

Multi-junction PVs reach 41.1%
IBM's graphene FETs hit 26GHz



Bookham and Avanex to merge • JDSU divests Shenzhen plant
Photonics West product launches • IEDM conference report

Veeco MBE: The element that takes you beyond cutting edge.



**Sharpening
the future**
one innovation at a time.

Introducing GEN10!
The next generation R&D system.

For more information, visit
www.veeco.com/GEN10_9

ENABLING TOMORROW'S DEVICES TODAY.

Take your research and production processes beyond the cutting edge. At Veeco, we're constantly innovating to provide you with the widest range of MBE sources, components and systems—with a proven lower cost of ownership. Our expertise includes applications ranging from traditional III-V material research, to solar, and wireless devices. Veeco's in-house Process Integration Center also works to explore solutions for emerging applications in data storage, semiconductor, metal oxides and other user-specific applications. Veeco MBE: elemental to your success. For more information, call 1.888.24.VEECO or visit www.veeco.com/GEN10_9

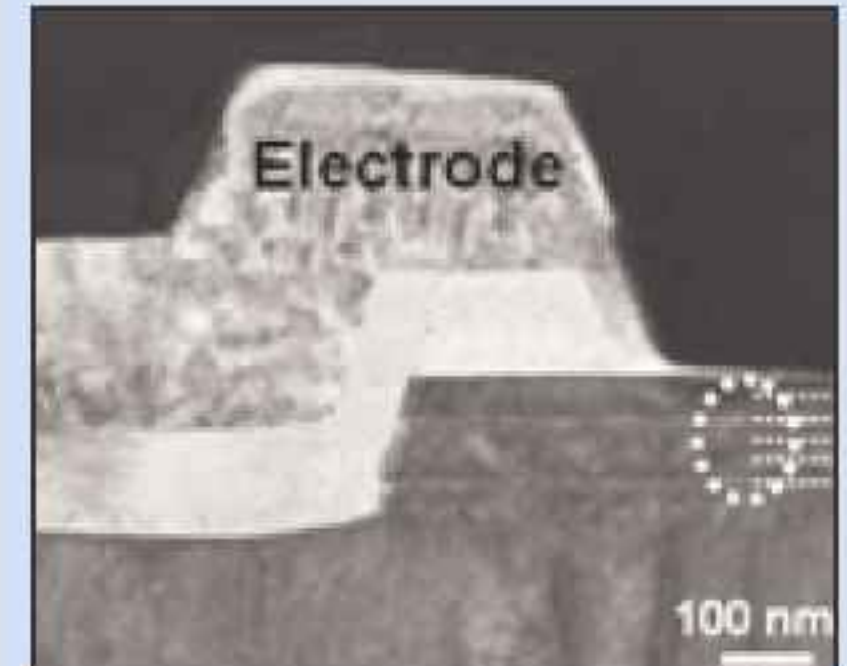
Veeco

Solutions for a nanoscale world.™

Editorial	2
News	
Markets	4
Q4 worst quarter for handsets since 2001 • GaN micro market to grow at 98% to 2012 • GaAs CPVs 10% of terrestrial market in 2012	
Micro	8
RFMD & TriQuint take impairment charges amid Q4 downturn, while Skyworks profits • Graphene FETs hit record 26GHz f_T • Fujitsu sells stake in Eudyna JV to Sumitomo	
Wide-bandgap electronics	22
International Rectifier sues ex-CEO • Cree samples GaN HEMTs for telecoms • Panasonic develops 'natural super junction' power device	
Materials and processing equipment	26
ASM cuts 200 jobs • SMI opens apps lab for ZnO MOCVD • Cree licenses GaN substrate technology to Mitsubishi Chemical	
LEDs	42
Bridgelux vs Cree and Nichia vs Seoul litigation settled; Nichia partners with Luminus and Opto Tech • VPEC closes LED lines • UC Davis becomes LED University; Indian Wells joins LED City program	
Optoelectronics	50
Osram blue laser for micro-projectors • QD Laser raises ¥700m • nLight raises \$10.7m • Photonics West 2009	
Optical communications	60
Bookham and Avanex merging • Avanex cuts staffing by 5% • JDSU divests Shenzhen plant • Nortel files for bankruptcy	
Photovoltaics	72
PVs temper Emcore's optical comms slump • SolFocus raises \$47m for CPVs • First Solar's CdTe modules for carbon-neutral city	
Technology focus: Photovoltaics	78
ISE raises multi-junction solar cell efficiency record to 41.1% Record achieved at concentration factor of 454.	
Technology focus: LEDs	80
Polarization-matched GaInN cuts LED efficiency droop LED lighting to save \$1.8 trillion over 10 years, reckons RPI.	
Conference report: IEDM 2008	82
III-Vs from a logical point of view Research on III-V channels reported at December's IEEE International Electron Devices Meeting.	
Suppliers' Directory	88
Event Calendar	94
Advertisers' Index	94

Contribute to Semiconductor Today

We want to hear from researchers, engineers and managers interested in contributing articles. Ideas for Feature articles or one-page Opinion articles can be e-mailed to the Editor at mark@semiconductor-today.com



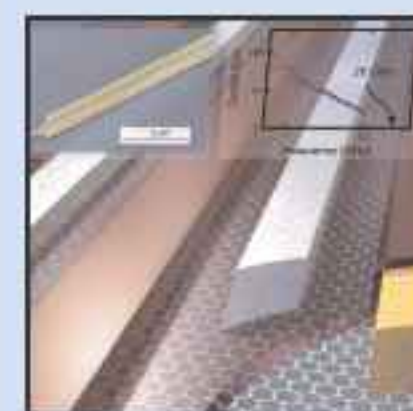
p24 Cross-sectional view of Panasonic's new 'natural super junction' GaN power device.



p43 New V10 version of Audi's R8, the first car with all-LED headlamps as standard.



p51 Osram Opto's new 450nm blue laser diode for micro-projectors.



Cover: Researchers at IBM claim to have conducted the first comprehensive experimental studies on the high-frequency response of top-gated graphene FETs for different gate voltages and gate lengths, and demonstrated operation at gigahertz frequencies, reaching a record cut-off frequency of 26GHz. **p19**

Signs of improvement as inventories re-balance

Since reporting their warnings in the December/January issue, sequential fourth-quarter 2008 revenue drops have been confirmed by GaAs RFIC makers RF Micro Devices (down 24%), TriQuint (20%) and Skyworks (a more modest 10%) — see pages 8–14. Anadigics has still not reported its results.

These results follow the economic downturn hitting consumer electronics spending in Q4/2008, to the extent that mobile phone shipments suffered the biggest slowdown since Q4/2001 (see page 7). Worst hit was Motorola, whose market share has almost halved year-on-year, to just 6.4% (leading to another 3000 job losses).

RFMD's net loss has been inflated by asset impairment charges of several hundred million dollars, mainly due to a drop in the valuation of Sirenza Microdevices (acquired in 2007). Likewise, TriQuint incurred charges of \$36m, partly from its acquisition of WJ Communications, although — unlike RFMD — it would otherwise have registered a profit. In contrast, Skyworks still made a profit in Q4/2008, thanks to its greater diversification in growth markets like remote metering (although even it has still reduced its headcount by 150 jobs, or 4%, and slowed its transition from 4" to 6" GaAs wafers).

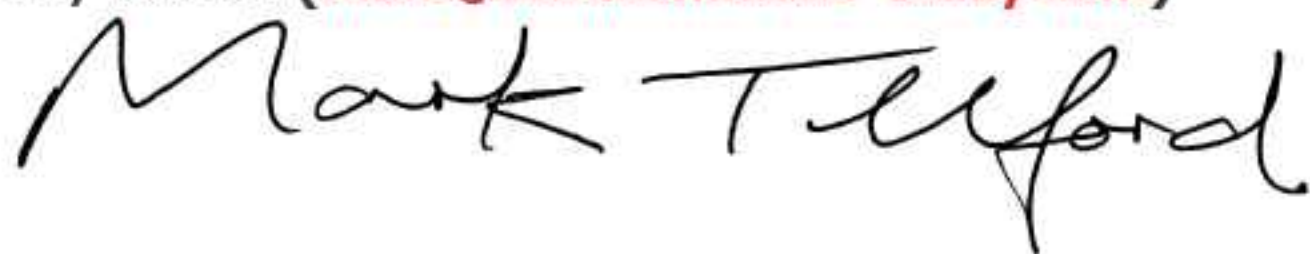
Nevertheless, despite its greater short-term pain, RFMD was perhaps first to report seeing signs of improvement (in early December) as customer inventory levels are reduced. Likewise, TriQuint reported order push-outs subsiding and signs of improvement in early January, although it does not expect any improvements in factory utilization and gross margin until Q2/2009.

Meanwhile, the economic downturn has also depressed the Q4/2008 revenues of optical communications component makers such as JDSU (by 6.2%), Opnext (12%), Oplink (12.5%), Finisar (14%), Bookham (25%) and Avanex (16%), which have been cutting costs and headcount (by 17%, or 200 jobs, in the case of Finisar) — see pages 62–71. In particular, JDSU has shed more than 2000 of its 6645 workforce by divesting its assembly & test plant in Shenzhen to contract manufacturer Sanmina. Also, while cutting its workforce by 5%, Avanex has agreed its long-anticipated merger with Bookham, adding to ongoing consolidation in the optical communications sector.

Although also suffering a slump in optical communications component sales, Emcore's quarter-to-quarter revenue decline has been ameliorated by growth in its photovoltaic segment, especially for space applications (see page 72). However, due to the economic slump and a reduction in market capitalization, it has also written down goodwill impairment (related to its acquisitions of Intel's telecom-related assets early last year). Emcore is also struggling to maintain cash reserves, and is seeking investors for its PV business.

Nevertheless, concentrating photovoltaic (CPV) applications are continuing to flourish, with system maker SolFocus for example raising \$47.5m of venture capital to fund commercialization (see page 75). This is despite what its CEO describes as "one of the most challenging funding environments in history" adding that "many good companies are going unfunded today" (especially if more exposed to the consumer-driven slump than technology such as CPVs).

Mark Telford, Editor (mark@semiconductor-today.com)



semiconductorTODAY
COMPOUNDS & ADVANCED SILICON



Editor

Mark Telford
Tel: +44 (0)1869 811 577
Cell: +44 (0)7944 455 602
Fax: +44 (0)1242 291 482

E-mail: mark@semiconductor-today.com

Commercial Director/Assistant Editor

Darren Cummings
Tel: +44 (0)121 288 0779
Cell: +44 (0)7990 623 395
Fax: +44 (0)1242 291 482
E-mail: darren@semiconductor-today.com

Advertisement Manager

Jon Craxford
Tel: +44 (0)207 193 9749
Cell: +44 (0)7989 558 168
Fax: +44 (0)1242 291 482
E-mail: jon@semiconductor-today.com

Original design Paul Johnson
www.higgs-boson.com

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.

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

© 2009 Juno Publishing and Media Solutions Ltd. All rights reserved. *Semiconductor Today* and the editorial material contained within is the copyright of Juno Publishing and Media Solutions Ltd. Reproduction in whole or in part without permission is forbidden. In most cases, permission will be granted, if the author, magazine and publisher are acknowledged.

Disclaimer: Material published within *Semiconductor Today* does not necessarily reflect the views of the publisher or staff. Juno Publishing and Media Solutions Ltd and its staff accept no responsibility for opinions expressed, editorial errors and damage/injury to property or persons as a result of material published.

*Do you want to be ahead
of the industry's roadmap?*

AIXTRON



Marathon production for the manufacture of As/P LEDs and Solar Cells on 2 inch to 8 inch Substrates

AIXTRON supplies MOCVD systems equipped with automated wafer handling up to 8 inch enabling high throughput production at low cost of ownership.

Be ahead of the industry's roadmap and increase your throughput, device yield and quality with AIXTRON's deposition equipment.

The AIXTRON product range comprises R&D and production tools for compound, organic, or SiC materials and nanostructures.

ALD ■ AVD® ■ CVD ■ MOCVD ■ OVPD® ■ PECVD ■ PVPD ■ SiC CVD



AIXTRON

AIXTRON AG · Kackertstraße 15–17 · 52072 Aachen, Germany
info@aixtron.com · www.aixtron.com

push your  **PERFORMANCE**

Base-station semiconductor market to drop 12.3% per year to 2012

Base-station semiconductor revenue fell from \$7.2bn in 2007 to \$4.6bn in 2008, and will decline an average of 12.3% per year from 2008–2012, according to market research firm In-Stat in its report 'A Tough road Ahead for Base Station Components — Worldwide Semiconductor Forecast'. Of the main technology types, WCDMA is the only technology expected to yield semiconductor revenue growth between 2008 and 2012.

There are several reasons for the overall decline. "The number of subscribers in many areas is reaching saturation, with former double-digit subscriber growth now running in the mid-to-low single-digits," says analyst Allen Nogee.

"The global recession will also have an impact," he adds. The slowing worldwide economy is having wide-ranging negative effects on all regions, with the possible exception of Africa. "Although most people aren't likely to part with

their cell phones, they may replace them less often, and reduce services they don't find value in or can't afford," Nogee says.

"Not only are we facing an economic slowdown the likes of which have not been seen in 25 years, but also infrastructure manufacturers are just coming off an unusual infrastructure growth spurt, with operators around the world spending billions on new 3G equipment. Unfortunately, that growth couldn't go on forever... They are now waiting for service revenues from these networks before they invest more," continues Nogee. Recession will get operators rethinking their spending plans, it is reckoned.

"Going forward, this will be a tough time for those producing base-station equipment and semiconductors, and the weaker companies, or those poorly positioned, will not likely survive," concludes In-Stat.

www.instat.com

GaAs CPVs to grow at 133% to 10% of terrestrial PV market in 2012

The terrestrial photovoltaic market will be worth \$20.2bn in 2008 and grow at a compound annual average growth rate (CAAGR) of 23% to \$35.2bn by 2012, according to the study 'Photovoltaics Market Supply Chain 2008' by Strategy Analytics' GaAs Service. This rapid growth is due mainly to increasing worldwide demand for renewable energy.

"Crystalline silicon-based solar technology still has a dominant market share of around 89% in 2008," says Asif Anwar, director of Strategy Analytics' GaAs service. "However, moving forward, its share will be eroded as a result of competing technologies based on

thin film and compound semiconductors," he adds. "Thin-film solar cells cost less and do not consume large amounts of crystalline silicon. Traditional crystalline silicon solar cell manufacturers, such as Q-Cells and Sharp, are involved in this new area."

Anwar concludes, "III-V based concentrated photovoltaic technology offers advantages of high cell conversion and lower material usage". Strategy Analytics believes that these advantages will translate to a CAAGR of 133% through 2012, accounting for 10% of the total terrestrial PV market.

www.strategyanalytics.com

IN BRIEF

GaN microelectronic market to grow at CAGR of 98% to 2012

The gallium nitride (GaN) microelectronic device market will expand at a compound annual average growth rate (CAAGR) of 98% through to 2012, forecasts market research firm Strategy Analytics in its latest study 'GaN Market Update 2007–2012'. In particular, military and defense applications will dominate demand, accounting for 55% of the total market in 2012.

With the automotive industry now looking to silicon carbide (SiC) technology to replace silicon bipolar junction transistors (BJTs) in hybrid vehicles, the primary commercial opportunity for GaN will now be represented by wireless infrastructure markets.

"Despite strong growth projections, the development of a commercial market for GaN still faces a number of challenges, not least of which will be the growing high-voltage, high-power and wide-bandwidth capabilities of GaAs and silicon technologies," cautions Strategy Analytics' Asif Anwar. "This will have an impact on long-term growth and could potentially limit GaN adoption to niches where other technologies simply cannot compete."

The new study also looks at long-term substrate material trends. SiC should remain the mainstay as a substrate technology for GaN devices, with GaN-on-SiC devices predicted to account for 83% of the GaN device market in 2012.

GaN bulk substrate technology development will progress through 2012, but GaN bulk substrates' penetration of the GaN RF market will be limited in the face of competition from Si and SiC substrates, concludes Strategy Analytics.

www.strategyanalytics.com

Pulsed RF power devices to grow

Markets for pulsed RF power devices below 4GHz are expected to show continued solid growth over the next five years despite the current economic turmoil, according to an ABI Research study 'High Power RF Semiconductors for Pulsed Applications' (covering devices with peak output power of more than 5W and operating frequencies up to 3.8GHz for the avionics, L-band, S-band, and sub-1GHz radar markets through 2013).

While the volatility of many electronics markets is fueled by their association with consumer spending, markets for pulsed RF power devices are supported by quite different priorities. "Many RF power semiconductor manufacturers are on a quest to find markets unrelated to mobile wireless infrastructure," notes director Lance Wilson. "Device prices in wireless infrastructure are falling, and the total available market is shrinking."

Some markets that use pulsed RF power devices, e.g. the transportation safety and military markets, are seeing solid growth even amid the current economic downturn. These devices are used in radars for military and marine applications, and in a worldwide upgrade of the

air traffic control system that is now occurring. There is also a market segment devoted to the avionics transponder and air navigation market, which is also boosted by the air traffic control upgrade.

Intrinsically less 'optional' than many consumer markets, these segments are therefore less sensitive to economic upheavals than consumer-driven markets.

Many semiconductor manufacturers understand these factors and are attempting to enter this market. However, some factors may complicate their efforts. Pulsed RF power device markets are becoming very competitive technologically: GaN and SiC devices are vying for market share along with the more established silicon-based technologies. Also, so many companies are rushing into these markets that there probably won't be the market size to support them all. "Undoubtedly, some consolidation will occur," reckons Wilson. "While not guaranteed success, those companies that have a track record working with government agencies and defense contractors are going to have an advantage over those that are new entrants."

www.abiresearch.com

A third of DWDM long-haul to be 40Gb/s by 2013

Optical transport equipment revenue will fall 9% in 2009 but then resume growth in 2010, reaching \$14.5bn in 2013, according to a Dell'Oro Group 5-Year Forecast Report.

Shipments of 40Gb/s wavelengths will grow at least 50% in each of the next five years and contribute nearly a third of capacity shipped in DWDM long-haul systems by 2013.

"The economy of most major countries is in a recession, and the consensus belief is that this recession may last through 2009," says Jimmy Yu, director of Optical Transport research. "There continues to be an opportunity for technologies that will help service providers reduce their capital expense while still expanding their network capacity," he adds. "40Gb/s is one of those technologies, as the price per bit of a 40Gb/s wavelength starts to be lower than that of a 10Gb/s wavelength in a DWDM long-haul system."

The report also indicates that shipments of 100Gb/s wavelengths are expected in late 2011.

www.DellOro.com

Thin-film PV forecast for 2015 cut from \$22bn to \$14bn

After lean years in 2009 and 2010, the thin-film photovoltaic (TFPV) module market will return to higher growth rates, rising from \$4.6bn in 2011 to just over \$14bn in 2015, says NanoMarkets in 'Thin Film Photovoltaics Markets: 2008 and Beyond (Revised Edition)'.

July's original report, which covers thin-film silicon, CdTe, CIS/CIGS, GaAs and nanomaterials, had forecast a TFPV market of almost \$2.4bn in 2008 rising to over \$12bn in 2013, then more than \$22bn by 2015.

Several factors are combining to make the near-term prospects for TFPV poorer than hoped. The global economy has had a widespread impact on thin-film solar markets,

which include electric utilities, commercial and industrial buildings, residential buildings, and military and emergency applications.

In particular, the recession in the construction industry will dampen solar panel demand in 2009-2010, depressed oil prices will make it harder to make the case for solar and other forms of alternative energies, and competition for capital will limit funding for R&D. Also, the shortage of crystalline silicon that drove TFPV demand has been resolved. Add in the capacity that is coming on line to meet demand, and the market has factors to overcome.

However, NanoMarkets says the thin-film solar business will not

evaporate. The unique combination of flexibility, low weight and low cost promised by TFPV should enable the technology to continue to penetrate the solar market as a whole. First Solar has already demonstrated how commercially successful its thin-film CdTe cell technology can be, and NanoMarkets also expects to see a major ramp up in CIGS solar panels in early 2011. Indeed, as CIGS begins to fulfill its mission of combining high efficiencies with all the advantages of TFPV, NanoMarkets expects that firms that are now focused on other materials platforms will switch to CIGS.

www.nanomarkets.net

LCD-TVs to drive LED growth to 2.9%

After 10.8% growth in 2008, the LED market is still expected to grow by 2.9% in 2009, aided by rising demand from LCD-TV makers, says market research firm iSuppli Corp. LEDs therefore provide a rare growth opportunity amid sharp revenue declines in most other electronics component categories.

In contrast, the total semiconductor market is set to decline by 9.4% in 2009. "LEDs are forecast for growth this year—a highly unusual item in our semiconductor forecast, given that almost all other components will suffer revenue contractions in 2009," says Dale Ford, senior VP, market intelligence services.

"Of the 12 major semiconductor categories tracked by iSuppli in its Application Market Forecast Tool (AMFT), nine are expected to suffer revenue declines in 2009—ranging from memory chips, to logic ICs, to power transistors," he adds.

"Although a 2.9% increase is only a moderate rise by the standards of the semiconductor industry, any revenue growth at all this year will be a remarkable accomplishment."

The LCD-TV LED market will grow 221.9% from \$51m in 2008 to \$163m in 2009, then almost nine-fold to \$1.4bn by 2012, says iSuppli.

LCDs are a transmissive display type, so they do not generate their own light and hence need a separate backlighting illumination source. Traditionally, most have used cold-cathode fluorescent lamps (CCFLs). However, newer higher-brightness LEDs and declining prices are making them a viable competitor for backlighting LCDs in TVs. The price premium for 40-42" LCD TVs using LEDs now is as little as \$200-500 compared to CCFL alternatives, estimates Riddhi Patel, principal analyst, TV, for iSuppli. While the overall mood of TV makers at January's 2009 Consumer Electronics Show (CES) in Las Vegas trended toward gloom, there was some optimism regarding the use of LED backlighting in new LCD-TVs.

At CES, some premium LCD-TV brands (Samsung and Sony) showed new lines of LED-equipped sets, which are expected to be introduced in the June timeframe. Second-tier brand General Electric (GE) sees LED backlighting as a chance to carve out a market niche. "GE, in combination with Tatung, have entered a joint venture to produce LED-based LCD TVs, and to try to do what Westinghouse did a few years ago, when it came into the market with lower-priced LCD TVs—opening up the market for value brands," Patel said. "As more LED-backlit LCD-TV brands enter the market, competition will intensify and prices will decline."

"One positive message was issued by LCD-TV makers at CES: LED backlighting and thinner form factors represent the future of the market," says Patel. "These two things go hand in hand, with edge-mounted LED-backlight systems enabling thinner sets, which are more attractive to consumers."

LED-backlit LCD TVs also consume less electricity than CCFL-equipped counterparts. "A majority of LED-backlit LCD TVs comply with Energy Star requirements," Patel notes. "This is an attractive feature for consumers, who have come to view the Energy Star label as a guarantee of greenness and reduced energy costs."

However, while the energy consumption and form-factor benefits of LED backlighting are unquestioned, there is some debate over how much the technology actually improves the image on LCD TVs.

Most current LED-equipped LCD TVs use edge-mounted designs that place the diodes at the borders of the display. This allows the thinner form factors, but does not provide any major improvement in contrast ratios (the ratio of the luminance of the brightest color to that of the darkest color a TV can produce), according to Sweta Dash, director of LCD research for iSuppli. TVs with superior contrast ratios get rid of excess off-state light when a LCD pixel is turned off. Using an edge-mounted LED backlighting design in a large-sized LCD TV yields no improvement in picture quality and the display's color gamut is actually less than when using a CCFL, says Jagdish Rebello, director and principal analyst for LED research.

An alternative approach to using LEDs in LCD TVs, the full-array backlight, provides sharp improvements in contrast ratio, says Dash. "The highest-quality images on LCD-TVs will be on sets that use the full-array backlight approach because it provides the best dynamic contrast ratio, which in turn improves perceived image color and sharpness," adds Randy Lawson, senior analyst, digital TV semiconductors. iSuppli expects that, in the coming years, LCD-TV makers will offer a mix of thin-form-factor edge-mounted designs and high-image-quality full-array alternatives.

Another aspect of image quality hinges on the type of LEDs used in LCD TVs. Most LED-backlit LCD TVs currently use white LEDs, rather than the more costly red, green, blue (RGB) alternatives. RGB LEDs provide a superior color gamut, providing richer and more varied colors in TV sets. "RGB LEDs are tidy and are the ideal best solution for LCD backlighting," Patel says. "But pricing is still too high and these won't show up in LCD TVs in significant numbers until 2010," he concludes.

www.isuppli.com

RGB LEDs are tidy and are the ideal best solution for LCD backlighting. But pricing is still too high and these won't show up in LCD TVs in significant numbers until 2010

Q4 worst quarter for handsets since 2001, but WCDMA to triple in 2009

Mobile phone shipments fell 10% year-on-year from 329 million units in Q4/2007 to 295 million units in Q4/2008, according to market research firm Strategy Analytics in its report 'Q4 2008 Global Handset Market Share Update'.

"An economic downturn in developed and developing markets caused the industry's slowest growth rate since Q4/2001," says senior analyst Bonny Joy. "Retailers have been de-stocking due to credit tightness, while consumers delayed purchases because of fears of a recession," he adds.

"Three of the big five cell-phone vendors recorded negative annual growth rates in Q4/2008. Motorola declined 54%, Sony Ericsson 21% and Nokia 15%," adds director Neil Mawston. "With volumes and revenues contracting sharply this year, much of the mobile industry's focus will inevitably be on controlling costs and restoring profitability during 2009."

Nokia's market share has fallen slightly year-on-year from 40.6% in Q4/2007 to 38.4% in Q4/2008, but Motorola's has fallen the most: by almost half, from 12.4% to 6.4%.

In contrast, Samsung performed best among the big five in Q4/2008, rising from 14.1% to an all-time high market share of nearly 18%, driven by an attractive handset portfolio and wider distribution channels.

Apple shipped a less-than-expected 4.4 million iPhones. Its annual growth rate of 88% was far below its 516% of the previous quarter. Apple continues to grow at an above-average pace, but is not immune to the wider recession affecting the global economy and handset market, Strategy Analytics concludes.

For full-year 2008, shipments for the industry grew just 5% on 2007's 1.12 billion units to 1.18 billion.

www.strategyanalytics.com

In its updated report 'Mobile Device Market Share Analysis and Forecasts', ABI Research says the global mobile handset market went into a tailspin in October and November, resulting what it reckons was a nearly 5% drop year-on-year in unit shipments in Q4/2008. However, while 2009 is likely to see more stormy economic weather, there are a few rays of sunshine.

"The number of WCDMA and CDMA2000 mobile handsets sold (currently 39% of the total) is expected to exceed 50% in 2009," says ABI Research Asia-Pacific VP Jake Saunders.

"Much of the brunt of the economic downturn will be experienced in the 2G categories." WCDMA shipments

should grow from 258m in 2008 to 725m in 2009. "By 2013, more than 67% of all handsets shipped will be 3G/3G+ capable," he adds.

"Another robust segment is smartphones," says practice director

Kevin Burden. "Smartphones captured 14% of the 2008 market and are expected to grow throughout the challenging period of 2009 and comprise 31% of the market by 2013." Smartphones are among the most coveted pieces of prosumer electronics.

