25m kW-hr per year and removed 830kW of demand load from the city grid. The city estimates that it has saved \$1.4m per year plus additional maintenance and labor savings.

[www.ledcity.org](http://www.ledcity.org)

## LEDs common in offices, garages and residences by 2009

LED solid-state lighting component maker Cree has announced the results of an independent survey on the adoption, deployment and benefits of LED lighting that validates strong global growth for LED lighting applications, confirms awareness of the energy-efficiency benefits of LEDs and indicates that the adoption trend should continue through the end of the decade.

The survey was conducted online at the end of October at the 2007 Hong Kong International Lighting Fair (the largest lighting show in Asia and the second largest in the

world) by independent third-party firm Mindwave Research Inc on behalf of Cree. Nearly half of the survey's respondents were from outside of Asia.

Findings of the survey include that:

- 72% of respondents have seen growth of more than 20% for LED lighting applications in their businesses over the past six months.
- 63% believe that LED lighting will comprise more than half of their sales or installations by 2009.
- LED lighting market growth is expected to come from a mix of uses, with street/parking (20%),

residential indoor (17%), retail/display (17%) and office (15%) cited as leading opportunities.

"The survey results present us with a clear and positive picture of growth patterns and expectations from leaders in fixture design and manufacturing," says Cree's director of corporate marketing Greg Merritt. "The survey shows increasing demand for the high-quality, energy-efficient LEDs that Cree currently provides and is continuing to develop... The general illumination market is at a tipping point."

[www.cree.com](http://www.cree.com)



## Emerging Standardization for Sapphire Substrate Inspection

By Frank Burkeen

Senior Product Marketing Director at KLA-Tencor  
Frank.Burkeen@kla-tencor.com

The HBLEDD industry continues to thrive driven by market demand from mobile devices, automobiles, computer screens, and niche exterior and interior lighting applications. As HBLEDD device technology evolves and fabrication techniques become more advanced, defect detection and process control are critical to improving device yields. Sapphire substrate contaminants such as particles, scratches, pits, bumps, stains and residues from CMP processing are known to impact subsequent epi deposition processes and substantially degrade device performance and yield. As such, the need for higher quality sapphire substrates is of critical concern for HBLEDD device manufacturers.

The adoption of optical surface analyzer (OSA) technology is gaining momentum for use in HBLEDD manufacturing, specifically sapphire substrate inspection.

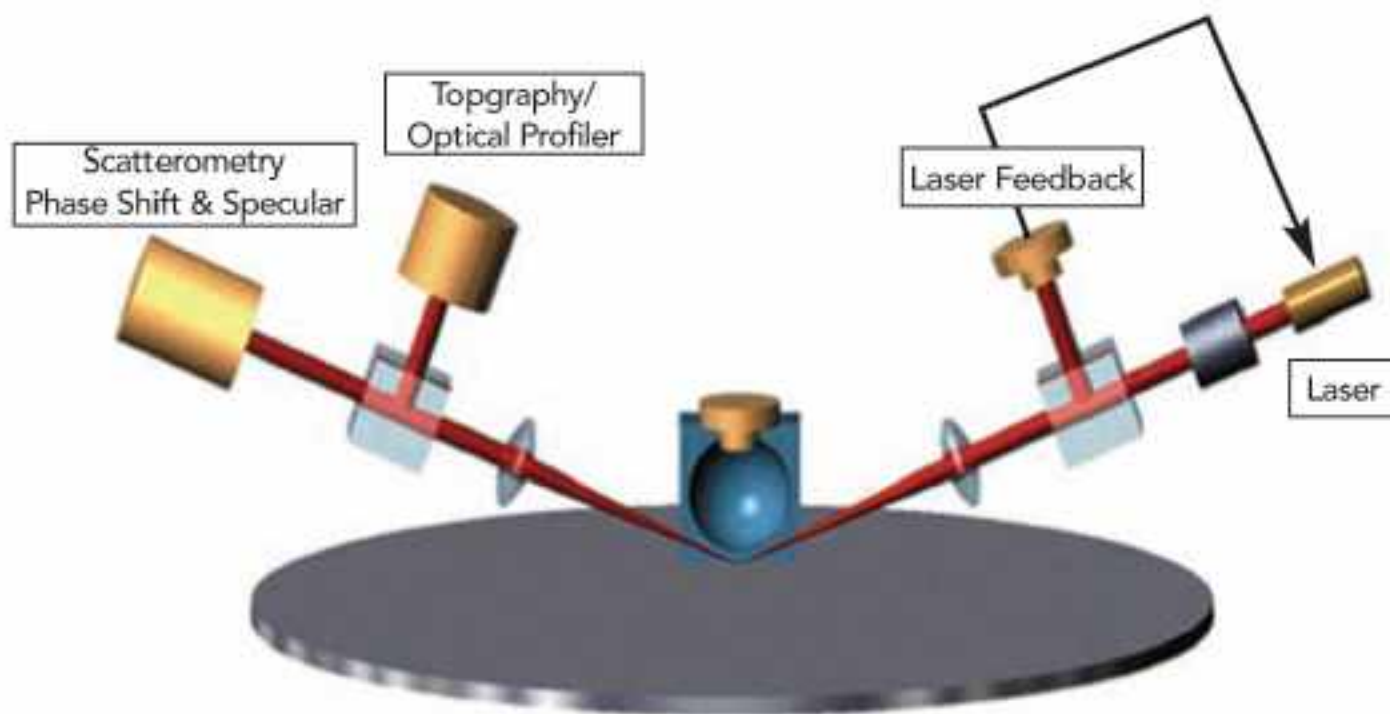


Figure 1: OSA technology combines four signal detection channels, enabling a wide range of inspection applications.

The design of OSA technology combines reflectometry, optical profilometry, scatterometry, and phase shift to measure topographic variations and detect a wide variety of surface defects. The inspection method achieves full surface coverage in minutes to produce high-resolution imaging, wafers maps, and automated defect classification.

At a throughput exceeding 40wph, an OSA system is the only wafer inspection method amenable to volume production and capable of advanced inspection of transparent sapphire substrates. Other inspection tools based solely on scatterometry cannot effectively measure transparent materials due to scattered light interference from the backside of the substrate. An OSA system is designed specifically for defect detection and classification of transparent materials including sapphire, GaN, SiC, and glass.

Figure 2 illustrates a sapphire substrate defect map after OSA inspection. Particles, scratches, pits, and stains are detected and classified in user-defined bins. The defect traceback images show a scratch as detected in the topography channel and two different types of stains as detected in the phase channel.



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Scratches are known to transfer to the subsequent epi layer thereby degrading or killing device performance. Substrate stains have been reported to cause poor epi layer adhesion or result in rough epi morphology.

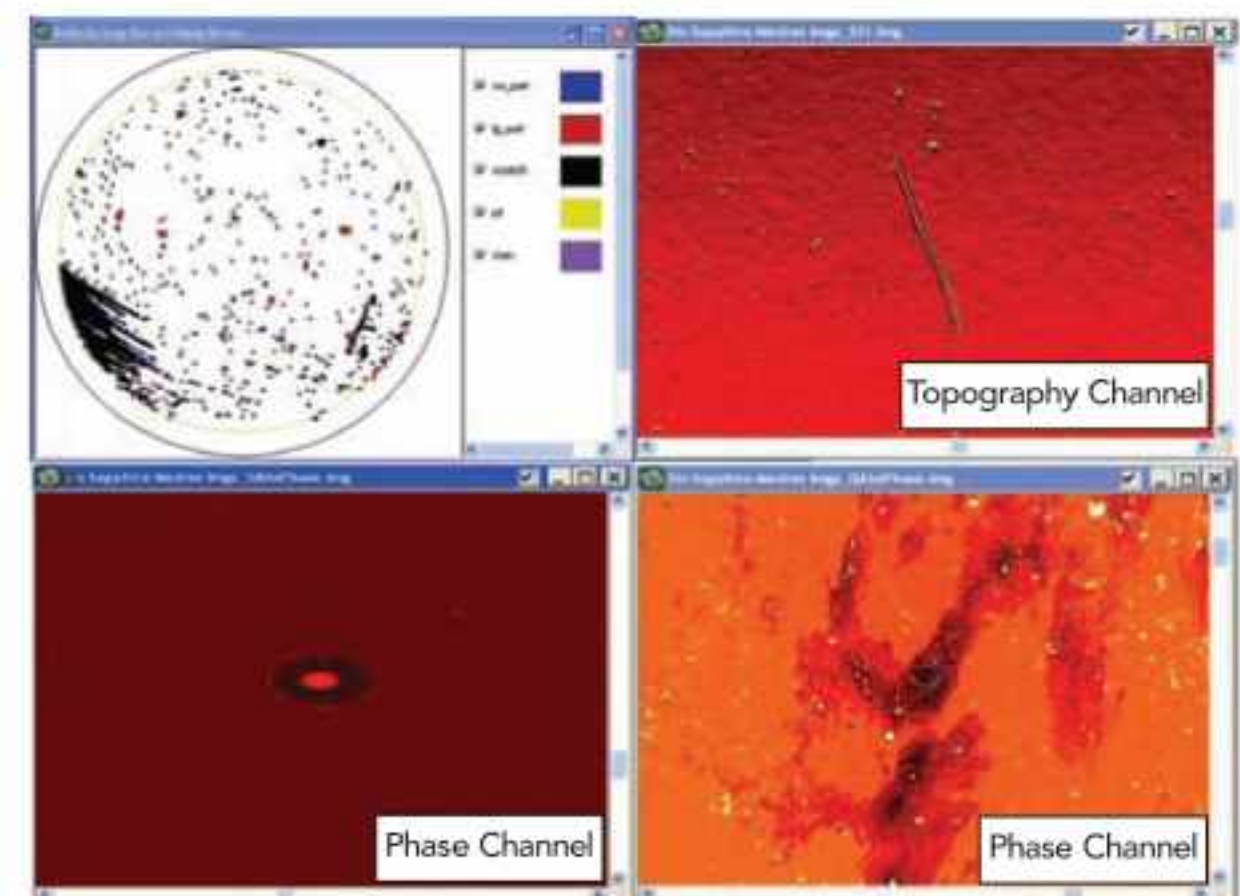


Figure 2: KLA-Tencor's Candela™ OSA defect map and traceback images of scratches and stains as detected in topography and phase channels, respectively.

As HBLEDD competition tightens and margins are squeezed, manufacturers are relying more on automated OSA inspection technology for process control and yield improvement. The emergence of sapphire substrate reclaim is also driving the need for advanced automated inspection. As supply is strained and material costs rise, the sapphire reclaim business is becoming more prevalent — whether for captive consumption or merchant supply. The reclaim business is even more dependant on OSA inspection as reworked material is highly susceptible to yield impacting defects.

Optical surface analyzer technology is setting the benchmark for automated inspection of sapphire substrates, and is emerging as the industry standard for overall sapphire quality control. HBLEDD device manufacturers and sapphire substrate suppliers are together converging on OSA inspection specs for quality assurance. Moreover, manufacturer's utilizing OSA technology are the beneficiaries of higher quality sapphire substrates passing distinct inspection specs.

Optical surface analysis technology enables manufacturers and suppliers to automate defect inspection and define objective-controlled process control limits. OSA technology can be employed at incoming substrate inspection, post-clean inspection, and after epi and film deposition processes.

To learn more, go to:  
[www.kla-tencor.com/candela](http://www.kla-tencor.com/candela)



# Cree considers adding Asian chip fab in next few years

For fiscal Q2/2008 (to end-December 2007), Cree Inc of Durham, NC, USA reported revenue of \$119m, up 5% on the prior quarter's \$113.4m and up 34% on \$88.8m a year ago.

LED revenue was \$98.9m, up 6% on \$93.4m last quarter and up 51% on \$65.5m a year ago, as Cree made 'significant' progress on increasing capacity.

Materials revenue (including silicon carbide wafers and gemstone products) was \$7.5m (6% of revenue).

RF and high-power microelectronic product revenue (including wide-band gap microwave devices) showed double-digit growth to \$4.8m (4% of revenue). This was mainly due to increased orders for Schottky diodes for power supply application (where energy efficiency is becoming a more important product requirement).

Gross margin grew from 31% of revenue last quarter to 35% due to: yield improvements across several product lines (especially XLamp LEDs); higher factory utilization in Durham (via increased internal component manufacturing); expanded production at China-based Cotco (acquired last year to support increased packaged XLamp LED demand and to reduce cost); and the transition of power products to 100mm wafers.

Increased expenses were mainly due to expanding the sales force, focusing on serving a wider range of applications and a more global customer base for Cotco's high-brightness LEDs. This included hiring a regional VP of sales for Europe and adding field application resources (both internally and at distributors) to ramp up HB-LED sales outside China over the next two quarters.

Non-GAAP net income was \$12.2m (\$0.14 per diluted share), up from \$7.2m (\$0.09 per diluted share) a year ago. Despite capital expenditure of \$9.9m, cash and investments grew by \$29.4m to \$361.9m.

"Q2 was a strong quarter for Cree, as we continued to execute our strategy and delivered revenue and earnings at the high end of our previously announced target range," chairman and CEO Chuck Swoboda says. "Revenue growth was driven by higher LED sales, with XLamp orders and shipments growing double digits sequentially as we were successful in bringing on-line additional XLamp capacity in China." Cree exited the quarter with an improved ability to meet near-term customer requirements, he adds.

During the quarter, Cree:

- commercially released zero-micropipe ZMP 100mm, n-type silicon carbide (SiC) substrates;
- revealed plans to convert all lighting at its Durham headquarters and manufacturing facility to LED lighting (energy usage has been cut by 48% in phase one);
- announced that Ann Arbor, MI is joining Raleigh, NC and Toronto, Canada in the LED City initiative (Ann Arbor aims to be the first US city to convert 100% of its downtown streetlights to LEDs — full implementation is projected to halve its public lighting energy);
- launched the Cree Solutions Providers network (offering a full range of LED lighting-system solutions and design assistance to help accelerate time to market and reduce product development costs).

"Looking ahead, the global momentum for sustainable, energy-efficient lighting products continued to build with the passage of the new US Energy bill, which will require the use of more-efficient lighting technology [by 2012] and should further accelerate the adoption of LEDs," says Swoboda. "This legislation is important and will force the lighting industry — which has been relatively slow to adopt new technologies in the past — to change."

For fiscal Q3/2008 (to end March), Cree expects revenue to rise to \$120–125m (mainly due to further double-digit XLamp sales growth). This, combined with increased sales of RF and high-power microelectronic products (including SiC Schottkys) should offset lower material sales (gemstones) and contract revenue.

"We are working on several new power products to expand a range of applications we can serve which are targeted to be introduced over the next two quarters," says Swoboda. "We are focused on continuing to expand our GaN product offering for broadband wireless applications with WiMAX," he adds. "We have started to see the benefit from converting our power products to 4" wafers."

Non-GAAP earnings are expected to be \$0.14–0.16 per diluted share. Cree is also targeting gross margin of 34–36% through continued yield gains in LEDs, the initial ramp up of 100mm wafers for LED chips, and increased XLamp production in Asia. The first phase of the new XLamp line has been qualified in China, greatly reducing major capacity constraints. "We are now in a better position to support the planned growth of this product line," says Swoboda.

More capacity should come online in the next two quarters. "We are on the planning stages for extra capacity additions for fiscal 2009 and 2010," he adds. "The LED industry will further consolidate over the next several years and we continue to evaluate ways to leverage our strong balance sheet to provide additional scale in terms of customers, channels, technology, people and manufacturing capability... At some point, and not in the too distant future, we have got to look at a second factory for packaging, and in the next couple of years we are going to have to bring online an Asian-based die fab."

[www.cree.com](http://www.cree.com)



# Cree expands to lighting systems

LED maker Cree of Durham, NC has agreed to acquire privately held LED Lighting Fixtures Inc (LLF) of Morrisville, NC for about \$77m in cash and stock, plus up to a further \$26.4m over the next three calendar years (tied to new product milestones and key-staff retention).

LLF was co-founded in September 2005 by chairman and CEO Neal Hunter, who was also a co-founder of Cree in 1987 and its chairman and CEO until leaving in April 2005. He rejoins Cree as president of the new Cree LED Lighting Solutions. Other LLF managers retain their roles.

LLF develops LED lighting retrofit products and claims to be first to develop a viable, energy-efficient LED down-light for general illumination, based on combining Cree's lighting-class XLamp LEDs and LLF's patented color-mixing technology. The product is being used in commercial and residential applications.

Cree reckons the acquisition will expand its market opportunity by providing direct access to the lighting market, enabling it to drive retrofit solutions to convert existing lighting infrastructure to energy-efficient lighting and accelerate the adoption of LED lighting. Cree's business hence now encompass LED chips, components and lighting systems.

"The combination of Cree's lighting-class LEDs and LLF's lighting-systems technologies should set the stage for Cree to obsolete the light bulb," says the firm's CEO Chuck Swoboda. "The market is at a tipping point, with billions of sockets in existing fixtures now addressable with energy-efficient LED lighting. Accelerating this market transformation benefits Cree, our LED customers and lighting consumers."

Cree aims for the acquisition to add about \$30m of revenue in fiscal 2009 from the combination of growing

LLF product sales and synergies with Cree's other LED product lines. For fiscal 2009, it forecasts that the acquisition will be slightly dilutive to earnings per share on a GAAP basis, and slightly accretive to earnings per share on a non-GAAP basis (excluding amortization of acquired intangibles and stock-based compensation). Providing that the transaction closes in early March (as intended), Cree targets that the acquisition will add about \$1m to its consolidated revenue and reduce earnings per share by about \$0.01 for its fiscal Q3.

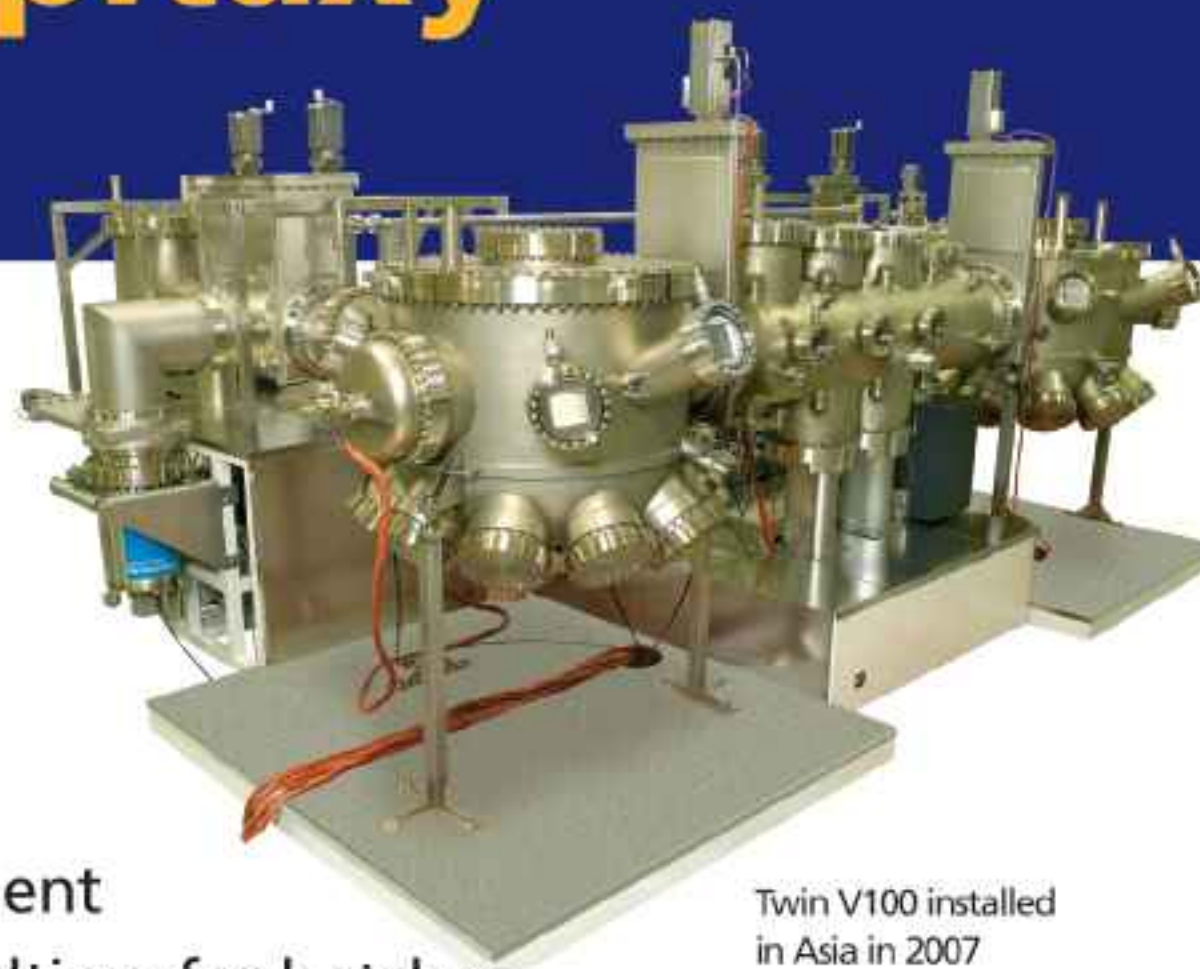
"Cree is as passionate as we are about moving the lighting market forward and making an impact on energy consumption into the next decade and beyond," says Hunter. "This acquisition should make Cree a powerful force for innovation around cutting-edge LED lighting solutions."

[www.llfinc.com](http://www.llfinc.com)

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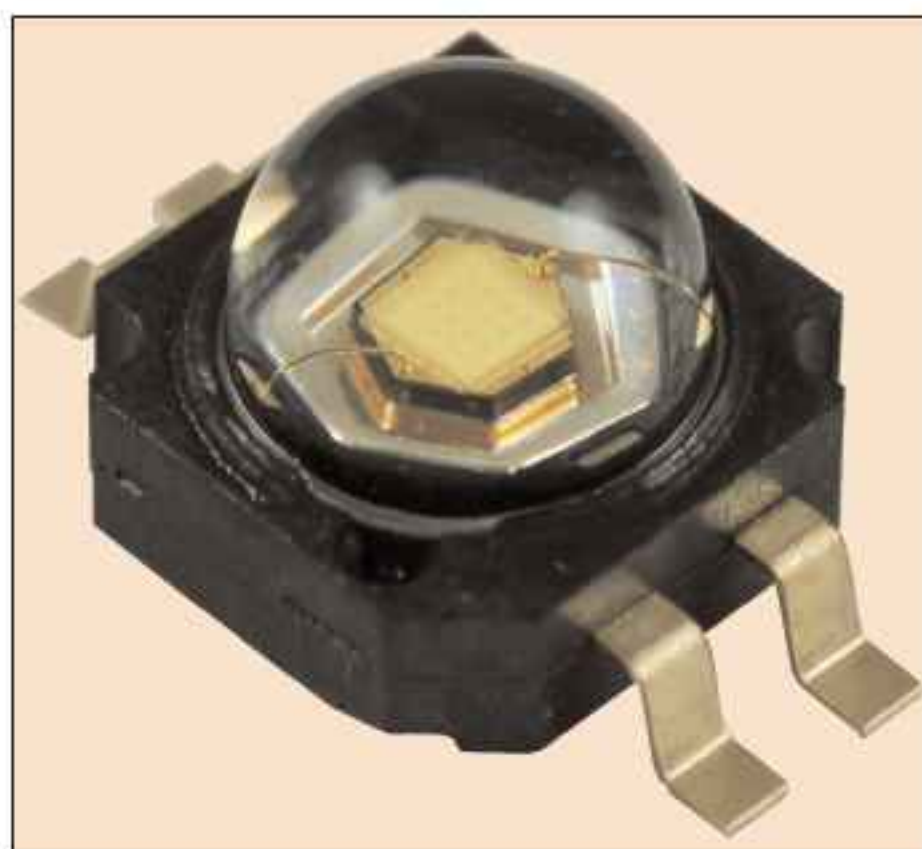




# Lumileds restarting TFFC LED packaging after replacing epoxy

In mid-January, Philips Lumileds of San Jose, CA, USA issued a Return Request Action for certain Luxeon Rebel and Luxeon K2 LEDs containing thin-film flip-chip (TFFC) die, made between 28 October 2007 and 12 January 2008 (coded WW0744 to WW0802) and halted packaging of the products. About 5% of Lumileds' customer base was affected.

The recall explained that Lumileds had identified a batch of contaminated epoxy material being used in the flip-chip process at its Malaysian plant that had the potential to cause the TFFC die to crack and fail during short-term operation, and that a failure rate exceeding specifications had been seen. Specifically, under normal operating conditions, the affected products experience



**Lumileds' Luxeon K2 with TFFC LED.**

infant mortality failure within the first 24 hours of normal operation with failure rates of 10–30%.

On 26 January, Lumileds said that the epoxy had been replaced with fresh supplies and that it had

restarted packaging ahead of the expected date of March. During the pause in production, Lumileds had continued to manufacture TFFC LED chips, so it could rapidly restart the TFFC packaging line after testing, corrective action and qualification.

Using the fresh epoxy (which performs as expected) products are now being manufactured and quarantined in the firm's Finished Goods Inventory, where they will wait for the completion of Outgoing Quality Assurance testing. This includes accelerated reliability testing and various other performance tests.

Lumileds has told customers that final qualification is expected by 28 February. Shipments should resume in the first week of March.

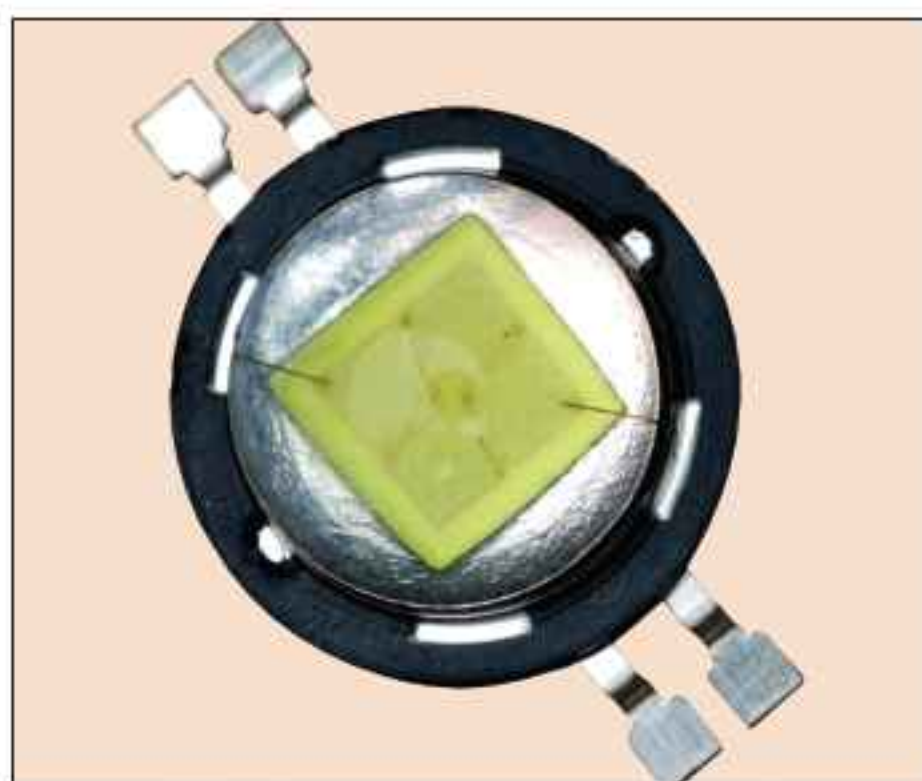
[www.philipslumileds.com](http://www.philipslumileds.com)

## Seoul Semiconductor boosts Acriche from 60 to 80lm/W

Korea's Seoul Semiconductor has developed a high-efficiency 80lm/W version of its Acriche LED.

The firm started mass production of the Acriche (which it claims to be the world's first semiconductor lighting source that can be driven directly from AC power outlets without an AC/DC converter) in November 2006. When it was launched on the market in second-quarter 2007, the luminous efficiency of the Acriche was only 40lm/W, but this was increased to 60lm/W last September.

Seoul Semiconductor says that the lifespans of DC-driven LEDs on the market are 50,000–100,000 hours but that the AC/DC converter required for effective application in lighting fixtures lasts only about 20,000 hours. Also, the AC/DC converter involves more cost and requires extra space, there are difficulties with space and thermal dissipation in lighting designs when



**Seoul's Acriche LED, now 80lm/W.**

replacing conventional bulbs, the converter's waste materials cause environment pollution, and its 80% efficiency causes electrical loss of 20%. In addition, in a small or enclosed space the build up of heat from the LED and converter can reduce the lifespan, and overheating can cause a fire hazard (requiring safety measures).

The firm acknowledges that Acriche has been less efficient than

DC LEDs, and it has been difficult for customers to apply it due to lack of knowledge of the new technology. However, Seoul Semiconductor stresses that its safety has been acknowledged through receiving CE Marking and German TUV certification last November and, with the development of an 80lm/W-efficient Acriche, it is almost as bright as conventional DC LEDs.

Also, Acriche has been developed in just a few years (much less than the 20 year history of the DC LED) and is hence relatively new technology with much potential for growth, reckons Sang Min Lee, head of Seoul Semiconductor's R&D center. Seoul Semiconductor said last March (when it introduced Acriche's first efficiency upgrade, by 20% to 48lm/W) that it planned to increase Acriche's efficacy to 120lm/W in 2008.

[www.seoulsemicon.com](http://www.seoulsemicon.com)



# Osram launches finer-tolerance binning for white LEDs

Osram Opto Semiconductors GmbH of Regensburg, Germany has refined its production and selection procedures for its warm-white and neutral-white Power TopLED, Advanced Power TopLED and Dragon high-power LEDs to offer narrower-tolerance binning on the color coordinates for different sorting grades.

Precisely defined color coordinates ensure that different LEDs within one white group reliably emit the same homogenous white light – with no visible color deviations. LEDs of a particular bin can be used in lighting applications without needing further checks. Even in critical applications such as diffused



Osram's white power LED.

or tightly packed light sources, they meet stringent requirements in terms of homogeneity, Osram says. The white tone is within a range that typically corresponds to a three-step McAdams Ellipse.

The LEDs have an improved typical color rendering index (CRI) of more than 80 (important for workplace, residential and retail lighting). Also, up to now the high-power LEDs appeared to have a slightly different white tone when viewed from different angles. But the color homogeneity has now been improved over the viewing angle, even with volume casting. So, it is now easier and potentially more cost-effective to achieve high-quality homogenous illumination with natural color rendering even in demanding lighting situations (e.g. backlighting of diffused surfaces and linear array applications), says Osram.

## Osram demos LED lighting with reference design drive circuitry

At the 2008 Strategies In Light event in Santa Clara, CA (11–13 February) Osram Opto Semiconductors showcased new LED lighting solutions, including working demos of the new Diamond Dragon LED and Advanced Power TopLED technologies with market-ready reference design drive circuitry from Linear Technology, National Semiconductor Corp, and mSilica Inc (combining high level of functionality and facilitating low component count).

Osram says that Diamond Dragon (launched in late November) is one of the world's brightest single-chip SMT LEDs (up to 250 lumens) with exceptionally low thermal resistance for general, automotive and industrial lighting applications. It can be driven at 2A continuous or 4A pulsed, requiring a new class of LED drivers.

Working demos include Linear Technologies' LT3518, a full-featured LED driver with a 2.3A current, 45V internal switch that provides a 3000:1 True Color PWM dimming ratio,

open LED protection, and a wide input voltage range, yielding stable operation suitable for automotive and general lighting applications.

National Semiconductor's Power-Wise LM3401 PFET controller driver powers a second Diamond Dragon reference design. It runs at up to 100% of duty cycle, maximizing the number of LEDs driven off an input rail. The driver requires no output capacitor or compensation, reducing part count and solution cost.

Also demonstrated was a new two-dimensional backlight designed with 160 RGB Advanced Power TopLEDs driven by mSilica's MSL3082 8-channel LED driver on a companion LED load board. The driver incorporates Adaptive SourcePower technology to control DC-DC power supplies with optimal efficiency, complementing the Advanced Power TopLED's performance capabilities for general lighting, LCD TV and monitor backlighting.

[www.osram-os.com](http://www.osram-os.com)

### IN BRIEF

#### PerkinElmer licenses white LED patent

Osram has licensed a patent held by subsidiary Osram Opto Semiconductors to PerkinElmer Inc for its subsidiary PerkinElmer Optoelectronics of Fremont, CA, which supplies components for specialty lighting, optical sensors and digital imaging displays for the health sector.

The patented technology enables white LEDs to be produced using blue-emitting InGaN-based chips and phosphor converters.

PerkinElmer aims to incorporate white LEDs in its ACULED platform, which is based on chip-on-board (COB) technology and includes ACULED VHL (very high lumen) standard and DYO (design-your-own) custom products.

PerkinElmer is targeting medical lighting applications, as well as architectural, decorative and mood lighting

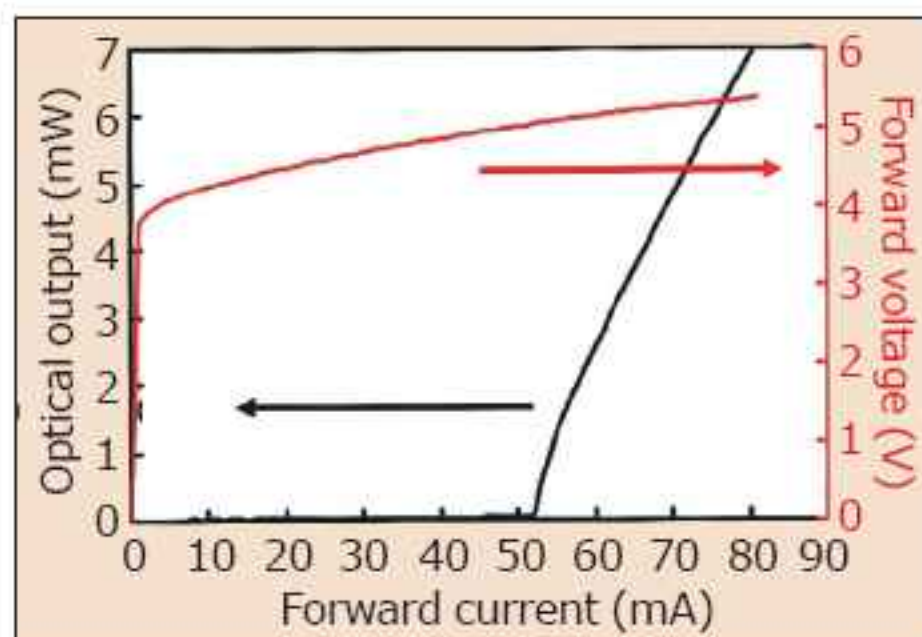
[www.perkinelmer.com](http://www.perkinelmer.com)



# Nichia shipping samples of record 488nm blue-green laser

At the Photonics West 2008 show in San Jose, CA, USA (22–24 January), Japan's Nichia Corp exhibited a blue-green GaN-based laser diode with a center luminous wavelength (in continuous oscillation) of 488nm, the longest of any GaN laser products that have been commercialized so far. Engineering samples will start shipping in March.

The new laser is targeted at replacing argon lasers, for example as excitation light sources for fluorescence analyses in biotechnology R&D, where a laser beam is applied to DNA with fluorescent materials to conduct a quantitative analysis of the materials' emission. The energy conversion efficiency of argon lasers is only a few percent, and they generate a large amount of heat, so cooling systems tend to be large, increasing demand for smaller laser-beam irradiation equipment, Nichia said. The efficiency of the new laser is as high as 13%, allowing smaller, lighter irradiation equipment. Other advantages include high-speed



**Output power and forward voltage versus forward current.**

direct modulation, lower power consumption, and low cost.

A drive current of 71mA and voltage of 5.3V yield a power output of 5mW in continuous-wave operation at 25°C (case temperature), stable for 1000 hours. The estimated lifetime exceeds 10,000 hours, extrapolated from the time that it takes to increase the initial current by 30%. The threshold current and voltage for continuous oscillation are 49mA and 5V, respectively.

Nichia is also developing a 20mW product for commercialization.

To increase the center wavelength to 488nm, Nichia enhanced the indium (In) ratio in the active light-emitting layer. Due to the difference in the lattice constants of the crystals, when the In ratio increases, the number of dislocation defects increases, strengthening the influence of the piezo-electric field and hence lowering the luminous efficiency. Nichia optimized the crystal growth to enhance the In ratio without increasing the number of dislocation defects excessively. The firm also devised an active-layer structure so that light is less likely to be absorbed in the crystal.

Like their previous products, Nichia formed the light-emitting structure on the polar face of a GaN substrate. However, to increase the wavelength further from blue-green towards the green part of the spectrum, Nichia is working on increasing the wavelength using not only the polar face of the GaN substrate but also the non-polar face.

[www.nichia.com](http://www.nichia.com)

## Sharp fabricates its first non-polar GaN laser

In January, the Advanced Technology Research Laboratories of Sharp Corp in Nara, Japan reported fabrication of the firm's first blue laser diodes on non-polar (m-plane oriented) gallium nitride substrates (Tsuda et al, Appl. Phys. Express 1 (2008) 011104; doi: 10.1143/APEX.1.011104). Most developments in non-polar GaN lasers up to now have been achieved by Japan's Rohm Corp and the University of California, Santa Barbara.

The researchers at Sharp grew the non-polar GaN laser structures by using atmospheric-pressure MOCVD, rather than MBE (which it uses to produce its commercial red lasers).

Sharp has been fabricating its existing production 406nm-wavelength blue-violet lasers for its Blu-ray players on conventional c-plane oriented GaN substrates since mid-2007. However, on c-plane oriented substrates, in-built polarization-induced electric fields produce an unwanted blue-shift (to shorter wavelength) of the light emitted from the quantum wells. This effect increases with injection current, as well as reducing output efficiency.

The researchers confirmed this by finding a blue-shift of the spontaneous emission peak at an injection current density just below threshold for c-plane lasers (with a stimulated emission wavelength of

$\lambda = 454\text{nm}$ ) of 26nm, compared to a blue-shift of just 10nm for m-plane lasers ( $\lambda = 463\text{nm}$ ).

Under pulsed operation, the typical threshold current for stimulated emission at a wavelength of  $\lambda = 463\text{nm}$  was 69mA, at a threshold current density of 7.8kA/cm<sup>2</sup>. At an operating current of 80mA, the output power was 10mW.

Sharp is aiming to lengthen the emission wavelength of GaN lasers further into the blue region of the spectrum, as well as to green wavelengths around 520nm, for application in full-color (red-green-blue) laser-based displays in TVs etc.

<http://apex.ipap.jp/link?APEX/1/011104>



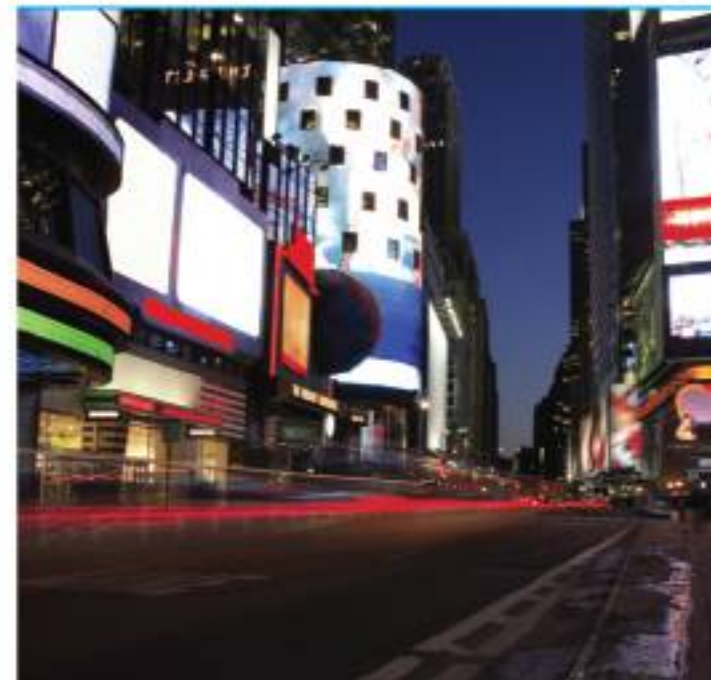


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## First 8Gb/s SFP transceiver for Fiber Channel

Avago Technologies of San Jose, CA, USA has launched what it claims is the first 8Gb/s SFP optical transceivers for Fibre Channel applications.

Due to its transmitter optical and electromagnetic interference (EMI) performance, the AFBR-57D5APZ doubles the bandwidth of previous Fibre Channel SFP optical transceivers. The new transceiver is also compliant with industry SFP+ multi-service agreements and enables the production of standards-based 8Gb/s storage-area network (SAN) switches, storage arrays, host bus adapters and tape drives.

"Our high-performance 8Gb/s Fibre Channel optical transceivers

are already in 8G storage products shipping today," says David D'Andrea, director of marketing for Avago's fiber optic products division. "We've aggressively increased our share in the storage market, with nearly two million 4Gb/s transceivers sold in the last 12 months," he adds. "Our internal VCSEL (vertical-cavity surface-emitting laser) source supports a steady and reliable supply of SAN products." Avago is also working on 16Gb/s technologies.

The AFBR-57D5APZ is designed to be compliant with FC-PI-4 standards over multimode optical fiber at signaling rates from 8.5Gb/s to 2.125Gb/s without the need for

external rate select inputs. It provides real-time temperature, supply voltage, laser bias current, laser average output power and received input power diagnostic information. Its digital diagnostic interface also adds the ability to disable the transmitter, monitor for transmitter faults and monitor for receiver loss of signal.

The new transceiver is available in link lengths up to 150m for 8.5Gb/s; up to 300m at 4.25Gb/s; and up to 500m at 2.125Gb/s. It leverages all standard features and capabilities of Avago's 4G SFP modules, including DMI and RoHS compliance. Pricing begins at \$100 in high volumes.

[www.avagotech.com/fiber](http://www.avagotech.com/fiber)

## IPG enters diode market with 20W fiber-coupled laser

High-power laser and amplifier manufacturer IPG Photonics of Oxford, MA, USA says that it is now selling what it claims are the most powerful and highest-brightness fiber-coupled laser diodes on a merchant basis to original equipment manufacturer (OEM) customers.

Taking advantage of its high-volume production capacity and quality control, IPG says that the laser diodes provide over 20W of output power in a compact size, allowing OEMs to lower their cost per watt and increase equipment lifetime.

The packaged lasers can be used in applications ranging from printing, medical, dental, industrial and laser pumping to telecoms and defense.

The diodes were developed and manufactured for use in IPG's line of industrial fiber lasers. Founded in 1990, IPG pioneered the commercialization of optical fiber-based lasers, and now manufactures both fiber lasers and amplifiers. "Now we are offering this same technology to OEMs for their applications," says Bill Shiner, VP-Industrial Markets. "With higher powers available, our PLD Series provides OEMs an alternative to low-power single emitters and inefficient diode bars with short lifecycles," he claims.