Cellular modems will also be a high-growth sector in 2009, driven largely by USB modems, which will account for 80% of shipments. ABI expects market volume to increase by more than 55% in the coming year as Asian vendors push forward with low-priced modems.

Operators continue to be creative with broadband plans to entice new users, offering options such as a free month with a modem purchase, as well as daily and weekend plans and per MB fees. "For as long as operators aggressively price and promote mobile broadband plans, cellular modems will continue to be a hot category, with considerable potential in SOHO [small office/home office] and SMB [server message block] segments," concludes Burden.

www.abiresearch.com

WCDMA shipments should grow from 258m in 2008 to 725m in 2009

Handset shipments (millions) & market shares (Strategy Analytics).

Shipments	Q4/07	Q4/08	±	2007	2008	±
Nokia	133.5	113.1	-15%	437.1	468.4	+7%
Samsung	46.3	52.8	+14%	161.1	196.6	+22%
LG Electronics	23.7	25.7	+4%	80.5	100.8	+25%
Motorola	40.9	19.0	-54%	159.0	99.9	-37%
Sony Ericsson	30.8	24.2	-21%	103.4	96.6	-7%
Others	53.9	59.8	+11%	181.5	215.8	+19%
Total	329.1	294.6	-10%	1122.6	1178.1	+5%
Share	Q4/07	Q4/08	±	2007	2008	±
Nokia	40.6%	38.4%	-2.2%	38.9%	39.8%	+0.9%
Samsung	14.1%	17.9%	+3.8%	14.4%	16.7%	+2.3%
LG Electronics	7.2%	8.7%	+1.5%	7.2%	8.6%	+1.4%
Motorola	12.4%	6.4%	-6.0%	14.2%	8.5%	-5.7%
Sony Ericsson	9.4%	8.2%	-1.2%	9.2%	8.2%	-1.0%
Others	16.4%	20.3%	+3.9%	16.2%	18.3%	+2.1%
Growth (y/y)	12.3%	-10.5%		12.0%	4.9%	

RFMD generates cash flow despite 25% revenue drop

For its fiscal Q3/2009 (ended 27 December), RF Micro Devices Inc of Greensboro, NC, USA has reported revenue of \$202m, down 25.6% on last quarter's \$271.7m.

President & CEO Bob Bruggeworth says that November was particularly challenging as demand dropped week-over-week in response to uncertainties surrounding consumer end-markets. This was compounded by customers' excess inventories that had been built up for expected growth that failed to materialize.

Despite continuing to ship production volumes of cellular front ends to all of the world's top-five handset OEMs, component shipments in the Cellular Product Group (CPG) fell sequentially, due mainly to reduced handset demand and excess inventories at OEMs. Likewise, in the Multi-market Products Group (MPG), shipments of RF components fell due to reduced end-market demand and excess inventories.

Due mainly to the drop in revenue and lower factory utilization rates (below 30%) and inventory-related charges of \$24.5m, gross margin fell sequentially from 28.3% to 19%.

Net loss has risen from \$11.8m last quarter to \$813.3m. However, this was mainly due to exceptional non-cash asset impairment charges of \$754m. These included: a drop in the valuation of Sirenza Micro-devices (acquired in 2007 for \$300m plus \$600m in stock) that led to a goodwill write-down of \$673m; a \$47m write-down from closing RFMD's 4" GaAs fab (concentrating production into the adjacent 6" fab); plus \$24.5m for inventory reserves. Excluding these one-time charges, non-GAAP loss was \$12.9m (versus a profit of \$18.6m last quarter).

During the quarter, RFMD surpassed its target of \$75m in annualized operating expense reductions, e.g. through cutting production and

staffing at its 6" GaAs fab in Newton Aycliffe, UK. Overall capital expenditure has been cut to less than \$6m (and should be even lower for the next 6-8 quarters, totaling \$15-20m in fiscal 2010).

Hence, despite the global economic downturn, cash and short-term investments still rose by \$19m to \$238m. "Flexibility and agility allow us to proactively manage for cash flow and improve RFMD's balance sheet," says Dean Priddy, CFO & corporate VP of administration.

Despite the rapidly declining demand environment, free cash flow has almost doubled from the prior quarter's \$21m to \$40m (operating cash flow of \$46m minus property and equipment expenditure of \$6m). RFMD repurchased \$33m worth of its convertible debt, resulting in net debt (long-term debt minus cash, cash equivalents and short-term investments) being cut by \$52m to \$344m. "We are structuring RFMD for superior financial leverage and significantly improved return on invested capital," Priddy adds.

RFMD cautions that the current market conditions have created a high degree of uncertainty regarding customer demand. "We have very limited visibility into end markets and we believe our customers are still unable to pinpoint with any certainty real normalized demand," says Bruggeworth. RFMD is hence suspending its practice of providing detailed quarterly guidance and is instead providing insight into its internal planning assumptions related to anticipated cash flows.

In the first few weeks of December RFMD began to see early signs of improvement... the rate of push-outs has slowed

For the March quarter, RFMD expects revenue to decline more than seasonally, as end-market demand remains weak. However, in the first few weeks of December RFMD began to see early signs of improvement. "The rate of push-outs has slowed and customer inventory levels are coming down," says Bruggeworth. The firm expects a significant reduction in its own inventory levels, which should boost operating cash flow but suppress gross margin (to below 30%) due to lower factory utilization. RFMD expects net cash and short-term investments to rise, although it may use some cash to repurchase outstanding convertible notes on an opportunistic basis (the firm's cash balance exceeds the remaining August 2010 convertible notes by more than \$30m). RFMD continues to expect \$80-120m in free cash flow during fiscal 2010 (which begins on 29 March 2009), despite the reduced demand environment.

"The fiscal discipline underlying our strategic restructuring three quarters ago is not only intact, it is central to our operating plan and execution as we manage through the current economic downturn," says Bruggeworth. "RFMD today is flexible and agile, and we are actively managing our manufacturing capacities and our expense structure to match what we anticipate to be the near-term demand environment."

"Despite the decreasing end-market demand, design activity for our products has remained strong," says Bruggeworth. CPG has secured major design wins for a dual-band GSM/GPRS transmit module at leading handset OEMs and platform providers in Korea, Taiwan and China. During the December quarter, CPG supported the launch of two new mass-market EDGE handsets fea-

turing POLARIS transceivers, as well as multiple 2G and 3G multi-mode handsets at a leading Korean handset OEM (now added as a 10% customer). Sales to another top-five handset OEM continued to ramp and doubled sequentially.

"RFMD is firmly committed to customer and end-market diversification and continued investments in new products and new enabling technologies," says Bruggeworth. The firm is diversifying not only through synergies between CPG and MPG but also within CPG, with an aggressive slate of new products, including a major refresh of open-market standard products. For example, CPG launched multiple new RF front-end and switch

products targeting GPRS, WCDMA, CDMA and WiMAX (with new product launches in fiscal 2009 expected to be up by 50% over fiscal 2008). MPG released 20 new products and more than 50 derivative products in the December quarter, and is on track to release 350 products (100 new and 250 derivative) in fiscal '09. In particular, MPG expects to benefit from the increasing content opportunity in 3G cellular infrastructure in China, starting in the March quarter.

MPG also anticipates increasing GaN-based revenue in 2009 related to both defense radar applications (after having signed a new government contract for additional funding for GaN process technology development) and CATV line amplifiers

(having received an initial production order from a prominent European customer). RFMD's GaN components are in the final stages of reliability qualification, according to MPG president Bob van Buskirk.

In addition, in the December quarter RFMD launched its first die-shrink GaAs-based products (for the GSM market) and is accelerating implementation of die-shrink technology across the rest of its cellular product portfolio. "Over the coming quarters we expect our reduced-die-sized designs will lower our product cost and improve our return on invested capital by allowing us to capture more revenue from our manufacturing assets," says Bruggeworth.

RFMD launches first fully integrated 5.8GHz transmitter for China's electronic toll collection standard

RFMD has launched what it claims is the first fully integrated 5.8GHz transmitter to comply with China's electronic toll collection (ETC) standard 'GB/T 20851.1-2007: Electronic Toll Collection — Dedicated Short Range Communication (DSRC) Part 1: Physical Layer'.

Available in a 6mm x 6mm x 1mm, 40-pin QFN package at \$5 each in sample and pre-production quantities of 10,000 units, the ML5830 is a low-power, amplitude shift key (ASK) and frequency shift key (FSK) transmitter operating in the 5.8GHz industrial, scientific and medical (ISM) band, and is designed for electronic toll collection applications, including on-board units (OBUs) and road-side units (RSUs).

With the implementation of RFMD's proprietary FastWave microcontroller technology, the ML5830 eliminates the cumbersome mass-production tuning process necessary with competing solutions, it is claimed. FastWave enhances performance through self-alignment of the voltage-controlled oscillator (VCO), filtering and phase-locked loop (PLL) detection and control. It also enables user-specific application configurations through modifications

via a three-wire serial interface to transmitter control, calibration and interface algorithms.

"As the industry's first fully integrated 5.8GHz transmitter to comply with China's ETC standard, the ML5830 significantly accelerates time-to-market for original equipment manufacturers (OEMs) while allowing RFMD to participate in a growing market segment for wireless data," reckons Alastair Upton, general manager of RFMD's Broadband and Consumer business unit. "Also, with the implementation of our proprietary FastWave microcontroller technology, the ML5830 delivers incremental benefits to designers and OEMs in time savings and simplified design," he adds.

"After testing and evaluating the ML5830, we have concluded that its features and functions do comply to the DSRC products according to Chinese National Standard, and do meet China ETC National Standard requirements," says Huang Wei-Ming of Guangzhou ITS Communications Equipment Co Ltd. "Our company is in the process of designing-in the ML5830, and we target to commence mass production with our end product in May."

The ML5830 integrates an up-conversion mixer, a buffer/pre-driver amplifier and an ASK modulator capable of producing a typical output power of +4dBm while consuming less than 36mA of current. The ML5830's unique design provides easy implementation and a minimal external bill-of-materials count as well as improved time-to-market for OEMs, RFMD claims. The FSK mode provides digitally selectable data rates of 1 and 2Mb/s. Importantly, the transmitter also incorporates a fully integrated fractional-N synthesizer (with 30Hz resolution), a VCO and the necessary filtering to digitally switch to a higher-power, higher-data-rate FSK modulation mode, providing the flexibility to meet both current and future needs of the ETC market.

Technical features include:

- a fully integrated digital FIR transmit data filter, which limits occupied bandwidth (OBW);
- three-wire serial control interface;
- integrated power regulation, enabling 2.7–3.6V operation.

Volume production is expected to start in the June quarter.

www.rfmd.com

Anadigics appoints new CEO; Delfassy stays as chairman

GaAs-based broadband wireless and wireline communications component maker Anadigics Inc of Warren, NJ, USA has appointed Mario Rivas as president & CEO.

Gilles Delfassy (interim CEO since the resignation of former president & CEO Dr Bami Bastani in mid-August) continues as chairman of the board. "Gilles has done an outstanding job leading Anadigics through this important transition, putting us on a path to successfully rebound and grow," says Lew Solomon, chair of the governance and nominating committee, on behalf of the board.

"Mario brings the ideal skills and experience to effectively lead this company going forward," says Solomon. Rivas was CEO of fabless semiconductor and software firm Quartics of Irvine, CA, USA from last November. Before that, he was an executive VP at microprocessor



CEO Mario Rivas.

maker AMD, where he led the computing solutions group and was corporate VP of strategy management. Rivas also managed the wireless communications business of Philips Semiconductor as well as its foundry operations, purchasing, and assembly & test. He has also served as a director on the board of Taiwanese silicon foundry TSMC. Rivas spent the bulk of his career at Motorola Inc, with responsibilities in both semiconductor and wireless communications.

As well as an undergraduate degree in electrical engineering from the University of Central America in San Salvador, Rivas holds master's

degrees in semiconductor physics and business from Rensselaer Polytechnic Institute of Troy, NY, USA.

"His extensive experience in the wireless semiconductor industry and his longstanding track record of driving business growth and leading successful operations will be invaluable as we move forward," says Delfassy.

"He also brings deep knowledge of our specific markets and customers... Under his leadership we will accelerate the progress we've made in predictably delivering leading-edge products to our customers," Delfassy adds.

"The company is well known in the industry for its best-in-class power amplifiers, tuners and splitters, and they're in the sweet spot of the large and growing wireless and broadband markets," says Rivas.

www.anadigics.com

Network interface module reference design for cable TV set-top boxes

Anadigics has introduced a cable TV NIM (network interface module) reference design that incorporates its AIT1042 integrated RF tuner (launched last October) and STMicroelectronics' ST0297E QAM demodulator with A/D converter, offering a cost-effective turnkey tuner-demodulator subsystem that eliminates complicated RF front-end design issues.

Jointly developed by Anadigics and STMicroelectronics, the design enables OEMs to deploy the latest RF tuner and QAM demodulator technologies via a ready-to-implement solution that reduces the footprint, cost and development time typically required to bring new CATV set-top boxes and home gateway products to market, says Anadigics.

The full-NIM reference design is engineered to offer a complete and highly optimized hardware-and-software solution that allows cable products to be quickly field tested, qualified, and brought to mass production. The platform comes



The AIT1042 integrated RF tuner.

with full design support, including circuit schematics, printed circuit board layout, bill of materials, and core software.

Set-top box makers can either build on the design or customize it to meet their specific requirements, applying the reference design directly to their main PCB for a 'tuner-on-board' solution. Manufacturers of canned tuners can use the higher levels of integration offered by the design to reduce the number of discrete components in a full-NIM tuner/demod solution. The reference design meets or exceeds the requirements of cable

operators in Japan, China, Europe, and other regions employing ITU-T J.83 Annex A/C and DVB-C bit-streams.

The AIT1042 is developed for use in CATV and HDTV tuners, set-top boxes and PC TV tuner cards. The highly integrated design minimizes board layout sensitivities, cuts the amount of external circuitry required for a complete receiver solution, and condenses board layout space. The RF tuner device includes an upconverter with RF gain control, a downconverter, a digital IF amplifier with gain control, a dual phase-locked loop (PLL) synthesizer, and a voltage-controlled oscillator (VCO) with integrated tank circuits, all in a single 7mm x 7mm x 1mm surface-mount package.

"China, Japan, and other markets require a small, competitive, high-performance solution for CATV set-top boxes," says senior product marketing manager Ray Aubert. "This reference design satisfies that need."

Veeco MOCVD. Non-stop productivity. Non-stop profits.



WORLD CLASS PRODUCTIVITY — HIGH YIELD WITH HIGHEST CAPACITY

Together, we're going places. The soaring demand for HB-LEDs requires MOCVD systems engineered for the highest levels of throughput and uniformity — and that's just what Veeco MOCVD delivers. Our proprietary TurboDisc® technology sets the global standard for non-stop productivity: higher capacity reactors, automated carrier transfers that let you run continuously under vacuum for long periods of time, plus an advanced chamber design and RealTemp® temperature control features to help improve process uniformity. Our K-Series platform is the most modular in the industry, so you can meet changing market demands and protect your capital investment. As you ramp up to your highest level of production, Veeco MOCVD is your first and only stop. For more information, visit <http://www.veeco.com/turbodisc2>

TurboDisc

K465 GaN MOCVD System

Veeco

Solutions for a nanoscale world.™

Impairment charges drive TriQuint into Q4 loss

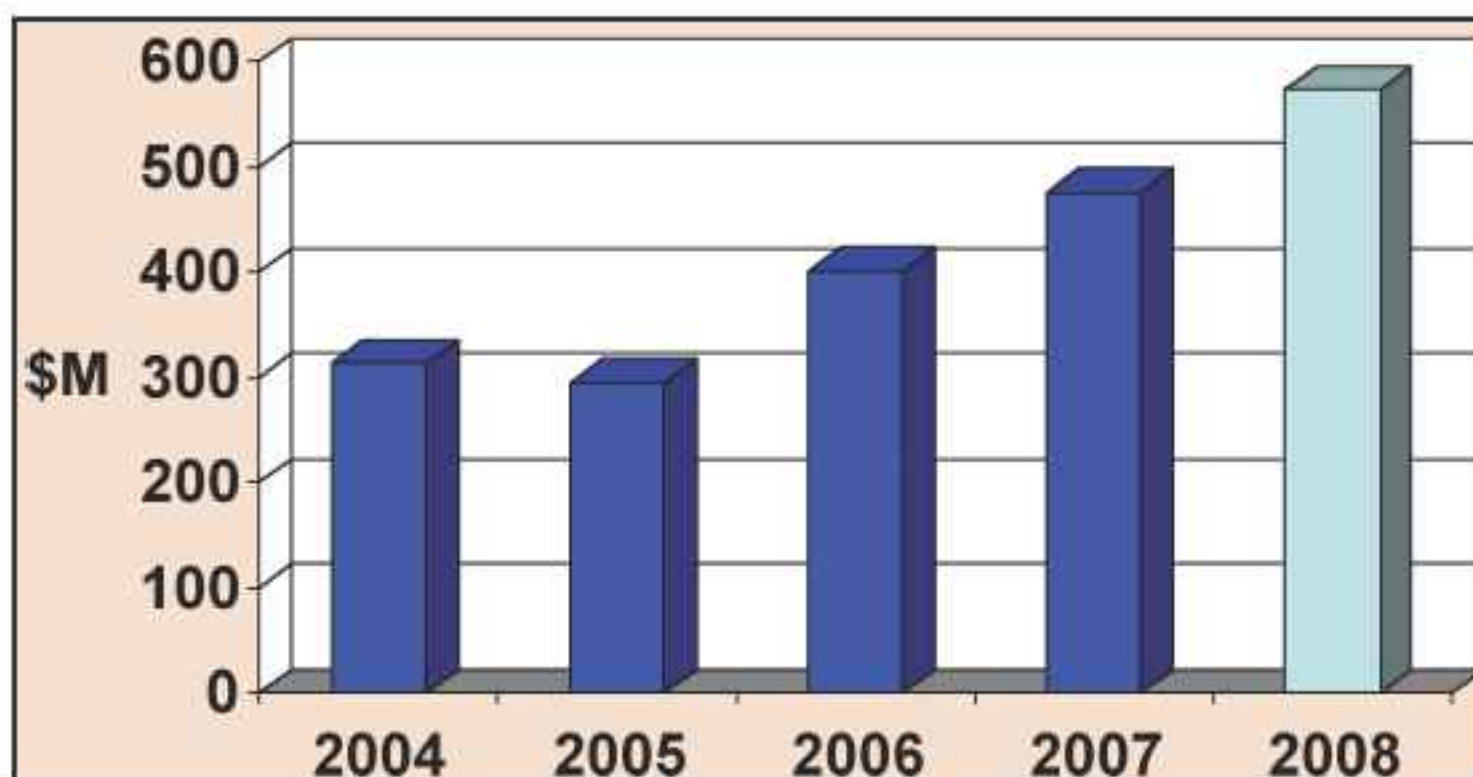
RF product maker and foundry services provider TriQuint Semiconductor Inc of Hillsboro, OR, USA has reported record revenue of \$573.4m for full-year 2008, up 21% on 2007's \$475.8m. Market share gains drove 19% growth in handset revenue (including 254% growth for 3G). This combined with revenue from WJ Communications (acquired in Q2/2008), as well as 51% growth for wireless LAN.

"In 2008 TriQuint delivered another solid growth year in spite of dramatic economic slowing in Q4," says president & CEO Ralph Quinsey.

Fourth-quarter revenue of \$149m, was up 16% on \$128.5m a year ago but down 20% on \$186.4m in Q3 (which was exceptionally strong due to 3G and WLAN product launches). As the quarter progressed, the situation deteriorated, with customers requesting order push-out (largely for handsets and WLAN).

Revenue split by end market was 54% handsets, 33% networks, and 13% military. TriQuint says that this diversity gives it strength in markets that are insulated from the economic slowdown. In particular, Q4 was a record quarter for military business (up 39% on a year ago), favorably impacted by the timing of major programs (including a \$4.5m, two-year contract from the Office of Naval Research). In contrast, the economic downturn and inventory reductions slowed demand abruptly in commercial markets.

The handset industry had been building inventory for the normally strong December quarter, before reacting to the unexpected decline in demand by cutting orders in order to reduce inventory levels. So, despite growing 16% year-on-year, handset revenue was down 21% from Q3's exceptionally high \$102m (which was boosted by a large initial order for a major 3G platform).



TriQuint's annual revenue growth since 2004.

Despite growing 4% on a year ago, networks revenue fell 28% from Q3, due mainly to WLAN (although the long-term WLAN market is robust, reckons the firm).

In addition to normal seasonality, the slowing demand and aggressive inventory reductions throughout the supply chain have reduced factory utilization from Q3's 83% to just 45%.

Due to the lower utilization and higher inventory reserves, gross margin has hence shrunk further, from 36.7% on a year ago and 31.4% last quarter to 30.1% in Q4.

Net loss for Q4/2008 was \$33.8m, compared to a profit of \$11.8m last quarter and \$13.8m a year ago.

However, excluding non-cash impairment charges of \$35.8m (mainly \$33.9m for goodwill and \$1.4m for in-process R&D) and charges from the acquisition of WJ Communications, non-GAAP net income in Q4 was \$6.6m, down from \$17.1m last quarter. This contributed to non-GAAP net income

The slowing demand and aggressive inventory reductions throughout the supply chain have reduced factory utilization from Q3's 83% to just 45%

for 2008 of \$40.2m, slightly above 2007's \$39.5m. During Q4, TriQuint generated operating cash flow of \$33.5m. Apart from capital expenditure of \$16.7m, the firm hence paid down the \$13m

balance on its revolving line of credit, while investments with a maturity of 1–2 years were \$15.9m. Cash, cash equivalents and short-term investments rose by \$5.9m to \$86.1m. "Our healthy cash balance and absence of debt allow us to stay focused on opportunities," says Quinsey.

"Inventory reductions throughout the supply chain will have a dampening impact on Q1 revenue," warns Quinsey. For first-quarter 2009, TriQuint expects handset revenue to fall 10–15% sequentially (to roughly level with Q2/2008), and overall revenue to be down 19–26% on Q4/2008 and almost flat on \$110m a year ago, at \$110–120m (the firm is currently 90% booked to the midpoint of this range). This is down more than seasonally on Q4 due to lower demand, as the industry works through the excess inventory. Cash flow is expected to be roughly neutral.

Utilization will drop further in Q1 due to continued inventory reductions (particularly as a significant amount of WLAN inventory remains in the system through into Q2, compared to channel inventory for handsets having largely burnt off in Q4/2008). Consequently, as announced in mid-December, TriQuint is significantly curtailing spending, involving a reduction in

the temporary workforce, restrictions on new hiring, and cost cutting through process improvements. The firm also targets 2009 capital expenditure to be no more than half that in 2008 (starting with just \$10m in Q1/2009).

Low utilization due to existing inventory levels will put pressure on gross margins in Q1, before improving in Q2, when supply and demand should be better aligned, says Quinsey. Order rescheduling and push-outs have subsided, and normal demand pull is returning. "We saw some improvement in the first part of January compared to the darkest days of Q4/2008," he adds. Quinsey thinks TriQuint can get utilization back up above 60% in Q2.

"Strong design-wins and market share gains position us well for Q2 and beyond," he believes, anticipating a return to profit in Q2 as cus-

The firm also targets 2009 capital expenditure to be no more than half that in 2008

tomers inventory levels return to normal, followed by stronger demand in second-half 2009.

In particular, he expects 3G and smart-phone unit sales to be up in 2009, with TriQuint's product lineup well positioned for these markets. Quinsey believes that the firm has the design wins in place to grow handset revenue in 2009, due to relative strength in GSM phones for emerging markets as well as smart-phones (for which sales volume is expected to grow 7%). TriQuint's product focus for 2009 is to launch a very low-cost transmit module for GSM and to expand product offerings for 3G. "We are continuing to see solid adoption of 3G products within multi-band smart-phones, driving content in excess of \$6 per handset," says Quinsey. TriQuint is also expecting handset design wins to improve WLAN market share, boosting revenue in second-half 2009. In addition, starting as soon as Q2, the firm expects sales of products for base-stations to benefit from China's investment in 3G infrastructure.

Nevertheless, due to the uncertainty caused by the current economy, the firm is not guiding for full-year performance, but it expects 2009 to show moderate revenue growth overall.

We saw some improvement in the first part of January compared to the darkest days of Q4/2008, says Quinsey

The military market currently provides better visibility and stability than TriQuint's other markets. Although Q1 military revenue will be down slightly on a very strong Q4/2008, Quinsey

expects it to grow in the high single or low double digits to a new record for full-year 2009.

"During this challenging business climate TriQuint will deliver innovation and operational efficiency, creating value out of adversity," says Quinsey. "TriQuint will emerge as a stronger company."

www.triquint.com

TRITIUM II PA duplexers shipping in volume for multi-band CDMA

TriQuint has started high-volume shipments of the TRITIUM II PA-Duplexer Module family (its latest RF module for mobile handset makers), which supports the CDMA 2000 (EV-DO) protocol.

The family includes the TQM663029A (PCS band), the TQM613029 (cellular band) and the TQM653029 (AWS band). Together with TriQuint's SP3T antenna switch, GPS LNA/filter module and RF filters, TRITIUM II PA-Duplexers provide a complete front-end solution for multi-band CDMA handsets.

The modules were developed using TriQuint's in-house technology assets, offering performance, cost and supply-chain benefits. Each module contains a transmit SAW (surface acoustic wave) filter, coupler, duplexer, biasing/regulator circuitry, internal matching and

a high-efficiency amplifier (yielding the world's most efficient integrated amplifier solution on the market, the firm claims, based on comparative talk-time measurements). As well as being half the size of solutions consisting of discrete components, the 7mm x 4mm second-generation TRITIUM II PA-Duplexer is also 30% smaller than the previous-generation TRITIUM PA-Duplexer.

According to Strategy Analytics' June 2008 report on power amplifier (PA) market growth, TriQuint's ability to shrink the module size is setting an industry standard, resulting in significant market share gains (nearly doubling in just two years).

TriQuint says that the TRITIUM PA-Duplexer architecture is quickly gaining mass market acceptance. In third-quarter 2008, its WCDMA

PA-Duplexer modules sales tripled over the previous quarter. "The TRITIUM II PA-Duplexers family expands TriQuint's RF leadership in the fast-growing product segment for WCDMA and CDMA phones... Our customers tell us they appreciate the simplicity of using modules over discrete components," says product marketing manager Mike Armentrout. The modules enable lay-out of one phone board to accommodate all tri-band and dual-band CDMA phone combinations. This offers scalability, reduced time to market and a 50% reduction in bill of materials (BOM) count/size versus discrete components, it is reckoned. "These benefits are critical for the next generation of phones, where size and performance are differentiating factors for handset customers," he adds.

Skyworks generates \$75m cash flow amid 10% sales drop

For fiscal first-quarter 2009 (ended 2 January), Skyworks Solutions Inc of Woburn, MA, USA, which manufactures linear products, power amplifiers, front-end modules and radio solutions for handset and infrastructure equipment, has reported revenue of \$210.2m. This is level with \$210.5m a year ago and down a relatively modest 10% on last quarter's \$232.6m (though down on November's original guidance of \$240m).