"The sale of diode lasers is a natural extension of our product line," says chairman and CEO Dr Valentin P. Gapontsev. "IPG has sold diode laser systems for years and has recently sold a small number of diode lasers for a dental application. With our three new multi-wafer MBE reactors put into production last year, expanded test station capacity up to 60,000 channels and higher yields, this is the ideal time to introduce the many advantages of IPG's unique and cost-effective diode lasers into the market," he adds.

Key features of the packaged diode lasers include:

- the highest power available in a compact package (up to 20W);
- the highest brightness from a 100µm fiber at a numerical aperture of 0.11 (the lowest in the industry);
- in-fiber electrical-to-optical power efficiency of 60% or more;
- expanded range of wavelengths at 9XXnm, allowing selection of the optimal wavelength;
- small and efficient package, accommodating smaller devices or higher-output devices;
- high reliability from telecom-grade single emitters (put through a rigorous test program).

[www.ipgphotonics.com](http://www.ipgphotonics.com)

## IPG opens NASDAQ one year after IPO

Chairman and CEO Dr Valentin P. Gapontsev (joined by members of the management team and board of directors) opened the NASDAQ stock market on 28 January at the Nasdaq MarketSite in Times Square, New York City.

IPG's participation in NASDAQ's opening bell ceremony celebrates the first anniversary of the firm's initial public offering in December 2007. "During the past year, we leveraged our disruptive technology

to displace conventional lasers as well as sell our fiber lasers into new applications where lasers have never been used before," says Gapontsev. "As the only fully integrated manufacturer of fiber lasers, IPG has major competitive advantages," he claims.

"In addition, our expanding global presence provides us with significant opportunities for growth. During 2008, we plan to continue to penetrate the laser market."



## Advanced Photonix's revenues fall 10% after 40G delays

For its fiscal third-quarter 2008 (ended 28 December 2007), Advanced Photonix Inc of Ann Arbor, MI, USA has reported revenue of \$5.31m, down 9.8% on \$5.88m a year ago. Net loss has grown from \$964,000 to \$2.73m.

Products of the vertically integrated optoelectronics manufacturer include patented silicon, InP- and GaAs-based APD, PIN, and FILTRODE photodetectors; high-speed optical receivers; and the T-Ray 2000 and QA1000 THz terahertz instrumentation platforms.

Telecoms revenues were \$1.52m, down 14% on \$1.77m after delays in shipments of new 40Gb/s design wins due to customers' supply chain difficulties causing delays in their product shipments. However, customers continue to be optimistic about prospects for growth of 40Gb/s product lines. Advanced Photonix expects shipments to resume in fiscal Q4/2008, resulting in modest growth for the year.

Medical revenues were \$372,000, down 36% on \$578,000 due to end-of-life product discontinuance by a customer. Revenue will be minimal for Q4. Industrial Sensing/NDT market revenues were \$2.01m, down 12% on \$2.29m, due mainly to stopping supply of a low-value-added optoelectronic contract manufacturing part and manufacturing delays during closure of the Dodgeville, WI facility in December (consolidating all assembly into Camarillo, CA), offset by increases in THz/NDT revenue. However, Advanced Photonix expects double-digit growth for the rest of the fiscal year. Military/Aerospace market revenues were \$1.23m, up 6% on \$1.16m due to orders that were delayed from fiscal first-half 2008. The firm expects modest growth in Q4, although military revenues will be down for the year. Homeland Security revenues were \$170,000, up from \$88,000. This should increase substantially in Q4.

"We remain confident that we will end up 2008 well ahead of last year," says chairman and CEO Richard Kurtz. "We have made significant investments in people and infrastructure this year, and now have the capacity to meet the growing demands we are experiencing for our HSOR [high-speed optical receiver] product platform, particularly in 40G."

The completion of a private equity placement (netting \$4.3m), along with the conversion of \$3.2m of debt to equity, allowed the firm to substantially deleverage its balance sheet and provide additional funds to help grow future revenues and earnings, Kurtz says. The broadening application development activities with the firm's Terahertz product platform during the quarter bring the firm closer to potential full-scale commercial deployment in a number of commercial, industrial and governmental sectors, he adds.

[www.advancedphotonix.com](http://www.advancedphotonix.com)

## DWDM SFP transceivers with 3200ps/nm dispersion tolerance

Tokyo-based Sumitomo Electric Industries Ltd (SEI) has launched a new series of 2.66057Gb/s dense wavelength division multiplexing (DWDM) small form factor pluggable (SFP) transceivers.

The SCP9FB8 series is designed to support a dispersion tolerance of 3200ps/nm and a reach of 160km by adopting a laser driver with low-chirp characteristics and optimizing the laser diode drive current. Previous 160km transmission dispersion tolerance (for the SCP9EA8 model) was 2400ps/nm; conventional models can be deployed in data links with spans of up to 120km.

Also, the transceiver is equipped with a variable decision threshold (VDT) function, which reshapes the received waveform by optimizing the logical judgment threshold level by means of I2C (inter-IC bus).



The SCP9FB8's minimum sensitivity is -30dBm and the overload is -7dBm (compared to the SCP9EA8's -28dBm and -9dBm, respectively).

"Expansion of distance is the key to fulfilling customer demand," says Ichiro Kono, general manager of SEI's Optical Transmission Components Division. "SEI is not the leading company in the long-haul market, but these products should expand our business opportunities," he adds.

[www.sei.co.jp](http://www.sei.co.jp)

## Gemfire and Covega merge

Gemfire Corp of Fremont, CA has acquired Covega Corp of Jessup, MD (now the active component division of its planar light circuit product family). Covega's products include InP-based superluminescent LEDs, Fabry-Perot lasers, tunable laser gain chips, semiconductor optical amplifiers and lithium niobate modulators.

"Through integration of more optical functions into PLCs, it is possible to provide better performance and cost-effective solutions to meet the needs of large system integrators," says Gemfire's president and CEO Richard Tompane.

"Our combined expertise enables us to be a leader in next generation 40G and beyond, passive optical networks and other advanced optical network applications," claims Covega's president and CEO Joe Dixon.

[www.gemfire.com](http://www.gemfire.com)



## Bookham growth driven by tunables and 980nm pumps, but legacy product fall-off to hit margins in short term

For its fiscal second-quarter 2008 (to end-December 2007), optical component, module and subsystem maker Bookham Inc of San Jose, CA, USA reported revenue of \$59m, up 9% on fiscal Q1's \$54.3m and above October's guidance of \$55–58m. This represents continued recovery following the low of \$45m in both fiscal Q3 and Q4/2007 (after the expiration of a long-term supply deal with Nortel Networks). Nortel represented 15% of revenue, followed by Cisco (11% of revenue) and Huawei (9%).

The latest growth is due to increasing sales of new products launched in the last 18 months, including 980nm pump and amplifier business (up 24%, including starting shipping submarine products to a second customer) as well as iTLA (integrated tunable laser) and TTA (tunable transmitter assembly) products together with small-form-factor (SFF) transponders (which started volume shipment in December) up 66% sequentially (on top of 33% growth last quarter).

Revenue from industrial products rose 5% sequentially and 21% year-on-year to \$14.2m, including record sales of thin-film filters (extending their applications to tier-1 life-science customers), as Bookham leverages its telecom technology and investment. This includes now using its telecom chip fab in Zurich to produce high-power laser chips designed for the materials processing segment.

"The strong second quarter results were driven by continued sales growth with many of our newer products, including tunables, 980nm pumps and amplifiers, ongoing marketshare gains in selected areas and increasing revenue with several important customers," says president and CEO Alain Couder.

However, despite increased revenues, non-GAAP gross margin of 24% was flat on last quarter due to:

- a shift in product mix to new products (incurring lower margins until reaching larger volumes);
- the lower yield of early-stage production; and
- higher-than-expected inventory charges and overhead costs.

Nevertheless, during the quarter Bookham achieved \$8m of savings through its latest restructuring plan (initiated a year ago). Restructuring is now essentially completed (with related costs already having fallen from \$1.2m in fiscal Q1/2008 to \$652,000 in Q2).

Non-GAAP net loss has been cut from \$18m (\$0.26 per share) a year ago to \$8.0m (\$0.10 per share) last quarter and now \$1.1m (\$0.01 per share).

Adjusted earnings before interest, taxes, depreciation and amortization (EBITDA) were

\$329,000, an improvement from minus \$2.5m last quarter and minus \$10.4m a year ago (a \$2.8m

improvement via a \$4.7m revenue increase). It is also the first time in eight quarters (the December 2005 quarter) that the firm has achieved a positive adjusted EBITDA.

This reflects the leverage in the vertically integrated business model, the firm says, which allows rapid product innovation.

During the quarter, Bookham completed a public stock offering of shares that raised about \$41m. Cash reserves hence almost doubled from \$34.4m to \$64.7m (after repaying \$4.3m drawn in the September quarter from the firm's existing \$25m credit facility).

This gives the firm the resources to expand business, says Bookham's chief financial officer Steve Abely. Capital expenditure will be maintained at \$3m per quarter for the next two to three quarters, he adds.

**Bookham has seen ongoing uncertainty in customers' forecasts, particularly for legacy products**

"Going into the March quarter, the market environment is becoming more unpredictable due primarily to the uncertain general economic conditions," says Couder, cautioning that the firm is taking a conservative approach with its short-term forecast (particularly the March quarter). Couder says that, in the last few weeks, Bookham has seen ongoing uncertainty in customers' forecasts, particularly for legacy products (which, as higher-margin products, have a greater impact on overall gross margin).

For fiscal Q3/2008 (to end-March), excluding restructuring and other non-recurring charges, Bookham expects revenue of \$56–60m (up 3–10%), non-GAAP gross margin of 21–25%, and adjusted EBITDA of between minus \$3m and +\$1m.

Abely estimates that Bookham needs to generate \$65m per quarter to break even. Nevertheless, Couder says that Bookham remains confident in its medium- to long-term growth expectations, due to:

- bandwidth demand (e.g. for video over the Internet) growing faster than capacity is coming online;
- 10–40Gb/s applications being forecast to grow at a compound annual growth rate of 21% through 2009;
- growth for tunable products accelerating as carriers replace older fixed-wavelength products to keep up with increasing bandwidth demand, and the pump market should be a good opportunity to quickly add additional sales (with the number of competitors falling, especially for submarine pumps, reckons Couder); and
- continued shortening of lead times at customers suits the flexibility of Bookham's vertically integrated structure.

Abely also confirmed that Bookham is still targeting a gross margin of 35–40% in the next few years.

[www.bookham.com](http://www.bookham.com)



## Bookham ships 4m polarization-stabilized VCSELs; expands in Zurich

Bookham Inc of San Jose, CA, USA has transitioned manufacturing of vertical-cavity surface-emitting lasers (VCSELs) to its High Power Laser facility in Zurich, Switzerland to meet increasing volume demand from consumer applications. VCSEL manufacturing was previously carried out at the Zurich-based facilities of Avalon (acquired in 2006).

The firm says it has made massive investment in the High Power Laser facility's wafer fabrication equipment to provide a high-capacity and well-controlled high-precision manufacturing environment. The move should allow Bookham to increase VCSEL production capacity and offer scalable manufacturing to meet growing demand.

As well as established business in the datacoms sector, VCSELs have seen significant uptake as an alternative to LEDs in optical computer mice.

"Low cost and high reliability, combined with stable single-mode emission and, crucially, low power

consumption, have made VCSELs an attractive option for optical computer mice manufacturers," says Karlheinz Gulden, director VCSEL products. In 2007, Bookham shipped more than 4 million 850nm single-mode VCSELs with active polarization stabilization. The optical navigation market will ultimately demand high-volume production capability approaching 100m chips annually," reckons Gulden. "With the completed transition to the new facility, we now have the infrastructure in place for further scaling of our manufacturing capacity to meet the explosive demand of VCSEL for low-power optical engines."

Executive VP Steve Turley adds, "The transition into our main Zurich wafer fabrication facility not only allows us to capitalize on the ever-increasing demand for VCSELs, it also enables us to maximize use of the facility and increase our day-to-day efficiency."

[www.bookham.com](http://www.bookham.com)

## Avanex's LeMaitre recruited as Bookham's VP of telecom sales and corporate marketing

Optical component, module and subsystem maker Bookham Inc has recruited Yves LeMaitre as VP of global sales for its telecoms division and VP of corporate marketing, based in San Jose and responsible for leading the telecom sales team and corporate communications group.

LeMaitre previously held executive positions with rival Avanex Corp of Fremont, CA, most recently as chief marketing officer in charge of worldwide sales and marketing. Prior to that, he was president and CEO of Lightconnect of Newark, CA, a maker of optical MEMS components and modules. He was also at Alcatel and its joint venture with Sprint International in general management, senior marketing and engineering positions in the USA, France, the Netherlands and Italy.



**Yves LeMaitre.**

LeMaitre graduated from France's Nantes University with a master's degree in mathematics and computer science. He also holds an engineering degree from Ecole Nationale Supérieure des Telecommunications (ENST) in Paris.

"His considerable experience and knowledge of the optical industry significantly strengthens the company and will help us to achieve our growth plans as we drive new products into our global customer base and keep recruiting new customers," says Adrian Meldrum, telecoms division general manager.

### IN BRIEF

#### QPC wins \$1.3m in orders for Ultra lasers

QPC Lasers Inc of Sylmar, CA, USA has received \$1.3m in new orders for its BrightLase Ultra lasers for use in medical applications.

The two orders come less than a month after the launch of the BrightLase Ultra product line. Shipping began in December and is due to finish by end 2008.

"We continue to see strong customer interest in our new Ultra lasers, particularly for surgical laser applications such as the treatment of cancerous tumors, benign prostrate hyperplasia, and cardiology where they show great promise because of the laser's ability to rapidly and precisely remove tissue in a sterile and minimally invasive fashion," says Paul Rudy, VP of marketing & sales.

[www.QPClasers.com](http://www.QPClasers.com)

#### DILAS to distribute m2k-laser products

DILAS Diodenlaser GmbH of Mainz, Germany, which designs and makes high-power diode laser components, modules and systems, is to begin distributing single-emitter diode lasers made by m2k-laser GmbH of Freiburg.

m2k was founded in 2001 and acquired by Rofin-Sinar Laser GmbH of Hamburg, Germany in 2007. DILAS is majority owned by parent firm Rofin-Sinar Technologies Europe S.L. (a subsidiary of Rofin-Sinar Technologies Inc of Plymouth, MI, USA).

m2k makes single-emitter lasers (mainly for scientific use). These include tapered amplifiers based on GaAs emitting at 755–1064nm and providing M2 beam quality for use in external-cavity and MOPA (master oscillator power amplifier) systems, and 1.8–2.4µm GaSb-based high-power lasers (broad-area or ridge-waveguide).

[www.DILAS.com](http://www.DILAS.com)



## IN BRIEF

## Firecomms signs rep for Illinois and Wisconsin

Firecomms Ltd of Cork, Ireland, which makes high-speed plastic optical fiber (POF) transceivers and VCSELs, has appointed ESA Technical Marketing Inc as its representative for the Illinois and Wisconsin areas of the USA. ESA will market and sell its full range of POF transceiver products, which are being adopted by developers of equipment for consumer electronics, industrial and automotive networks worldwide.

This follows the signing of two rep agreements in last November: Sylvester Sales Associates of Milford, NJ for the New York Metro area and WaveLink Associates of Orlando, FL for south-east USA.

"ESA's long history of success in Illinois and Wisconsin will bring substantial benefits to support our rapidly growing sales of our groundbreaking products in the USA," says Lawrence Thorne, Firecomms' VP of sales & marketing in the Americas.

ESA's president Tom McGuire highlights the rapid growth for optical data communications in small-area networks such as those in cars and homes. "For several years we have offered our customers POF from Mitsubishi. "With the addition of Firecomms to our line card, we will be able to offer our customers a total solution."

For consumer, industrial and automotive applications (in which plastic fiber can be used more easily and at lower costs than copper or glass fiber), POF is now used in millions of small-area networks, such as those used in many car models, and is rapidly gaining ground in home network and point-to-point interconnection. The POF market is estimated to be worth over \$1bn per year by the end of 2008, says Firecomms.

[www.firecomms.com](http://www.firecomms.com)

## Finisar's record revenue driven by 10-40Gb/s product sales up 60%

On the basis of preliminary financial results for its fiscal third-quarter 2008 (ended 27 January 2008), fiber-optic component and subsystem maker Finisar Corp of Sunnyvale, CA, USA expects to report record revenue of \$112m (exceeding its guidance of \$104-108m).

This is up 4% on \$107.5m a year ago and up 11% on last quarter's \$100.7m, due to revenues from 10 and 40Gb/s products rising to about \$29m (up 61% on \$18m last quarter), including:

- \$8m from increased shipments of SFP+, XFP and X2 transceivers for 10Gb/s Ethernet and SONET applications;

- \$2m from 40Gb/s 300-pin transponders that could not be shipped in the second quarter due to firmware problems (corrected during the third quarter);

- more than \$2m from 8 Gigabit Fibre Channel SAN (storage-area network) transceivers.

During the quarter, the firm's balance of cash and investments that could be readily converted into cash rose from \$115m to about \$122m.

For its fiscal fourth-quarter 2008, Finisar expects revenues of \$110-115m (roughly flat on Q3).

Finisar releases full third-quarter results on 3 March 2008.

[www.finisar.com](http://www.finisar.com)

## Infinera diversifies customer base

Infinera Corp of Sunnyvale, CA, USA, a vertically integrated manufacturer of digital optical network systems incorporating its in-house made InP-based photonic integrated circuits, has reported fourth-quarter 2007 revenue of \$76.1m, up 22% on Q3's \$62.2m and up 74% on \$43.8m a year ago.

The firm has continued to grow gross margin (from just 6% a year ago and 34% in Q3 to 36%) and to cut net loss (from \$25m a year ago and \$5.5m in Q3 to \$3.9m).

For full-year 2007, revenue was \$245.9m (more than quadrupling 2006's \$58.2m). Gross margin was 31% (compared to negative 23%). Net loss was cut from \$89.9m to \$55.3m.

Infinera's strong performance reflects solid execution against its business strategy, increased customer momentum in favor of its unique approach to optical networks, and continued growth in bandwidth demand, reckons president and CEO Jagdeep Singh.

"Customers tell us they are choosing Infinera because of the system's flexibility, rapid service provisioning and ability to deliver differentiated

services without having to re-engineer their optical plants," Singh adds.

"We have a growing and increasingly diversified global customer set of service providers, cable MSOs (multi-system operators) and internet content providers who are utilizing Infinera's unique combination of large-scale photonic integration and bandwidth virtualization technology," says Singh.

In Q4/2007, four customers (including Cox Communications and Level 3 Communications) accounted for over 10% of invoiced shipments, with no single customer more than 18% (one year ago, there were just two 10% or more customers, with the largest comprising as much as 47%). The customer base grew by three (Equinix Inc, XO Communications Inc and 360networks Inc) to 41 (versus 23 a year ago), including additions from fast-growing internet content providers, and now includes four of the top five cable MSOs in North America.

However, North America comprises 81% of invoiced shipments (versus 72% a year ago), so a target is to grow custom in Europe and Asia.

[www.infinera.com](http://www.infinera.com)



## Avanex grows profit despite falling revenues

For its fiscal Q2/2008 (to end-December 2007), optical communications component and module maker Avanex Corp of Fremont, CA, USA has reported revenue of \$52m, down 5% on \$54.7m last quarter and 7% on \$55.6m a year ago.

North America represented \$25.9m (up 7% on last quarter) and Europe and Asia \$26.1m (down 15%, mainly due to December's abrupt termination of distribution revenue from 3S Photonics, formerly Avanex France).

Despite the drop in revenue, gross margin still rose, from 19% a year ago and 28% last quarter to 31%. This is due to new products and platforms as well as continued benefits from programs implemented last year. Net income of \$86,000 is up from \$45,000 last quarter and a loss of \$8.6m a year ago.

"We demonstrated strength in our core business [up a few per cent, driven by growth in amplifiers and dispersion compensation products, offset by 3S distribution revenue], achieved solid gross margins and generated over \$6m in cash from operations [boosting reserves to \$53m]," says chairman, president and CEO Jo Major. "With our healthy operating structure, we are well positioned for future growth from our new products as we take advantage of growing bandwidth demand."

During the quarter, Avanex began shipping its Oasis amplification platform, which will obsolete the

previous platform in the March quarter and, from the June quarter, should boost revenue growth. However, in the near term, growth will be modest as it completes the transition of existing customers to the new platform.

As bandwidth demand is driving the replacement of SONET by agile DWDM systems, Avanex is beginning to see revenue from reconfigurable optical add-drop multiplexers (ROADMs) and is expanding its development team to address demand through 2008–2009. In particular, with qualification with its lead customer completing, Avanex is moving from providing simple switch modules to full ROADM subsystems. This presents an opportunity to increase revenue long term, but in the near term the transition will push out revenue by a month or so.

For fiscal Q3/2008 (to end-March), Avanex expects revenue of \$46–50m (down 4–12% sequentially). Gross margin should drop to 25%, when much of Avanex's annual pricing adjustment will occur (reducing the average selling price by 9%, out of a total of 15–17% per year). Also, the firm had been expecting the decline in 3S distribution revenue to be spread throughout 2008. Instead, the arbitration complaint filed in late December against 3S for breach of contract may lead to legal expenses of \$2–3m and take 12–24 months to resolve.

However, Major expects growth in second-half 2008. ROADM revenue should start up with two other tier-1 customers in the June quarter. Also, as new products are launched, gross margin should still rise to the target 35% in the next 9 months.

In particular, after de-emphasizing gain-blocks while restructuring due to margin pressures, Avanex is now re-engaging the market profitably after transferring R&D to China. All key products are being re-designed, with design wins already in America and Europe and products now being taken into the Chinese market.

Regarding last July's acquisition of the 10Gb/s 300-pin MSA transponder and XFP MSA transceiver businesses of Essex Corp's Commercial Communication Products Division (CCPD) in Melbourne, FL, Avanex had intended it to be accretive to earnings no later than the June quarter. However, while the long-term market remains strong, current market uncertainty may delay profitability in the near term, says Major.

Nevertheless, the firm's new tunable dispersion management product (necessary for 40Gb/s transponders), coupled with the new Oasis 1600 amplifier, is getting feedback from tier-1 and -2 customers that it meets the needs of the growing 40Gb/s transmission market, Avanex says. The market should grow rapidly with migration to 40Gb/s, says Major.

[www.avanex.com](http://www.avanex.com)

## 3S reports positive EBITDA as sales triple year-on-year

Just eight months after divestiture last April by Avanex, 3S Photonics of Essonne near Paris (formerly Alcatel Optronics then Avanex France) has reported a positive EBITDA (earnings before interest, taxes, depreciation, and amortization) of \$230,000 for fiscal Q2/2007–2008 (to end-December). This compares with a negative EBITDA of \$1.2m the prior quarter and \$3.5m a year ago (considering the post-divestiture product portfolio only).

Revenue was over \$10m, up 22% on last quarter and up three-fold year-on-year. Growth is due partly to growth in the submarine market and soaring sales in pump laser modules and filters using fiber Bragg gratings (FBG). Income from these components has multiplied four-fold in the last three quarters. 3S says the results are also due to good sales of the LDM product line (including transmission laser modules) and the launch of new products.

Also, restructuring and the new management team's cost reduction plan have led to a 10% cut in fixed costs in the last 12 months.

Since last April's buy-out, every profitability indicator is gradually turning positive, says chairman and CEO Alexandre Krivine. The recovery should carry on into the coming months, due to a solid backlog and recent product launches, including terrestrial pump laser modules.

[www.3sphotronics.com](http://www.3sphotronics.com)



# Optium's 40G DPSK & SFF NRZ transceivers enter production

Optical subsystem maker Optium Corp of Horsham, PA, USA has transitioned two additional 40Gb/s solutions to production. The new 40Gb/s DPSK 300-pin transceiver and 40Gb/s small-form-factor (SFF) NRZ 300-pin transceiver began shipping in early December as part of Optium's fiscal 2008 ramp of its 40Gb/s product line.

The DPSK transceiver allows full C-band operation at data rates of 39.8–44.6Gb/s with improved performance in long-haul applications.

The SFF NRZ transceiver is a client-side solution supporting data rates of 39.8–43.1Gb/s that is lower cost than Optium's tunable NRZ transceiver, and is designed in a smaller footprint (4" x 5" x 0.53"), enabling higher port density on smaller-size line cards (as required by certain customers).

The DPSK and SFF NRZ 40Gb/s products complement Optium's existing 40Gb/s portfolio of:

- tunable NRZ transceivers (with full C-band operation at data rates

of 39.8–44.6Gb/s) for applications including client-side interface and test equipment; and

- Optical Duo-Binary 300-pin transceivers (which have a modulation format more tolerant to the effects of chromatic dispersion than NRZ) for line-side applications (with full C-band operation at data rates of 39.8–44.6Gb/s).

Optium says that all of its 40Gb/s products are offered with a 300-pin MSA interface (with a footprint of 5" x 7" x 0.7", unless otherwise noted), are designed to support the OIF SFI-5 standard and applicable Telecordia/ITU interface requirements, and address both line- and client-side applications. The full line of 40Gb/s transceiver products was exhibited at January's 8th Fiber Optics Exposition in Tokyo, Japan.

"Demand for 40Gb/s transceivers continues to build as our customers adopt 40Gb/s solutions to address increasing bandwidth requirements cost effectively," says Tony Musto, VP of sales & marketing. "Similar to

our approach in 10Gb/s, we are developing a powerful portfolio of 40Gb/s products by utilizing a common 40Gb/s 300-pin platform with diverse modulation schemes and advanced features, including tunability on multiple modulation formats, high tolerance to chromatic dispersion and polarization mode dispersion (PMD) impairments, and the ability to work in a network through multiple ROADMs at 100 and 50GHz channel spacing," he adds. "This module-based approach can enable unmatched design, cost and performance flexibility for our customers as they migrate to next-generation 40Gb/s technologies."

Optium aims to further expand its 40Gb/s portfolio by the end of fiscal 2008 by launching an RZ-DQPSK solution offering higher tolerance to chromatic dispersion and PMD, along with a narrow spectrum to be easily transported on ROADM-based networks with a 50GHz channel plan and optimized for metro and long-haul networks.

## Optium launches 10G SFF 300-pin tunable transponder

Optium has launched its 10Gb/s small-form-factor (SFF) 300-pin tunable transponder (the latest addition to its portfolio of 10 and 40Gb/s transponders).

Optium says it has drawn on its experience in the design and manufacturing of tunable optical transmission products to offer a compact 2.2" x 3" module that provides an almost 60% reduction in surface area compared to a large-form-factor 300-pin transponder while maintaining the same standards of performance.

The SFF tunable transponder is based on a standard 300-pin MSA and features full C-band and L-band tunability. Available in both

±800ps/nm and 1600ps/nm versions, the device can operate at up to 11.35Gb/s, has a minimum extinction ratio of 12dB and low power dissipation. The transponder is also designed to accommodate multiple optical sources for all optical components, including the tunable laser, lithium niobate modulator and receiver, which can be configured as a PIN diode or an avalanche photodiode (APD) and can also include an integrated VOA (variable optical attenuator).

Optium says that the SFF tunable transponder provides enhanced network flexibility by enabling the upgrade of single-channel applications often used in metro net-

works. In addition, it allows current users of large-form-factor tunable devices to achieve higher port density on their line cards without sacrificing performance.

"This combination of performance and value creates a compelling alternative as customers look for innovative solutions to improve network agility through tenability," says VP of sales & marketing Tony Musto. "We are already seeing strong acceptance of this new product with existing and new customers."

The SFF tunable transponder began shipping to multiple customers during Optium's fiscal Q2/2008 (ended 2 February).

[www.optium.com](http://www.optium.com)



## Opnext revenue hit by supply issues

For its fiscal third-quarter (to end-December 2007), optical module and component maker Opnext Inc of Eatontown, NJ, USA has reported preliminary unaudited revenue of \$66.4m, down on its original guidance of \$77–80m. This is also down 13% from \$76.6m last quarter but up 8% on \$61.7m a year ago.

The shortfall is mainly due to:

- \$4m of supply- and quality-related issues, including 40Gb/s digital mux/demux ICs purchased from an external supplier requiring a change to alleviate potential quality issues (with the transition to the new IC beginning during the quarter) and XENPAK SR (short-reach) production being limited due to shortages of parts provided by external suppliers (resolved by the end of the quarter);
- \$4m of 10Gb/s transceiver demand related mainly to customer inventory management programs not being pulled by the end of the quarter;

- \$2.5m related to lower-than-expected 300-pin fixed-wavelength demand.

However, for its fiscal Q4/2008 (to end March), Opnext expects revenue to bounce back due to:

- increased shipments of 40Gb/s and Xenpak SR products;
- qualification of XFP transceivers at a large data communication network equipment customer; and
- qualification of 300-pin tunable transceivers at a large telecom network equipment customer.

\* Opnext's board of directors has approved the repurchase of up to \$20m of its common stock over the next 24 months. The firm says it may buy stock on the open market or in privately negotiated transactions from time-to-time, depending on market and business conditions. Any repurchases will be made using available working capital.

[www.opnext.com](http://www.opnext.com)

## Financial statements to be re-stated

In the course of preparing its financial statements for fiscal Q3, Opnext has determined that errors occurred in the valuation of inventory consigned to one of its contract manufacturers. Hence, inventory and trade payables balances and the reported amounts of cost of goods sold and other income expense, net, were not properly reported for the fiscal years to end-March 2006 and to end-March 2007, and for the affected quarterly periods in each.

Net income was overstated by \$1.8m for the fiscal year to-end March 2007; net loss was understated by \$1m for the fiscal year to end-March 2006. Also, net income was overstated by \$0.7m for the quarter to end-December 2006 and understated by \$0.1m for the quarter to end-September 2006, and net loss was understated by \$0.5m for the quarter to end-June 2006.

Management has reviewed the errors and decided that its prior statements for the above periods

should no longer be relied upon.

Opnext expects to file an amendment to its Form 10-K report for the fiscal year to end-March 2007 to restate for the years to end-March 2007 and end-March 2006. It also expects to file amendments to its reports on Form 10-Q for the quarters to end-June and end-September 2007 to restate the previously issued statements for the quarters to end-June and end-September 2006, respectively. The previously issued statements for the quarter and nine-month period to end-December 2006 will be restated in the Form 10-Q report for the quarter to end-December 2007.

Opnext has notified the NASDAQ National Market of the review and of the expected restatements.

Pending completion of the restatement, Opnext is postponing its earnings release and the filing of its Form 10-Q report for the quarter to end-December 2007.

## IN BRIEF

### Opnext enters human body light measuring market

At Photonics West, optical module and component maker Opnext Inc of Eatontown, NJ, USA launched its HL7001/7002MG laser diode, representing its entry into the human-body light-measuring device market.

The device emits in the 705nm infrared wavelength band and has the high optical output power (50mW), high reliability and low operating current necessary for medical applications such as blood, analysis light source and endoscopy, the firm claims.

Also, compact size allows for smaller biomedical measurement equipment while improving the quality of existing medical device applications, Opnext adds.

### First 640nm/150mW red laser

Opnext also launched the HL6385DG, which it claims is the world's first red laser diode with 640nm/150mW capabilities, and offers the highest optical output power and red color wavelength band available.

As light sources for miniature displays, due to their greater monochromaticity, lasers have better color reproducibility as well as higher efficiency, smaller size and lower weight than UHP (ultra-high performance) lamps and LEDs.

In January 2007, Opnext launched the HL6366DG series 642nm/90mW red laser for miniature displays. Now, via a development process that included a new waveguide structure, the single-longitudinal-mode 642nm/150mW red laser diode offers more brilliant image and is suited to miniature displays for personal computers, cell phones and other mobile devices.



# JDSU exceeds growth forecast

For its fiscal Q2/2008 (to 29 December 2007), JDSU of Milpitas, CA, USA has reported revenue of \$399.2m (up 11.8% on the previous quarter's \$356.7m and 9% on \$366.3m a year ago, as well as up on October's forecast of \$372–394m).

Compared to last quarter, Communications Test and Measurement revenue was up 14% to \$197.5m (49% of total revenue). Advanced Optical Technologies segment revenue was up 3.8% to \$49.8m (12% of revenue). Commercial Lasers business revenue was up 11.6% to \$22.2m (6% of revenue).

Optical Communications revenue was up 11.8% from \$116m to \$129.7m (33% of revenue), with particular strength in the agile optical network (AON) unit. The latter includes revenues for ROADMs (reconfigurable optical add/drop multiplexers) up 39%, via record shipments of 2500 units. (Analysts forecast that the ROADM market will grow at a compound annual growth rate of 33% over 2006–2009.) Revenue for 10Gb/s transceivers and transponders grew 32% sequentially. Gross margins for Optical Communications rose (due mainly to higher factory utilization, improved material costs, and favorable product mix), while the operating margin was positive for the first time in over a year (at 7.6%). Near-term

targets for Optical Communications are gross margin of 20–30% and operating margin of 5–15% (which Kennedy sees as sustainable).

JDSU's overall net income was \$21.2m, an improvement on a net loss of \$6.9m last quarter. On a non-GAAP basis, gross margin has grown from 40.6% a year ago and 41.3% last quarter to 46.3% (compared to the firm's near-term goal of more than 40%). Operating margin rose from 2.2% last quarter to 11.4% (well above the firm's near-term goal of 2–5%).

"In Q2 we achieved our near-term operating model goals, with evidence of progress towards longer-term targets" says CEO Kevin Kennedy.

"For the fourth consecutive quarter the company was free cash flow positive [generating more than \$40m]."

Kennedy says that JDSU continues to see favorable end-market indications for broadband services and network build-outs. He believes that broadband capacity will continue to expand as higher data rates are being delivered to the access edge accompanied by video applications.

In particular, after its new next-generation 8 and 10Gb/s SFP+ products continued to gain strong customer acceptance in fiscal Q2, JDSU expects to ship more than 100,000 units by the end of fiscal Q3/2008.

Kennedy also highlighted JDSU's launch during fiscal Q2 of its avalanche photodetector (APD) chip for gigabit passive optical networks (GPONs) for fiber-to-the home (FTTH), its Integrated Laser Mach Zehnder (ILMZ) chip (which incorporates a tunable laser and optical modulator in a photonic integrated circuit), and its 10Gb/s widely tunable transmitter optical subassembly (TOSA), which uses the ILMZ chip. Such functional integration is a consequence of JDSU's vertically integrated structure, and forms a key strategic principal of the firm's roadmap going forward, Kennedy says.

Overall for its fiscal Q3/2008 (to 29 March), JDSU expects revenue of \$380–402m, but non-GAAP operating margin will fall to 4–7%, while gross margin will also fall, due to cycles in the product mix.

However, Kennedy believes that JDSU is now moving towards its long-term goal of sustainable gross margins of 43–47% and operating margin of 10% or more. While these figures were actually achieved in fiscal Q2, the firm expects to generally operate to these metrics by the end of calendar-year 2008. "Over time, we will evaluate the potential for operating to a more aggressive model," he adds.

[www.jdsu.com](http://www.jdsu.com)

## Smallest widely tunable optical transmitter for DWDM

JDSU has created what it claims is the smallest widely tunable transmitter optical subassembly (TOSA) for DWDM transceivers (dramatically reducing the size and cost compared to previous discrete solutions for tunable transmitters).

The 6mm x 6mm x 17mm TOSA houses JDSU's ILMZ chip (launched last September), a photonic integrated circuit combining a tunable laser and optical modulator.

"Our ability to leverage the expertise of JDSU's in-house data-

com and telecom teams provided a competitive advantage when it came to packing the most innovation possible into a dramatically smaller assembly," says Alex Schoenfelder, VP and general manager of Integrated Photonics.

The ILMZ TOSA brings full-band tunability (the ability for service providers to change to any wavelength on demand) to pluggable small-form-factor (XFP) transceivers that previously only supported one to two wavelengths.

It should also enable the use of pluggable small-form-factor products to support 50GHz channel spacing in metro area networks, where traffic continues to grow due to increased use of voice, video and data applications by consumers. According to a recent report by analyst firm IDC, the fastest growth in optical networking over the next three years is expected in the metro space.

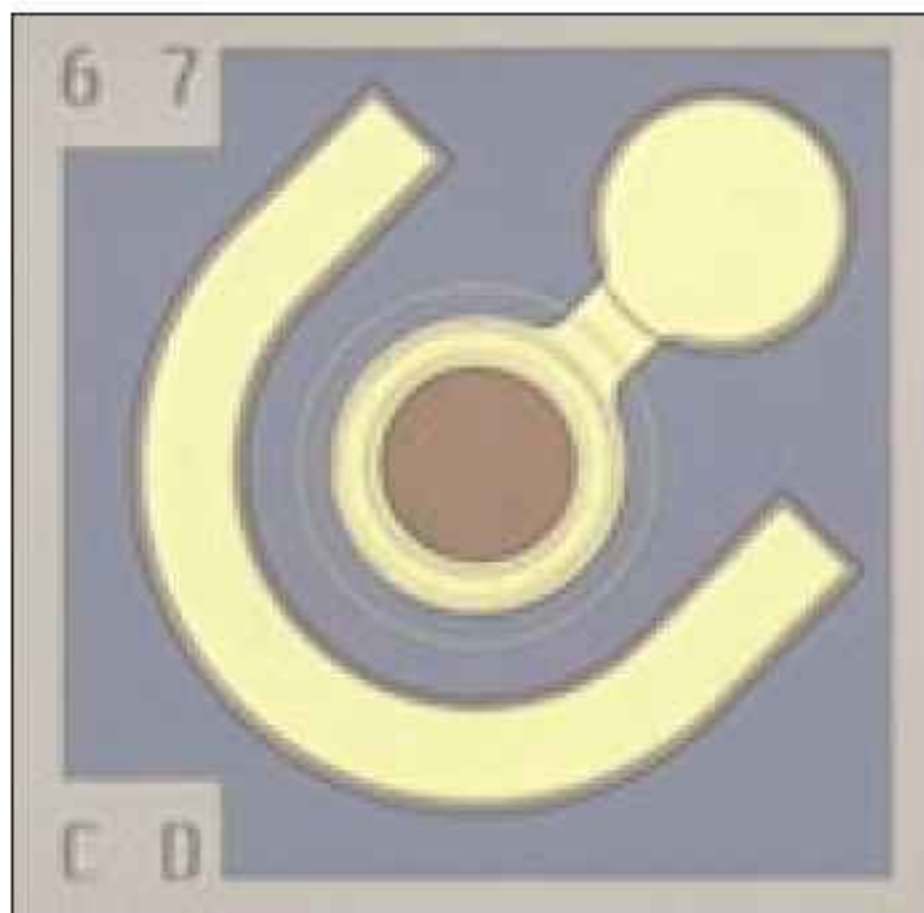
JDSU will market transceivers in the TOSA package later this year.



## JDSU ships avalanche photodiode chip for GPON

Optoelectronic chip and module manufacturer JDSU of Milpitas, CA, USA says that it is now shipping a 2.5Gb/s front-illuminated avalanche photodiode (FI-APD) chip designed for gigabit passive optical networks (GPONs) that enable data transmission for fiber-to-the home (FTTH). The new chip provides high functionality at low cost, claims the firm, suiting FTTH deployment.

Network equipment manufacturers (NEMs) and their service provider customers are implementing GPON networks and offering FTTH solutions to consumers as a high-performance option to hybrid fiber coax (HFC) and digital subscriber line (DSL) solutions for combined high-speed voice, video and data transmission. To maintain reasonable costs for these services, the optical components that make up the GPON infrastructure must also be low cost and perform at very high levels to ensure quality of service to consumers.



JDSU's front-illuminated APD.

"The GPON market is starting to take off and is expected to grow at a CAGR [compound annual growth rate] of greater than 150% over the next several years, as service providers increase FTTH rollouts to consumers," says Lynn Hutcheson, VP of Communication Components at Ovum RHK. "It makes sense that JDSU would offer an APD chip for GPON, leveraging its expertise at photonic integration and its

strength at developing receiver products to deliver a low-cost solution to the market."

To make APD chips affordable for the GPON market, JDSU has leveraged its manufacturing expertise to create a new low-cost chip, the firm says. Legacy designs have been updated to reduce manufacturing complexity, while retaining the same high reliability and performance of legacy APD chips. The chip is based on a planar platform, known for higher reliability and easier fabrication. JDSU has previously shipped tens of thousands of APD chips for telecom applications.

"With the new APD chip, JDSU has combined its telecom expertise and manufacturing savvy to enter the high-growth GPON market," says Alex Schoenfelder, VP and general manager of Integrated Photonics.

JDSU is currently developing packaged versions of the APD chip for the GPON space and other telecom markets.

[www.jdsu.com](http://www.jdsu.com)

## Mintera ships first 40Gb/s DWDM DPSK module

Optical transport system supplier Mintera Corp of Acton, MA, USA has made the industry's first commercial shipment of a 40Gb/s DWDM DPSK transceiver module (in December to a new European customer, one of several new customers that have selected it for their next-generation 40Gb/s line cards).

Available in a standard 300-pin package, the new MI 4000XM Adaptive-DPSK module was developed in collaboration with JDSU of Milpitas, CA, with which Mintera announced a partnership last October to provide a complete 40Bb/s solution set to the telecom industry.

"This shipment signals the beginning of an inflection point for the industry with the first delivery of a new generation of 40Gb/s DWDM modules," says president and CEO Terry Unter. "Dramatic increases in video content are driving service

providers to embrace the performance and cost advantages of 40Gb/s optical transport; the performance advantages of Adaptive-DPSK have been validated by all transport equipment manufacturers (TEMs) who have tested it," he adds. "The MI 4000XM has already won several new customers and will be shipping in significant volumes early this year."

Mintera says that its patent-pending Adaptive-DPSK technology enables 40Gb/s transport on 50GHz-channel-spaced systems and transmission over agile ROADMs (reconfigurable optical add-drop multiplexer) networks without compromising critical ultra-long-haul reach. The unit conforms to the industry-standard footprint and is compliant to ITU-T G.693 for optical interfaces and OIF SFI-5 standards. Incorporating an electrical

mux/demux for compatibility with any 40Gb/s framer, the module has a 300-pin MSA connector with support for the appropriate I2C commands, enabling simple hardware and software integration.

"The DWDM 40Gb/s module market takeoff was obvious in 2007," says Michael Howard, principal analyst at Infonetics. "Mintera's release of the MI 4000XM Adaptive-DPSK product is a timely response to the changing market needs, which enables the 40Gb/s DWDM interface to be delivered in a common physical form factor. This reduces the number of variants, driving up volume, leading to lower costs," he adds. "The move to common, modular solutions was instrumental in enabling the 10Gb/s market to take off, and we believe it will have the same effect for 40Gb/s."

[www.mintera.com](http://www.mintera.com)



# CPVs driving Emcore spin-off

For its fiscal Q1/2008 (to end-December 2007), Emcore Corp of Albuquerque, NM cut net loss from \$7.8m a year ago to \$6.8m, on revenue of \$46.9m (flat on last quarter but up 21% on \$38.6m a year ago).