At the beginning of December, Skyworks lowered its guidance to reflect weakness in the handset market and broader analog markets (driven by customer booking levels pointing to a broad-based slowdown in several end markets). However, it added that its diversification, market share gains and balance-sheet strength were offsetting this, sustaining its strong financial performance during the downturn.

President & CEO David J. Aldrich now adds that, despite significant market weakness, Skyworks has outperformed its rivals during the quarter, boosted by accelerating the energy-management program ramp, analog component product launches, and smart-phone demand (after Skyworks doubled its smart-phone front-end module shipments in fiscal 2008 to more than 40 million units).

During the quarter, Skyworks ramped energy-management solutions in support of Itron, Sensus, Landis & Gyr and others (yielding more than 30% sequential growth for remote meter readers). It also gained traction with 3G base-station solutions at Nokia-Siemens, Huawei and ZTE, introduced the industry's first 4G long-term evolution (LTE), multi-band, multi-mode FDD/TDD front-end modules, and launched a portfolio of SMT discretes for high-performance mixer and detector applications.

After rising for six consecutive quarters, gross margin fell slightly from 40.8% to 39.9% (though still up from 39.1% a year ago). "Our ability to maintain gross margins in

the 39–40% range is driven by the flexibility of our fab-lite model, improved equipment efficiencies at all of our factories, progress on yield improvement initiatives, double-digit year-over-year material cost reductions, and the continued migration to a richer product mix," says VP & chief financial officer Donald W. Palette.

After more than doubling to \$54.8m last quarter, net income has fallen back to \$22m (\$0.13 per share), though still up from \$19m (\$0.12 per share) a year ago.

Nevertheless, during the quarter, Skyworks generated \$75m of cash flow from operations (adding to \$174m in fiscal 2008), retired \$41m of convertible debt (for \$0.93 on the dollar, giving a \$2m gain), and grew cash reserves from \$231m to \$250m.

The ongoing inventory contraction (which began in December) is exacerbating Skyworks' traditional seasonal March-quarter market decline of 15%, says Palette. "As a result, we believe the supply-chain sell-in will decline 20–30% sequentially in the March quarter." Against this backdrop, Skyworks expects its fiscal Q2/2009 (March-quarter) revenue to fall 20% sequentially.

"Though the market environment remains uncertain, Skyworks is taking steps to further differentiate and position our business for the eventual market recovery," says Aldrich. Specifically, after a 'rigorous approach to portfolio management', early in the quarter Skyworks ceased development programs for low-margin 3.5G and 4G cellular transceivers (which comprised about \$30m of revenue last year, but just 1% of December-quarter revenue) and transitioned resources to increase R&D for higher-growth, higher-margin adja-

cent analog markets. Leveraging its analog and mixed-signal integration competences, Skyworks has enhanced its focus within the linear products business by creating two dedicated development and marketing teams (with a much lower R&D burn rate) directed at custom vertical markets or adjacent markets and standard analog component applications (complementing the firm's front-end solutions).

Effective from January, the actions have reduced headcount by 4% (about 150 jobs, mainly in the transceiver development group). This leaves about 3150 (including 1600 in assembly & test in Mexico). Operating expenses should hence be cut by more than \$20m annually, from December quarter's \$56.2m (\$33m R&D) to a planned quarterly OpEx of \$49–50m (\$28m R&D). "These actions will enable us to capitalize on our expanding market opportunity and rich product pipeline while improving operating income," Aldrich adds.

Skyworks has also been executing process qualification for transitioning its fab in Newbury Park, CA from 4" to 6" GaAs wafers. However, while still a core part of Skyworks' long-term strategy for growing margin, this has now been

slowed, delaying 6" production going live from 2009 to early 2010. Meanwhile, the firm has HBT foundry Kopin of Taunton, MA, USA as a partner to ramp 6" externally.

Coupled with completing its OpEx reduction initiative, Skyworks expects that its fab-lite, hybrid manufacturing strategy (whereby partnering with foundry suppliers such as Kopin and Taiwan's WIN Semiconductor allows it to rapidly balance external capacity with market demands) will still yield non-GAAP diluted earnings per share of \$0.10–0.11 in the March quarter.

www.skyworksinc.com

Early in the quarter Skyworks ceased development programs for low-margin 3.5G and 4G cellular transceivers

Transitioning from 4" to 6" GaAs wafers has now been slowed

Jazz named Skyworks' 2008 Foundry Supplier of the Year

Specialty silicon wafer foundry Tower Semiconductor Ltd of Migdal Haemek, Israel says that its wafer foundry subsidiary Jazz Semiconductor Inc of Newport Beach, CA, USA, which focuses on analog-intensive mixed-signal process technologies, has received the 2008 Foundry Supplier of the Year Award from Skyworks Solutions Inc of Woburn, MA, USA.

Skyworks designs and manufactures linear products, power amplifiers, front-end modules and radio solutions based on analog and mixed-signal semiconductors for handset and infrastructure equipment. Jazz says that it was selected as Foundry Supplier of the Year for its improved cycle times and quality, technology innovation enabling key initiatives, strong customer support and improved alignment on business strategies. Skyworks recognized Jazz's dedication to providing process technologies and design enablement capabilities to meet critical time-to-market demands quickly and cost-effectively. Skyworks has collaborated

with Jazz to leverage its specialty process offerings, from 0.5 micron mixed-signal CMOS and 0.35 micron BiCMOS to highly integrated solutions enabled by silicon-germanium (SiGe) and RF nodes to develop several Skyworks products such as transmit/receive modules, power amplifier controllers, switch controllers, linear devices, and wireless LAN solutions.

"We congratulate Jazz on their proven commitment over the past year in providing Skyworks with excellent service and support," says Bruce J. Freyman, VP worldwide operations for Skyworks. "This award also recognizes Jazz's technology leadership and superior design enablement services, which have allowed Skyworks to deliver its complex, innovative products to the market quickly," he adds.

"This award is a significant milestone in our expanding relationship," says Chuck Fox, senior VP of worldwide sales & corporate marketing for Tower and Jazz.

www.jazzsemi.com

www.towersemi.com

Skyworks' FEMs and PAs support Samsung's latest GPRS, EDGE and 3G handsets

Skyworks Solutions Inc of Woburn, MA, USA, which manufactures linear products, power amplifiers, front-end modules and radio solutions for handset and infrastructure equipment, says that Samsung is leveraging its front-end modules (FEM) and power amplifiers (PA) in its latest mobile handsets for general packet radio service (GPRS), enhanced data GSM management (EDGE), and 3G (in particular, UMTS).

Skyworks is also partnering with a broader set of base-band suppliers such as Qualcomm, Broadcom, Infineon and NXP to provide highly integrated front-end solu-

tions for tier-one mobile handset manufacturers such as Samsung.

Samsung is using Skyworks' FEMs and PAs in its latest B3030, B320 and S7330 models. Optimized features include Bluetooth, USB, web browsing, camera, gaming and messaging functionality — included in ultra-compact devices with talk times of up to 7 hours.

"Our front-end module and power amplifier participation in their newest models is a reflection of yet another multimode design-win and increasing market share gains at Samsung and other OEMs," says Liam K. Griffin, senior VP of sales & marketing.

Microsemi claims smallest WiFi PA with integrated 50Ω I/O matching

Microsemi Corp of Irvine, CA, USA, which designs and manufactures analog and mixed-signal ICs and high-reliability semiconductors, has launched what it claims is the world's smallest wireless LAN power amplifier (PA).

With all circuitry packaged in an RoHS-compliant ultra-compact, 2mm x 2mm x 0.45mm 12-lead MLP, the LX5516 (which uses InGaP HBT technology) features integrated 50Ω input and output matching circuits, eliminating the external passive components and additional design work typically required to optimally tune the transmit section of an 802.11/b/g/n design. Also included is a temperature-compensated on-chip output power detector with a wide dynamic range. Output power is about 18dBm for 3% error vector magnitude (EVM). Power gain is 30dB for orthogonal frequency division multiplexing modulation (OFDM).

"By simplifying their design complexity in our ultra-compact package, we enable designers to dramatically cut product size, bill of materials cost, and time to market," says Kang Hee Kim, RF product line manager at Microsemi's Analog Mixed Signal Group.

The LX5516 supports IEEE 802.11b/g/n WLAN applications in the 2.4–2.5GHz frequency range, and further extends the firm's portfolio of WiFi and 802.16e WiMAX and WiBro PAs, which are used in applications including wireless access points and half mini-cards for notebooks and netbooks.

"The LX5516 is ideal for OEMs and module manufacturers designing portable and mobile devices with challenging size constraints," says Kim.

Pricing is \$0.55 in 10,000-unit quantities.

www.microsemi.com

SiGe grows 42% to record revenue and shipments in 2008

SiGe Semiconductor Inc of Andover, MA, USA and Ottawa, Canada, which supplies RF front-end solutions enabling wireless multimedia for consumer electronics, reported another record-setting year of growth in 2008. Revenue was US\$98m (up 42% on 2007's \$69m). Record shipments of more than 120 million units in 2008 (up 43% on 2007's 84 million) took the total to more than 350 million units since the firm began supplying products in 2000.

Spanning the consumer, mobile, and computing marketplace, SiGe's diverse portfolio provides products for wireless local-area networks (802.11b/g/a and Wi-Fi), Bluetooth, WiMAX, GPS, and home entertainment systems. The firm's highly integrated solutions are targeted at original equipment manufacturers (OEMs) such as Apple, Nintendo, Dell, and HP.

"This is the fifth consecutive year that SiGe Semiconductor has achieved annual revenue growth of more than 40%," says CEO Sohail Khan. "We have increased our leadership position in the wireless LAN and WiMAX markets," he claims. "SiGe has made the right investments to keep pace with the demands of the consumer industry while maintaining their no.1 leadership position in the WLAN space," adds Will Strauss, president & principal analyst for Forward Concepts.

In 2008, SiGe expanded its global

operations, earned four industry awards, and launched many new solutions with features for WLAN, WiMAX, and GPS.

Achievements included:

- ranking number 114 fastest-growing firm in North America on Deloitte's 2008 Technology Fast 500 and number 5 on the list of the top 10 wireless solution companies in Canada and number 58 on the Branham300 List of Canada's top 250 technology companies (as published by Branham Group Inc);
- being awarded leading product status in the Electronic Design News (EDN) China Innovation Awards 2008 for the SE2593A (claimed to be the most integrated RF front-end module for Wi-Fi applications that meets and exceeds the IEEE 802.11n specification requirements); and
- winning Electronic Products China's Product Award for the SE4120S, which is claimed to be the smallest Global Navigation Satellite System (GNSS) receiver.

We see significant opportunities in 2009, and plan to continue to expand our market influence and product portfolio to meet increased global demand for wireless multimedia solutions

New 'industry-first' solutions launched in 2008 included:

- the SE2568U high-performance power amplifier (PA), which offers what is claimed to be the smallest solution footprint for embedded WLAN functionality;
- the SE2566U, which is claimed to be the only RF front-end solution to integrate two 2.4GHz fully matched power amplifiers on a single die (and the world's smallest, most cost-effective RF front-end solution for Wi-Fi applications);
- the SE4150L, which is claimed to be the smallest dual-antenna input GPS receiver IC (supporting next-generation, embedded GPS systems);
- industry-leading performance for mobile WiMAX with the SE7262L high-power amplifier, while exceeding the spectral mask requirements outlined in IEEE 802.16e and WiMAX Forum specifications.

Also during 2008, SiGe expanded its facilities globally, with a particular focus on Asia (increasing its footprint in Hong Kong, Japan, and Taiwan). SiGe reckons these new operational bases position it better to support its customer base worldwide.

"Despite the current economic climate, we see significant opportunities in 2009, and plan to continue to expand our market influence and product portfolio to meet increased global demand for wireless multimedia solutions by consumer electronics manufacturers," says Khan.

www.sige.com

Mimix launches 1.6GHz 30W power amplifier module

Mimix Broadband Inc of Houston, TX, USA, which supplies GaAs semiconductors from DC to 50GHz for microwave and millimeter-wave applications, has launched a highly linear, three-stage power amplifier module with 30W of peak-power and 38dB of small-signal gain, designed specifically for satellite communications transmitters with high peak-to-average ratio signals.

Housed in a 40mm x 36mm,

RoHS-compliant, surface-mount, thermally efficient package with a shielded metal lid, the XP9003 operates at 1.6GHz and is fully matched internally, with no external components required. The module offers active bias circuit and control voltage, allowing for current setting and minimizing variation over temperature and voltage.

"The XP9003 offers a great deal of integration, enabling users to

reduce component count, save valuable board space and minimize system size while achieving high linear performance," says product manager Amer Droubi. "In addition, this surface-mount amplifier module has excellent thermal performance due to its high power efficiency combined with a copper heat spreader attached to the bottom of the package," he adds.

www.mimixbroadband.com

Mitsubishi launches Ka-band plastic-package low-noise GaAs HEMT for DBS and VSAT systems

Tokyo-based Mitsubishi Electric Corp has launched the MGF4963BL, a Ka-band plastic-package low-noise GaAs high-electron-mobility transistor (HEMT) suited to low-noise amplifiers in 18–20GHz band direct broadcast satellite (DBS) reception systems and very small aperture terminal (VSAT) systems.

Satellite communications uses mainly Ku-band DBS systems with a 12GHz downlink and 14GHz uplink. With the recent development and spread of high-speed data links and high-definition broadcasting, attention is focusing on Ka-band DBS, which better suits high-speed and high-volume data communication with a downlink of 20GHz and an uplink of 30GHz. Especially in North America, the service area for DBS systems that deliver high-definition TV (HDTV) content is expanding.

In broadcast satellite reception systems, a reception converter

inside the antenna receives 20GHz waves from satellites and converts them into 1GHz band intermediate-frequency waves for the tuner. HEMTs are used in low-noise amplifiers for these reception converters. In the amplifier's first stage, where low noise performance is required, ceramic package HEMTs are typically used due to their high performance, despite their high price. However, with the spread of HDTV content delivered via Ka-band DBS, there is growing demand for first-stage HEMTs with high performance at a lower price.

Due to its plastic package, the MGF4963BL is more cost effective than ceramic-packaged models. Also, with a chip structure optimized to suit 20GHz transmission, it has what is said to be industry-best low-noise and high-gain performance. Compared to the firm's MGF4941AL model for 12GHz (measured at

20GHz), noise figure (NF_{min}) is 0.05dB better and associated gain (G_s) of 13.5dB is 3dB better.

These improvements enable DBS and VSAT reception system makers to use the product not only in the first stage of low-noise amplifiers (where low NF is essential) but also in the second/third stages (where high G_s is important), contributing to cost reduction in DBS and VSAT reception systems.

Also, the MGF4963BL has an industry-standard micro-X package with a footprint that is unchanged from previous models, helping to shorten development time for sat-coms equipment makers.

Shipments begin on 25 February at a production rate of 1 million per month. The sample price is 50 yen.

Mitsubishi Electric aims in future to increase its lineup of plastic-package HEMTs for higher frequencies.

<http://global.mitsubishielectric.com>

III/V-Reclaim 

The Cheapest Way to Excellent Quality.

III/V-Reclaim

Wald 10
84568 Pleiskirchen / Germany
Telefon: + (49) 8728-911093
Telefax: + (49) 8728-911156
E-Mail: sales@35reclaim.com
Internet: www.35reclaim.com

- We recycle your GaAs and InP wafer (all formats and sizes)
- One and double side polished wafer
- Best surface quality for direct use in Epitaxy
- Backside thinning of fully structured wafer
- Thin wafer (60 μ m)
- Single wafer processing possible
- We buy used wafer and sell recycled wafer

Fujitsu sells stake in Eudyna to JV partner Sumitomo Electric

A basic agreement has been reached on the transfer of Tokyo-based Fujitsu Ltd's 50% stake in joint venture Eudyna Devices Inc to JV partner Sumitomo Electric Industries Ltd. The firms say that they will continue negotiations following the basic agreement and plan to complete the transfer of Fujitsu's 29,680,000 shares on 1 April. Eudyna will become a subsidiary of Sumitomo Electric.

Eudyna was established in April 2004 as a 50:50 joint venture of Fujitsu Quantum Devices Ltd (FQD) and Sumitomo Electric Industries' Electron Devices Department (SEI-EDD), consolidating the two firms' compound semiconductor optical and electronic device units. However, due to the accelerated commoditization of high-end products (where the JV has been particularly strong) as well as other changes in the market, there is an increased need to reinforce Eudyna's business foundation, the firms say.

As wireline and wireless networking technologies evolve, systems equip-

ment makers expect suppliers to provide new and expanded product portfolios, and are concerned about the long-term stability of critical components within their supply chain.

Sumitomo Electric says that it is therefore acquiring Eudyna in a strategic move that should increase market share by adding new products and technologies to better serve Sumitomo Electric's large customer base.

Furthermore, the additional R&D resources, together with larger-scale manufacturing operations, should ensure a more competitive and sustainable business for the future, the firm adds. Sumitomo Electric believes that the take-over will provide a synergistic combination of technologies and markets to better support its customers worldwide, as new fiber-to-the-home (FTTH), next-generation network (NGN) and WiMAX services fuel ongoing demand for higher and more flexible bandwidth channels.

The firm reckons that operating Eudyna and Sumitomo Electric under

a unified governance structure should enable more managerial resources to be channeled into Eudyna, while its management base will be strengthened. Sumitomo Electric also believes that, by combining the two firms' management resources and utilizing them effectively, the development and launch of new products should be accelerated and competitiveness in cost, quality and marketing should be enhanced.

Sumitomo Electric reckons that Eudyna should enhance its optical device/transceiver and electronic device businesses, as well as reinforcing the business infrastructure of the whole Sumitomo Electric Group.

Fujitsu says that it plans to maintain a strong business relationship with Eudyna after the stock transfer. Incorporating Eudyna's compound semiconductor products into Fujitsu's range of optical modules and wireless systems should support the expansion of these businesses, the firm adds.

www.eudyna.com

HRL becomes SIA's only compound semi Charter Member

HRL Laboratories LLC of Malibu, CA, USA (a corporate R&D lab owned by The Boeing Company and General Motors) has become the only compound semiconductor fabrication facility to participate as a charter member of the Semiconductor Industry Association (SIA).

Founded in 1977, the SIA unites more than 70 firms that account for nearly 90% of semiconductor production in the USA. Twenty-nine companies currently work with the association as charter members.

The SIA provides domestic semiconductor companies a forum to advance the global competitiveness of the \$118bn US microchip industry. Charter members join the asso-

ciation based on their profits and size (charter membership is the highest in the association), and participate on committees focusing on public policy, technology strategy, workforce strategy, safety and health, among other areas of importance to the industry.

HRL says that it has become a charter member to take part in meetings and voice its opinions on how the USA's Trusted Foundry Program affects the rest of the industry. The lab received its initial accreditation in 2007 as a Trusted Foundry for the Department of Defense from the Trusted Access Foundry Program Office of the National Security Agency. In 2008,

it received its reaccreditation from the Defense Microelectronics Activity, which has since taken over the program.

HRL is one of 19 firms currently accredited by the program, which was established to assess and verify the integrity of the facilities and processes used to design, develop, manufacture, and distribute critical national-security microelectronic components. HRL has served the DoD, US government agencies, and major contractors in providing microelectronics foundry services for military and aerospace applications since 1960.

www.hrl.com

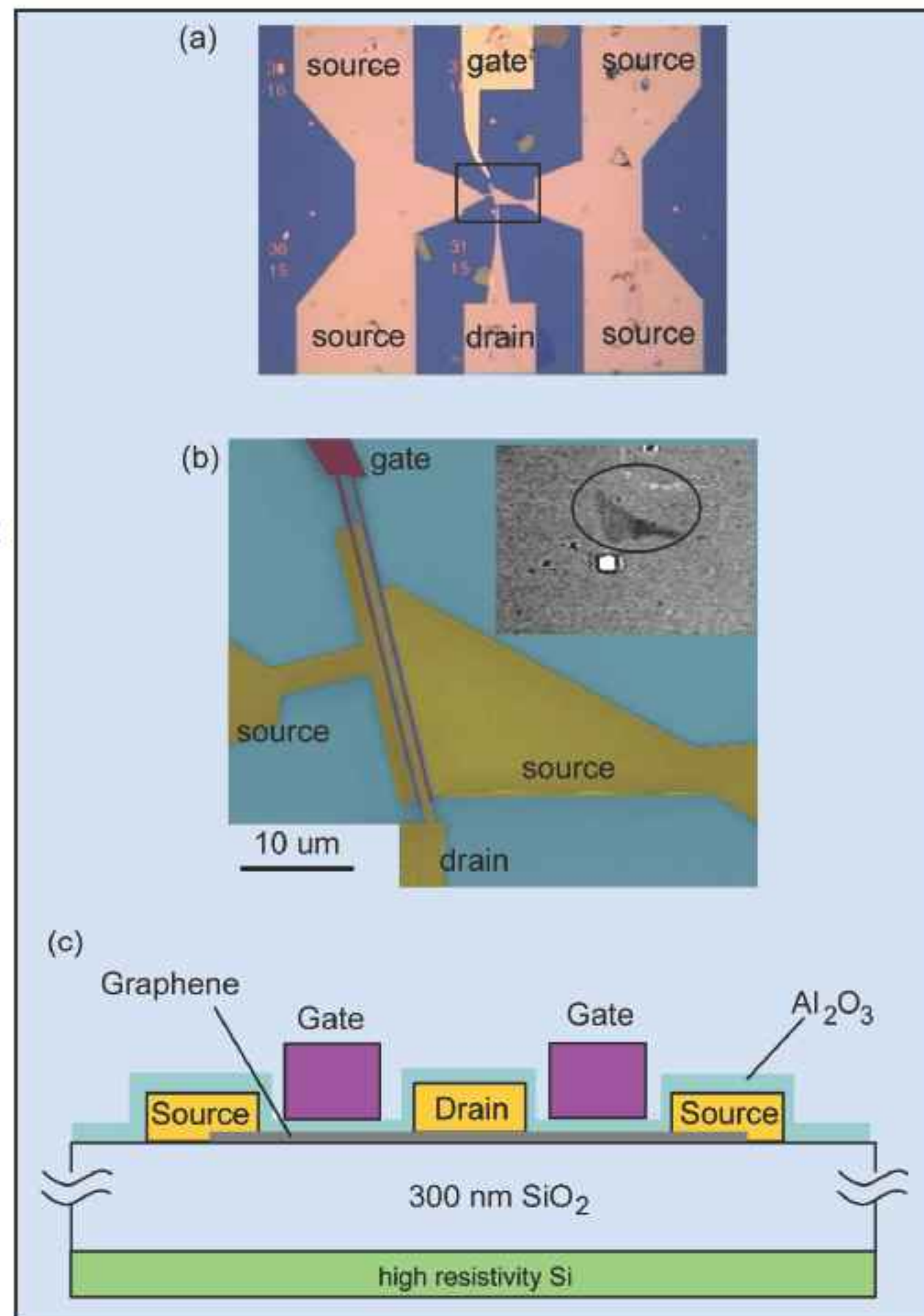
www.sia-online.org

IBM reports record 26GHz cut-off frequency for graphene FET

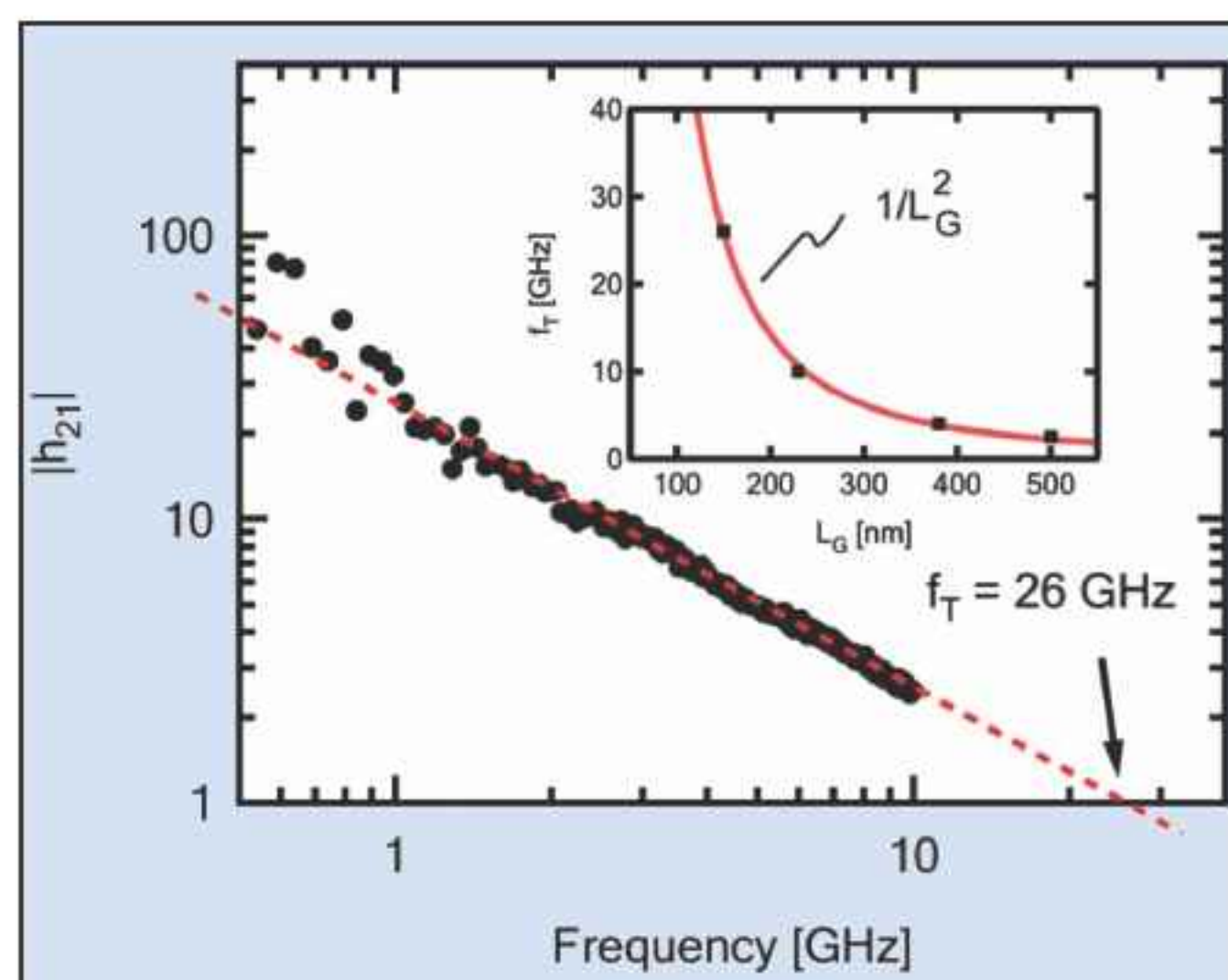
Researchers at IBM's T.J. Watson Research Center in Yorktown Heights, NY, USA have conducted what are claimed to be the first comprehensive experimental studies on the high-frequency response of top-gated graphene field-effect transistors (FETs) for different gate voltages and gate lengths and demonstrated operation at gigahertz frequencies, reaching a record cut-off frequency of 26GHz (Yu-Ming Lin et al, Nano Letters (2009), 9 (1), p422). This is a key milestone for the program 'Carbon Electronics for RF Applications' (CERA) sponsored by DARPA, as part of the effort to develop the next-generation of communication devices.