Fiber Optics revenue was \$34m, up 34% on \$25.3m a year ago and 9% on \$31.2m last quarter, due mainly to record broadband sales (up 43% year-on-year), as well as the digital fiber optics sector (up 16% on last quarter as it recovers to 2006 levels, driven by market share gains and demand for 10G products, especially optical backplanes).

PV revenue was \$13m, down 18% on \$15.8m last quarter, due to the delay (from November to January) in the delivery of automated, high-volume die-attach equipment for the new concentrator photovoltaics (CPV) solar cell manufacturing line (causing a \$3m shortfall in scheduled CPV shipments). However, the equipment should be online in the current quarter, so shipments will start soon. Emcore expects to recoup the shortfall this fiscal year, with no impact on revenue guidance. Without the delays, overall revenue would have exceeded the guidance of \$49m, says CEO Reuben Richards.

Gross margin rose again, from 17% to 21%. Fiber Optics gross margin is up from 18% to 23% due to the revenue growth plus restructuring completed last year (consolidating design centers in Virginia, Illinois and northern California into the manufacturing sites in Albuquerque and Alhambra, CA). Also during the quarter, Emcore began shipping products from its new packaging facility in Langfang City, China, which should improve the cost structure and gross margin. PV gross margin is down from 17% to 14% due to the deferred revenue and unfavorable product mix. Without the delays, PV gross margin would have risen.

Order backlog rose from \$149m to \$156m: just \$14m in Fiber Optics, but a huge \$142m in PVs (\$53m in satellite and up to \$89m in terrestrial).

This includes a 300kW CPV system for Spain's Institute of Concentrator Photovoltaics Systems (ISFOC) to be installed in Castilla-La Mancha by December. But it excludes orders taken since mid-December 2007 for: 850kW for a project in Extremadura, Spain (to be completed by July); 60MW for Pod Generating Group in Ontario, Canada over three years from mid-2008; 5.7MW for South Korea, plus a letter of intent for 14.3MW more (expected to be released in the next six months); and at least 15MW annually from a new manufacturing joint venture formed with Seoul-based semiconductor packaging firm DI Semicon.

"Fiscal 2008 has started on a positive note with our recent success in developing large CPV solar power system opportunities," says Richards. Also, at the end of January, Emcore agreed to supply 200-700MW to SunPeak Solar of Palm Desert, CA for two utility-scale projects in south-western USA (of 200MW and 500MW, respectively, for construction from early 2009), pending US Congress renewal of the federal investment tax credit for renewable energy sources to 2009 and beyond.

Emcore's 'Gen II' CPV system (which should achieve \$3 per Watt installed) is also now operational in Albuquerque, with 8% higher-than-expected output. The new design is now in production.

The Fiber Optics division continues to experience significant growth, both year-over-year and quarterly, adds Richards. The digital fiber-optic portfolio has also been complemented by December's acquisition (for \$85m) of the telecom-related part of Intel's Optical Platform Division (tunable lasers and assemblies, tunable transponders and 300-pin transponders).

"We remain confident that 2008 will be a year of solid earnings improvement and profitability," says Richards. Including \$4m from the Intel acquisition (which was completed on 22 February), Emcore expects fiscal Q2 revenue

of \$56-57m (up 41-44% on \$39.7m a year ago). Full-year fiscal 2008 revenue should be \$265-285m, including \$35m from the acquisition (up 25% on October's guidance of \$210-230m and up 56-68% on fiscal 2007's \$170m), due to order backlog for new terrestrial solar cells as well as the launch of the new CPV solar power system.

For calendar 2008, Emcore expects revenue of \$340m (\$190m in Fiber Optics and \$150m in PV), with substantial growth for PVs in calendar Q4 due to the contracts announced last December. Also, even without the SunPeak's 700MW, 2009 revenue should scale well beyond the Q4 run rate of \$112m per quarter to total \$450-475m (which can be addressed with the current capacity in Emcore's fab). Nevertheless, Emcore plans to bring online four CPV lines (three in Albuquerque and one in China), Richards says. It will also expand further, pending progress on the SunPeak projects. Most of the extra capacity needed could be brought online within 6 months (by Q4).

"Given the fact that the size of renewable energy projects contemplated will require dramatic and unprecedented expansion, it is likely that the board of directors at this March's meeting will determine that, in order to finance this rapid growth, Emcore will split into two separate businesses: a standalone fiber-optics company and a renewable energy company that would be spun off to Emcore shareholders after an initial public offering (IPO) to raise the capital in support of the significant growth in the terrestrial power business," says Richards.

"With the Intel telecom acquisition, the fiber-optic business, along with the growth from the broadband digital products, will make a very competitive and profitable company," he reckons. Broadband revenues should grow 20-25% in 2008, with expanding margins and profitability.

[www.emcore.com](http://www.emcore.com)



## Emcore supplies Spain with CPV components & systems

Emcore of Albuquerque, NM, USA is to supply its solar concentrator photovoltaic (CPV) components and systems to the Spanish market through several agreements, worth about \$18m in total over the next 15 months.

Last November, Emcore won a 300kW CPV system contract from Spain's Institute of Concentrator Photovoltaics Systems (ISFOC). Established in 2006, the ISFOC is to be the center of reference on the power, reliability, and productivity of commercial CPV systems. Emcore says it will have its CPV systems installed in Castilla-La Mancha, Spain by December.

Also, in January, Emcore agreed a deal to construct an 850kW solar power park in Extremadura, Spain. The firm will be using its CPV solar

power system and providing a turn-key solution with a scope of work including engineering, procurement and construction (EPC). The project will complete by July, to take advantage of the current high feed-in tariff.

Emcore also recently won an order from an unnamed CPV system integrator for 1 million CPV components, due to be completed by March 2009, with CPV products deployed in projects within the Spanish market.

"These purchase orders from various customers mark the acceptance of our CPV technology and product solutions as high-performance and low-cost solar power system in the Spanish market, and represent a success for our business development efforts in Spain. We expect additional and larger contracts from Spain once the new feed-in tariff

settles," says Dr Hong Hou, president and chief operating officer. "The CPV solution is still in the early growth stages. As the world's primary supplier of CPV components, we expect to grow our CPV business dramatically as the market is more developed and deployed."

In August 2007, Emcore achieved 39% peak conversion efficiency under 1000x concentration from its triple-junction solar cells. The firm says it is supplying CPV solar cells and receivers in volume to more than 20 different customers worldwide, and already plans to supply CPV systems to Canada and Korea.

Emcore says it continues to invest in advancing solar cell technology to a projected efficiency of greater than 45% by 2010.

[www.isfoc.com](http://www.isfoc.com)

## CPV system deal for utility-scale projects in southwest US

Emcore has signed a memorandum of understanding with SunPeak Solar LLC of Palm Desert, CA for a multi-year agreement to supply 200-700MW of solar power systems, scheduled for deployment in utility-scale projects under development in south-west USA.

Emcore will install turnkey solar power systems using its CPVs. SunPeak is securing land and grid access throughout 2008, and project construction is expected to begin in early 2009. The principals of privately held SunPeak have developed wind power projects in North America and Europe in the past decade and are well funded through the sale of wind power assets, and are now turning their attention to large-scale terrestrial solar energy projects in the US. SunPeak says it is developing a pipeline of more than 1000MW of utility-scale solar energy projects in south-west USA.

Emcore says that the deal is not expected to contribute revenues until 2009 and is dependent on the renewal of the federal investment tax credit into 2009 and beyond.

"We have conducted comprehensive research on different technologies and products, including concentrating solar thermal and various solar photovoltaic solutions, and concluded that the solar CPV represents the best solution based on the project requirement and our experience,"

says SunPeak's CEO David Rennie. "CPV is our preferred technology in many locations throughout the desert southwest. CPV has the advantage of requiring very little water during operation, and CPV systems can be installed with minimal impact on the desert environment," he adds.

"Emcore is the only vertically integrated CPV product provider and has the capacity and commitment for such projects," continues Rennie. "We are encouraging our

**We are encouraging our congressional delegation to extend the investment tax credit for renewables**

congressional delegation to extend the investment tax credit for renewables, which was left out of the recent energy bill, and keep the US competitive in renewable energy policy with the rest of the world."

Emcore's CPV systems incorporate high-efficiency multi-junction solar cells that operate with 500x concentration. CPV improves the performance of compound semiconductor-based solar cells, avoids the supply constraint that currently exists with silicon-based solar modules, and provides a lower cost-per-watt, says the firm.

"Emcore's CPV systems are optimized for the lowest cost-per-watt of any utility-scale photovoltaic power system," claims Earl Fuller, VP and general manager of Emcore's Solar Power Systems division. "The use of our GaAs-based multi-junction solar cells has the added advantage of retaining high efficiency even in the hot summers in the desert southwest," he adds.

[www.sunpeaksolar.com](http://www.sunpeaksolar.com)



# SolFocus installs first CPV array for 3MW Spanish project

SolFocus Inc of Mountain View, CA, USA, a Palo Alto Research Center spin-off that manufactures III-V-based concentrator photovoltaic (CPV) systems, has installed the first CPV array in the 3MW pilot-plant project in Puertollano, Castilla-La Mancha co-ordinated by Spain's Instituto de Sistemas Fotovoltaicos de Concentración S.A. (ISFOC). The project also represents the first commercial deployment of SolFocus' systems.

ISFOC was initiated in 2006 by the Castilla-La Mancha regional government's Department of Education and Science when it commissioned professors Antonio Luque and Gabriel Sala of the Institute of Solar Energy (IES) of Universidad Politécnica de Madrid (UPM) to develop the CPV R&D project (financed by Spain's Ministry of Education and Science).

ISFOC acts as an international center of reference on the power, reliability and productivity of commercial CPV systems, and aims to demonstrate different CPV technologies to accelerate development and adoption. The project aims to support participating companies by carrying out R&D on their installed systems, including studies and norms, developing measurement technology for large systems, reliability testing, maintenance, and analysis of solar radiation and the energy produced. The headquarters, laboratories and some of the pilot CPV plants are in Puertollano, from which all activities are coordinated.

In October 2006, for its 1.7MW first phase of pilot plants (due to be operational in first-half 2008) ISFOC selected CPV system suppliers Isofotón of Spain (700kW), Fraunhofer ISE spin-off Concentrix Solar of Germany (500kW) and SolFocus (500kW), incorporating multi-junction III-V-based PV cells

made by Emcore, Azur Solar and Spectrolab (in August 2006, SolFocus agreed a 12-month deal for Boeing subsidiary Spectrolab to supply it with 600,000 PV cells). Of the 1.7MW first-phase capacity, 800kW is being installed near ISFOC in Puertollano (200kW each from SolFocus and Concentrix and 400kW from Isofoton) and 900kW in three plants (of 300kW each) in rural areas of Castilla La Mancha with differing microclimates and solar radiation: Talavera de la Reina near Toledo (Isofoton); Almodovar near Guadalajara (SolFocus); and Sotos, north of Cuenca (Concentrix).

SolFocus' ISFOC program is being overseen by subsidiary SolFocus Europe Inc of Madrid, Spain, which was founded last September with \$27.4m (€20m) of Series A venture capital funding and is handling business development, marketing, engineering, and R&D activities, as well as continuing collaborative work with IES. Also, after SolFocus acquired Madrid-based solar tracker provider Inspira S.L. last August, SolFocus Europe is home to the firm's tracker and solar thermal product development activities (while SolFocus Inc in Mountain View focuses on panel, optics, and solar cell technologies).

SolFocus broke ground at Puertollano last October for a 200kW installation (the first of the 500kW to be installed over the next few months). Each SolFocus array is rated at 6.2kW, and performance has

already exceeded the design output (significant at this early stage of this project, the firm claims).

SolFocus says that its installation of the first power-producing system is a milestone in achieving the objectives of the project. The installation brings the industry one step closer towards commercial deployment of CPV technologies, adds ISFOC director general Dr Pedro Banda. "SolFocus' first installation marks the official launch of the power-generation phase of the program."

SolFocus (which already has over 40kW of test arrays installed at various sites) says that it selected ISFOC for its first large-scale installation because of the project founders' vision for CPVs and their plans to address the key challenges of commercializing the technology.

"We share the belief with the ISFOC leadership that CPV is the disruptive technology that will have a major impact in moving solar energy toward a more cost-effective and scalable mainstream energy source," says Pedro Ladrón de Guevara, VP and general manager of SolFocus' Tracker Division. "The focus of the ISFOC on addressing the most important components of CPV, including performance, energy production, safety and reliability, is directly in line with SolFocus' goals this year, as the company moves into full-scale commercial deployment in late 2008."

● To complete the 3kW program, last November ISFOC selected four more firms to install the second phase of a further 1.3MW of CPV systems: Emcore of Albuquerque, NM (300kW), Arima Eco of Taiwan (300kW), and Concentración Solar La Mancha S.L. (300kW) and Sol3g S.L. of Cerdanyola (400kW), both of Spain.

[www.solfocus.com](http://www.solfocus.com)

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**CPV is the disruptive technology that will have a major impact in moving solar energy toward a more cost-effective and scalable mainstream energy source**



## Spire providing custom CPV cell design and production

Spire Corp of Bedford, MA, USA says its subsidiary Spire Semiconductor (formerly Bandwidth Semiconductor until January) is to provide manufacturers of concentrator photovoltaic (CPV) cells with dedicated, large-scale contract design and manufacturing capabilities within its 50,000ft<sup>2</sup> facility in Hudson, NH.

Spire Semiconductor manufactures custom GaAs solar cells and specializes in high-end wafer epitaxy, foundry services, thin-film products, and device fabrication for the defense, biomedical, telecoms and consumer products markets.

Spire has developed a Captive Custom Capacity initiative to leverage its experience and facilities, says Spire Corp's chairman and CEO Roger G. Little. "We now can offer our partners the benefits of an optimized design and manufac-

turing process with the potential for large-scale contract production based on their individual needs."

Spire Semiconductor operates a complete compound semiconductor device fabrication line focused on the fabrication of custom devices, as well as development, prototyping, pilot production and volume manufacturing. Custom and production wafer processing capabilities range from prototype development to full production and include photolithographic processing of III-V cell structures and deposition of broadband, dual-layer anti-reflective (AR) coatings. It maintains more than 50MW of expandable capacity on multiple Veeco E450 LDM MOCVD reactors.

"Our extensive MOCVD experience and capabilities enable us to grow a wide variety of GaAs and InP epi-

taxial structures," says Spire Semiconductor's general manager Edward D. Gagnon. "With this new initiative, we have committed to providing the fastest turnaround times possible," he adds. "Our epitaxy engineers work closely with customers to assure that every wafer meets their expectations."

Spire says that its original optoelectronics division was an early pioneer in using GaAs for both concentrator solar arrays and space system solar cells. It developed and fabricated GaAs solar cells with record levels of efficiency as early as 1985. The firm has recently been awarded research contracts from the US National Aeronautics and Space Administration (NASA), the Department of Energy and the Air Force to develop GaAs cells for both terrestrial and outer space applications.

### ● Spire appoints UST as south-east Asia representative

Spire has selected UST Technology of Singapore as its representative for solar turnkey solutions and capital equipment in the south-east Asia solar energy market (Singapore, Malaysia, Thailand, the Philippines, and Indonesia).

Established in 1974, UST has 120 staff providing technical and engineering support throughout the region, serving major multinational semiconductor and electronics industries.

"The booming south-east Asia solar market represents a compelling opportunity for manufacturers, and UST is an excellent partner to help us tap this market," says Spire's VP of corporate marketing, Mark Willingham. With solar demand doubling in the region by 2010, Spire is seeing an increase in new sales activity, he adds. Also, existing customers are locating large manufacturing facilities in the region. "UST's strong technical capability will deliver considerable value to our growing customer base."

[www.spirecorp.com](http://www.spirecorp.com)

[www.ust.com.sg](http://www.ust.com.sg)

## Synthesis of quantum dot nanostructures

Spire has been awarded US patent 7,306,963 'Precision Synthesis of Quantum Dot Nanostructures for Fluorescent and Optoelectronic Devices' describing a method for improved uniformity and size.

Nanometer-sized semiconductor quantum dots have the potential to create new higher-efficiency, low-cost solar cells and other optoelectronic devices including lasers, LEDs, and photodetectors, says Spire. Their small size also makes them useful for medical assays, diagnostic systems, and therapeutic compounds.

"The challenge has always been how to manufacture these small structures with the consistency needed to take advantage of their unique properties," says chairman & CEO Roger G. Little. "Our scientists have conceived a large-scale method that may allow the promise of this technology to be realized."

The confinement of electrons in three-dimensional nanostructures enables the use of quantum dots to precisely control the optical prop-

erties of devices such as solar cells or biomarkers for detecting cancer.

"The technique we conceived for fabricating the quantum dots involves using compound semiconductor technology developed at Spire Semiconductor [in Hudson, NH], Spire Corporation's solar cell manufacturing operation," says Spire's senior scientist Kurt J. Linden. "It involves the synthesis of free-standing nanoparticles by using a specially designed release layer that separates uniformly sized nanoparticles from gallium arsenide (GaAs) thin films that are grown in our existing GaAs wafer fabrication systems. Such techniques are expected to achieve large-scale volumes of active nanostructures with a highly consistent size. This consistency of size can provide a number of important scientific and commercial benefits," he adds.

"This patent further strengthens our intellectual property portfolio in our solar and optoelectronic market areas," says Little.



# LCA increases its investment in PV maker QuantaSol to 25.6%

Low Carbon Accelerator Ltd (LCA) has invested a further £320,000 in solar cell maker QuantaSol Ltd, increasing its total equity ownership to 25.6%.

LCA invested £480,000 last June as part of an overall £1.35m seed funding round of the Imperial College London spin-off, co-led by LCA and Imperial Innovations and joined by Numis Securities Ltd, Netscientific Ltd and Sheffield University Enterprise.

Since the first investment, QuantaSol has exceeded the milestones that were set, says LCA's chief investment officer Dr Stephen Mahon.

QuantaSol aims to provide solar photovoltaic (PV) cells for use in concentrating photovoltaic (CPV) systems for the fast-growing utility-scale solar power generation market.

QuantaSol used the original funds to produce prototypes of its quantum-well photovoltaic (QWPV) cells and to engage with potential customers. It will use the additional funds to continue its product development.

CPV systems use relatively inexpensive optics such as mirrors or lenses to concentrate or focus light from a broad collection area onto a much smaller area of active semiconductor PV cell material. Since the PV semiconductor material usually dominates the costs of a solar PV system, reducing the amount of PV material required to capture a given amount of sunlight leads to substantially lower system cost and cost per watt of output.

QuantaSol's third-generation cells are based on gallium arsenide plus other semiconductor materials. Although the materials are more expensive than the silicon commonly used for flat-panel PV cells, QuantaSol plans to manufacture single- and multi-junction concentrator solar cells with efficiency levels of up to 40% (compared to below 20% for silicon and thin-film cells).

The world efficiency record for single-junction cells, held by US firm Varian, stands at 27.8% and

has been unequalled for 20 years. However, QuantaSol's cells are consistently recording efficiency levels of 27.5%, and the management team says they are confident of reaching levels equal to or in excess of the world record during 2008.

"The world record for solar efficiency was a real one-off and our results consistently come very close to equalling that. With the new round of funding in place we are confident of setting a new efficiency record for single-junction cells during 2008," says CEO Kevin Arthur. "The quantum wells also make it possible to enhance the efficiency of multi-junction cells and, during 2008, QuantaSol also aims to set a record 35% tandem cell efficiency," he adds.

"The market for CPV is enormous, and, if they can show their cells are the world's most efficient, QuantaSol looks poised to take full advantage of it," concludes Mahon.

[www.quantasol.com](http://www.quantasol.com)

## Cyrium boosts funding to CDN\$5.5m; recruits new CEO

Cyrium Technologies Inc of Ottawa, Canada, which is developing multi-junction concentrated photovoltaic (CPV) solar cells incorporating InAs/GaAs quantum dot layers to increase efficiency, has raised its total funding to over CDN\$5.5m.

The latest funding (about CDN\$2m) is a follow-on round from the firm's main investors, Business Development Bank of Canada (BDC) Venture Capital, Chrysalix Energy Venture Capital and Pangaea Ventures Ltd, supplementing CDN\$3m raised in December 2005 and its first venture capital funding in August 2005. Cyrium was founded in 2002 as a spin-off from National Research Council of Canada (NRC) at its Industrial Partnership facility.

"The increased funding moves the company further down the runway toward commercial availability of its new solar cell," says founder and chief technology officer, Dr Simon Fafard.

As part of its product and commercialization strategy, Cyrium says it is working with leading CPV system manufacturers.

Also, joining the firm as president and CEO is Dr Steve Eglash (former venture capitalist at Worldview Technology Partners). Previously,

**Increased funding moves the company further down the runway toward commercial availability**

he was vice president at SDL (JDSU) where he managed efforts in pump lasers, and optical amplifiers.

"Steve's leadership and insight will enable the company to secure a major role in the rapidly growing solar energy market," comments Jim Fletcher, board member and managing director at investor Chrysalix Energy. "Steve's strong connections in Silicon Valley will help the company to expand its operations to include northern California." Fafard adds: "His background in venture capital and in particular with semiconductors, optoelectronics and energy are perfectly suited to the company's product roadmap".