Graphene is a special form of graphite, consisting of a single, two-dimensional layer of carbon atoms packed in honeycomb lattice. It has attracted attention because its unusual electronic properties could lead to much faster transistors than any transistors achieved so far, offering a possible replacement for silicon. "Integrating new materials along with the miniaturization of transistors is the driving force in improving the performance of next-generation electronic chips," say the researchers.

A transistor's speed of operation depends on the speed at which electrons travel in it and on the size of the device (smaller devices can run faster). A key advantage of graphene lies in the very high electron speed with which electrons propagate in it,



(a) Photo of device layout; (b) (false color) SEM image of graphene channel and contacts (inset: photo of as-deposited graphene flake (circled) before electrode formation); (c) Schematic cross-section of transistor.



Current gain vs frequency of FET with $L_G=150\text{nm}$.

which is essential for achieving high-speed, high-performance transistors. The size dependence has been one of the driving forces for the continuous efforts to shrink silicon transistors.

The team has also established the scaling (size dependence) behavior of the graphene FET's performance for the first time, i.e. that the peak cut-off frequency is inversely proportional to the square of the gate length, rising from 3GHz to a record of 26GHz by shrinking the gate length from 500nm to 150nm.

In addition, whereas most graphene FETs have previously been back-gated (using a 300nm-thick silicon dioxide layer as the gate dielectric), IBM's FET uses a top-gate dielectric structure consisting of aluminium oxide (Al_2O_3), which allows operation at lower voltages.

IBM researchers expect that by improving the gate dielectric materials, the electrical properties can be enhanced and the performance of the graphene transistors further increased. They expect that a gate length of 50nm could yield terahertz operating frequencies. In the next phase, IBM also plans to pursue RF circuits based on these high-performance transistors. "We also plan to demonstrate graphene transistors made by other approaches," adds Yu-Ming Lin, lead author of the Nano Letters paper.

<http://pubs.acs.org/doi/abs/10.1021/nl803316h>
www.research.ibm.com/nanoscience/group.html

CMOS logic 10V-breakdown transistor for power amplifiers

At December's IEEE International Electron Devices Meeting (IEDM 2008) in San Francisco, CA, USA, Japan's Fujitsu Laboratories Ltd and Fujitsu Microelectronics Ltd reported the development of a high-voltage transistor (based on CMOS logic in silicon) that has a high breakdown voltage, suitable for power amplifiers (PAs) used in wireless devices.

Fujitsu claims it is the first 45nm-generation CMOS-based transistor capable of handling 10V output, suiting the requirements for power amplifiers used in WiMAX and other high-frequency applications.

The new technology enables power amplifiers to be formed on the same die as CMOS logic control circuitry to achieve single-chip integration, making high-performance, low-cost power amplifiers feasible.

Conventionally, due to PAs for wireless devices needing high power output at high frequencies, compound semiconductor chips such as GaAs are mounted separate from control circuitry based on a general-purpose CMOS logic chip. If these chips' functions could be integrated onto a single chip, it would enable cost reduction of the overall module and likely speed the adoption of devices for wireless standards such as WiMAX and LTE (long-term evolution), says Fujitsu. There is hence a need for transistors that are compatible with CMOS logic process technology, and which can satisfy the requirements of PAs necessary for WiMAX and other wireless communication standards.

However, the power output required of PAs for use in high-frequency applications such as WiMAX exceeds the breakdown voltage of transistors used with standard CMOS logic processes. Overcoming this while remaining

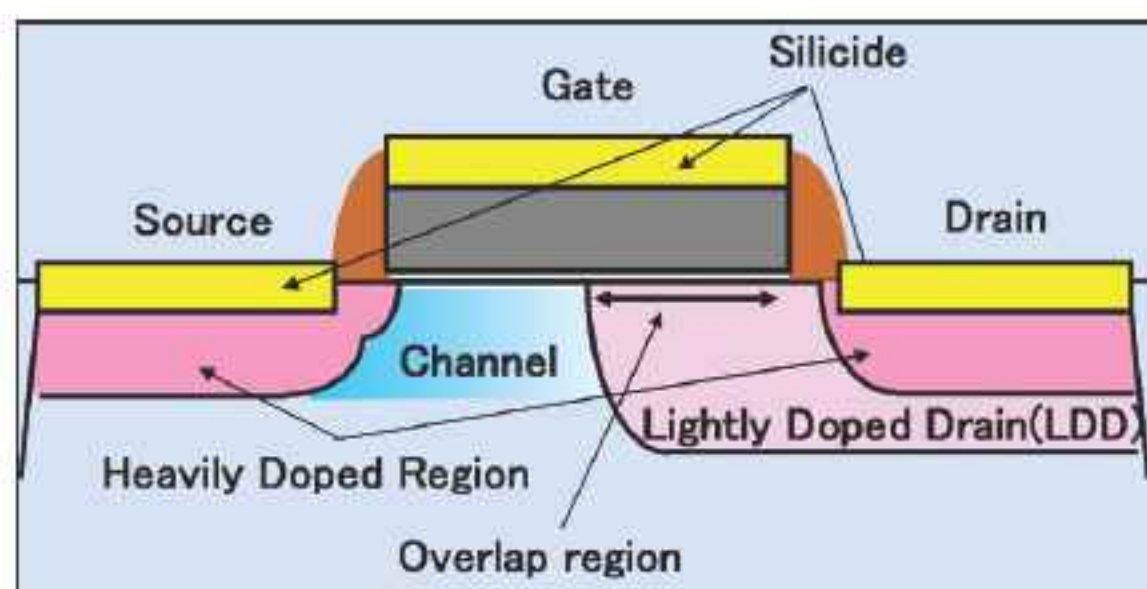


Figure 1. Structure of the new transistor.

compatible with CMOS technology requires an increase in the transistor's breakdown voltage. Since electric fields can lead to transistor failure, this is achieved via a structure that lowers the field around the drain. Also, structures with high breakdown voltages typically raise the transistor's on-resistance, making it hard to obtain satisfactory performance at high frequencies. So, any solution would need to both raise breakdown voltage and avoid increasing on-resistance.

To overcome the above issues, Fujitsu has developed a new transistor structure with the following characteristics (see Figure 1):

- The transistor's drain is surrounded by a lightly doped drain (LDD) region that overlaps with the gate. This lowers the electrical field extending horizontally to the drain as well as the electrical field extend-

ing to the gate oxide layer, raising the breakdown voltage.

- The dopant distribution in the transistor channel follows a lateral gradient. This lowers the density of dopant on the drain side of the channel, limiting the increase in drain resistance (which is the main part of the on-resistance).

It also lowers the electrical field extending horizontally to the drain, raising the breakdown voltage.

The typical method for raising the breakdown voltage of a CMOS transistor has been to widen the gap separating the gate and the drain. The new structure suppresses on-resistance effectively compared to the conventional method, without increasing the gap.

This new structure is also highly compatible with standard transistors with 3.3V I/O circuitry, since it needs only the additional steps of forming the LDD and custom channel regions.

By using a 45nm process to apply the new transistor's technology to standard transistors with 3.3V I/O, Fujitsu reckons it has developed the first transistor to raise the breakdown voltage from 6V to 10V. Regarding features that make it suitable for power amplifiers, output of 0.6W per gate width of 1mm was reached at a maximum oscillation frequency of 43GHz (Figure 2),

giving enough performance for use as a power transistor in WiMAX. The transistor also produced good results in basic reliability testing.

Fujitsu reckons that its new high-voltage transistor technology paves the way for CMOS logic-based transistors with high breakdown voltages for use in power amplifiers. The firm targets single-chip integration of power amplifiers and control circuitry to realize low-cost high-performance power amplifier modules.

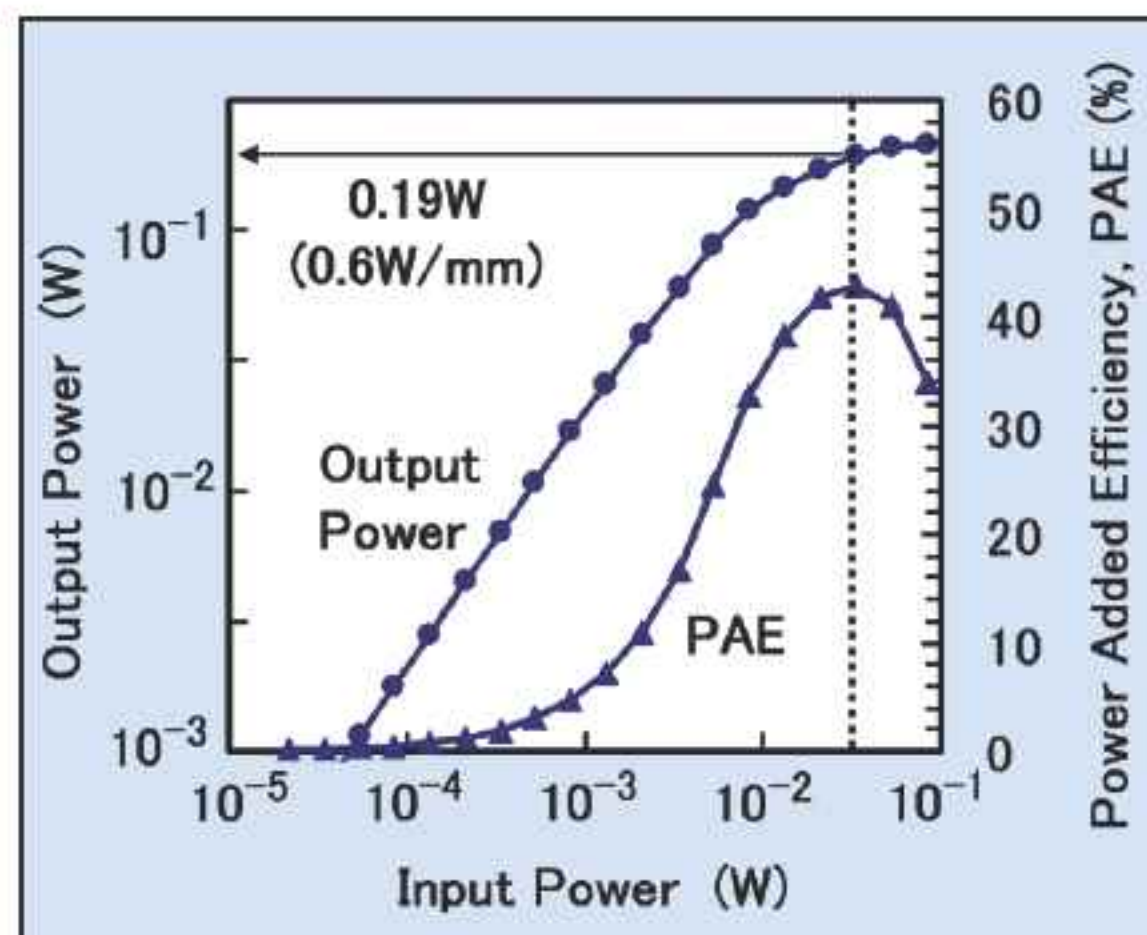


Figure 2. Output and PAE versus input power. <http://jp.fujitsu.com/group/labs>

SAFC Hitech™

Changing the face of materials technology



SAFC Hitech is the new face that's set to transform the materials technology sector.

It sees Epichem, the proven market leader with a 25 year pedigree supplying the compound semiconductor industry, joining forces with the strength of SAFC®. Bringing you a reliable and responsive partner who is now even more prepared to deliver the innovative chemistry and extensive supply chain expertise you need, when and where you need it.

SAFC Hitech offers a global manufacturing and regional support infrastructure that is essential to enable technology and make your ideas happen.

The future of materials technology is revealed. Look to SAFC Hitech today.

SAFC Hitech™
| Enabling Technology

www.safchitech.com

SIGMA-ALDRICH®

IXYS launches GaN RF power amplifier

IXYS Corp subsidiary MicroWave Technology Inc (MwT) of Fremont, CA, USA, which makes GaAs-based devices, MMICs, and amplifier modules for microwave and wireless communications, has launched a family of three high-linearity and high-efficiency RF power amplifiers (PAs) based on gallium nitride.

The power amplifiers (MGA-242740-02, MGA-495922-02 and MGA-4959-02) are targeted at 802.16d/e WiMAX applications and 802.11 WLAN-related applications in three bands: 2.4–2.7GHz, 3.3–3.8GHz, 4.9–5.9GHz GHz. All have a high output power of 10W (40dBm) measured at 3dB gain compression point and a linear power gain of 12–15dB. The PAs have achieved 23% power-added efficiency at 2W (33dBm) linear power (burst power) with 2.5% EVM (error vector magnitude) under the 64 QAM 802.16 WiMAX digital signal modulation scheme.

Linear power efficiency performance is double that achieved with GaAs or silicon LDMOS-based PA counterparts, reckons MwT general manager Dr Greg Zhou. "We have demonstrated the excellent suitability of GaN-based power devices for the applications we target," he adds. "We will continue to leverage the advantages of the microwave/RF GaN power device technology with high reliability and expand the product family to other applications that demand high linear power and power-added efficiency performances, including military and high-reliability applications."

The PAs, biased at 28V on drain with quiescent current of 80–300mA, are available in various packages including low-cost surface-mount 02 packages. The mean time before failure for the GaN-based microwave/RF power amplifiers is more than 100 years at 85°C ambient temperature. Evaluation boards for PAs in 02 packages are available.

www.mwtinc.com

International Rectifier sues ex-CEO for theft of trade secrets

A hearing is expected in February regarding a federal lawsuit in the California Central District Court filed on 8 September by power-management chip maker International Rectifier Corp (IR) of El Segundo, CA, USA against former CEO Alexander Lidow (son of Eric Lidow, who founded IR in 1947 and was chairman until last May).

After starting work at IR in 1977, Dr Alex Lidow was CEO from 1995 until October 2007. He resigned following an investigation by an IR-appointed independent audit committee revealed that April that accounting irregularities (including premature revenue recognition of product sales at the firm's Japanese subsidiary) had cost IR about \$117m, forcing it to restate two years of earnings.

The lawsuit alleges that Lidow engaged in an ongoing criminal enterprise — a racketeer-influenced and corrupt organization (RICO) — by stealing information, intellectual property and technology related to IR's \$60m research program on gallium nitride power devices for power management, which he oversaw as head of the R&D team.

IR has developed its proprietary GaN-on-silicon technology platform over the past five years, but kept it a trade secret to ensure a lead in developing and marketing GaN products. In an article in the Los Angeles Business Journal, IR is quoted as saying that the GaN research was not widely known about even within the firm, and that the researchers were part of a group known only as CSC. The firm announced its GaN power device technology publicly only last September, and demonstrated prototype devices in November.

However, IR claims that Lidow stalled IR from making its GaN technology public in 2007. It claims that instead, in a breach of his duties to act in IR's best interest, Lidow during that time began

secretly recruiting six IR staff (from the R&D team plus senior sales representatives) for his plan to establish his new, El Segundo-based firm Efficient Power Conversion Corp (EPCC, of which he is CEO), with the aim of providing rival GaN-based products. IR also claims that Lidow's actions have undermined its five years of R&D and caused it to lose its competitive advantage.

As well as Lidow and EPCC, fellow defendants include the six former IR staff (Robert Beach, JianJuan 'Joe' Cao, David Tam, Alana Nakata, Stephen Tsang, and Guangyuan Zhao), as well as gallium nitride-based processing service provider GNOEM Systems Inc of Bolder Creek, CA (founded by Beach in 2004), process equipment maker Hermes-Epitek Corp and silicon wafer supplier EPISIL Technologies Inc (both of Taiwan), and MOCVD reactor supplier Aixtron AG.

In response to the lawsuit, in the Los Angeles Business Journal article,

Lidow's attorney Robert Sacks claims that his clients are not using IR's GaN technology

Lidow's attorney Robert Sacks claims that his clients are not using IR's GaN technology, and that EPCC is developing a different semiconductor product.

"There is no substance to the claims," Sacks said. "It's an effort to retaliate further and to cause him harm."

Lidow and the other former IR staff are asking a federal judge to dismiss the RICO allegations. On 22 December, EPCC and Aixtron also presented motions for the lawsuit to be dismissed. The presiding judge Manuel Real was expected to rule on the matter in a hearing to be held in February.

www.irf.com

<http://news.justia.com/cases/featured/california/cacdce/2:2008cv05869/425149>

Cree samples GaN HEMTs for telecom applications

Cree Inc of Durham, NC, USA has announced the sample release of two 120W, highly efficient gallium nitride HEMT microwave transistors for telecom applications such as W-CDMA, LTE and WiMAX.

The firm claims that, due to a unique combination of high RF power density, low capacitance and high-thermal-conductivity silicon carbide substrates, the transistors provide superior performance compared to other technologies such as GaAs MESFET or silicon LDMOSFET. Two demonstration amplifiers—one for each device—are available for transistor evaluation.

The new transistors consist of single, input-pre-matched GaN HEMT devices providing more than 120W of saturated power in small, industry-standard ceramic-metal packages. The transistors provide what is said to be convenient values of input and output impedances to allow device matching over greater than 30% instantaneous bandwidths.

The CGH21120F is designed to be used primarily in the 1800–2300MHz



Cree's 120W CGH21120F GaN HEMT for the 1800–2300MHz range.

frequency range, while the CGH25120F is optimized for the 2300–2700MHz range, allowing use for DCS (GSM), PCS (GSM & CDMA), W-CDMA, and LTE.

As an example, the CGH21120F provides more than 110W of peak CW power at 70% efficiency with a gain of 16dB when operated at 28V. Under W-CDMA 3GPP stimulus, the transistor provides 25W average power with 40% efficiency in Class A/B operation. This is claimed to be the highest known W-CDMA efficiency from any commercially available transistor at this power level.

Each transistor has demonstrated the performance needed for demanding 3G and 4G telecom networks, says Jim Milligan, director of RF and microwave products. "High efficiency is becoming a driving factor, along with increased emphasis on higher average powers, for multi-channel/carrier applications," he adds.

"These transistors also allow a high degree of digital pre-distortion correction, so that ACLRs (adjacent channel level ratios) of –60dBc can be routinely achieved," says Milligan.

In a recent demonstration, two CGH21120F transistors, in a Doherty amplifier configuration, generated 80W of average power under W-CDMA with a record efficiency of 52%.

The CGH21120F and CGH25120F complement the range of Cree's RoHS-compliant HEMT microwave transistors for WiMAX applications available for 802.11x OFDM average power levels of 2, 4 and 8W.

www.cree.com

High-efficiency 120W GaN HEMT microwave transistor launched for general-purpose military and industrial applications

Cree has announced the sample release of a highly efficient 120W gallium nitride (GaN) HEMT microwave transistor for general-purpose military and industrial applications (such as electronic warfare, tactical communications, radar, instrumentation and direct video broadcast). Cree claims that the transistor provides outstanding RF power performance over wide instantaneous bandwidths compared to other technologies such as GaAs MESFET or Si LDMOSFET.

The CGH40120F consists of a single, unmatched GaN HEMT die providing a minimum of 120W of saturated output power at 28V, in a small, industry-standard, flanged ceramic-metal package. The transistor's performance has been demonstrated in a number of



Cree's CGH40120F GaN HEMT.

amplifier applications, including a 1200–1400MHz instantaneous-bandwidth reference amplifier that offers greater than 18dB typical small-signal gain, 100W typical CW output power, and typical power-added efficiencies of 75% across the entire band. Similar amplifiers have also been demon-

strated over the 800–1300MHz frequency range with output powers greater than 90W at efficiencies greater than 65%.

"The CGH40120F is an important addition to our general-purpose GaN HEMT product family [available with power outputs of 10W, 25W, 35W, 45W and 90W]," says Jim Milligan, director of RF and microwave products. "This part has been engineered for use in a wide variety of applications, including high-efficiency pulsed modes with duty cycles extending to CW operation," he adds. The transistor's power and efficiency can positively impact system thermal design, cooling costs, and DC power distribution for both current- and next-generation systems, he claims.

'Natural super junction' power device developed by Panasonic

At the International Electron Devices Meeting (IEDM 2008) in San Francisco, CA, USA (15–17 December), Panasonic Corp (Matsushita Electric Industrial Co Ltd) of Osaka, Japan reported R&D results for a gallium nitride-based diode with a new junction structure that it terms a 'natural super junction'. The new GaN diode, which has low operating loss, is applicable to consumer and industrial power switching systems, the firm says.

The junction structure consists of multi-layered GaN-based thin films with different compositions, with each interface producing fixed positive and negative charges due to the material's unique polarization. Due to complete balancing of the fixed charges, the layered structure acts as an insulator at reverse bias, so the breakdown voltage can be increased just by extension of the distance between the two electrodes, says the firm. Increasing the number of layers and hence current channels also effectively reduces the on-state resistance.

The proposed device structure is similar to a super junction in silicon

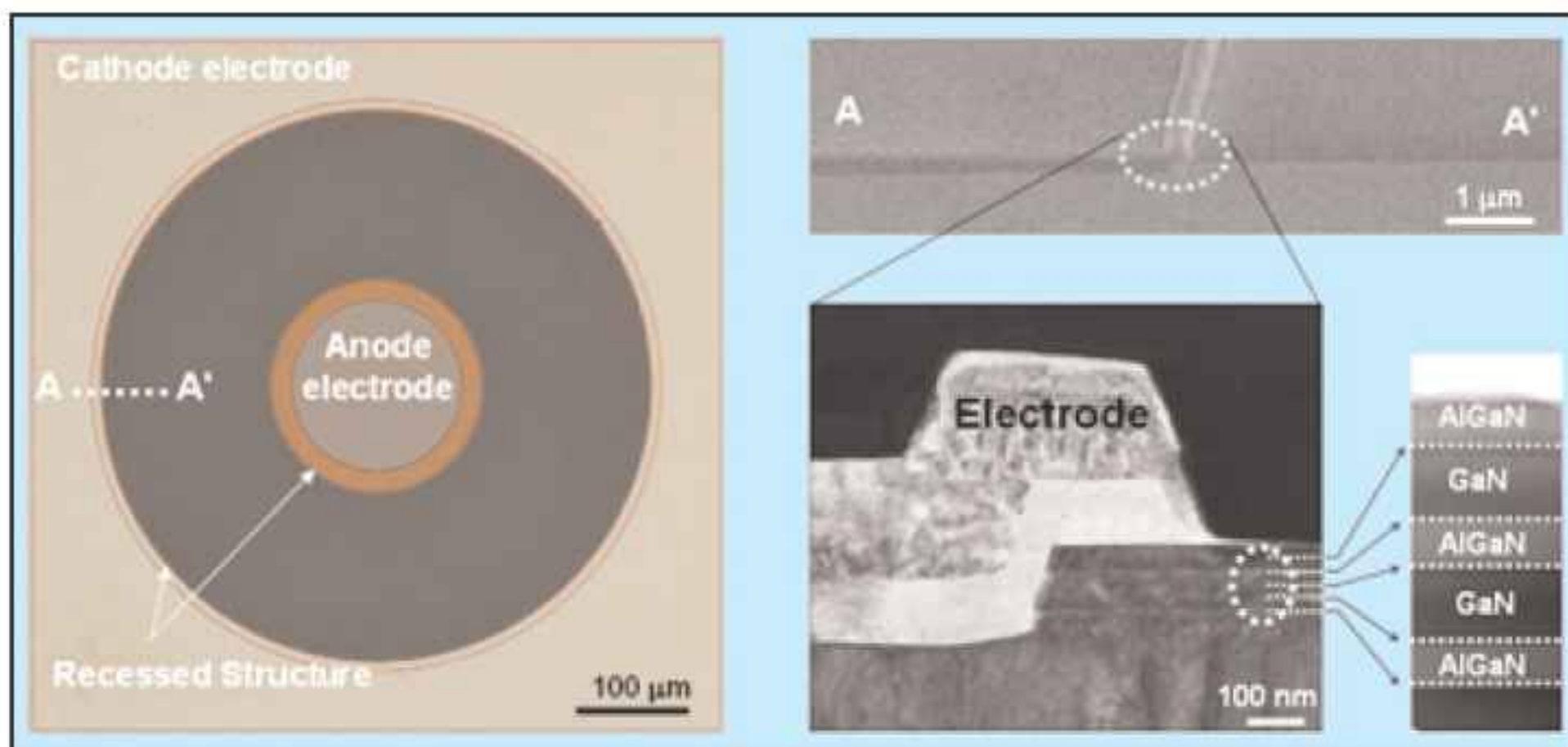


Photo of the chip (left) and cross-sectional view (right) of Panasonic's new 'natural super junction' GaN power device.

devices, in which p-type and n-type layers are stacked alternately. However, unlike the silicon super junction, the new GaN junction structure does not require any precise control of the doping concentration in the layers. Also, high breakdown voltages can be achieved by taking advantage of naturally formed fixed charges, hence the name 'natural super junction'.

The new GaN-based diode exhibits a breakdown voltage of 9400V with a low on-state resistance of

52mΩcm², reaching the predicted limitation of GaN-based semiconductors for the first time, it is claimed.

Also, the firm says that its proprietary technique for forming the electrodes over the recessed structure reduces the contact resistance between the electrodes and the current channels, helping greatly to reduce the on-state resistance.

Applications have been filed for 124 domestic and 80 international patents relating to the technology.

<http://panasonic.co.jp>

Nitronex launches first 200W GaN HEMT power transistor

Nitronex of Durham, NC, USA, which manufactures gallium nitride on silicon (GaN-on-Si) RF power transistors for commercial wireless infrastructure, broadband and military markets, has launched the NPT1007 for applications up to 1.2GHz.

The device consists of two power transistors, of 100W each, in an industry-standard four-lead Gemini package. The small footprint allows easy combination of both transistors into a compact high-power amplifier. After combining losses, the device achieves 200W at 63% efficiency with 18.3dB of gain at 900MHz.



Nitronex's NPT1007 GaN-on-Si HEMT.

The NPT1007 is robust to an output mismatch of 10:1 while in saturation.

"The NPT1007 was developed while working with leading power amplifier designers who needed a smaller,

more efficient solution than was available on the market to date," says director of marketing Ray Crampton.

"The NPT1007 has high gain and efficiency performance from 14–28V, allowing designers to co-optimize power, thermal rise, efficiency and linearity," he adds. "Success with early customers has confirmed that the NPT1007 offers a compelling solution across this voltage range."

The NPT1007 is available in a thermally enhanced ceramic air-cavity bolt-down package.

www.nitronex.com



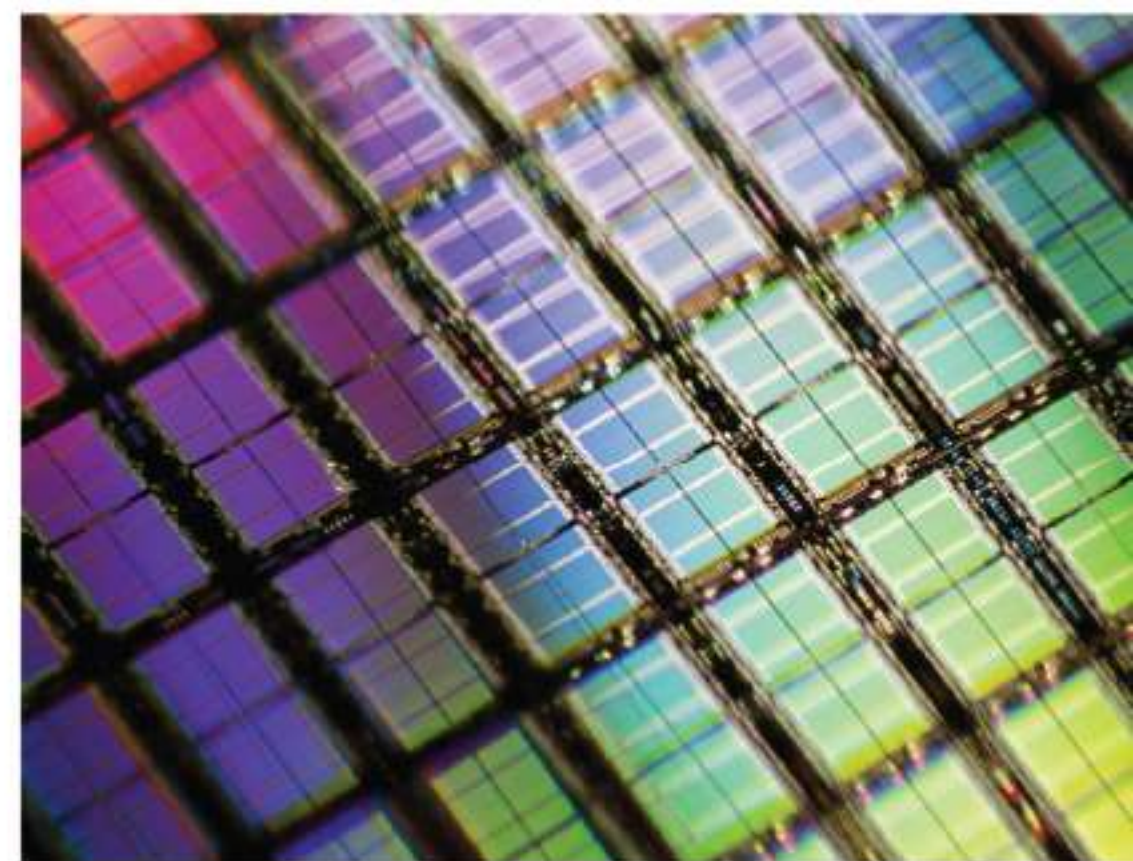
Imagination...

...engineered

Whatever your inspiration, STS takes your ideas further. As a key provider of plasma etch and deposition technologies for over 20 years, STS continues to deliver expert knowledge and advanced thinking to customers based on proven technology.

Whether you are an emerging or established enterprise we offer unrivalled experience, and unparalleled knowledge of our proven technologies turning your innovations into reality. Above all, we listen to our customers. Their success is all the inspiration we need.

To find out more visit: www.stsystems.com



MEMS • COMPOUND SEMICONDUCTORS • PHOTONICS • ADVANCED PACKAGING • DATA STORAGE

THINK • INNOVATE • CREATE



SURFACE TECHNOLOGY SYSTEMS

SAFC Hitech and ASM partner on ALD of strontium- and barium-based ultra-high-k insulators

Equipment and materials maker ASM International N.V. of Almere, The Netherlands and chemical manufacturer SAFC Hitech of St Louis, MO, USA (a business segment of SAFC within Sigma-Aldrich Group) have entered into a certified manufacturer and partnership agreement for certain atomic layer deposition (ALD) source materials for advanced ultra-high-k insulators. The agreement provides certification criteria for the chemical source materials, a license to certain ASM ALD patents, and a partnership for the marketing and further development of these chemical source materials.

The newly developed 'cyclopentadienyl' source materials will enable ALD of next-generation strontium- and barium-based ultra-high-k insulators with dielectric constants exceeding 100. By comparison, the zirconium- and hafnium-based high-k insulators currently in production have dielectric constants of less than 30-40. An insulator with

a higher dielectric constant is expected to allow device makers to produce much smaller capacitors for DRAM memory chips, and microprocessors with smaller transistors. These ultra-high-k materials are expected to be needed for the production of 3x nm node memories, beginning around 2011.

"We see Moore's law being increasingly enabled by the ability to produce and integrate new materials in the chip manufacturing process," says Dr Ivo Raaijmakers, ASM's chief technology officer and director of R&D. "Partnership agreements such as this will allow us to develop new materials much more efficiently, and to prepare the

We are working towards the scale-up for high-volume manufacture of both strontium and barium ultra-high-k source precursors

supply chain for timely introduction of ultra-high-k materials in the manufacturing process," he adds.

"SAFC Hitech has been working closely with ASM's research groups for some time, focusing on evaluation and process development of this class of cyclopentadienyl source materials," adds Dr Peter Heys, SAFC Hitech's R&D director. "This effort has resulted in sources that have demonstrated ALD of high-quality, ultra-high-k films," he adds.

"We are now working towards the scale-up for high-volume manufacture of both strontium and barium ultra-high-k source precursors. The current target is to have product available in quantities up to and beyond 2011, consistent with ITRS [International Technology Roadmap for Semiconductors] requirements and ASM and SAFC Hitech projections."

www.asm.com

www.safchitech.com

University of Helsinki and ASMI renew ALD research agreement

ASM International (ASMI) and Finland's University of Helsinki have renewed their long-term atomic layer deposition (ALD) research agreement for another five years.

ASMI and the University of Helsinki have been pioneers in ALD technology for more than two decades. ASMI's ALD technology stems from its 1999 acquisition of ALD reactor maker Microchemistry Ltd of Espoo, Finland from Neste/Fortum Corp. Microchemistry was founded in 1987 by Dr Tuomo Suntola, who in 1974 invented what was then known as atomic-layer chemical vapor deposition (ALCVD) or atomic-layer epitaxy (ALE), originally for the deposition of zinc sulfide films for electroluminescent displays. Research on ALD processes was started at Helsinki University of Technology in 1982 by professor Lauri Niinistö.

"The cooperation of university basic ALD research and ASMI equipment development has proved very successful in bringing ALD process technology to the semiconductor industry since this project began in 2004," says ASMI's chief technology officer Ivo Raaijmakers. "It has also strengthened our portfolio of intellectual property rights in this process technology platform. Recently, the accord has generated some key innovations in such areas as noble metals and phase-change materials deposi-

The accord has generated some key innovations in such areas as noble metals and phase-change materials

tion, previously thought impossible with ALD, which are currently under study for high-volume manufacturing," he adds.

"In the current global situation of fragmented research funding, this agreement is exceptional both in terms of length and volume," comment professors Markku Leskelä and Mikko Ritala, heads of the ALD research group at the university's Laboratory of Inorganic Chemistry. "We and our students also greatly appreciate the kind of collaboration with industry that takes us to the area where basic and applied research becomes mixed," they add. "The questions we deal with in our research are fundamental by their nature, yet their solutions may find rapid use in future semiconductor devices."

www.helsinki.fi

ASM cuts 200 jobs as it brings forward transfer of vertical furnace assembly & testing to Singapore

On 9 January, equipment and materials maker ASM International N.V. (ASMI) of Almere, The Netherlands announced plans to restructure ASM Europe (ASME) by transferring the remaining manufacturing and operational procurement activities for its vertical furnace product line over the next 12 months to its front-end manufacturing operations in Singapore (FEMS) and cutting ASME staffing in Almere by 200.

The remaining ASME workforce of about 350 will concentrate on vertical furnace R&D and product management, as well as regional sales & service activities for all front-end products. "ASMI will maintain a strong, highly skilled technology workforce at Almere, underscoring our commitment to retaining a strong base in the Netherlands," stresses president & CEO Chuck del Prado.

ASMI expects the proposed measures to have a positive impact on front-end gross margins and to lower the operating break-even level for vertical furnaces by at least 30% (cutting vertical furnace costs by about €7m in 2009). Reorganization charges of €25–30m are expected to be recorded, mainly in 2009, including about €6m in non-cash fixed asset impairment charges.

"Lowered capacity utilization at our FEMS facility — the result of deteriorating global economic and industry conditions — today allows us to execute several steps in our 'April 2008 Roadmap to Front-end Profitability' simultaneously and to accelerate our roadmap," says del Prado.

Five years ago, ASMI established FEMS as its low-cost manufacturing hub for front-end production in

Singapore. The transfer of manufacturing was planned in three stages. Phase 1 includes the transfer of the manufacturing of generic parts and subassemblies (about 70% of the cost of goods sold) for all products: completed by December for three core product groups (vertical furnaces, epitaxy and PECVD) and now starting for its Transistor Products ALD components. The firm is using the current conditions of low production volumes to initiate the next step, involving the transfer of vertical furnace final assembly & testing, concurrent with completing Phase 1 for the remaining product categories.

The new measures should lead to a leaner and more focused, cost-competitive front-end operation, capable of generating higher gross margins with a structurally lower cost base, concludes del Prado.

www.asm.com

Oxford Instruments Etch, Deposition and Growth

For precise, controllable and repeatable etching, deposition and growth of micro and nano structures

Plasma Etch & Deposition

Atomic Layer Deposition

Ion Beam Etch & Deposition

Nanoscale Growth Systems

Hydride Vapour Phase Epitaxy



For more information email: plasma.technology@oxinst.com

Oxford Instruments Plasma Technology Tel: +44 (0)1934 837000

www.oxford-instruments.com/semi

OXFORD
INSTRUMENTS

The Business of Science®

SRA files for bankruptcy

In mid-January, mining company Strategic Resource Acquisition Corp of Toronto, Canada and its subsidiary Mid-Tennessee Zinc Corp (MTZ) of Gordonsville, TN, USA filed for Chapter 11 bankruptcy protection in the USA and ancillary protection in Canada. SRA lists assets of \$1m and debt of \$100m. MTZ lists assets of \$50,000 and debt of \$50m.

In the prior 18 months, SRA invested \$150m in reviving the MTZ zinc and germanium complex, which had operated continuously from 1975 to 2003. Beginning last April, it was expected to ramp to become the largest US zinc producer.

Last July, a scoping study affirmed the viability of recovering germanium and gallium from zinc concentrate. A pilot plant was hence planned for completion by Q1/2009.

However, cash costs per pound of payable zinc have since been well above prevailing commodity prices, rendering the project uneconomic.

Combined with the credit market environment, on 9 October SRA initiated a temporary care and maintenance program of the mining assets (cutting staff accordingly) while it pursued funding and strategic alternatives to enable project re-start when prices improve.

On 31 December, SRA failed to file its audited financial statements for the fiscal year to end September within the required 90 days, and failed to make interest payments on credit notes. Bankruptcy filings aimed to allow the firm to develop a restructuring plan to address debt, capital and cost structures.

The firm says that, while court protection enables SRA and MTZ to continue their day-to-day operations until their status changes, the implications for SRA shareholders are uncertain and will not be determined until the end of the restructuring process and according to the terms of a restructuring plan approved by affected stakeholders.

www.sra-corporation.com

AXT expects fourth-quarter 2008 revenue down 27% on guidance

Based on preliminary results (subject to the completion of year-end closing processes), for fourth-quarter 2008 AXT Inc of Fremont, CA, USA, which manufactures GaAs, InP and germanium substrates as well as raw materials, expects to report revenue of \$15.5–15.9m. This is down about 27% on early November's guidance of \$21.4–21.9m. It is also down 12% on Q3/2008's revenue of \$17.9m (rather than the previously expected rise of 21%), as well as being down on \$17.6m a year ago.

The expected shortfall on guidance is attributed mainly to lower-than-expected demand as a result of the weak economic conditions. As a result, AXT also expects to report net income (loss) per diluted share for fourth-quarter 2008 below the firm's guidance range of between -\$0.01 and \$0.02.

"Customer demand for our products deteriorated more than anticipated in November and December as a result of a weakened demand environment," says chairman & CEO Phil Yin. "Further, we experienced some customer requests for push-outs of orders that had been sched-

uled for fourth-quarter deliveries. We accepted these requests in order to accelerate our customers' efforts to reduce their inventory levels going into 2009," he adds.

"Although we are disappointed with our fourth-quarter revenue expectation in this difficult economic environment, we remain

We experienced some customer requests for push-outs of orders scheduled for Q4 deliveries. We accepted these requests in order to accelerate our customers' efforts to reduce their inventory levels going into 2009

confident in our market position and the continued need for our products to serve the advancing technology requirements in the wireless and photovoltaic markets," states Yin.

AXT will announce its full

financial results for fourth-quarter 2008 on 25 February.

www.axt.com

IQE GaAs substrate deal renewed for \$14.3m

AXT has been awarded a production order worth about \$14.3m for semi-insulating GaAs substrates for the 2009 worldwide substrate requirements of epiwafer foundry IQE plc of Cardiff, UK. The order includes both 4" and 6" diameter semi-insulating GaAs to support IQE's wide-ranging materials needs.

"AXT continues to be a great partner for IQE," says IQE's president & CEO Drew Nelson. Previously, in Q4/2007, IQE placed an \$18.6m GaAs substrate order with AXT for its 2008 manufacturing requirements. "Its strong customer service focus, ample manufacturing capacity and

diverse product portfolio allow us to support diverse and unique requirements of our growing customer base," he adds.

"As the industry continues to move towards larger-diameter substrates, we have made a firm commitment to supporting this transition through targeted capacity increases in our 6" manufacturing capability," says AXT's chairman & CEO Phil Yin.

"We believe we are well positioned to support IQE's substrate needs in the coming year, and we look forward to continued close collaboration between our two companies," he adds.

IQE reports 20% growth in 2008, despite Q4 inventory reductions

Despite the severe global economic downturn in second-half 2008, epi-wafer foundry and substrate maker IQE plc of Cardiff, Wales, UK expects to report full-year 2008 results in line with expectations pre-dating the downturn. Revenue of about £60m is up 20% on 2007, as second-half 2008 almost matched the first half's £30.2m.

Earnings before interest, tax, depreciation and amortization (EBITDA) were £8.4m (more than double that of 2007 as second-half 2008 well exceeded the first half's £3.6m). IQE expects to report a strong conversion of EBITDA into cash flow from operations, reflecting a minimal absorption of cash into working capital despite the continued growth in the business.

The firm also expects to deliver positive free cash flow, even after funding the final phase of a major investment program to commission spare capacity, relocating the Singapore business to a new complex (completed last September), and investing in the development of new product lines such as solar cells and ultra-efficient LEDs. Following completion of this capital program, the investment in infrastructure in 2009 is expected to be minimal, resulting in a significant improvement in free cash generation.

IQE says that it has proactively cut costs to meet challenging market conditions. Following a strong third-quarter 2008, the global economic upheaval affected business during Q4, with a dramatic inventory reduction occurring throughout the supply chains of IQE's major customer base. To ensure that the cost base remained aligned with underlying levels of activity and to protect margins, IQE cut its fixed cost base, partly by consolidating and restructuring some operations.

This resulted in exceptional costs of £1.2m (in addition to the £2.4m for relocating the Singapore plant). About half of the £1.2m is non-cash

items relating to asset write-downs. Overall exceptional charges for 2008 are hence expected to be about £3.6m, with the restructuring completed by the end of 2008.

IQE says that the combination of cost reductions and investment in infrastructure, coupled with developing a range of new products, has positioned it to respond rapidly to improvements in demand in its end markets as and when they arise.

Although the inventory reductions are expected to continue through Q1/2009, IQE sees signs that the markets will begin to pick up during Q2 as inventories stabilize and customer pulls return to actual consumption levels.

During 2009 as a whole, the smartphone/3G wireless market, which has been the major driver for

Markets will begin to pick up during Q2 as inventories stabilize and customer pulls return to actual consumption levels

IQE's revenue growth over the last three years, is expected to be broadly similar in volume to 2008. However, IQE expects to bring additional products to market in 2009 to serve rapidly expanding markets for utility-scale solar power generation and high-performance LEDs, driven by the increasing global focus on energy-efficient devices and systems.

"Our focus on reducing costs and investing in infrastructure and new product innovation has positioned IQE strongly to benefit from any upturn in the semiconductor market and the global emphasis on energy efficiency," says president & CEO Dr Drew Nelson. "We were strongly cash generative in 2008 and expect free cash generation to improve significantly in 2009 now that our infrastructure investment program has been completed," he adds.

www.iqep.com

IN BRIEF

MBE pioneer Cho to join US Inventors Hall of Fame

The US National Inventors Hall of Fame has announced its 2009 class of inductees, which focuses on advances related to or enabled by IC technology (in celebration of the 50th anniversary of the IC).

Included in the 15 inductees is Alfred Y. Cho who, at Bell Labs, developed molecular beam epitaxy (MBE) for the precise deposition of layers to form devices including transistors, LEDs, and lasers.



The other inductees include: Martin M. (John) Atalla, formerly of Bell Labs' (for the MOS transistor); Intel Israel founder Dov Frohman-Bentchkowsky (for EPROM); George Heilmeyer, formerly of RCA Laboratories (liquid crystal displays); Texas Instruments' Larry Hornbeck (for the digital micromirror device—DMD); John Macdougall and Ken Manchester of Sprague Electronics (ion implantation); Caltech's Carver Mead (VLSI method for designing chips); Fairchild Semiconductor and Intel co-founder Gordon Moore (semiconductor production); and Frank Wanlass, formerly of Fairchild Semiconductor (complementary metal oxide semiconductor—CMOS).

Recognized posthumously are Xilinx co-founder, Ross Freeman (field-programmable gate array—FPGA); Fairchild Semiconductor co-founder Jean Hoerni (planar process); Dawon Kahng, formerly of Bell Labs (MOS transistor); Texas Instruments' Gordon Teal (silicon transistor); and Robert Widlar (linear integrated circuits).

The 2009 class will be inducted on 2 May at the annual induction ceremony in Mountain View, CA.

www.invent.org/2009induction

IN BRIEF

SMI licenses SiC MOCVD from Veeco

Structured Materials Industries Inc of Piscataway, NJ, USA, which provides MOCVD systems, components, materials, and process development services, has licensed silicon carbide MOCVD technology (US patent 6,368,404) from Veeco Instruments Inc of Plainview, NY, USA.

"SMI's licensing of Veeco SiC MOCVD technology will greatly further and expand our efforts in helping to commercialize SiC MOCVD production tools," says SMI's president Dr Gary S Tompa.

SMI is developing SiC production tools scaled at sizes for 2", 4" and 6" wafers. The tools are compatible with processes featuring high and efficient deposition rates.

www.structuredmaterials.com

LG orders four GaN MOCVD systems

Veeco says that, in Q4/2008, LG subsidiary LG Innotek Co Inc of Seoul, Korea ordered four further TurboDisc K465 GaN MOCVD systems for making high-brightness LEDs (HB-LEDs) for TV backlighting applications.

"Veeco's MOCVD tools enable a smooth transition to larger wafer sizes, offering a longer capital life along with a proven advantage in productivity," says Dr Steve (Tchanghun) Oh, VP in charge of LED technology at LG Innotek.

"The K465 has been designed to help customers seamlessly transition to larger wafer sizes," says Bill Miller, senior VP, general manager of Veeco's MOCVD operations.

Veeco claims that its TurboDisc K465 GaN MOCVD system is the only production-proven, fully automated MOCVD platform available on the market.

www.lginnotek.com

www.veeco.com/mocvd

Aviza's accelerated cost cutting yields profit, but loss due in March quarter

For its fiscal first-quarter 2009 (to 26 December 2008), etch and deposition equipment maker Aviza Technology Inc of Scotts Valley, CA, USA has reported net sales of \$25.2m, down 29% on \$35.5m last quarter.

To decrease its overall dependence on the falling DRAM market, Aviza has been downsizing its programs, products and spending related to trench capacitors for DRAMs, involving ceasing development of large batch thermal systems.

Meanwhile, last April, Aviza announced a restructuring of its product strategy, served markets and internal operations to refocus on growth market segments with its single-wafer products, including its core strengths in ALD technology for the sub-45nm nodes, and PVD and etch technologies for the 3D-IC, MEMS and III-Vs markets. In particular, during the quarter Aviza's CVD system was installed and qualified at a major LED maker in Europe. Of total sales, as much as 44% came from Europe and 33% from Asia-Pacific, and just 23% from North America. This "validates our strategy of serving our markets with differentiated and cost-effective systems," says president & CEO Jerry Cutini.

Aviza cut 18% of its staff and contractors last year and about 90-110 more in the December quarter. "We have made good progress in reducing our breakeven by accelerating cost reductions," says Cutini. Operating expenses have been cut from \$16.6m last quarter to \$11.8m (including a one-time restructuring charge of \$1.2m due mainly to an impairment of demonstration lab equipment). Operating loss has been more than halved from \$3.6m last quarter to \$1.5m.

Gross margin rose from 36.5% last quarter to 41%. Net income was \$1.3m versus a loss of \$3.1m. Aviza also gained \$3.6m from the dollar's strength against foreign currencies (mainly the British pound).

Adjusted net income was hence \$4.9m, up on an expected \$1-4m and an improvement from \$0.9m last quarter and a net loss of \$5.8m a year ago. Nevertheless, cash and cash equivalents have fallen further from \$14.9m last quarter to \$6.7m.

December-quarter results reflect ongoing efforts to improve financial performance in the face of an extremely challenging macroeconomic environment with no visibility into the buying cycle of Aviza's customer base, says Cutini.

Fiscal second-quarter 2009 (ending 27 March) will continue to be challenging as Aviza again faces an unpredictable environment for orders, says Cutini. On the basis of continued weakness in customers' demand, the firm expects net sales of \$13-18m (down by 30-50%), with an adjusted net loss of \$1-5m. "I do not expect the semiconductor market to stabilize for quite some

We anticipate further restructuring charges in the March quarter, warns Cutini

time. However, I am optimistic that the markets we serve will continue to purchase our systems, albeit at a reduced rate from pre-

vious quarters," he adds.

"As we continue to size the company appropriately, we anticipate further restructuring charges in the March quarter," warns Cutini. Aviza will continue to institute shut-down days at varying times and locations. US staff are required to take off one Friday every two weeks (amounting to a pay cut of about 10%) and similar cuts are taking place internationally. Board members and senior management have accepted a 20% cut in fees and salaries.

In early January, Aviza said that it had engaged Needham & Company to help to evaluate strategic options, including partnering, financing and business development.

www.aviza.com

Riber grew 13% in 2008, driven by production MBE reactors

Riber S.A. of Bezons, France, which manufactures molecular beam epitaxy (MBE) systems as well as evaporation sources and effusion cells, says that, for 2008, its consolidated revenues totaled €19.2m, up 13% on 2007's €17m. This follows sales of just €5.2m in first-half 2008 (in late September, Riber acquired Oxford Instruments Plasma Technology's MBE business, whose average turnover in recent years has been about €1.2m).

In 2008 an 11% decline in European revenue was offset by strong growth in Asia (up 33%) and the USA (up 175%). Nevertheless, Europe still represented 47% of total revenue, Asia 42%, and the USA 11%.

In line with guidance, the components and after-sales-service business reported strong growth of 37% from €4.3m in 2007 to €5.9m in 2008.

Machine revenues grew by 5% to €13.3m (16 systems, compared to 12 in 2007). In particular, production machine revenue grew 17% to €5.2m, whereas research machine revenue was stable at €8.1m.

In 2009, the component and after-sales-service businesses should continue to grow, due in particular to the acquisition of Oxford Instruments Plasma Technology's MBE business and the launch of new products, notably for the organic LED screen and copper indium gallium diselenide (CIGS) solar cells markets.

Riber adds that, regarding research machines, the market should remain strong. However, the outlook for production machines remains uncertain during the current economic climate.

Full 2008 financial results will be reported on 11 March.

www.riber.com

Orders ramp for cluster tools

In Q4/2008, Veeco's MBE operation in St Paul, MN, USA received five MBE system orders, extending across its complete product line and spanning users in the USA, Asia and Europe. Also, in the past year Veeco has seen an increase in orders for its multiple growth module cluster tool systems, as well as a record order rate in Q4 and a third consecutive year of market share growth.

The systems are planned for a wide range of R&D applications including emerging material research, LEDs and next-generation devices for the optical and solar markets.

With the rise in next-generation applications requiring incompatible material processing, Veeco says it has seen a ramp in orders due to the architecture of its cluster tool systems, which supports multiple independent growth modules for reliable, efficient automated growth.

www.veeco.com/mbc

MBE SYSTEMS AND COMPONENTS FOR R&D AND PRODUCTION

VERSATILE MBE SOLUTIONS



Compact 21 System

- Very high performance
- Twelve source ports
- Modular and expandable
- Suitable for III-V's, II-VI's, MCT, oxides, spintronics, etc.
- Small footprint
- Low cost of operation

For more information, call: +33 (0)1 39 96 65 00

Email at info@riber.com

or visit our website www.riber.com

INNOVATIVE SOLUTIONS FOR SEMICONDUCTOR INDUSTRY

RIBER

CVD Equipment doubles orders in 2008 to \$29m

CVD Equipment Corp of Ronkonkoma, NY, USA says that orders more than doubled in 2008, from 2007's \$14.4m to \$29m. About half of the orders were related to solar and energy markets, with most incorporating CVD proprietary and/or patent-pending thin-film solutions.

Most of the order growth came from the fields of solar/energy generation and energy saving as a result of the firm's expanded process and equipment solution offerings, which are designed to accelerate the commercialization of such technologies.

Impacted by the downturn in the electronics industry over the last two quarters, orders shrank by 3% for the Conceptronic division (which supplies reflow ovens and rework stations for PCB assembly and

ball-attach ovens for back-end semiconductor packaging). This trend is expected to continue at least through the first two quarters in 2009.

However, orders grew by 146% for the CVD/First Nano division (which makes pilot and production equipment for custom CVD processes, as well as the EasyTube product line for nanowire, nanotube and thin-film materials) and by 58% for the Stainless Design Concepts (SDC) division (which makes ultra-high-purity gas and chemical delivery systems). The order growth is being driven by increased interest in the energy generation and energy savings fields. The firm expects this trend to continue.

The large demand for energy savings/generation materials and products needed to address rising

energy costs is creating a growing demand for manufacturing solutions using thin-film coatings on glass, wafers and other substrates, says the firm. Using the CVD/First Nano Division's application laboratory, it aims to expand the areas where low-cost thin-film manufacturing solutions can be applied and further optimize its technologies for cost and performance. The solar, energy and power semiconductor markets that it is addressing with multiple products have significant growth opportunities for technologies that deliver favorable cost benefits, the firm adds. These fields should benefit further from a renewed drive for energy savings and generation driven by President-elect Obama's administration, it is predicted.