[www.cyriumtechnologies.com](http://www.cyriumtechnologies.com)



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# Lighting up CIGS PVs

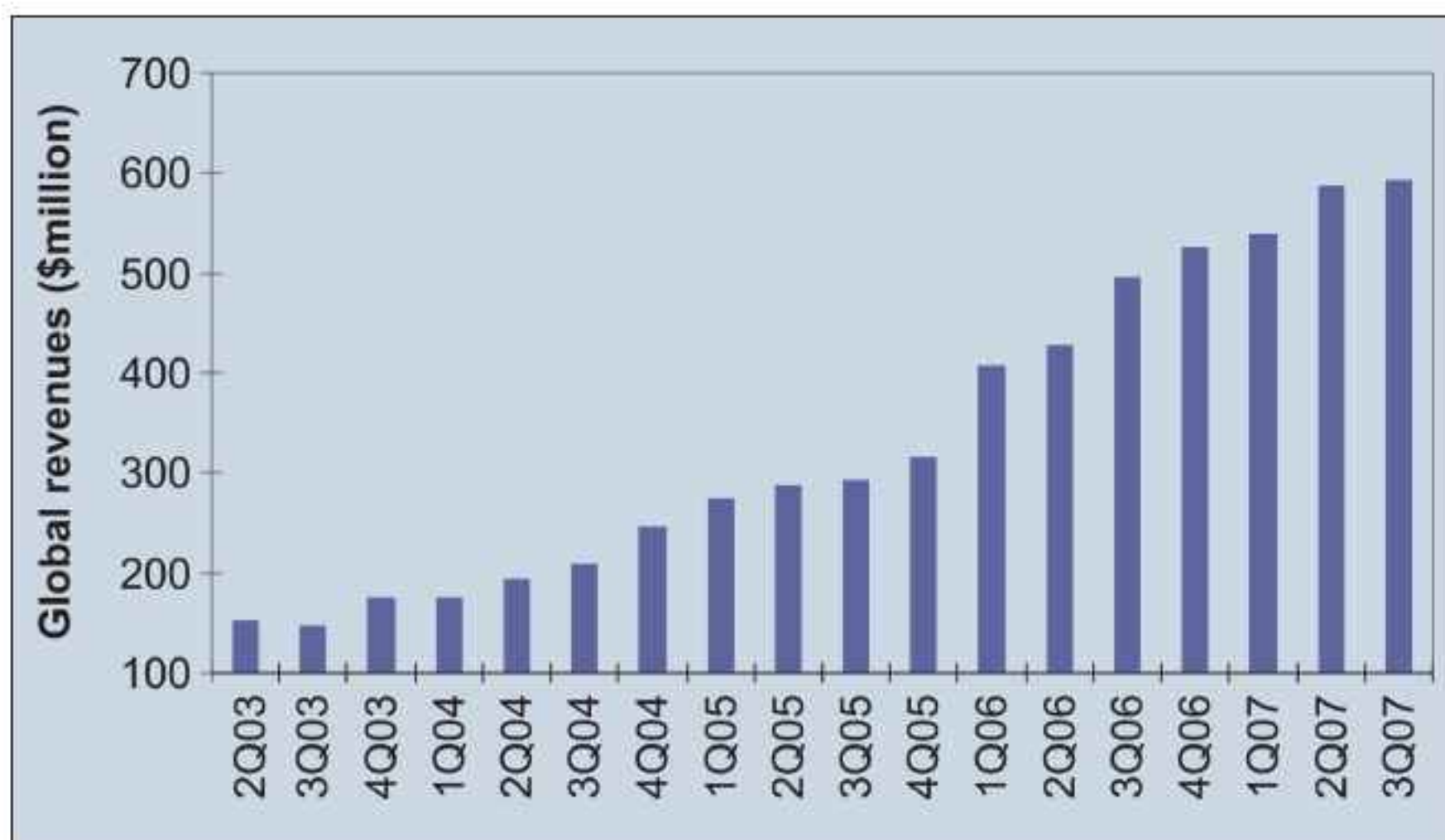
**Dr Mike Cooke** reports on developments in producing lower-cost solar energy based on compounds of the elements copper, indium, gallium and selenium.

**I**n the last couple of years, photovoltaics have moved from an interesting fringe activity to being one of the centers of high-tech attention. Apart from technological progress in the area, this attention results from an international focus on the benefits of renewable forms of energy production. Outside the USA, the main reason for this has been the increasing realization that non-renewable energy production and usage has contributed to climate changes across the planet. As part of its efforts to reduce carbon emissions, the European Union (EU) is calling for 20% of its energy to come from renewable sources, including solar, by 2020.

In the USA, another factor has been more prominent in PV motivation — the perceived need to “reduce the dependence on oil”, particularly with gas prices at the filling station reaching around \$3 per gallon (approximately doubling over the price five years ago). Of course, these figures remain lower than the cost in much of the rest of the world. In much of Europe, gas costs around twice as much. In addition, crude oil is predominantly supplied by regions with populations, if not governments, hostile to the USA.

The stated aim of the US National Renewable Energy Laboratory’s (NREL) Photovoltaic (PV) research is to focus on “decreasing the nation’s reliance on fossil-fuel generated electricity by lowering the cost of delivered electricity and improving the efficiency of PV modules and systems.” NREL’s PV division carries out fundamental research on advanced materials and devices, as well as technology development work.

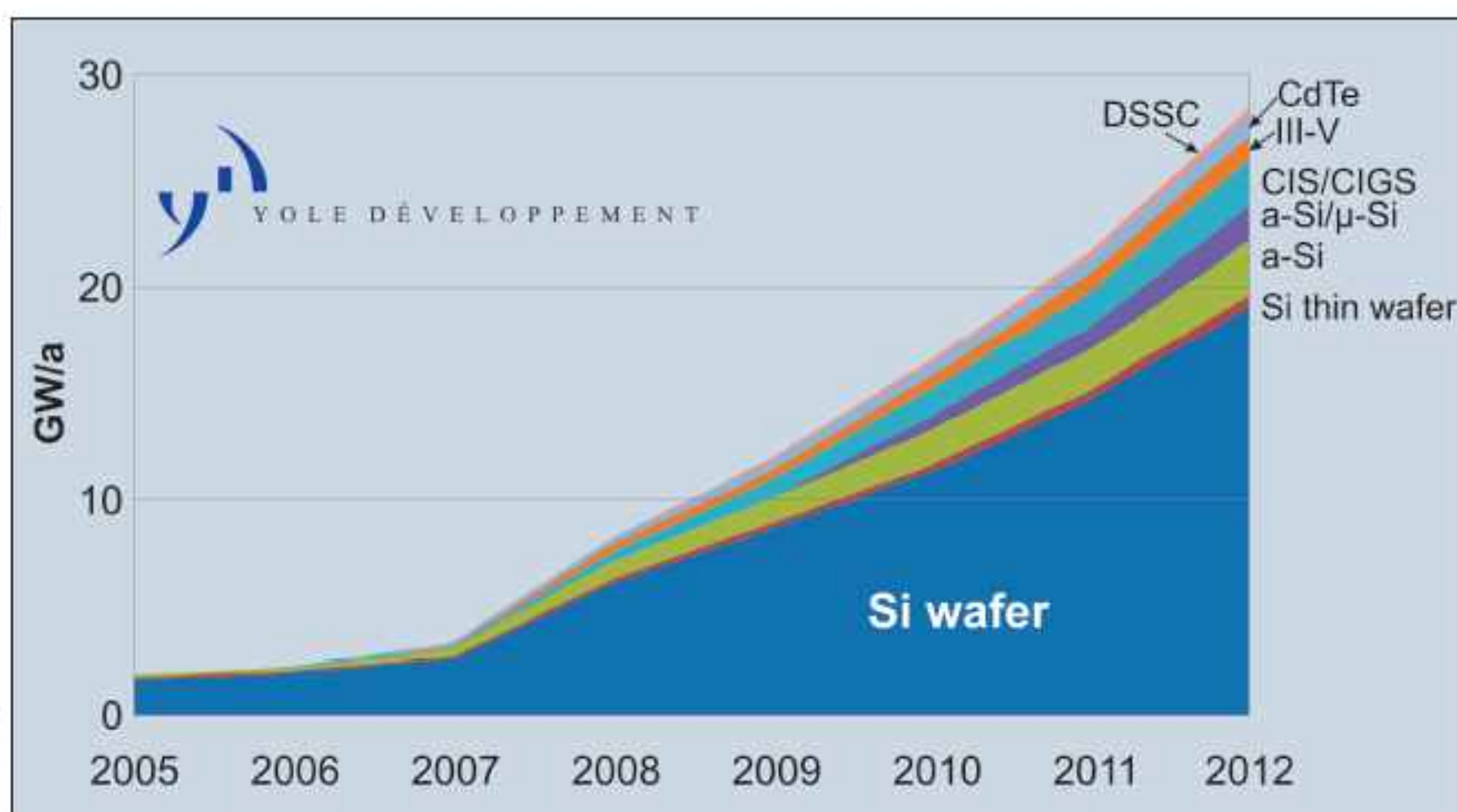
Increased PV activity has put a strain on silicon wafer supplies — the predominant substrate in photovoltaic cell manufacturing. However, prompted partly by these difficulties, alternative ‘thin-film’ photovoltaics have been developed for mass production and are rapidly coming on-line, using different substrate materials that range from glass to flexible plastic or metal rolls. Being a late enthusiast on the PV scene, the USA is implementing the newer techniques most rapidly. The US is looking for technologies that operate in



**Figure 1. Revenues for polysilicon have been driven up by rising solar cell demand. Source: SEMI Silicon Manufacturers Group.**

higher temperatures than the 25°C of silicon wafer cells. Apart from application in the higher-temperature conditions of some areas of the USA, such modules could find civilian and military use in places like Iraq. According to PV News ([www.pvenergy.com/news.html](http://www.pvenergy.com/news.html)), the 2006 market share for thin-film over traditional PV cells was 44% in the USA versus less than 6% globally.

In many ways, increasing PV production in recent years saved the suppliers of silicon raw materials and



**Figure 2. Yole’s projection and historical data for production capacity for 2005–2012. Product types shown are silicon normal and thin wafer-based and the thin-film technologies using amorphous silicon (a-Si), amorphous and microcrystalline tandem/multi-junction silicon cells (a-Si/μ-Si), CIGS, III-V, cadmium telluride (CdTe) and dye-sensitized solar cells (DSSC).**



wafers from a squeeze on prices that they had been subjected to for many years by integrated circuit manufacturers (Figure 1). While this new outlet for silicon wafers could be short lived, for example if PV manufacturing goes thin-film en masse, the industry analyst Yole Développement expects silicon wafer products to dominate the solar market up to at least 2012 (Figure 2).

Yole's Gaetan Rull believes that while, thin-film technologies may reach 30% by 2015, there is still significant potential for reducing the manufacturing costs of traditional silicon wafer-based production. The balance is between potentially lower manufacturing costs but higher investment costs for thin-film production. At this stage, the investment risks are much higher for the newer technologies.

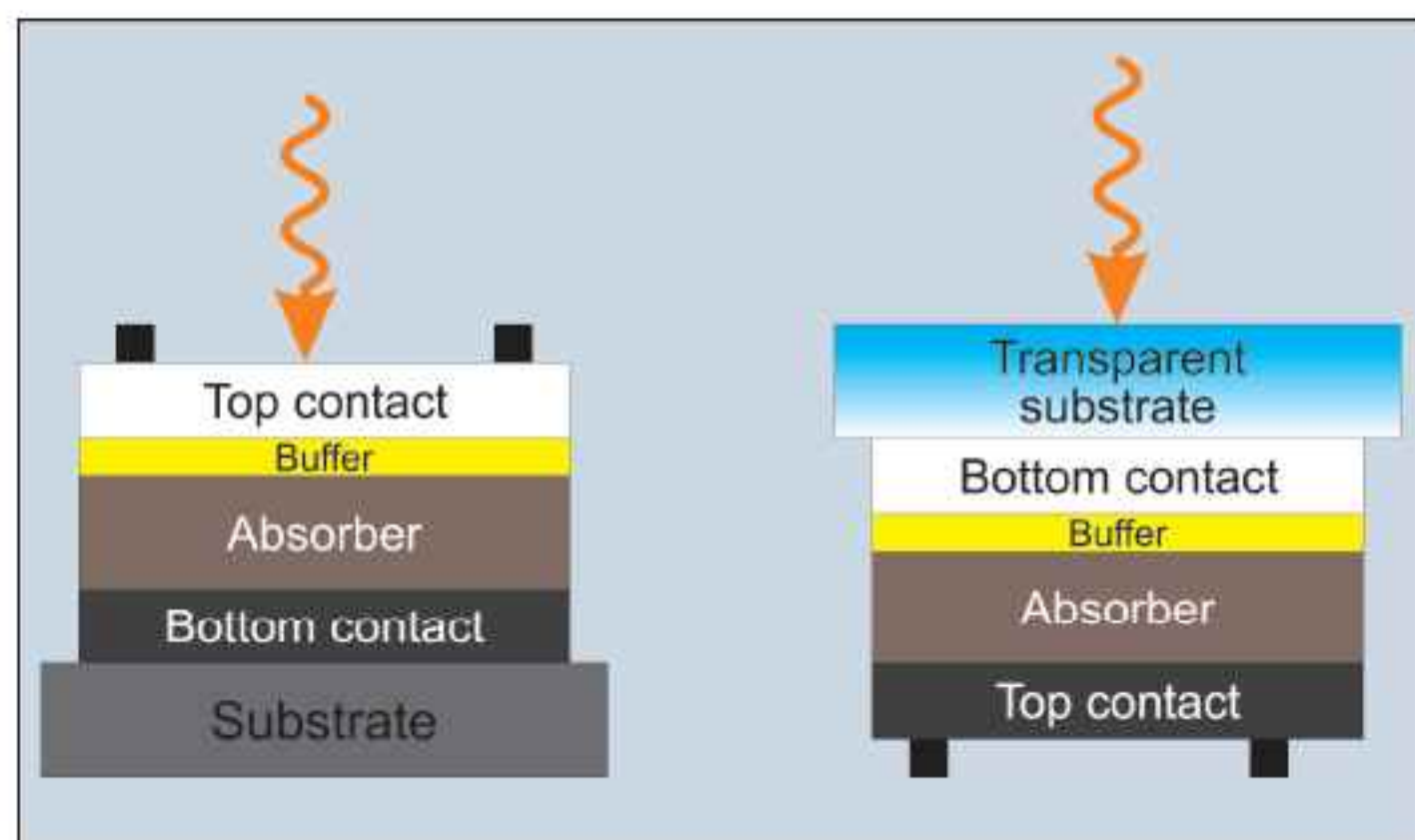
As always, a technological breakthrough could disrupt this established landscape. But, even then, there will be a significant time delay between discovery and mass production.

### Solar structures

Thin-film PV cells (Figure 3) use a wide range of semi-conducting materials: crystalline and amorphous silicon, cadmium telluride, cadmium sulfide, and materials based on the copper, indium, gallium diselenide quaternary system (which is variously represented as  $\text{CuIn}_{1-x}\text{Ga}_x\text{Se}_2$ ,  $\text{Cu}(\text{In},\text{Ga})\text{Se}_2$  or 'CIGS'). These materials are used to create absorber and buffer layers in various solar cell configurations (Figure 4). A photon hitting the absorber layer excites an electron across the bandgap, creating an electron-hole pair. A pn junction between the absorber and buffer layers creates a selective valve for separating the pair, avoiding immediate recombination (conversion back to either photons/light or phonons/heat) and allowing access to the solar energy for practical use.

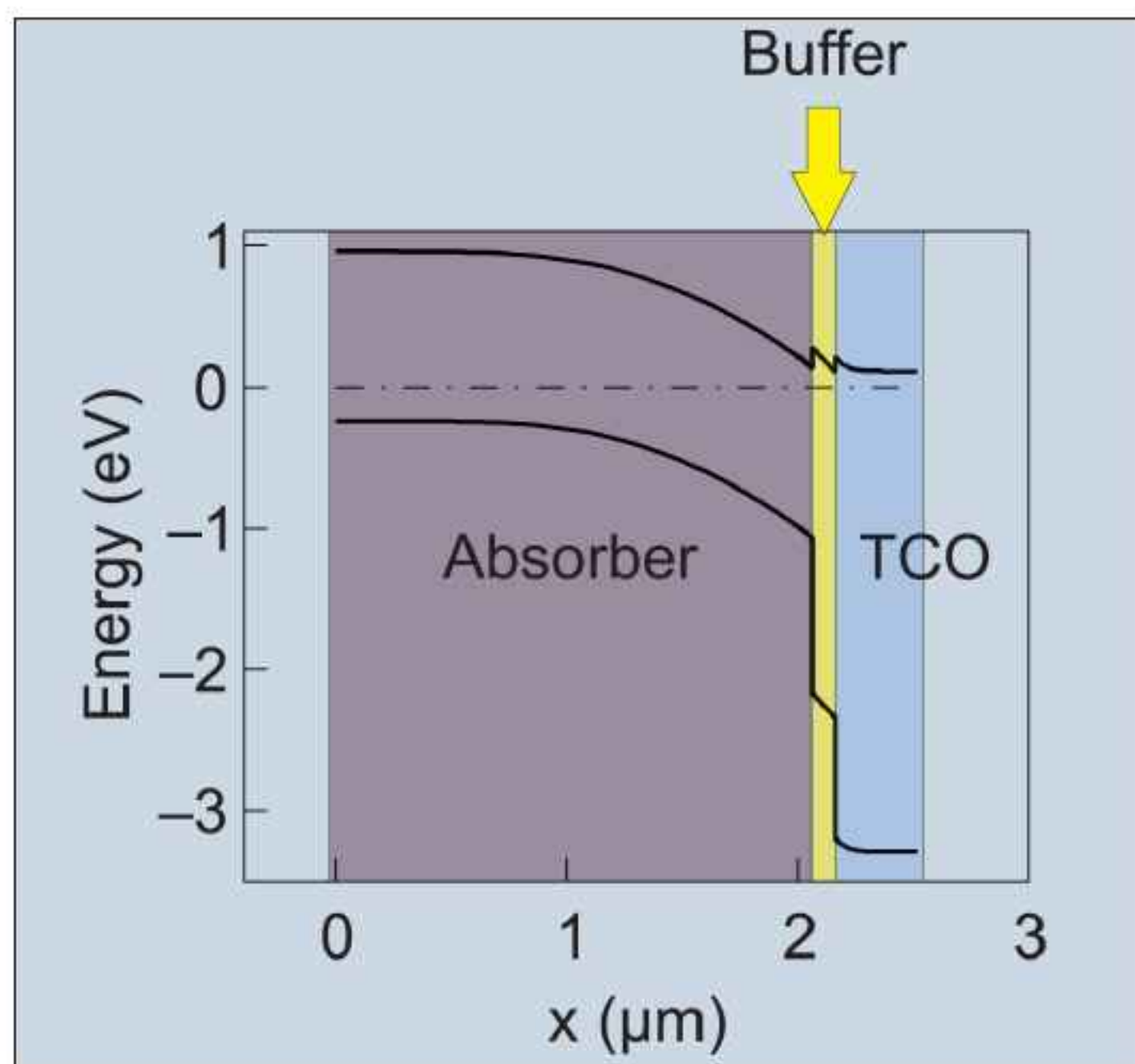
In addition to substrates and semiconducting materials, one needs top and bottom contact materials. If a transparent substrate is being used with the intention that it is to let the sunlight into the system, the bottom contact should also be transparent. Conversely, if the substrate is opaque, the light comes in from the top and thus the top contact instead should be transparent. Indium tin oxide (ITO) and zinc oxide (ZnO) are two popular materials for transparent contacts. The transparent contact can also have a layered structure to electrically match with the buffer layer. Non-transparent contacts range from silver/stainless-steel substrates to molybdenum (most widely used for CIGS cells).