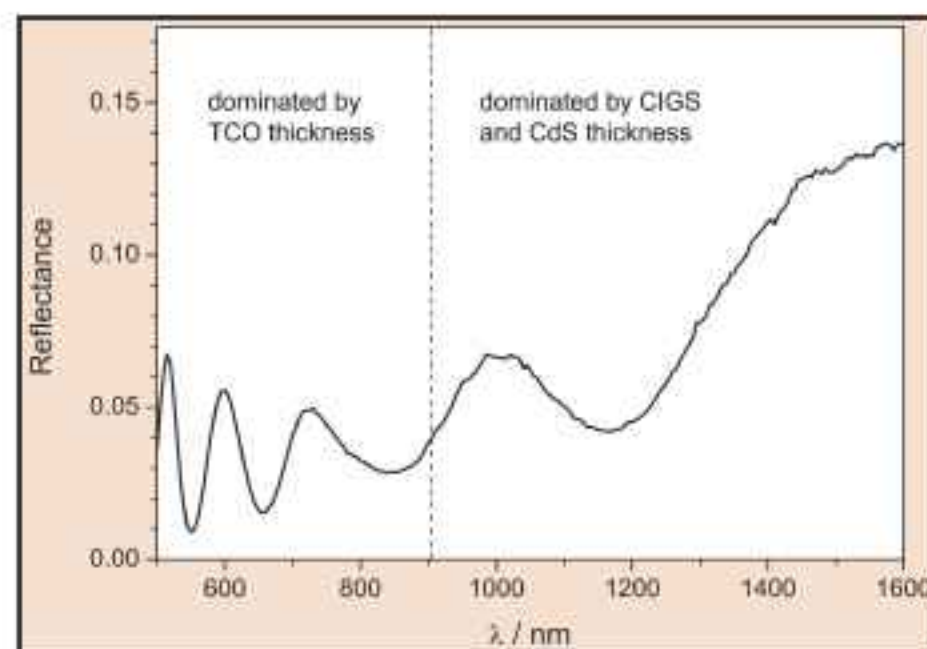
www.cvdequipment.com

LayTec developing in-line monitoring for thin-film PV

LayTec GmbH of Berlin, Germany says that it is developing a product for in-line monitoring of thin-film solar cell production processes. The systems will measure the thickness of all functional layers and provide information on optical properties of the layer materials as well as surface roughness and the formation of interdiffusion regions between layers.

The future of chalcopyrite and II-VI thin-film solar cell production depends heavily on reliable in-line thickness monitoring methods, says the firm. Existing methods are insufficient for two reasons: (i) accurate film thickness measurements by specular reflectance are hindered by diffuse scattering on rough-textured copper indium gallium diselenide (CIGS) or cadmium telluride (CdTe) absorbers; (ii) in high-temperature processes, inter-diffusion of adjacent layers takes place.

For accurate measurements of rough materials, LayTec is developing a new optical head with highly sensitive detectors that suppresses



Typical reflectance spectrum of a Mo/CIGS/CdS/TCO test structure.

these factors. For precise analysis of the spectra, LayTec says that it has extended the conventional thin-film optical equation by correcting terms for texture, light scattering and inter-diffusion effects.

LayTec says that it has already approved its methods in CdTe- and CIGS-based processes, for photovoltaic cells on both glass and metallized polymer foils. It has conducted many tests for CdTe and CIGS absorbers, CdS buffers on absorber layers, and various TCOs, both on substrates and on top of multi-layer stacks.

The new product is designed to be integrated into almost any deposition process, ranging from in-line processes on glass to roll-to-roll processes on polymer or metal foil.

LayTec's Dr Steffen Uredat presented the first results at the 18th International Photovoltaic Science and Engineering Conference (PVSEC 18) in Kolkata, India on 19–23 January. Product release is planned for third-quarter 2009.

● Schenk to head R&D

Tobias Schenk has taken over the management of LayTec's R&D department, which was headed until summer by founder Dr Thomas Zettler (who is now focusing on his position as president).

Schenk joined LayTec eight years ago and has gained extensive experience in hardware and software development. After graduating in Physics from the Technical University of Berlin, Schenk continued his studies at the Berlin School of Economics (last summer gaining a Masters in Business Administration).

www.laytec.de

Aixtron & Ovonyx partner to develop AVD for phase-change memory

Aixtron AG of Aachen, Germany and Ovonyx Inc of Rochester Hills, MI, USA have announced an agreement to cooperate on the qualification of atomic vapor deposition (AVD) process technology to further advance scaling of next-generation phase change memory (PCM) products. As Flash and DRAM both encounter increasing scaling challenges in the face of shrinking chip geometries, PCM is widely considered to be a practical alternative for future commercial, high-volume memory.

"Aixtron's leading market position in thin-film deposition equipment for the semiconductor industry provides an excellent platform for competitive development of new phase-change material by AVD technique for next-generation, high-density confined cell PCM device structures," says Ovonyx's president & CEO Tyler Lowrey. "We look forward to working with Aixtron to develop conformal deposition processes that will further enhance the commercialization of PCM products by worldwide chipmakers," he adds.

"PCM is on the verge of commercial adoption using conventional sputter physical vapor deposition (PVD) techniques, however it is clear that subsequent-generation PCM cells would significantly benefit from AVD of phase-change materials to further increase scalability and accelerate cost reductions," says Dr Bernd Schulte, Aixtron's executive VP & chief operating officer. "We believe that, working with Ovonyx, we can accelerate commercialization of AVD phase-change material deposition into high-volume production and offer chip manufacturers higher productivity and low cost of ownership."

Ovonyx was formed with the charter to commercialize the proprietary phase-change semiconductor memory technology of its largest shareholder, Energy Conversion Devices Inc, which invented and pioneered the development of

phase-change memory technology, gaining a fundamental understanding of PCM operation, including devices, materials, processing, design, modeling, and performance. Ovonyx's PCM technology uses a reversible phase-change memory process that provides for high-performance, dense, array-addressed semiconductor memory technology that can be used as a cost-effective Flash and DRAM device replacement as well as in embedded applications such as microcontrollers and reconfigurable MOS logic.

The nonvolatile PCM technology offers much faster write and erase speeds through its capability for

PCM is on the verge of commercial adoption using conventional sputter PVD techniques... subsequent-generation PCM cells would significantly benefit from AVD

byte-write in either direction (avoiding the need to erase a block to write a bit), higher cycling endurance, and better scaling performance with new generations of photolithography than conventional Flash or DRAM memory. Relative to DRAM, PCM eliminates the refresh power by retaining its memory without power. PCM also has the advantage of a simple fabrication process that allows the design of chips with embedded nonvolatile memory using only a few additional mask steps.

Ovonyx is pursuing commercialization of its array-addressed memory systems through licenses and joint development programs with semiconductor manufacturers including BAE Systems, Intel Corp, ST Microelectronics, Elpida Memory, Samsung Electronics, Qimonda AG, and Hynix Semiconductor Inc.

www.ovonyx.com

IN BRIEF

INER orders MOCVD system for solar cells

Aixtron says that in fourth-quarter 2008 the Institute of Nuclear Energy Research (INER) in Taoyuan, Taiwan ordered an AIX 2800G4 Planetary Reactor MOCVD system, to be delivered in first-quarter 2009 in 15x4-inch wafer configuration (with options to use wafers of up to 8 inch diameter). "Already we have enjoyed a professional and responsive working relationship with the local Aixtron team, which we expect to continue when the new MOCVD tool arrives," says Dr Cherng-Tsong Kuo, project leader of INER's High Concentration Photovoltaic System Research and Development Project.

INER will use the reactor to develop germanium/III-V-based higher-efficiency photovoltaic devices for its High Concentration Photovoltaic (HCPV) project, in which it has already set up a solar power demonstration system with a capacity of 100kW. Construction of a 1MW demonstration system is nearly complete.

"The Institute of Nuclear Energy Research has focussed on the development of solar cell modules for some years now," says Kuo. INER applied technology developed from its research on radiation detectors to the development of III-V solar cells, modules, and solar tracking systems. Working with local companies, it completed a prototype with energy conversion efficiency of over 35%.

With its new AIX 2800G4, INER expects to own the complete turn-key process and beat its own project targets, Kuo adds. Building on this, INER aims to further develop an epitaxy manufacturing process to produce cells with energy conversion efficiency of 45%.

www.aixtron.com

Matheson Tri-Gas expands for advanced semiconductor manufacturing; divests SEMI-GAS line to Applied Energy

As part of its overall growth strategy to meet the demands of advanced semiconductor manufacturing, Matheson Tri-Gas Inc (MTG) of Basking Ridge, NJ, USA plans to expand the capabilities of its Advanced Technology Center in Longmont, CO, focusing on emerging material technologies and process solutions.

"Our overall growth strategy calls for investing in developing cutting-edge molecule technology and delivery systems," says Scott Pufahl, general manager of Matheson Tri-Gas Inc's Equipment Business Group. Matheson Tri-Gas is the largest subsidiary of industrial, specialty and electronics gas supplier Taiyo Nippon Sanso Corporation Group.

Plans include an estimated 25,000 square foot expansion (to be completed by July) of MTG's cleanroom

manufacturing facilities (for building gas and molecule delivery systems) and the R&D facilities (for developing materials technologies, including molecule development, purification and molecule delivery systems).

Also, MTG has divested its SEMI-GAS gas cabinet product line in North America to Applied Energy Systems of Malvern, PA, which manufactures ultra-high-purity gas source and distribution systems. MTG's manufacturing of advanced ultra-high-purity (UHP) products will be relocated to Longmont.

The SEMI-GAS gas cabinet product line will become part of the Applied Energy Systems organization but operate as a separate business unit, focusing mainly on the semiconductor and related industries. The transfer of technology, materials and staff will occur gradually over

the next few months to allow a transition of manufacturing and engineering functions that will ensure orders are delivered on-time and to the same quality.

"This acquisition allows us to expand our product offering while improving economics of scale in a competitive marketplace," says Applied Energy Systems' president & owner Steven R. Buerkel. "It also allows us to grow our Customer Service and Engineering groups for improved product support and technological development," he adds.

Applied Energy Systems will continue to support the customer base with ongoing technical support, manufacturing needs, as well as product enhancement and future development, comments Pufahl, general manager of MTG's Equipment Business Group.

www.mathesontrigas.com

Boosted by AMMS acquisition, Tegal doubles revenue and halves losses, but cuts headcount by another 10%

For its fiscal third-quarter 2009 (to end-December 2008), Tegal Corp of Petaluma, CA, USA, which makes plasma etch and deposition systems for producing MEMS, power semiconductor and optoelectronic devices, has reported revenue of \$4.5m, down 56% on \$10.1m a year ago but up 123% on last quarter's \$2m as systems revenue more than doubled.

"Additional shipments of DRIE (deep reactive ion etch) systems this quarter, so soon after the completion of our acquisition of the DRIE product line from Alcatel Micro Machining Systems (AMMS), is further evidence that our strategy to achieve a leading position among MEMS producers is working," says president & CEO Thomas Mika.

"In addition, our PVD products are increasingly recognized by MEMS producers for their critical role in

the development of advanced imaging sensors and other MEMS devices, a market that is still growing despite the overall weakness in the global economy," he adds.

"Despite completing the integration of the AMMS acquisition during the quarter, we substantially reduced operating expenses and our cash burn rate compared to last quarter," continues Mika.

Operating expenses have been cut by 20% sequentially to \$2.8m (following a 10% cut in headcount from 76, announced last quarter). Quarterly cash burn has been halved from \$2m to \$1m.

Reflecting the continued weakness in the global economy, Tegal is continuing to streamline operations

Net loss has been almost halved from last quarter's \$2.5m to \$1.4m (compared to net income of \$2.8m a year ago). Nevertheless, cash reserves have fallen from \$14m to \$12.7m.

During the quarter, order backlog rose from \$1.1m to \$2.8m. However, this is largely due to the AMMS acquisition. So, reflecting the continued weakness in the global economy, Tegal is continuing to streamline operations and has initiated another 10% cut in headcount.

"We believe these are the steps that are necessary in the current economic climate and will continue to conserve cash, enabling us to protect our balance sheet and improve our competitive position as the economy turns around," says Mika.

www.tegal.com

Lam goes into loss as sales drop 36%; to drop further 38% in March quarter

Reflecting continued deterioration in semiconductor equipment market conditions in early December, for its fiscal second-quarter (ended 28 December 2008), etch and wafer-cleaning equipment maker Lam Research Corp of Fremont, CA, USA has reported revenue of \$283.4m (down 36% on last quarter's \$440m and 54% on \$610m a year ago). Of total revenue, 32% came from the Asia-Pacific, 22% from Japan, 17% from Korea, 17% from North America, and 12% from Europe.

"The weakness in memory pricing, the softening end-user demand environment, and restrictions in the capital markets have caused our customers to dramatically reduce their equipment purchases," says president & CEO Steve Newberry.

On 20 November, Lam announced restructuring activities and other cost-reduction actions targeted at reducing expenses by \$15–20m per quarter. Associated charges are expected to be \$20–26m, comprising \$15–20m of cash charges (related to one-time termination benefits from workforce reductions) and \$5–6m in non-cash charges (for asset impairments). Restructuring should be completed in the March quarter.

Excluding such charges, operating expenses have been cut from last quarter's \$149.9m to \$126.5m, driven by a reduction in employee variable compensation expenses, a reduction in deferred compensation liabilities due to recent stock market declines, and the partial quarter impact of the restructuring activities.

However, gross margin still fell, from 42.3% last quarter to 38.5%, due mainly to reduced manufacturing and field utilization levels and product mix challenges resulting from the reduced business activity. Ongoing net loss was \$11.7m compared to ongoing net income of \$32.6m last quarter.

During the quarter, cash flow from operating activities was about \$39m.

Nevertheless, cash and cash equivalents, short-term investments and restricted cash and investments balances fell from \$1.2bn to \$1.1bn. Deferred revenue and deferred profit balances at the end of the December quarter were \$68.4m and \$54.2m, respectively. The anticipated future revenue value of orders shipped to Japanese customers that was not recorded as deferred revenue was \$8.6m.

"The global semiconductor industry has entered one of the most difficult periods in its history, one that is presenting severe challenges to our customers and thus severely limiting investment in wafer fab equipment," says Newberry. "We expect this challenging environment will persist going into 2009."

For its fiscal third quarter (to end-March 2009), Lam expects revenue to fall a further 38% to \$175m (\pm \$15m). During the quarter, the firm will cut salaries for all staff, ranging from 17.5% for the CEO to 2.5% for its lowest-paid staff.

"Throughout this economic cycle we are maintaining focused expense discipline to preserve a strong balance sheet with healthy cash balances," Newberry says. "While this environment will persist near-term, we remain optimistic about our long-term technology roadmap in etch, clean and other new markets," he adds.

"During the pause in customer spending we are strategically targeting our capital resources to new penetration opportunities, qualifying our next-generation tools and delivering cost-effective technology solutions aimed at reducing our customers' production costs," Newberry says. "Our objective through these actions is to deliver superior value to our customers and emerge from this period of reduced spending well positioned to deliver strong financial and operational performance."

www.lamresearch.com

IN BRIEF

Edwards hires operations and technology director

Vacuum and exhaust-management equipment maker Edwards of Crawley, West Sussex, UK has appointed Ron Krisanda as operations and technology director. Krisanda joins Edwards from Tyco International, where he was president of the Fire and Security business for Europe, Middle East and Africa. Previously, he held senior management positions at Motorola/General Instrument Corp and Multilink Technology Corp.



Krisanda's senior management experience at some of the world's most successful blue chip electronics companies, and his extensive experience in Asia (where many of Edwards' key customers are located), will be valuable to Edwards, says CEO Nigel Hunton. "We have transformed the per-

We have transformed the performance of Edwards during the last 18 months, despite tough market conditions... as we continue to adapt our business to market demands formance of Edwards during the last 18 months, despite tough market conditions, and Ron will play a key role as we continue to adapt our business to market demands so that we emerge from the downturn stronger than before," Hunton adds.

www.edwardsvacuum.com

KLA-Tencor's sales fall 26% as it mulls further cost cuts

Reflecting further deterioration of conditions in the semiconductor and related industries, for its fiscal second-quarter 2009 (to end-December 2008), process control and yield management solutions provider KLA-Tencor Corp of Milpitas, CA, USA has reported revenue of \$397m, down 26% on \$533m last quarter and 38% on \$636m a year ago.

Net loss was \$434m, compared to a profit of \$19m last quarter and \$84m a year ago.

However, excluding the pre-tax impact of a \$435m charge (related to the aggregate impairment of goodwill and purchased intangible assets), non-GAAP net loss was \$20m, compared to a profit of \$55m last quarter and \$138m a year ago.

"Global economic uncertainty, weak consumer demand, and turbulent financial markets have led our customers to scale back pro-

duction operations and reduce capital expenditures. Business conditions in our markets have

deteriorated sharply in recent weeks, leading to unanticipated short-fall in quarterly new orders, revenues and earnings for KLA-Tencor, with weak services revenue a key contributing factor to that result," said president & CEO Rick Wallace in mid-January when announcing revised guidance for the quarter.

"We cannot predict the severity or duration of this economic downturn," adds Wallace. In light of the current economic environment and

KLA-Tencor has been taking aggressive steps to optimize its cost structure and drive structural efficiencies across its organization

its limited visibility regarding future market conditions, KLA-Tencor has been taking aggressive steps to optimize its cost structure and drive structural efficiencies across its organization in order to lower its break-even level (cutting the quarterly operating expense run rate to \$165-170m). In mid-November, KLA-Tencor announced a 15% cut in its workforce by the end of June. "We will continue to evaluate further cost savings as conditions merit," says Wallace.

Meanwhile, the firm aims to maintain a high level of investment in R&D, as well as a focus on customer service.

"We are confident these actions will allow us to sustain our technological and market leadership during this severe downturn and position us well when industry conditions improve, while protecting our balance sheet," concludes Wallace.

www.kla-tencor.com

In-line composition analysis and thickness measurement for CIGS and CdTe thin-film photovoltaics

X-ray fluorescence (XRF) analysis system maker Solar Metrology of Hollbrook, NY, USA has expanded its System SMX portfolio, which provides a production-ready suite of thin-film thickness and composition measurement tools for research and process development, in-process monitoring and post-process quality control.

The new model SMX-ILH (In-Line x-ray Head) is designed for in-line composition and thickness control of copper indium gallium diselenide (CIGS) and cadmium telluride (CdTe) photovoltaic (PV) thin films. It offers a full (600mm x 120 mm) lateral range of measurement and can be inserted into printed, electrochemical and thermal film deposition processes.

SMX-ILH provides process control for active, contact and TCO layers in PV thin-film stacks, and is capable of



The SMX-ILH In-Line Head system.

analyzing rigid glass, flexible stainless steel, and polyimide roll-to-roll substrates. An optional proprietary thermal shield allows film control at panel temperatures up to 300°C.

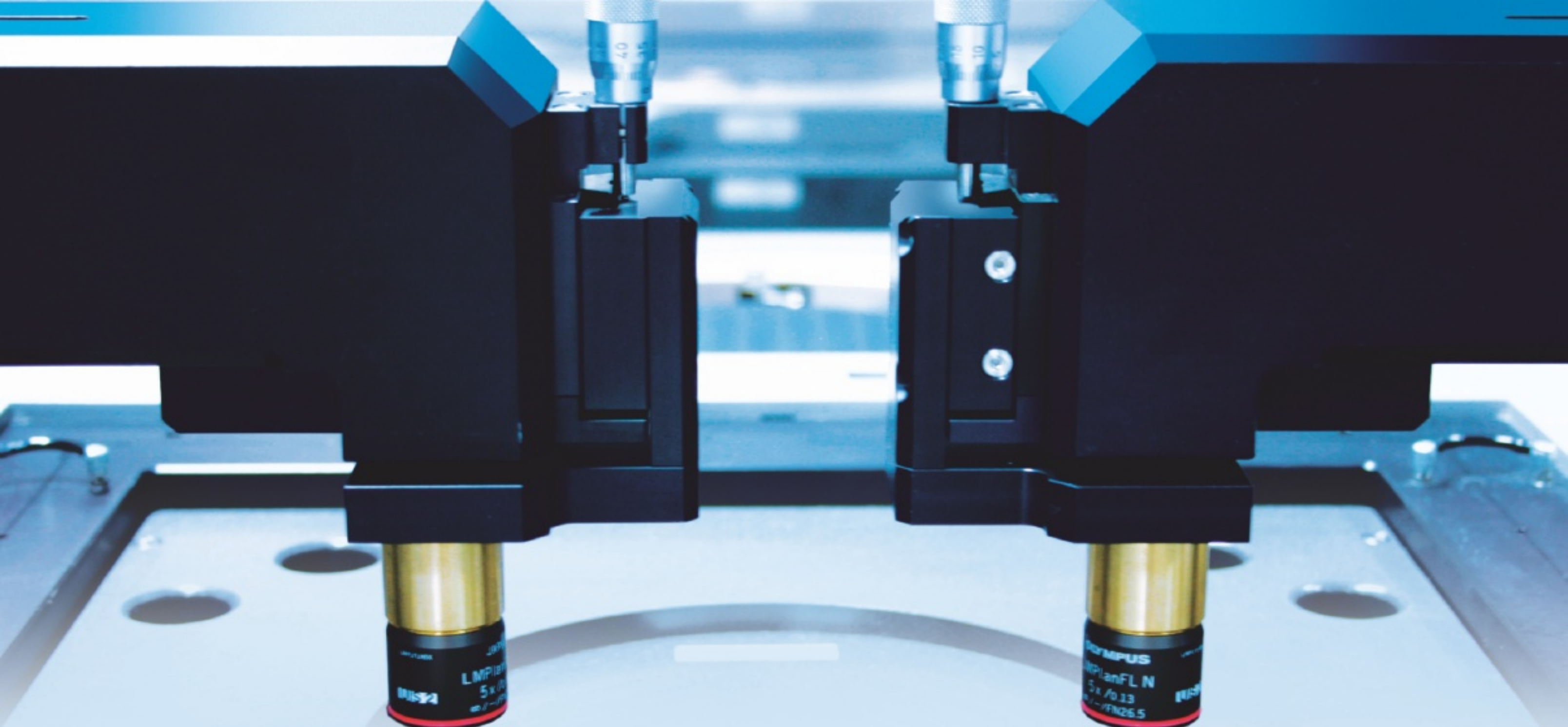
Offering fast and repeatable copper-to-gallium ratio determination and both cross-web and cross-panel gradient analysis capability, SMX-ILH tools enable CIGS and CdTe PV panel manufacturers to

realize significant yield improvements and conversion efficiency gains in production, the firm claims.

Solar Metrology is also offering a 12-page XRF technology guide for CIGS and CdTe PV thin-film composition and thickness measurement, describing typical XRF tool layout and sub-assemblies along with the features and benefits of various methods for solar PV film control.

The guide is designed to inform the user on the basic theory and operation of the systems, and covers topics such as generation and detection columns (tubes, collimation, detectors, processing), algorithmic tools, and user interfaces. It is intended as a quick reference to determine the appropriate insertion points of XRF measurement equipment for specific CIS, CIGS and CdTe PV applications.

www.solarmetrology.com



Solutions for

3D

Integration and TSV



Lithography for 3D-ICs and CMOS image sensors

Wafer-to-wafer and chip-to-wafer bonding

Temporary bonding and debonding for thin wafer processing



www.EVGroup.com

FBH orders Vistec litho system for GaAs and GaN R&D

Vistec Electron Beam GmbH of Jena, Germany has received an order for an SB250 series variable shaped beam lithography system from Ferdinand-Braun-Institut für Höchstfrequenztechnik (FBH) in Berlin, Germany.

FBH explores technologies for microwave and optoelectronic applications in close co-operation with industry, ranging from basic research projects to devices delivered as demonstrators or pilot series to industrial partners.

Installed in FBH's existing process line, the new electron-beam litho system will be used for developing electronic and optoelectronic high-power devices based on both GaAs and GaN. It will also be used as an in-house mask writer.

"The investment is vital for FBH in order to remain competitive," says Dr Krueger, head of its Process Technology Department. "The system's performance, as demonstrated in a series of tests, meets our demands and will provide a solid basis for future R&D of high-value products and services."

The SB250 was designed as a universal electron-beam lithography system for both direct-write and mask-making applications. As a variable shaped beam system operating at 50kV, it can handle a variety of substrate types and sizes using a maximum stage travel range of 210mm x 210mm in fully automated operation. The lithography performance and high throughput open possibilities for a wide range of applications, says Vistec.

"We are very glad to continue our long-standing partnership with FBH," says Wolfgang Dorl, general manager of Vistec Electron Beam. "Vistec is looking forward to contributing with this new, highly flexible lithography system to FBH's strategy to bridge the gap between research and application."

www.fbh-berlin.de

www.vistec-semi.com

JPSA ships laser-based LED lift-off system to LED maker FOREPI

J P Sercel Associates Inc (JPSA) of Manchester, NH, USA, a supplier of UV laser processing workstations, has shipped an IX-260 UV laser LED lift-off (LLO) production system to Formosa Epitaxy Inc of Taiwan (FOREPI), a manufacturer of full-spectrum LED products.

The IX-260 is a flexible, powerful, industrial-grade system designed for high-volume throughput and high-accuracy processing for large field-of-view (LFOV) applications, such as the LED liftoff process.

The system is a UV laser workstation used for delamination (lift-off) of the epitaxial layer from the sapphire wafer. This LLO advance dramatically reduces the time and cost of the LED fabrication process, JPSA claims, allowing the packaging of more high-brightness, high-performance vertical LEDs.

The IX-260 provides the ability to greatly enhance the performance and the volume of LEDs produced, claims JPSA's president Charlie



JPSA's IX-260 UV laser LED lift-off production system.

Cuneo. "This improvement is also cost effective because it reduces the operating time, allowing our customer to generate more high-performance LEDs in an increasingly demanding market," he adds.

www.forepi.com.tw

www.jpsalaser.com

Nextreme ships high-voltage, low-current thermoelectric cooler module

At the Photonics West 2009 event in San Jose, CA, Nextreme Thermal Solutions of Durham, NC, USA, which manufactures microscale thermal and power management products, announced that it has made the first customer shipment of the latest product in its OptoCooler family of thermoelectric coolers, designed specifically for the optoelectronics and telecoms industries.

The OptoCooler HV14 is the first module in a new HV Series of high-voltage and high-heat-pumping thermoelectric coolers that operate at low currents and are optimized for standard circuitry and power requirements, allowing easy integration into existing control systems with compatible voltage and current specifications.

The HV14 can pump up to 1.5W of heat and operates at a maximum voltage of 2.7V and a peak current of around 1A, with a footprint of just 2.8mm². The module can create a temperature differential of up to 51°C between its hot and cold sides, making it suitable for the cooling and temperature control of optoelectronic devices such as laser diodes for transmission modules and photodiodes for sensing.

At the core of the OptoCooler module is Nextreme's thin-film Thermal Copper Pillar Bump technology, which acts as a solid-state heat pump to add thermal management functionality locally on the surface of a chip or other electrical component.

www.nextreme.com/optocooler

Oerlikon sells Esec & etch businesses

Oerlikon Corp AG of Pfäffikon, Switzerland has agreed to sell two of its semiconductor businesses as it focuses on growth areas such as its solar unit (following profit warnings last year due to the effect of the economic downturn on its textile production unit).

The Esec back-end chip assembly equipment business unit is being sold to BE Semiconductor Industries NV (BESI) of Duiven, The Netherlands, which manufactures die sorting, flip-chip and multi-chip die bonding, packaging and plating equipment. Oerlikon also expects to agree a management buyout of the Etch business from Oerlikon Systems.