Here we will focus on CIGS developments that are expected to increase rapidly over the next couple of years (Figure 5). There is a bewildering variety of firms involved in developing CIGS-based cells and modules. One expects that the investment lottery will weed this profusion in the next year or so. A number of CIGS projects are planning to start volume production in



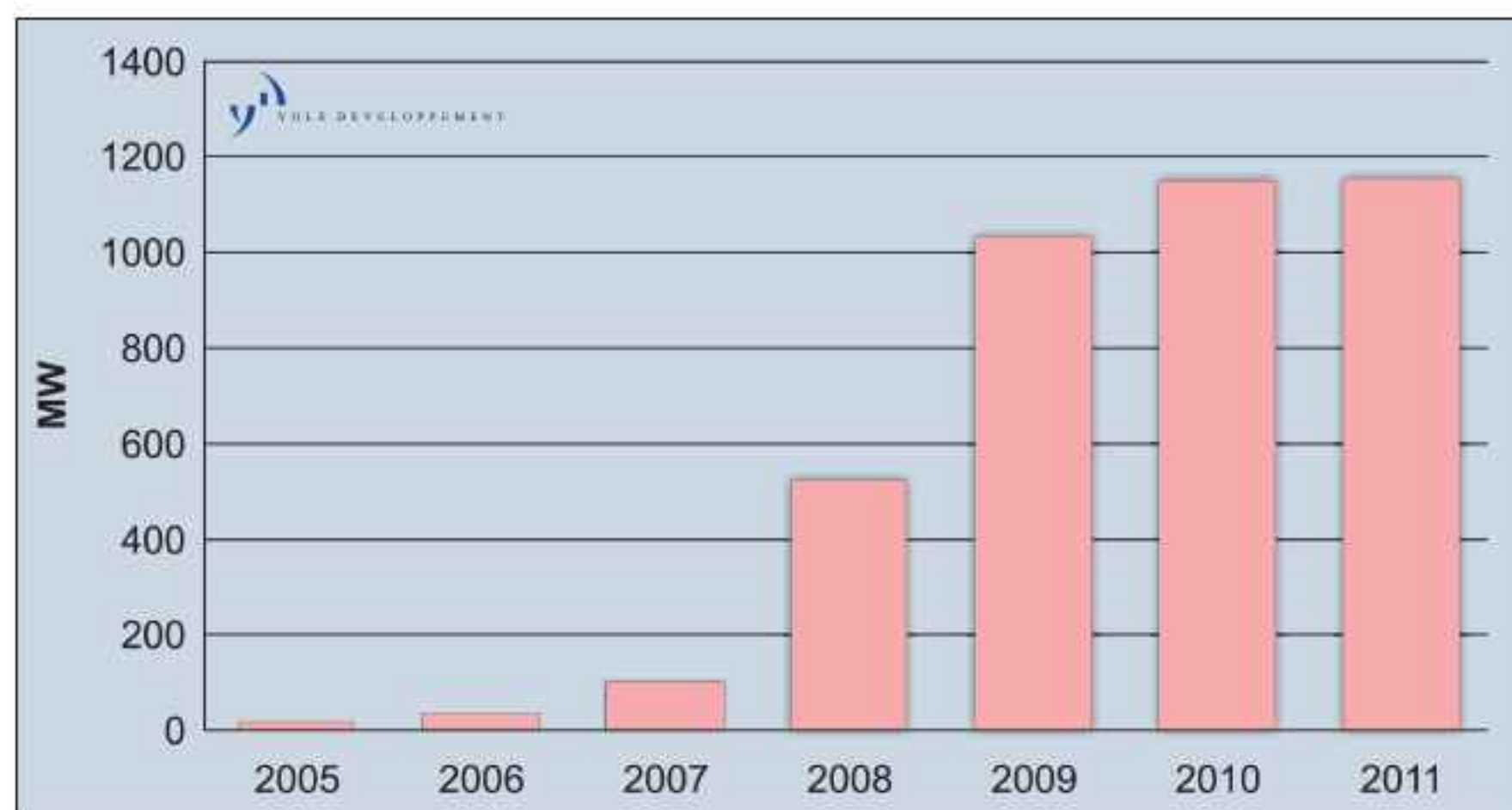
**Figure 3:** For CIGS-based cells (left) the absorber material is the CIGS itself. The buffer layer is typically CdS, although alternatives such as  $\text{In}(\text{OH},\text{S})$  and  $\text{Zn}(\text{Se},\text{OH})_x$  have been used. For opaque substrates, the top contact is a transparent conducting oxide (TCO) such as of indium tin (ITO) or zinc (ZnO). In CIGS production, the non-transparent contact is most often molybdenum. Transparent substrates allow the alternative configuration on the right. The CIGS layer is generally p-type, while the buffer and TCO are n-type, allowing separation of the liberated charges after photon absorption.

2008, so it will be very interesting to see which of them deliver on their promises to investors. On the negative side, in the past year a number of reports have come out that some of these companies have laid-off staff. These reports are often vehemently denied by the firms involved. Other reports are of start-up companies



**Figure 4.** PV band-structure diagram of CIGS cell based on Igalson and Urbaniak, *Bull. Pol. Ac.: Tech.* vol.53(2), p.157, 2005. Curve is based on CIGS absorber, CdS buffer and ZnO as TCO.





**Figure 5. Yole Développement's projection for increased CIGS production capacity up to 2011.**

set up by former founders of the older companies and staffed by some ex-employees of the original company. Such activities express tensions between finance and technological delivery of mass production. One would not be surprised to see acquisitions of the less successful start-ups by the more successful start-ups, or even by corporations wanting to buy into and dominate the market. Some may fail outright.

### Print run

Vacuum deposition has been used extensively in production of all PV types up to now, in some ways a transfer from semiconductor production. However, more recently, printing-type techniques have been applied with a view to lower production costs.

One firm promoting printing of solar cells is Nanosolar, which has in addition won a contract to supply CIGS-based photovoltaic panels for a solar power plant located on a former landfill site owned by one of the largest waste management companies in east Germany. The project will be based on Nanosolar's 'Utility Panel' in combination with systems technology and services from Beck Energy. The initial size of the plant is planned at 1MW (an amount sufficient to power about 400 homes).

The Utility Panel is the first product in Nanosolar's PowerSheet product line. The company has designed the product line as a 'solution' for solar power plants on free fields at the outskirts of towns and cities.

"After five years of product development — including aggressively pipelined science, research and development, manufacturing process development, product testing, manufacturing engineering and tool development, and factory construction — we now have shipped first product and received our first check of product revenue," said Nanosolar's CEO Martin Roscheisen on the company's 'blog'.

Nanosolar describes itself as being in the 'third wave' of solar power development. The 'first wave' refers to

the silicon-based solar cells of 30 years ago. The second was the development of commercial thin-film technology a decade or so ago. Nanosolar believes that it has tackled the shortcomings of previous solar technologies with seven innovations: the use of nanoparticle inks, semiconductor printing, conductive substrates, roll-to-roll processing, low-cost top electrode, sorted cell assembly into modules, and creating a high-current panel.

The ink contains the CIGS semiconductor material. According to Nanosolar, the four elements have to be in just the right atomic ratios to each other, locking in a uniform distribution. The homogeneous mix of nanoparticles in the ink in just the right

overall amounts ensures that the atomic ratios of the four elements are correct wherever the ink is printed, even across large areas of deposition. This enables a low-cost roll-to-roll printing process in contrast to the usual vacuum deposition processes where, due to the four-element nature of CIGS, one has to atomically synchronize various material sources.

The ink is printed onto a conducting metal foil substrate rather than having to deposit an additional metal thin-film bottom electrode on a non-conducting substrate such as glass or polymer. Nanosolar claims that its metal substrate is 20 times more conductive than the stainless steel used by some competitors. Nanosolar also claims a low-cost transparent top electrode that supports an order-of-magnitude higher current than attained previously.

The company also claims to have dealt with problems of the electrical mismatches between cells in assembled panels that lead to significant power losses. All told, the company claims that its products deliver 5–10 times higher current compared with other thin-film solar panels on the market today. However, more detailed specs seem to be hard to find.

Nanosolar was founded in 2002 and says that it is building the world's largest solar cell factory in California and the world's largest panel-assembly factory in Germany. The US facility in San Jose covers an area of 140,000ft<sup>2</sup> and that in Berlin covers 507,000ft<sup>2</sup>.

Global Solar Energy (GSE) is one of those using stainless-steel substrates. It makes a polycrystalline thin-film CIGS PV device, aiming for lightweight, durable cells. The company can provide these cells in strings for drop-in power sets in solar glass modules, allowing use of a similar process to silicon glass module manufacture. GSE's strings come in varying power sets and can be used for glass modules in the power range 6–100W. Like Nanosolar, GSE has a roll-to-roll process. In February 2008, the plan is to expand into a new factory in Tucson, Arizona, moving from a 20,000ft<sup>2</sup>



facility to one with 100,000ft<sup>2</sup>. Production capacity is expected to grow from 4.2MW to 40MW.

One US company using vacuum deposition is Miasolé. The firm's management team derives much of its expertise from the thin-film hard-disk industry and from the metrology company KLA-Tencor and thin-film technologies such as PVD and plasma deposition (Novellus and Lam). The cells are wrapped in rugged, flexible encapsulants, not glass. Miasolé claims to be able to deliver products in very large quantities using its process.

### Cadmium-free layers

In Japan, Honda has set up Honda Soltec, with a CIGS facility starting mass production in October 2007 (see Figure 6). Honda boasts that its next-generation solar cell achieves a reduction of 50% in the amount of energy consumed during the manufacturing process compared to conventional crystalline silicon solar cells. Honda sees this as part of its 2006 global CO<sub>2</sub> reduction target for its products (including automobiles) and their manufacturing. Honda also says that it is focusing on the development and sales of energy-creation products such as thin-film solar cells to reduce the threat of global warming.

The company's CIGS-based modules come with two maximum powers: 125W and 115W. The module's dimensions are 1417mm x 791mm x 37mm and the weight is 14.3kg. The highest-wattage module is priced at about \$540 (¥57,500) before tax. Honda's cells are produced on glass substrates. Interestingly, the company uses an indium sulfide layer rather than a cadmium sulfide layer. One motivation for this is cadmium's highly toxic nature. Cadmium is one of six chemicals whose use is restricted in the EU by the Restriction of Hazardous Substances (ROHS) directive. On the other hand, indium is rather expensive. CIGS development is seen as one of the contributors to the current high price of indium. Moves to mass production could give a further unwelcome boost to pricing. A few other groups have tried CdS alternatives such as In(OH,S) and Zn(Se,OH)<sub>x</sub>.

Honda's figure for maximum output was measured under the conditions of air mass (AM) 1.5, solar radiation intensity of 1kW/m<sup>2</sup>, and module temperature of 25°C. The AM1.5 standard is common for evaluating solar cell performance in northern Europe. The air mass figure (1.5) gives the relative attenuation compared with that for a straight down (zenith) light path. The AM figure is greater than 1 because the sun is only ever directly overhead at noon in the tropics. Honda's cell operating temperature range is from +40°C to -20°C. The maximum output will differ depending on solar radiation intensity, installation conditions (direction, angle, surrounding environment), geographical area, and temperature conditions.



Figure 6. Honda's CIGS production facility.

Shell Solar has also transferred its efforts from silicon to CuInSe<sub>2</sub> (CIS, i.e. CIGS with x = 0). It has joined with Saint-Gobain in a new company, Avancis, based in Torgau, Germany. Production is due to commence in the middle of 2008, with an annual capacity of 20MW. Among the reasons given for the change from silicon is independence from shortages of the material. The firm claims that its pilot-production 1ft x 4ft CIS modules have an average efficiency of almost 13%, compared with the best performance in small laboratory samples of more than 19%.

### Putting sulfur into the CIGS mix

Based on development work over 13 years at the University of Johannesburg in South Africa, Johanna Solar Technology uses a 3µm-thick absorber layer. The firm says that, due to improved temperature coefficients — which means lower performance losses at high temperatures — its thin-film modules are especially suited to temperatures above 25°C.

The firm is putting its devices on glass, with the first step being deposition of the molybdenum back contact. A precursor layer consisting of copper, indium and gallium is then applied. These three elements are then

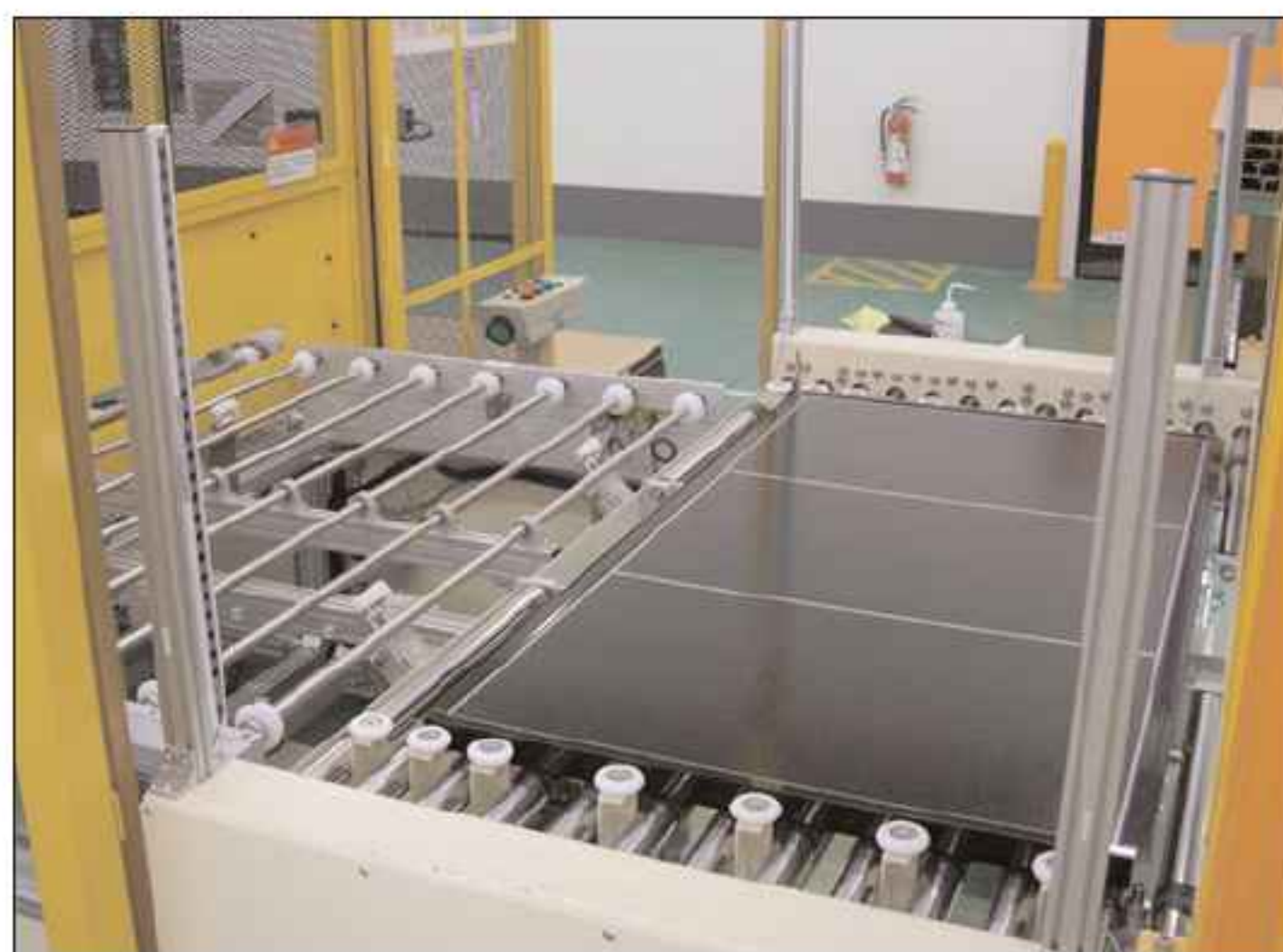


Figure 7. CIGS panel on a production line at Honda.



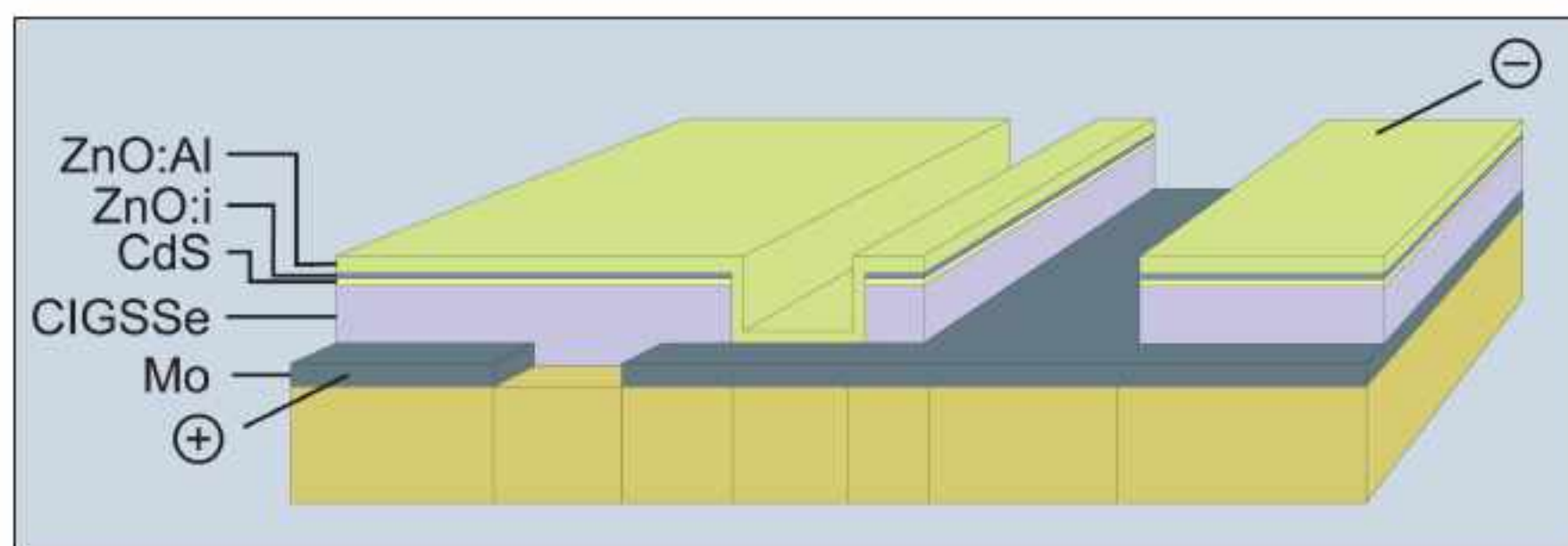


Figure 8. Schematic of Johanna Solar Technology's CIGSse cell.

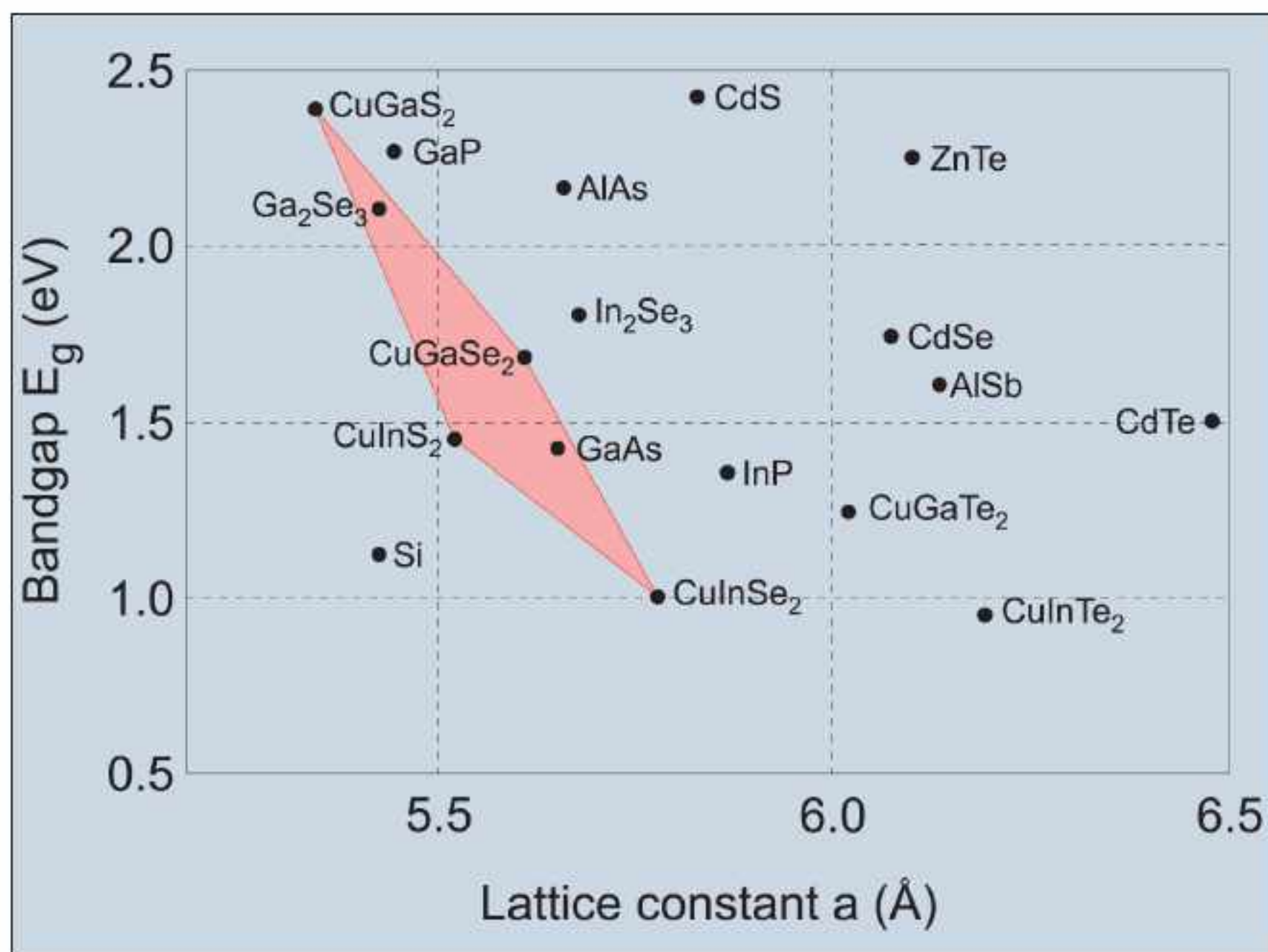


Figure 9. Bandgap energies and lattice constants of a number of semiconductor materials including  $\text{Cu}(\text{In,Ga})(\text{S,Se})_2$ , or 'CIGSse', compounds that may be used to create single- or multijunction solar cells. The quadrilateral ( $\text{CuGaS}_2$ ,  $\text{CuGaSe}_2$ ,  $\text{CuInSe}_2$ ,  $\text{CuInS}_2$ ) shows approximate ranges (i.e. linear interpolation) for CIGSse.