"Oerlikon continues to fulfil its commitment to streamline its portfolio," says CEO Dr Uwe Krüger. "Oerlikon has significantly reduced its exposure to the cyclical semiconductor market and can focus on its core competence in applications for thin film and coating," he adds.

Founded in 1968, Esec makes die bonding equipment for the semiconductor, telecoms and smart-card industries at its headquarters in Cham, Switzerland, and makes and services wire bonding systems from its Singapore assembly facility.

Esec's sale is motivated by strategic considerations. The back-end chip assembly business does not provide any synergies with the group's core technological competences in the coating/thin-film sector, the firm says. Economies of scale are also only of limited benefit to the group.

In contrast, BESI is an established player in the assembly equipment market, with an existing presence in the sale of die bonding systems, and Esec (which has an estimated installed base of more than 9000 systems) will reinforce and expand its market position. BESI intends to retain the Esec brand name. "Esec will be integrated into the operations of an experienced, strategic partner who will continue to utilize the main technologies and products of Oerlikon Esec, as well as the expertise of its employees," says Krüger.

The transaction is expected to close in April. In parallel, ongoing reorganization measures at Esec will be continued and extended. Of the 280 jobs at the Cham site, about 70 will be affected; in addition, another 80 will be cut from Esec worldwide. An extension of three months in the current short-time work programme has also been applied for, involving 70 staff.

BESI says that it targets synergies from the Esec acquisition by: (i) using BESI's Asian manufacturing operations and global supply chain network; (ii) integrating and coordinating R&D activities with BESI's Datacon die handling activities; (iii) leveraging the respective resources of the combined sales and customer support networks; and (iv) sharing and coordinating global IT and general and administrative functions.

With the management buyout of the Etch business, Oerlikon continues the strategic realignment of its

Oerlikon can focus on its core competence in applications for thin film and coating

Systems business unit to focus on its core physical vapor deposition (PVD) process competence. The business unit will continue to serve select semiconductor and optical disc clients even as it transitions to future applications in 'clean technologies' and 'advanced nanotechnology'.

The sale of the two businesses is accompanied by a continued concentration of Oerlikon group's structure. Due to its increased significance, Oerlikon Balzers is elevated for the first time from being a business unit of the Oerlikon Coating segment to being a segment of its own, while Oerlikon Coating's Oerlikon Systems business unit is absorbed into the Oerlikon Components segment (which no longer includes Esec).

www.oerlikon.com

www.besi.nl

IN BRIEF

Averdung becomes SUSS MicroTec CEO ahead of schedule

Wafer-level engineering test solutions provider SUSS MicroTec AG of Munich, Germany says that Frank Averdung has assumed the position of CEO four months



earlier than the planned date of 1 June, after being appointed to management board last November by the firm's supervisory board.

Until now, Averdung was managing director of Carl Zeiss SMS GmbH of Jena, Germany, which specializes in the inspection and repair of photo-masks. At SUSS MicroTec he will be responsible for sales, marketing, production and corporate strategy.

"His extensive industry and marketing experience will be invaluable to the strategic advancement of the company," says Dr Franz Richter, chairman of the supervisory board.

Christian Schubert, who took temporary office on 2 October, will remain on the management board until the end of his appointment on 31 May and will primarily address the continued optimization of the management of purchasing and procurement as well as materials.

"2009 will not be an easy year for the SUSS MicroTec Group," says Averdung. "The global economic crisis has already left its mark on the semiconductor industry," he adds. "I am nevertheless confident that, with the solid foundation of our leading technological product portfolio and timely introduction of cost-reduction measures, we are well positioned to successfully master this challenge."

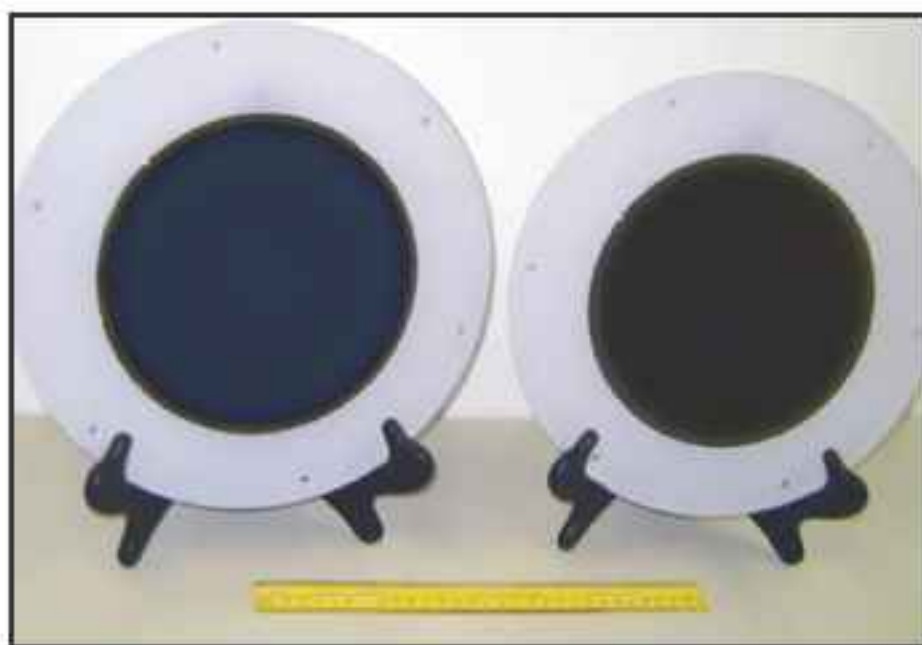
www.suss.com

SMI opens apps lab for MOCVD of ZnO-based films

Structured Materials Industries Inc (SMI) of Piscataway, NJ, USA, which provides MOCVD systems, components, materials, and process development services, has opened its application lab facilities for the MOCVD growth of ZnO-based films for transparent contacts, as used with LEDs and photovoltaics, as well as ZnO films for transparent and power transistors.

SMI has a decades-long history of developing zinc oxide and its alloys and has built capabilities in its in-house applications lab, including four ZnO deposition tools, thermal and laser annealing stations, and other support services. The tools are used predominantly in support of customer development needs and deposition tool purchasers.

In-house tools include platters with sizes of 5–12". Materials properties include n-type conductors doped to a concentration of 10^{20} with



SMI-MOCVD-grown ZnO thin films (conductive or insulating) through 8", now routinely produced with uniformity of better than 3%.

conductivities as low as $5 \times 10^{-4} \Omega\text{-cm}$ or insulating films with conductivities greater than $10^7 \Omega\text{-cm}$. SMI says that it has experience with a wide range of dopants for tuning the energy bandgap, the index of refraction, and the conductivity. Also available are p-type exploration services.

Deposition services include

demonstrated development of alloys of ZnO (Cd, Mg, Se, Te, and S), doping of ZnO (In, Ga, Al, B, N, P, As, Li, Na, K, and Sb, among others) and phosphor or spin materials compositions (Cu, Fe, Co, Mn, Si, Ge, Er, Nb, Eu, and Tb, among others).

Application areas include gallium nitride (GaN) LEDs, especially UV LEDs, where only ZnO alloys will effectively allow ultraviolet light out while maintaining conductivity.

SMI says ZnO conductors are applicable to cadmium telluride (CdTe) and copper indium gallium diselenide (CIGS) photovoltaics. As well as being used in conventional LEDs, ZnO (or its alloys) can also be used as a phosphor layer in a device structure, e.g. in white LEDs.

In addition, ZnO nanowire structures have great potential as sensors and possibly even a new type of laser, says SMI.

www.structuredmaterials.com

SMI selected for ZnO-contacted solar cell properties

SMI has been selected by a University of Oslo-led research group to pursue development of MOCVD for production of ZnO transparent conductive contacts for photovoltaics.

The effort, in part, will use SMI design and modeling work to pro-

duce a viable ZnO deposition tool for University of Oslo researchers to apply in their efforts to develop superior contacts for photovoltaics and will rely on SMI's decades of experience in oxide MOCVD and, in particular, on SMI's demonstrated

ZnO contact work. SMI will also provide initial sample materials to the program.

The project benefits from SMI's proven track record of delivering ZnO MOCVD tools for research and for production.

Cree licenses GaN substrate technology to Mitsubishi

Cree Inc of Durham, NC, USA, which makes LEDs as well as SiC- and GaN-based electronic devices, has entered into an exclusive patent license agreement (subject to some exceptions) with Japan's Mitsubishi Chemical Corp (MCC).

MCC, which develops and commercializes phosphors, GaN substrates, and GaAs and GaP materials for lighting and display-related products, has been given the right to manufacture and sell freestanding GaN substrates and the right to enter into similarly scoped sublicenses, subject to cer-

tain conditions. Over the life of the agreement, Cree will receive a combination of guaranteed payments and royalties on the sale of GaN substrates.

MCC is a well known and respected materials supplier that has both the resources and expertise to take full advantage of Cree's GaN substrate technology, according to Cree's chief operating officer Steve Kelley. "The license agreement is a further indication of Cree's willingness to promote innovation and technological advances in optoelectronic materials, while

realizing additional value from our intellectual property," he adds.

"GaN substrates are important products in the optoelectronics business at MCC," says Yasuji Kobashi, general manager of MCC's optoelectronics business. "By entering into this exclusive license agreement with Cree, MCC will expand the GaN substrate business for optical and electrical devices," he adds. "MCC will be able to accelerate R&D and production for high-quality GaN substrates with different crystalline orientations."

www.m-kagaku.co.jp

BluGlass's LED technology to be distributed in Japan by Itochu Plastics

BluGlass Ltd, which was spun off from Australia's Macquarie University in 2005, has signed a sales and distribution agreement giving the sole rights to market its GaN-on-glass LED manufacturing technology in Japan to Itochu Plastics Inc (CIPS), a subsidiary of Tokyo-based Itochu Corp (one of Japan's oldest and largest trading companies). CIPS specializes in importing and exporting materials for electronic devices, packaging, industrial materials and synthetic resin materials.

The deal follows a visit by CIPS executives in late December to BluGlass's commercial-scale pilot manufacturing plant in Silverwater, Sydney (opened just last July). "We have been talking to CIPS since August and they, together with BluGlass, have successfully introduced BluGlass technology to the Japanese market [one of the world's largest markets for LEDs]," says BluGlass CEO Giles Bourne. BluGlass claims that its unique remote plasma chemical vapor deposition (RPCVD) technology allows the production of gallium nitride based wafers (for LEDs) much more cheaply than existing processes.

CIPS' sales team will promote the RPCVD technology and equipment to demonstrate the core competences of both firms regarding GaN-based wafers for the Japanese LED market, says CIPS' general manager. BluGlass's technology and equipment complement the technology that CIPS already delivers to the Japanese LED market, as well as enabling expansion of CIPS' range of materials for LEDs to leading-edge GaN LED applications, he adds.

Bourne says that BluGlass's ultimate plan is to sell its manufacturing equipment to the Japanese market through Itochu Plastics, involving payments for the plant



BluGlass's RPCVD pilot manufacturing reactor.

equipment as well as ongoing licensing fees. "We are also hoping to negotiate strategic collaborations with Japanese corporations so that we can further develop uses for our technology," he adds.

The deal with Itochu shows that BluGlass is progressing well on its

BluGlass's ultimate plan is to sell its manufacturing equipment to the Japanese market through Itochu Plastics

BluGlass will be seeking to set up similar agreements in different markets around the world.

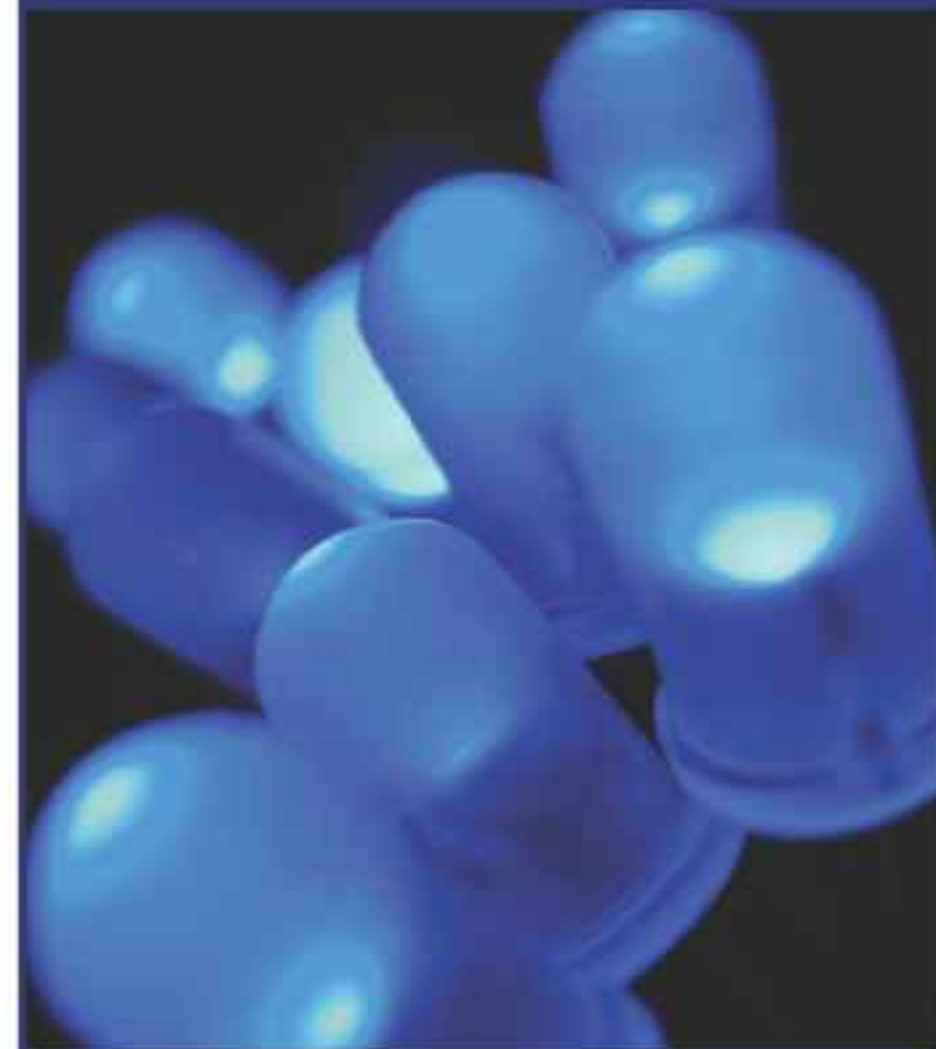
www.bluglass.com.au

www.itc-ps.co.jp

long-stated plan to commercialize its GaN technology, says Bourne. "This is a breakthrough in the commercialization of our next-generation lighting technology," he adds.

Templates for Blue and UV LEDs

GaN, AlN, AlGaIn, InN, InGaIn



World leaders in development of **Hydride Vapour Phase Epitaxy (HVPE)** processes and techniques for the production of novel compound semiconductors

- Templates
- Wafer size: 50mm-150mm
- Research grade InGaIn wafers
- Custom design epitaxy
- Contract development
- Small and large batch quantities available

Wide range of materials (GaN, AlN, AlGaIn, InN and InGaIn) on different sizes and types of substrates (sapphire or SiC)

Contact us now!
welcome@tdii.com
Technologies & Devices International
Tel: +1 301 572 7834



An Oxford Instruments Company



The Business of Science®

www.oxford-instruments.com/tdi2

Bridgelux wins patent for surface-mountable LED chip

Bridgelux Inc of Sunnyvale, CA, USA, which designs and makes power LED chips based on ITO/InGaN for solid-state lighting, has been awarded a US patent for its surface-mountable chip (SMC) LED design.

The firm claims that the SMC architecture fundamentally changes how LEDs will be deployed by eliminating the need for traditional LED packaging. The chip design offers a high-flux-density LED with an ultra-small footprint and thin profile, with the ability to closely pack together multiple chips for increased performance in space-limited applications such as camera flash, LCD display backlighting, and general or specialty lighting applications. The chip design also delivers a surface-mountable 'thin-film' architecture, providing a flat surface for direct deposition of a phosphor layer on the LED die.

The SMC LED design will enable manufacturers to bond the chip directly onto the printed circuit board, eliminating the need for an additional substrate or traditional LED package. The firm reckons that this is the first discrete, thin-film device with two bottom contacts and a flat surface on which a phosphor can be applied. Direct deposition of phosphor film at either the wafer or package level can achieve a quality of white color consistency that no other commercially available LED die platform can currently offer, it is claimed.

With this chip design, non-value-add components or manufacturing processes can be eliminated, gaining the ability to enhance system integration and reduce the cost of the total lighting solution. The chip will deliver greater manufacturing flexibility for high-flux applications

requiring multiple emitters, enable higher flux density for étendue-limited applications, and allow individual chip addressability via the board to which multiple SMCs are attached, the firm claims.

Bridgelux intends to use its SMC design to manufacture LED chips at its facility in Sunnyvale or, where appropriate, through one of its manufacturing partners.

Since Bridgelux was founded in 2002, it has invested in developing its intellectual property (IP) portfolio relating to MOCVD reactor design, epitaxy technologies, LED chip design, manufacturing processes, and packaging techniques.

"The company is aggressively adding to its IP portfolio," says R&D director Steve Lester. Bridgelux currently has over 75 patents filed in the US and over 130 patent applications filed worldwide.

LED arrays introduced for solid-state lighting

Bridgelux has launched an LED array product line to provide high-performance, compact and cost-effective light sources for solid-state lighting (SSL).

The LED arrays have been specifically developed to simplify system-level integration for lamp and luminaire manufacturers, further reducing system cost. Typical applications include task, accent, spot, track, down-light, wide-area and security lighting. This market is estimated by the Next Generation Lighting Industry Alliance (NGLIA) to be \$40bn. Bridgelux estimates that the annual potential for LED lamps and luminaires alone will be about \$10bn by 2012.

The product suite is designed to deliver comparable performance to standard incandescent, halogen, compact fluorescent and high-intensity discharge (HID) lamps. The arrays have an output of 400–2000 lumens and are offered in warm-, neutral- and cool-white color temperatures, allowing opti-



Bridgelux's rectangular- and star-shaped white LEDs.

mization of the light distribution for specific applications. The arrays are RoHS compliant and are tested and binned to an ANSI/Energy Star compliant binning structure.

"Bridgelux's innovative packaging technology not only offers a light source that can be seamlessly integrated into a luminaire, but also delivers increased usable light through a simplified thermal design," says director of marketing Jason Posselt. "These products have been designed with the end application in mind, focusing on delivering both the quantity and quality of light required for general lighting applications together with an ability to significantly reduce the cost of light."

The LED Array technology should enable the optimization of overall system design, reducing SSL manufacturing costs, he adds.

Bridgelux controls all the core LED technologies involved—from epitaxy to packaging—enabling it to deliver light sources that can be integrated easily into lamp and luminaire designs, reducing system cost and accelerating time-to-market, the firm claims. The LED array also improves the light source's lumen per watt per dollar performance.

"This product launch represents a significant milestone achievement in line with the company's commitment to deliver high-quality, energy-efficient lighting solutions," says CEO Mark Swoboda. "Lamps and luminaires that incorporate LED lighting sources will play an increasingly important role in our effort to reduce overall carbon footprint by minimizing energy consumption and eliminating the use of hazardous materials," he adds.

www.bridgelux.com

All-LED headlamps added to new V10 version of Audi R8

German car manufacturer Audi has begun taking orders for the second, 5.2-liter V10-powered model of its top-of-the-range R8 mid-engined sports car, which has become the first car to be equipped as standard with all-LED headlamps.

Launched in January at the 2009 North American International Auto Show in Detroit (for delivery in Germany in second-quarter 2009 at EUR142,400), power output and top speed are boosted from the 420PS and 187mph of the existing 4.2 liter V8-powered R8 model (launched in 2006) to 525PS and 196mph for the R8 V10 5.2 FSI quattro model. The engine is almost identical to that powering the R8 LMS that will race this year at customer level in the GT3 class.

LEDs have been used in production vehicles previously for tail-lights, brake lights and daytime running lights, which become mandatory in the European Union in May 2011 (although drivers in many European countries — such as Italy, Denmark, Finland, Estonia, and Sweden — already must use their lights during the day).

Audi was a pioneer in incorporating LED lighting into cars. Its Pikes Peak quattro concept sports-utility vehicle (presented at the 2003 North American International Auto Show in Detroit, and a forerunner of the Q7 production model) had the world's first fog lights equipped with LEDs (in strips integrated into the broad bumper). However, these LEDs had a luminous efficiency of just 18lm/W (compared to 20–25lm/W for a household light bulb). In late 2003, the 12-cylinder Audi A8 W12 became the world's first vehicle in series production with LED daytime running lights. The first full-LED headlamps appeared on Audi concept cars the Nuvolari quattro at 2003's Geneva



Audi's R8: (inset) close-up of its all-LED headlamp.

Auto Show and the Le Mans quattro (a predecessor to the R8) at the International Motor Show IAA 2003 in Frankfurt.

However, Audi claims that the R8 5.2 is the first car to use LEDs for not only the turn signals, daytime running lights (which now feature 24 LEDs each) and all interior lighting (including the engine compartment and footwells), but also for the high- and low-beam headlights (with 54 LEDs per headlight, supplied by Philips Lumileds).

The LEDs in the R8 have an efficiency of 100lm/W, for the first time surpassing that of xenon headlights (about 80lm/W), which are already four times more efficient than halogen headlights. By 2018, LED technology should be about eight times more efficient, Audi reckons.

So, as well as having a virtually unlimited service life (exceeding the lifetime of the vehicle), LEDs can also reduce fuel consumption. Audi reckons that just one vehicle's conventional low-beam headlights, tail-lights, and license-plate illumination consume 200W, which the alternator must constantly generate. By comparison, just 15W is required to power the Audi A4's LED daytime running lights (equating to a decrease of about 0.2 litres of fuel per 100km and about 4g fewer CO₂ emissions per km). Audi reckons that its models with LED DRLs sold

in 2008 alone consumed — during just their first year in use — about 10 million fewer litres of fuel and emitted about 25,000 fewer metric tons of CO₂.

Audi says that the R8's new LED headlamps have been designed with a color temperature of 6000K, which more closely

resembles daylight and provides greater contrast (less tiring to the eyes in night driving). "A lot of people initially viewed this development [LED lighting] as a mere marketing gimmick," says Dr Wolfgang Huhn, head of Audi's Light and Visibility Department. "Yet everyone who has seen these lights in action is not only astonished by the excellent output but also thrilled with the homogenous distribution of light and the agreeable, daylight-esque colour of the light."

Also, since LEDs can be digitally controlled, future generations of headlights should be able to react to weather conditions, speed, the distance between vehicles, and potentially dangerous objects. "We're striving to create intelligent headlights and tail-lights which 'think' and anticipate in the interest of enhancing a driver's safety and comfort," says Huhn. "For example, there are already high-beam headlights in pre-series development which will allow drivers to navigate roads at night without temporarily blinding oncoming drivers," he adds. "This is made possible by a variable distribution of light: an electronic system continuously calculates the distance to any approaching vehicles to ensure that the road ahead is ideally illuminated at all times — without irritating oncoming drivers."

www.audi.com

Cree's LR24 recessed LED luminaires for Pentagon

Cree says that more than 4200 LR24 recessed LED luminaires are planned for installation in Wedge 5 of the Pentagon in Washington DC as part of a major renovation.

The luminaires have undergone extensive government testing and business-case analysis, including a preliminary Pentagon installation to meter the fixtures and compare the results to fluorescent technology.

This independent analysis demonstrated a 22% reduction in energy usage and improved light quality, as well as a payback of less than four years. The payback analysis considered energy savings, lifetime maintenance savings, savings from reduced load on the HVAC system, and elimination of hazardous waste disposal fees for mercury-laden fluorescent bulbs. Modeling was also performed to determine opti-

mal lighting design — analyzing the light distribution and spacing for superior lighting and efficiency. The Wedge 5 installation should save 140 tons of CO₂ emissions per year.

"The US federal government is taking a leadership role in energy efficiency for federal buildings both through existing mandates, as well as President Obama's American Recovery and Reinvestment Plan, which calls for the renovation of public buildings to make them more energy efficient," says Cree's chairman & CEO Chuck Swoboda.

The LR24 units being used are being bought by the Department of Defense's (DoD) Title III program as a part of its ongoing development program with Cree, and provided to the Washington Headquarters Services (WHS), which is overseeing the Pentagon renovation program.

"The Title III program has long supported the development and deployment of silicon carbide (SiC) substrates and devices for use in high-power RF and power-switching applications for DoD systems," says John Palmour, Cree co-founder & chief technology officer for advanced devices. "The program realized the importance of ensuring a strong domestic supply of SiC substrates and related devices, and the potential growth of solid-state lighting in the US. This Pentagon lighting project is a perfect example of stimulating America's leadership in high-technology manufacturing, yielding unique commercial and defense products while saving energy," he adds. Title III funding was also used to develop the technology in Cree's lighting-class XLamp XR-E LED platform (the light source in the LR24).

Bridgelux and Cree settle patent infringement litigation

Bridgelux Inc of Sunnyvale, CA, USA has reached agreement with rival LED maker Cree of Durham, NC and Boston University to settle their patent infringement litigation and to dismiss all claims and counterclaims.

Founded in December 2002 as eLite Optoelectronics Inc by chief technology officer Dr Heng Liu (formerly of North Carolina State University, Emcore, HP, and AXT), Bridgelux designs and makes power LED chips based on ITO/InGaN for solid-state lighting (using proprietary epitaxy and LED packaging technology with high-volume production capacity in Taiwan).

In September 2006, Cree filed the patent infringement lawsuit in the US District Court for the Middle District of North Carolina, seeking monetary damages and injunctive relief to prohibit Bridgelux from infringing two US Patents:

- 6,657,236, 'Enhanced Light Extraction in LEDs through the Use of Internal and External Optical Elements' (assigned to Cree Lighting Company);

- 5,686,738, 'Highly Insulating Monocrystalline Gallium Nitride Thin Films', relating to devices made using a GaN-based buffer technology, comprising a GaN layer and one or more doped GaN layers.

Subsequently, in October 2006, Bridgelux filed a motion to dismiss the lawsuit, and countered by suing Cree for infringement of Bridgelux's US patent 6,869,812.

Co-plaintiffs in the '738 suit are the trustees of Boston University, who own the patent and license it to Cree exclusively. The patent was invented by College of Engineering professor Ted Moustakas, a founder of the university's Photonics Center in 1994. The patent was also the subject of two suits brought by Cree and Boston against Japan's Nichia Corp and AXT Inc of Fremont, CA, USA, which were settled in 2002 (via a cross-licensing agreement) and 2004, respectively. Bridgelux's Heng Liu was formerly in charge of AXT's LED operations.

As part of the latest settlement, Bridgelux has been granted a

license to the Cree and Boston patents, in exchange for paying a license fee and royalties. Bridgelux and Cree have also entered into a supply agreement under which Cree will become a significant supplier to Bridgelux, which has been seeking to expand its market reach beyond its LED chips into value-added, application-specific LED lighting products. Cree's product families include blue and green LED chips, lighting LEDs, and LED backlighting.

"This agreement creates a collaborative environment between Bridgelux and Cree, while affirming the commitment of both companies to the protection of IP," says Bridgelux's CEO Mark Swoboda.