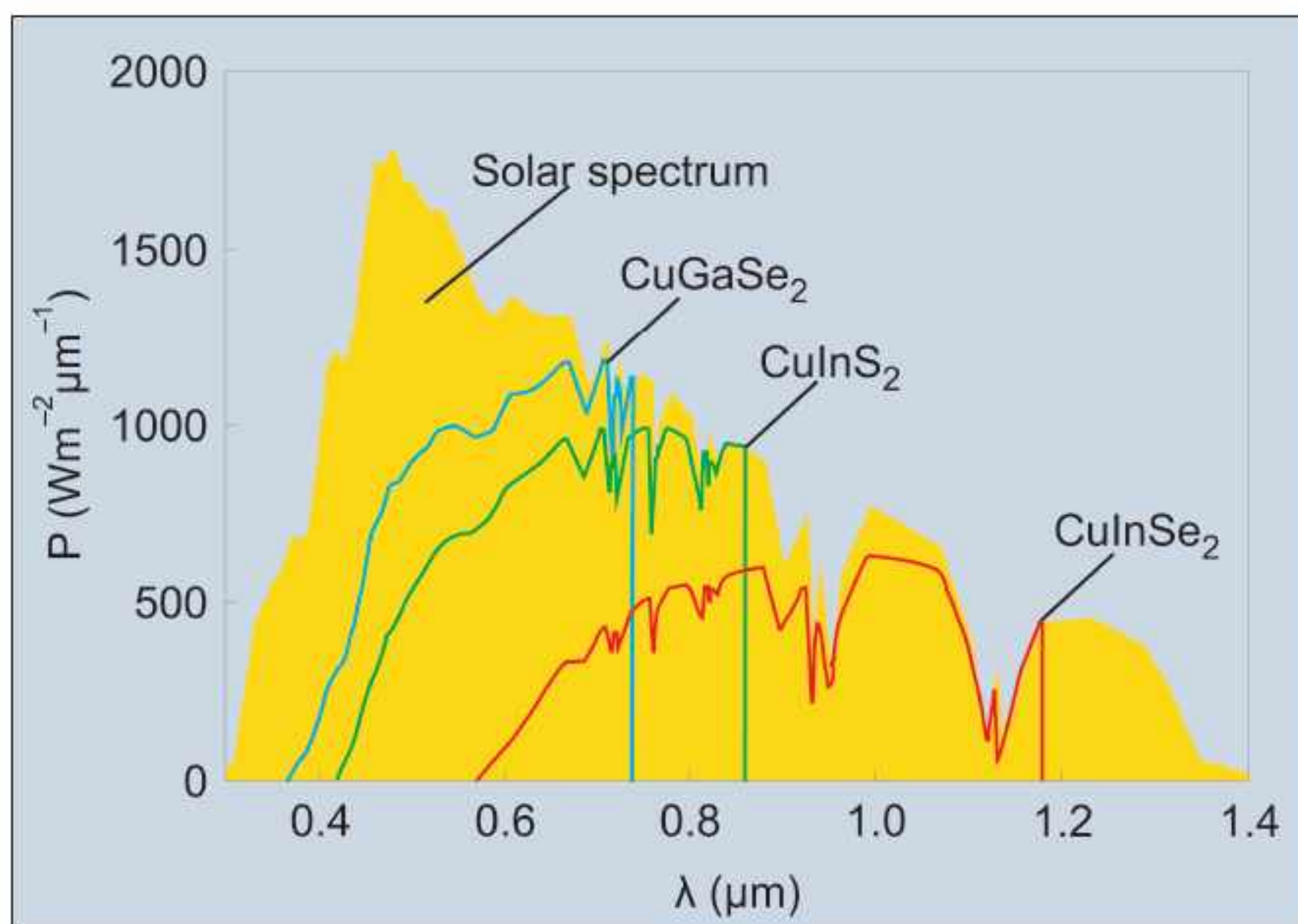


Figure 10. Solar spectrum and response of CIGS materials, showing possibilities for multi-junction solar cells.

chemically transformed in a diffusion process under a gaseous atmosphere containing sulfur and selenium, resulting in a CIGSse ( $\text{Cu}(\text{In,Ga})(\text{S,Se})_2$ ) absorber layer (Figure 8). An electrical serial connection of individual cells into a module is realized during the coating process by structuring individual layers, giving rise to a 'pinstripe' pattern for the thin-film modules.

The firm's production site at Brandenburg an der Havel, Germany is due to come on-line this year with an initial output capacity of modules nominally capable of 30MW/year.

Adding sulfur extends the accessible range of bandgap energies and lattice constants (Figure 9). The bandgap determines the range of photon energies that the cell can transform to electric power (Figure 10). It gives a lower limit for photon energy absorption and hence an upper limit for wavelength. As with silicon-based solar cell technology, researchers (e.g. at NREL) are investigating multi-junction or tandem cells that can extend the range of photons that can be absorbed and converted to power, thus boosting efficiency (Figure 11). However, at this stage, tandem cell production, even in silicon, is struggling to achieve efficiencies above 10% while, as we have seen, 13% is being achieved with CIGSse commercial production. ■

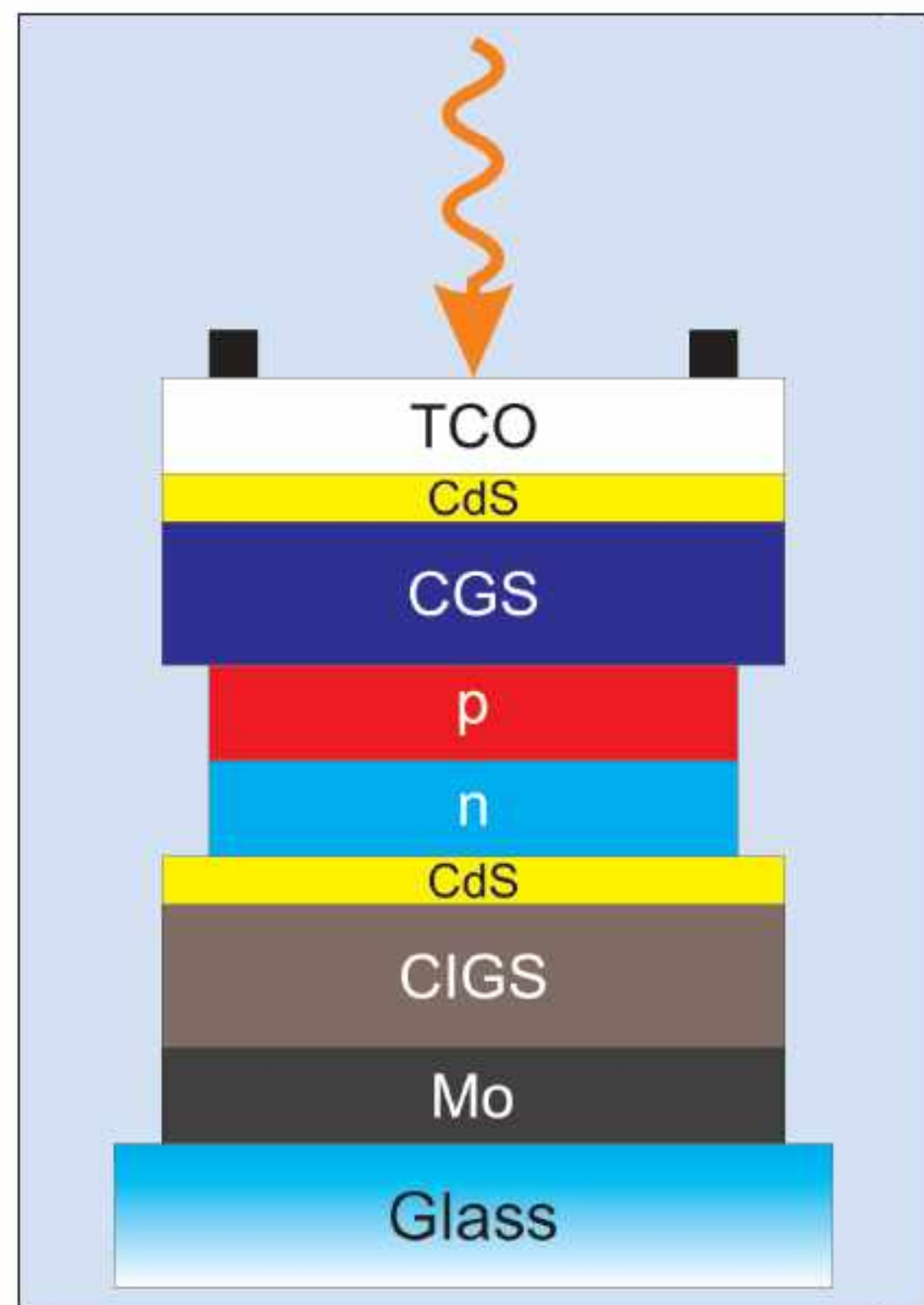


Figure 11. Structure for multi-junction CIGS solar cell being investigated by NREL.





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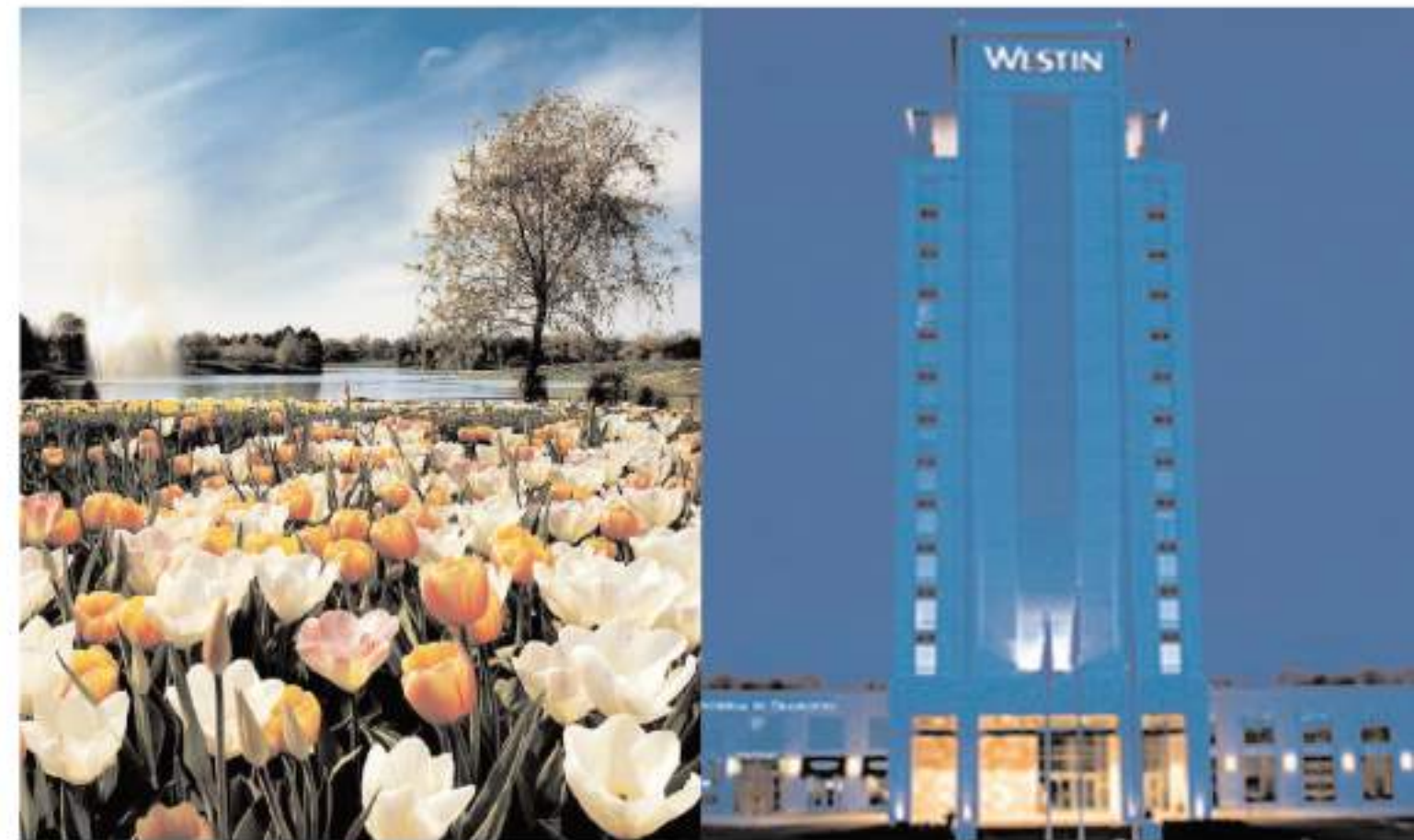
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[www.tegal.com](http://www.tegal.com)

#### Veeco Instruments Inc

(see section 6 for full contact details)

## 9 Materials & metals

#### Goodfellow Cambridge Ltd

Ermine Business Park, Huntingdon,  
Cambridgeshire PE29 6WR,  
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[www.goodfellow.com](http://www.goodfellow.com)



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## 10 Gas and liquid handling equipment

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(see section 7 for full contact details)

#### Cambridge Fluid Systems

12 Trafalgar Way, Bar Hill,  
Cambridge CB3 8SQ, UK

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Fax: +44 (0)1954 786818

[www.cambridge-fluid.com](http://www.cambridge-fluid.com)

#### CS CLEAN SYSTEMS AG

Fraunhoferstrasse 4,  
Ismaning, 85737,  
Germany

Tel: +49 89 96 24 00 0

Fax: +49 89 96 24 00 122

[www.cscleansystems.com](http://www.cscleansystems.com)

#### EMF Semiconductor Systems Ltd

(see section 6 for full contact details)

#### IEM Technologies Ltd

Fothergill House, Colley Lane,  
Bridgwater, Somerset TA6 5JJ,  
UK

Tel: +44 (0)1278 420555

Fax: +44 (0)1278 420666

[www.iemtec.com](http://www.iemtec.com)

#### Power + Energy Inc

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Ivyland,  
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Fax: +1 805 541 9399

[www.saesgetters.com](http://www.saesgetters.com)

## 11 Process monitoring and control

#### EMF Semiconductor Systems Ltd

(see section 6 for full contact details)

#### k-Space Associates Inc

3626 W. Liberty Rd.,  
Ann Arbor,  
MI 48103,  
USA

Tel: +1 734 668 4644

Fax: +1 734 668 4663

[www.k-space.com](http://www.k-space.com)



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Fax: +49 30 3180 8237  
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**Optical Reference Systems Ltd**

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Fax: +44 (0)1745 535 186  
[www.ors-ltd.com](http://www.ors-ltd.com)

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Furtwangen im Schwarzwald,  
Germany  
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Fax: +49 7723 9197 22  
[www.wepcontrol.com](http://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](http://www.bruker-axs.de)

**KLA-Tencor**

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Tel: +1 408 875 3000  
Fax: +1 510 456 2498  
[www.kla-tencor.com](http://www.kla-tencor.com)

**13 Characterization  
equipment****J.A. Woollam Co. Inc.**

645 M Street Suite 102,  
Lincoln, NE 68508, USA  
Tel: +1 402 477 7501  
Fax: +1 402 477 8214  
[www.jawoollam.com](http://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](http://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](http://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](http://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](http://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](http://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](http://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](http://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](http://www.jpsalaser.com)

**Kulicke & Soffa Industries**

1005 Virginia Drive,  
Fort Washington,  
PA 19034,  
USA  
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Fax: +1 215 784 6001  
[www.kns.com](http://www.kns.com)

**Palomar Technologies Inc**

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Tel: +1 760 931 3600  
Fax: +1 760 931 5191  
[www.PalomarTechnologies.com](http://www.PalomarTechnologies.com)

**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](http://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](http://www.compoundsemi.co.uk)

**United Monolithic  
Semiconductors**

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BP46, Orsay, 91401,  
France  
Tel: +33 1 69 33 04 72  
Fax: +33 169 33 02 92  
[www.ums-gaas.com](http://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](http://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](http://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](http://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](http://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](http://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](http://www.ClassOneEquipment.com)

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### Henry Butcher International

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UK

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Fax: +44 (0)20 7405 9772  
[www.henrybutcher.com](http://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](http://www.mw-zander.com)

## 24 Consulting

### WSR Optical Device Solutions

P.O. Box 248, Flemington,  
NJ 08822,  
USA  
Tel: +1 908 428 4986  
[www.wsr-ods.com](http://www.wsr-ods.com)

## 25 Resources

### SEMI Global Headquarters

3081 Zanker Road,  
San Jose, CA 95134, USA  
Tel: +1 408 943 6900  
Fax: +1 408 428 9600  
[www.semi.org](http://www.semi.org)

### Yole Développement

45 rue Sainte Geneviève,  
69006 Lyon,  
France  
Tel: +33 472 83 01 86  
[www.yole.fr](http://www.yole.fr)

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**4–6 March 2008**

## 2008 China International LED Show (LED CHINA 2008)

Chinese Import & Export Fair Pazhou Complex, Guangzhou, China

**E-mail:** [LED@TrustExhibition.com](mailto:LED@TrustExhibition.com)

[www.LedChina-gz.com](http://www.LedChina-gz.com)

**5–7 March 2008**

## SEMI Europe Standards Spring Conference and Meetings

Brussels, Belgium

**E-mail:** [salfino@semi.org](mailto:salfino@semi.org)

[www.semi.org/eustandards](http://www.semi.org/eustandards)

**9–11 March 2008**

## 2nd SEMI PV FMF (Photovoltaic Fab Managers Forum)

Dresden's International Congress Centre, Germany

**E-mail:** [eblokken@semi.org](mailto:eblokken@semi.org)

[www.PVGroup.org](http://www.PVGroup.org)

**18–20 March 2008**

## SEMICON China 2008

Shanghai New International Expo Centre (SNIEC), China

**E-mail:** [semichina@semi.org](mailto:semichina@semi.org)

<http://semiconchina.semi.org>

**18–20 March 2008**

## 2nd annual WiMAX World Asia 2008

Bangkok, Thailand

**E-mail:** [ehealey@trendsmmedia.com](mailto:ehealey@trendsmmedia.com)

<http://asia.wimaxworld.com>

**24–28 March 2008**

## 2008 MRS Spring Meeting

San Francisco, CA, USA

**E-mail:** [info@mrs.org](mailto:info@mrs.org)

[www.mrs.org](http://www.mrs.org)

**31 March–2 April 2008**

## The 4rd Newgrace International Solar PV (Shanghai) Exhibition

China Shanghai International Exhibition Centre, China

**E-mail:** [nuogaisi2004@126.com](mailto:nuogaisi2004@126.com)

[www.ch-solar.com](http://www.ch-solar.com)

**1–2 April 2008**

## Concentrated Photovoltaic Summit '08

Madrid, Spain

**E-mail:** [belen@csptoday.com](mailto:belen@csptoday.com)

[www.cpvtoday.com](http://www.cpvtoday.com)

**2–4 April 2008**

## 4th Photovoltaic Science Application and Technology (PVSAT-4) Conference and Exhibition

University of Bath, UK

**E-mail:** [info@uk-ises.org](mailto:info@uk-ises.org)

[www.pvsat.org.uk](http://www.pvsat.org.uk)

**7–9 April 2008**

## WRA-LDSD

### (Workshop on Recent Advances of Low Dimensional Structures and Devices)

University of Nottingham, UK

**E-mail:** [mohamed.henini@nottingham.ac.uk](mailto:mohamed.henini@nottingham.ac.uk)

[www.nottingham.ac.uk/~ppzmmh/WRA\\_LDSD](http://www.nottingham.ac.uk/~ppzmmh/WRA_LDSD)

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**7–11 April 2008**

**SPIE Europe Photonics Europe 2008**

Palais de la Musique et des Congrès, Strasbourg,  
France

**E-mail:** info@SPIEEurope.org

<http://spie.org>

**14–17 April 2008**

**CS MANTECH (2008 International  
Conference on Compound Semiconductor  
Manufacturing Technology)**

Westin Chicago North Shore,  
Wheeling, IL, USA

**E-mail:** csmantech@csmantech.org

[www.gaasmantech.org](http://www.gaasmantech.org)

**7–8 May 2008**

**Blue 2008**

**(The 6th International Industry Review)**

Ambassador Hotel, Hsinchu, Taiwan

**E-mail:** Blue-2008@solidstatelighting.net

[www.Blue-2008.com](http://www.Blue-2008.com)

**8–9 May 2008**

**S2K 2008**

City Hall, Cardiff, Wales, UK

**E-mail:** jemi-enquiries@see.ed.ac.uk

[www.semiconductor2k.com](http://www.semiconductor2k.com)

**11–16 May 2008**

**33rd IEEE Photovoltaic Specialists  
Conference (PVSC)**

San Diego, CA, USA

**E-mail:** wendy\_larsen@nrel.gov

[www.33pvsc.org](http://www.33pvsc.org)

**18–21 May 2008**

**WOCSDICE 2008**

**(32nd Workshop on Compound Semiconductor  
Devices and Integrated Circuits)**

Leuven, Belgium

**E-mail:** wocsdice@imec.be

[www.wocsdice2008.org](http://www.wocsdice2008.org)

**19–21 May 2008**

**3rd annual WiMAX World Europe 2008**

Munich, Germany

**E-mail:** ehealey@trendsmmedia.com

<http://europe.wimaxworld.com>

**25–29 May 2008**

**20th International Conference on Indium  
Phosphide and Related Materials (IPRM '08)**

Versailles, France

**E-mail:** iprm08@see.asso.fr

<http://iprm2008.org>

**28–30 May 2008**

**Lightfair International 2008**

Las Vegas Convention Center, NV, USA

**E-mail:** info@lightfair.com

[www.lightfair.com](http://www.lightfair.com)

**1–4 June 2008**

**EXMATEC 2008**

**(9th International Workshop on Expert  
Evaluation & Control of Compound  
Semiconductor Materials & Technologies)**

Lodz, Poland

**E-mail:** sibinski@mail.p.lodz.pl

[www.exmatec08.p.lodz.pl](http://www.exmatec08.p.lodz.pl)

**2–4 June 2008**

**SEMI Expo CIS 2008**

World Trade Center Moscow, Russia

**E-mail:** afamitskaya@semi.org


[www.semi.org](http://www.semi.org)

**2–6 June 2008**

**ICMOVPE – XIV (14th International  
Conference of Metalorganic Vapor Phase  
Epitaxy)**


Metz, France

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