"Cree will become an important technology and manufacturing partner for Bridgelux, supporting our efforts to enable the mass adoption of solid-state lighting," he adds.

"This resolution underscores the importance of IP in the nitride LED market," says Adam Broome, Cree's VP legal and general counsel.

www.bridgelux.com

Lighting products sustain Cree's record revenues: China manufacturing transfer and 4" wafers accelerated

For its fiscal second-quarter 2009 (ended 28 December 2008), Cree Inc of Durham, NC, USA has reported record revenue of \$147.6m, despite the challenging economic conditions.

Product and contract revenue was \$142m (up 1.3% on last quarter and 19% year-on-year) excluding \$5.6m in up-front patent licensing fees.

During the quarter, Cree granted Japan's Mitsubishi Chemical Corp an exclusive license to manufacture and sell free-standing GaN substrates. Cree also settled patent infringement litigation involving granting a license to patents belonging to Cree and Boston University in exchange for a license fee and royalties from LED maker Bridgelux Inc of Sunnyvale, CA, USA, as well as Cree becoming a significant supplier to Bridgelux.

Non-LED product and contract revenues were \$15.3m, down 11% sequentially and 23% on a year ago: materials revenue (SiC substrates) and government contract revenue were both in line with expectations, but power and RF business fell about 5% sequentially (with lower SiC Schottky diode device sales offsetting higher RF revenue).

This decline was more than offset by LED revenue of \$126.7m, up 3% sequentially and 28% on a year ago. This was driven by double-digit growth for XLamp LED components and lighting fixtures (led by sales of LR6 downlights and Cree's first LR24 recessed LED luminaire shipments). This growth was despite a single-digit decline in LED chip and high-brightness component sales due to lower demand in consumer, mobile, and automotive applications.

Excluding benefits of license deals, gross margin rose from 35.2% last quarter to 36.8%, due mainly to higher LED chip and wafer fab utilization, improved yields for both LED chips and XLamp components, and a favorable LED product mix (with above-average profit margins for XLamp components). This helped to offset increasingly aggressive

pricing pressure from Asian rivals for both LED chips and components.

Net income rose from \$5.9m last quarter to \$10.7m, though mainly due to \$4.4m from patent licensing fees and a franchise tax benefit. Cash & investments grew by \$26.5m to \$365.5m, with operating cash flow of \$40.7m and free cash flow (operating cash flow minus \$17.8m in capital expenditure) of \$22.9m.

"As we start the third fiscal quarter [ending 29 March], we are facing reduced visibility from both our customers and distributors," says chairman & CEO Chuck Swoboda. Overall backlog is down on last quarter but in line with the seasonal booking pattern a year ago.

Sales should show a single-digit decline for LED components, as stronger demand for commercial lighting products and China video screens will be offset by a recession-driven drop in demand for consumer, mobile and automotive applications, a shorter sales quarter due to a longer Chinese New Year shutdown, and reduced inventory levels at both customers and distributors. Power and RF revenue will be flat on fiscal Q2, and material and contract revenue flat to down single digits.

Cree expects overall fiscal Q3 revenue to fall 5–10% to \$128–135m. Cree hence aims for lower factory utilization to limit inventory growth.

Gross margin will fall back to 34–36% as recent gains are offset by lower factory utilization and increased pricing pressure. Swoboda says that Cree remains focused on activities to cut costs over the next several quarters, including further yield improvements at the LED chip and component level.

Gross margin will fall back to 34–36% as recent gains are offset by lower factory utilization and increased pricing pressure

In particular, Cree is continuing to closely manage operating expenses (targeting a reduction of \$1m) and capital spending (targeting \$10–15m in fiscal Q3, mainly for accelerating the transfer of XP and MC XLamp production to its plant in Huizhou,

We have cut our overall capital spending for the year by over 25%

China by about one quarter to fiscal Q3 in order to boost profit margins). Cree also aims to fully transition most high-volume LED chip products to 4"

wafers by the end of fiscal 2009 (the end of June). However, while cutting R&D spending for materials and LED chips, Cree is maintaining LED component R&D levels and boosting LED lighting product R&D. "We continue to make capital investments to support new product introduction, but we have cut our overall capital spending for the year by over 25%," says Swoboda.

For 2009, Cree is in a better position than many competitors due to its focus on the LED lighting market, Swoboda reckons. The firm is targeting for LED lighting adoption to continue to gain momentum as product availability increases and as recognition of the benefits grows, due in particular to new installations of the LR24 such as at the US Federal Reserve in Washington DC (as part of its ongoing energy-efficiency program) and the planned Pentagon renovation (involving installing 4200 of the luminaires in an entire wing, with a payback of less than four years).

In addition, regarding SiC power devices, Cree says that the priority over the next couple of quarters is to build sales momentum for Schottky diodes from a broader customer base beyond the server power supply market, which should increase the factory loading and improve operating margins.

www.cree.com

UC Davis joins LED University program; installs LED lights

LED chip, lamp and lighting fixture maker Cree Inc of Durham, NC, USA says that University of California, Davis (close to Sacramento, CA) is joining the LED University program.

Launched in April 2008, the LED University initiative is an international community of universities working to evaluate, deploy and promote the adoption of energy-efficient LEDs across their infrastructures (in areas such as offices, student housing, parking garages, walkways and streets). The aim is to save energy, protect the environment, reduce maintenance costs, and provide better light quality for improved visibility and safety.

University of California, Davis joins inaugural participant North Carolina State University as well as University of California at Santa Barbara, the University of Arkansas, Marquette University, the University of Notre Dame, and Madison Area Technical College (MATC) in the USA, as well as Tianjin Polytechnic University in China.

In conjunction, University of California, Davis has unveiled new bi-level LED lighting at its South Entry Parking Structure near the Robert and Margrit Mondavi Center for the Performing Arts.



Bi-level LED lighting at parking lot of University of California, Davis.

The light fixtures, featuring activity-sensing technology adapted and developed at California Lighting Technology Center (CLTC) at UC Davis, provide enhanced night-time visibility compared with prior metal-halide fixtures.

Switching to LED lights and adding bi-level activity-sensing technology yields energy savings for the project averaging 50%, it is reckoned. In low mode, energy savings are up to 80%. The university installed 50 BetaLED fixtures and, based on night-time, bi-level operation with an average ambient temperature near 15°C, the luminaires should require no re-lamping and be virtually maintenance free for 20–25 years.

"With LED lighting, we are improving visibility and enhancing the safety of our parking structure while reducing energy consumption," says

Chris Cioni, associate director of UC Davis facilities management, utilities division. "We are also significantly reducing both maintenance costs and light trespass compared to the incumbent metal-halide technology... We plan to evaluate LED lighting in other applications," he adds.

"Our initial LED lighting installation is part of CLTC's Smart Lighting Initiative, an effort we have pursued over the past two years to utilize high-efficiency lighting sources with bi-level activity sensors to reduce lighting levels when no one is using the parking facility," says CLTC director Michael Siminovitch. "Even at half-power, the LED fixtures are delivering plenty of light to the space," he adds. "We may be able to cut levels further, saving even more electricity and lengthening fixture lifetimes."

Safety can be improved with the bi-level system, it is reckoned. When motion is detected and the higher light mode is activated, the change in the visual environment alerts people nearby. Drivers, pedestrians and security agents now have an indicator when there is activity in the area.

<http://cltc.ucdavis.edu>
www.leduniversity.org

California's Indian Wells joins LED City program

Indian Wells, CA, USA has joined the LED City program, an international community of government and industry parties initiated by LED maker Cree Inc of Durham, NC, USA in December 2006 to evaluate, deploy and promote LED lighting for municipal infrastructure. Indian Wells joins existing program members Raleigh, NC, Ann Arbor, MI, Austin, TX and Anchorage, AK in the USA, Toronto in Canada, Tianjin in China, and Torraca in Italy.

The city has converted much of the lighting in City Hall, the Emergency Operations Center and the Public Works Maintenance Facility to LED lighting.



Exterior LED lighting at Indian Wells.

All circular recessed lighting in the Indian Wells city buildings was converted to Cree's LR6 LED light, cutting electricity consumption by 80%. The city now plans to evaluate LED lighting for other municipal lighting applications to further

increase its energy savings.

"The recessed LED lighting is targeted to last for 12–25 years, significantly reducing the time and money we spend changing and tossing away bulbs," says Mayor Larry Spicer.

"We collaborated with Southern California Edison for these initial LED lighting installations," notes Indian Wells city manager Greg Johnson. "They gave us a directive to save energy. We conducted an initial evaluation of many different efficient lighting solutions, and the Cree LR6 LED recessed light was far superior to the others," he adds.

www.ledcity.org

Cree announces volume availability of brightest lighting-class LEDs

Cree Inc of Durham, NC, USA has announced the high-volume availability of lighting-class XLamp XP-E LEDs (which were introduced in August) with light output of up to 122 lumens.

Cree now offers XLamp XP-E cool-white LEDs — with a color correlated temperature (CCT) of 5000–10,000K — in a minimum R2 flux bin (114–122lm at 350mA). This is the highest commercially available minimum-flux order code for a single-die LED (at 350mA) in the industry, Cree claims.

Cree says that the volume availability of XLamp LEDs is aimed at further stimulating the LED lighting market, driving applications in outdoor and indoor general illumination as well as portable and retail display lighting.

"In the past 18 months, Cree has shipped millions of 100+ lumen XLamp LEDs," says Paul Thielen, Cree's marketing director for LED components.

www.cree.com/products/xlamp_xpe_r2.asp



Cree's XLamp XP-E LED.

● Cree says that Robert Ingram, vice chairman Pharmaceuticals of GlaxoSmithKline in Research Triangle Park, NC since January 2003, has been elected to its board of directors, and to the board's Compensation Committee and Governance and Nominations Committee.

"His wealth of experience in research-intensive businesses facing global marketing and manufacturing challenges give him an ideal foundation to help us address the opportunities Cree anticipates [as it works toward replacing traditional lighting]," says chairman & CEO Chuck Swoboda.

Cree to supply LED chips and packaging support to LG Display for LCD backlighting

LG Display Co Ltd of Seoul, South Korea, which makes thin-film transistor liquid crystal display (TFT-LCD) panels, OLEDs and flexible displays, has formed a strategic alliance with LED chip maker Cree.

LG Display says that in early January it signed a supply agreement under which it has secured a stable supply of LED chips to be used in LCD backlighting, and receives technological support from Cree for LED packaging.

The firm also plans to secure an early lead in LED-backlight notebook PCs by internalizing LED-related technologies such as packaging and backlighting production. The firm aims to

strengthen its leading position in the notebook LCD market.

"LG Display will expand the share of panels featuring LED-backlight to 50% of its total notebook LCD output," says Sang Beom Han, executive VP & head of the IT business unit.

According to market research firm DisplaySearch, in fourth-quarter 2008 LG Display claimed the largest share of the notebook LCD market (in terms of shipments). The firm has also launched production of the world's first 17.1" RGB LED notebook LCD with color reproduction ratio of 105%, and unveiled the slimmest LCD TV panel with an LED direct backlight system.

www.lgdisplay.com

IN BRIEF

Golden DRAGON LEDs for Taiwan street-lighting

Osram Opto Semiconductors GmbH of Regensburg, Germany says that its Golden DRAGON LED series has been chosen by Advanced Thermal Devices Inc (ATD) of Sindian City, Taipei County, Taiwan for two LED illumination projects.

Integrating the chip technology and fitted with a silicone dome for greater light extraction efficiency, the Golden DRAGON and Golden DRAGON Plus LEDs provide light sources for outdoor illumination, and are characterized by a long lifetime.

In fall 2008, 23 solar-powered LED street luminaires were installed for Taiwan Power Company in Taipei. Combined with ATD's solar technology, Golden DRAGON Plus LEDs (which have a lifetime of more than 50,000 hours) give the new street lamps what are claimed to be outstanding energy efficiency results. The luminaires are also fully adjustable so that, for example, in the middle of the night, the light output can be dimmed by 50%, reducing energy consumption.

Also, 111 sets of 100W LED street luminaires have been installed in the motorcycle lanes of Zhong-Gang Road in Taichung City. Incorporating Golden DRAGON LEDs, the luminaires demonstrate the wide and even light distribution of energy-efficient LED lighting in roadways and public areas, the firms say.

"Not only illumination enterprises but also the general public now recognize that LEDs are a viable alternative to conventional street lighting," says Dr Alfred Felder, president & CEO of Osram Opto Semiconductors Asia Ltd.

www.osram-os.com
www.atdi-web.com

Opto Tech invests in Nichia, targeting notebook backlight unit market

According to a Taiwan Economic News report from the Chinese Economic News Service, LED chip maker and packager Opto Tech Corp of Taipei, Taiwan and Japan's Nichia Corp are expanding their LED manufacturing collaboration (which started in August 2004).

Nichia has previously made LED chips mainly for its own packaging lines, but now wants to boost sales of its chips to packaging firms worldwide. It has hence pledged to increase the supply of its LED chips in return for Opto Tech committing to also making the firm's chips on a contract basis and hence selling more Nichia-branded bare die to LED packaging firms.

Opto Tech says that it has sent samples of the contract chips it

makes for Nichia to its customers in Taiwan, the USA and Japan, and has consequently acquired verifications from three LED chip packaging firms in Taiwan and started shipments in small volume, entering the supply chain for small-size notebook backlight units (BLUs).

With LED backlit notebooks forecast to account for up to 40% of all notebook PCs made in 2009, Opto Tech reckons Nichia-related LED orders from BLU OEMs will grow 50% in 2009. So, despite the slowdown in LED sales for other, more established applications, Opto Tech expects its annual revenue from sales of Nichia-branded chips to double this year to NT\$1bn (US\$30m), about 20% of its total revenue. Opto Tech's revenues in

2008 were NT\$6.5bn (US\$196m), including NT\$5.1bn (US\$154m) from chip making (and the remainder from large outdoor LED signs).

As part of the cooperation, in late December Opto Tech invested NT\$379m (US\$11.5m) in Nichia in order to further develop the market for notebook-use LED backlighting, said VP Dean Chang in a report by Digitimes. This investment will likely be reciprocated by Nichia increasing its shareholding in Opto Tech.

With Opto Tech using more LED chips made by Nichia, in late December it decided to reschedule indefinitely completion of its factory Ningbo Opto Tech Semiconductor in China (see below).

http://cens.com/cens/html/en/news/news_inner_26139.html

VPEC closes LED production lines

To cut losses and focus resources on solar cell and microwave components business, epiwafer foundry Visual Photonics Epitaxy Co Ltd (VPEC) in Taiwan closed down its LED production lines on 15 January. The firm has sold the corresponding process equipment and patents for its ultra-bright red and yellow AlGaInP-based LEDs to Crystal Light Optotech.

VPEC says its LED product lines were not strong enough to compete with first-tier LED companies due to price erosion under the current global economic difficulties.

VPEC's LED business has fallen from 40.1% of total revenue in 2006 to 30.1% in 2007 and only 18.3% for January–November 2008.

Total revenue for January–November was NT\$1.13bn. November revenue was NT\$41.8m (US\$1.26m), down 60% from October's NT\$105m and 55% on a year ago.

www.vpec.com.tw

Opto Tech postpones China factory start-up

Due to the pessimistic business outlook for 2009, Taiwan-based LED chip and system product maker Opto Tech Corp has decided to reschedule indefinitely its start-up of a factory Ningbo Opto Tech Semiconductor Co Ltd in Ningbo Wangchun Industrial Park, Zhejiang province, China, according to Digitimes.com.

Construction of the plant was announced in October 2007, for start up in Q4/2008. It was originally set to deliver a monthly production capacity of 3bn LED chips, focusing exclusively on high-brightness LEDs (due to instability in orders from the traditional LED market, which then accounted for nearly 90% of Opto Tech's revenue). The firm now says that it will restart the project when the business environment is more favorable.

At its factory in Taiwan, Opto Tech has already ordered four MOCVD systems, two of

which are currently being installed (with production due to begin in March 2009). Installation of the other two is being postponed until some time in 2009.

Opto Tech currently has a monthly production capacity of 3bn LED chips (including high-brightness LEDs) and 600m optical sensor chips. The use of LED-illuminated backlight units (BLUs) in notebook PCs is expected to continue to accelerate in 2009, offering a source of revenue growth, Opto Tech notes.

The use of LED-illuminated backlight units (BLUs) in notebook PCs is expected to accelerate in 2009, Opto Tech notes

www.optotech.com.tw
www.digitimes.com/news/a20081224PD210.html

Nichia and Luminus enter cross-licensing and manufacturing partnership

Nichia Corp of Anan City, Japan, which is reckoned to be the world's largest manufacturer of white LEDs, and Luminus Devices Inc of Billerica, MA, USA, which manufactures solid-state light sources for illumination applications, have announced an alliance based on cross-licensing of intellectual property, technology sharing, and a manufacturing partnership. The two firms say that they have agreed to combine their expertise and resources to bring to market a new breed of high-power white LEDs.

The companies say that the combination of their technologies, including Nichia's phosphor and

epitaxial materials and Luminus' PhlatLight (Photonic Lattice) large-chip technology, will create high-power LED products with the aim of enabling new applications that accelerate the adoption of solid-state lighting.

The firms will cross license intellectual property and share critical process knowledge which is expected to result in innovative products. They have also established a manufacturing partnership, whereby each firm will contribute the resources, materials and capabilities needed to meet the quality and performance requirements for the products.

"We look forward to working together to create environmentally friendly products," says Nichia's president Eiji Ogawa. "The biggest winners will be our customers, who will have unprecedented LED performance and the benefit of a reliable, high-volume supply of these novel products," says Luminus' CEO Udi Meirav.

Some of the jointly developed products will be marketed by Nichia and others by Luminus, both of which will be able to use the PhlatLight trademark. The first of these products is planned for launch in 2009.

www.nichia.com

www.luminus.com

Nichia and Seoul settle litigation and agree cross-license

Nichia Corp of Anan City, Japan and Korea's Seoul Semiconductor Co Ltd say that they have settled all litigation on patent and other issues as well as other legal disputes currently pending between them in the USA, Germany, Japan, the UK, and Korea.

The settlement includes a cross-license agreement covering certain LED and laser diode technologies, which will permit the firms to access all of each other's patented technologies.

In accordance with the settlement terms, all litigation will be

terminated as soon as possible by mutual withdrawals, with the exception of litigation in Germany involving patent DE 691-07-630 T2 of EP 0-437-385 B1, which will be resolved following a hearing in February.

www.seoulsemicon.com

Luminus launches PhlatLight LED PT-121 chipset

At the CES'09 Consumer Electronics Show in Las Vegas (8-11 January), Luminus Devices Inc of Billerica, MA, USA launched the PhlatLight LED PT-121 chipset, which is designed to deliver high brightness levels, enhanced color, and long-term performance and reliability for next-generation, lamp-free data projectors.

The PT-121 is enhanced when used in conjunction with Texas Instruments' digital light processing (DLP) technology. Each chipset consists of a red, green and blue LED, and is best suited to data projectors that use micro-displays ranging from 0.65-1". Like other PhlatLight LEDs, the PT-121 offers instant start up without the warm-

up and cool-down periods required by existing conventional mercury lamp technologies. The PT-121 also includes a wide color gamut that exceeds NTSC standards and surpasses 60,000 hours of lifetime, eliminating the need to replace the projector light source.

"Texas Instruments and Luminus have a long-standing collaborative relationship that fosters innovation," says Lars Yoder, vice president for DLP Front Projection Products at Texas Instruments. "The integration of our individual expertise in DLP chip technology and PhlatLight LEDs results in expanding the global market with unmatched levels of picture quality and product reliability of DLP projectors," he claims.

"The PT-121 is built for next-generation, lamp-free data projectors providing a high-brightness, mercury-free technology, not available in traditional lamp technologies," says Luminus' president & CEO Udi Meirav.

When they are combined, the red, green and blue chips produce more than 2000 lumens of white light at a color temperature of 8000K in time sequential pulsed mode. There is also 100% uniform surface emission for high collection efficiency and low optical losses. In addition, the monolithic emission area per color allows single-lens collection and simplified optics, the firm adds.

www.luminus.com

Alfalight launches 0.65W pump for green micro-lasers

Alfalight Inc of Madison, WI, USA, which manufactures high-power diode lasers for industrial, defense and telecoms markets, has made available samples of a wavelength-stabilized 0.65W, 808nm single-emitter pump diode laser, packaged on a small form factor 3mm x 4mm x 1mm Q-mount. Custom wavelengths and power outputs (0.5–5W) are also available.

The XMQ-808BW-48-061 extends Alfalight's Wavelength Stabilization Technology (WST) to high-efficiency, temperature-stable diode-pumped solid-state (DPSS) micro-laser applications such as pico-projector and laser display systems.

The proprietary WST technology uses an integrated grating on the laser chip, providing a pump wavelength locked on the narrow absorption band of the micro-laser gain medium without the need for power-hungry temperature control circuitry. Since the WST pump

laser has an efficiency that matches standard pump technology, it can boost power efficiency and stability for both existing and new micro-laser designs, claims Alfalight.

Moreover, operation and packaging are identical to a standard laser diode, simplifying design transitions.

By scaling down the emitter size of its high-power WST diodes, Alfalight can now provide a pumping solution that impacts the expansive opportunity for micro-laser suppliers to the consumer projection and display market, says VP sales & marketing Ron Bechtold. "Customers can now utilize Alfalight 808nm wavelength-stabilized technology to improve performance, while extending both the operating temperature range and the battery life of micro-green lasers."

Due to improved absorption in the solid-state laser material, WST diodes can provide a significant increase in performance for existing micro-laser designs, the firm claims.

Additional gains can be made in new designs, as one can maintain performance over a broad temperature range without temperature control circuitry. Specifically, WST provides much higher absorption in Nd:YAG and Nd:YVO₄ micro-lasers — the peak absorption coefficient is more than 80% higher than for a standard broad-area laser (BAL) — as the pump laser wavelength stays locked on the absorption peak of the gain material from 25°C to 45°C.

By adding a frequency-doubling technology, these micro-lasers are converted to efficient green laser light sources. For DPSS laser applications, this also means lower modal noise, since the grating stabilizes the modal content of the pump diode. For green laser applications, the output power stability is enhanced because the absorption of the pump beam is less dependent on temperature than for standard BAL.

www.alfalight.com

Mitsubishi Electric launches record-power 110mW 638nm red laser for mobile color projectors

Tokyo-based Mitsubishi Electric Corp, which manufactures high-power 660nm-wavelength laser diodes, has developed a 638nm-wavelength red laser diode which, due to its optimized materials and structure, offers what is claimed to be record output power of 110mW in CW single-lateral-mode operation (across its operating temperature range from -5°C up to +50°C). It also claims record wall-plug efficiency of 28% at 25°C.

The compact 5.6mm diameter of the ML520G54's standard TO CAN package suits high-level integration in brighter, lower-power-consumption palm-size mobile red/green/blue color projectors as well as in laser display equipment, industrial instrumentation, and biomedical fields.

While laser diodes are widely used in optical disc systems such as recordable DVD players and optical

communication equipment, the market has recently sought to extend their application to displays.

In particular, palm-size mobile color projectors (used to project applications in personal entertainment players, mobile phones and other mobile equipment) are gaining attention. Among methods for projecting these applications, the greatest expectation is being placed on the use of small, high-output and highly efficient laser diodes as a light source, while employing micro-mirror devices to scan the laser beams. Such projection technology requires high beam quality and wave-front uniformity. It is also essential for the laser diode to have single-lateral-mode lasing characteristics. However, to date, there have been no laser diodes with sufficient output power and brightness to satisfy mobile

color projector manufacturers, says Mitsubishi Electric.

Previous red laser diodes with a wavelength of 640nm or lower (the wavelength most suitable to reproduce optical red color clearly and brightly) had difficulty maintaining single-lateral-mode lasing characteristics at high output power. The ML520G54 uses Mitsubishi Electric's expertise in applying window mirror structures and ridge waveguide structures. The firm reckons that its new product should therefore contribute to the production of brighter mobile color projectors with lower power consumption. Sample shipments began on 1 February at a price of \$120 each.

Mitsubishi Electric adds that, in future, it aims to continue development of higher-power laser diodes for display applications.

<http://global.mitsubishielectric.com>

Osram blue laser for micro-projectors

Osram Opto Semiconductors GmbH of Regensburg, Germany has launched a new 450nm-wavelength blue laser diode with an output of 50mW and voltage of 5.5V. The new laser has key attributes required for micro-projectors, such as small size (3.2mm height), high efficiency (0.9W/A) and what is claimed to be excellent blue light visibility. Also, as a ridge laser with high beam quality, it needs only relatively simple, small optics to shape the beam.

An optimized TO38 package makes the blue laser diode the smallest in its class, it is claimed. "Our newly developed blue laser is the next step in our quest to enable miniaturized projectors that can be fully integrated in mobile devices [cell phones and digital cameras]," says Dr Thomas Höfer, head of Laser Projection at Osram Opto. Mobile devices currently on the market can produce and download high-quality photos and video clips. Integrated laser projectors will enable these to project this content in high quality on almost any surface.

Laser projection represents the



Osram's new 450nm blue laser diode.

next milestone in the development of mobile devices and has a promising future in terms of integrated projection modules, Osram Opto reckons. Laser-based projection units offer extremely low power requirements and compact dimensions, while lasers also offer vibrant colors, high contrast and sharp images, irrespective of the distance over which images are projected.

Osram Opto is also developing red and green lasers for laser projection. The red laser, like the blue laser, will be designed as a direct semiconductor laser but green lasers will be implemented using frequency-doubling techniques.

www.osram-os.com

IN BRIEF

nLight raises \$10.7m for integrated laser module development

High-power diode laser manufacturer nLight Corp of Vancouver, WA, USA has received \$10.7m in the first closing of a new round of equity financing. Continued investment came from existing venture investors Oak Investment Partners, Mohr Davidow Ventures and Menlo Ventures.

nLight says that it will use the new growth capital to drive continued product development of integrated laser modules and to boost sales in its core industrial, defense and medical markets.

"Despite the worldwide downturn, we finished 2008 with record bookings," says CEO Scott Keeney. "We see multiple opportunities for continued strong growth as our industry continues to consolidate and high-power semiconductor lasers continue to expand in new applications," he adds.

www.nlightphotonics.com

Light Blue Optics recruits VP of sales & marketing

Light Blue Optics of Cambridge, UK, which develops miniature holographic laser projection systems, has recruited Chris Hoggarth as VP of sales & marketing, responsible for overall sales and marketing strategy, evaluating product requirements, and building relationships with key customers and strategic partners in markets including automotive, information display and consumer electronics.

Founded in 2004, LBO's projection technology uses laser light sources and patented holographic techniques to deliver large, full-colour, high-quality video images. A diffraction pattern of the desired two-dimensional image, calculated using LBO's holographic algorithms, is displayed on a phase-modulating

liquid crystal on silicon (LCOS) microdisplay. When illuminated by coherent laser light, rather than blocking light, the microdisplay steers the light to exactly where it is needed, making the system highly efficient. Unlike conventional projection systems, no projection lens is needed. Instead, a demagnification lens pair expands the diffracted image from the microdisplay, producing an ultra-wide throw angle greater than 90°. The projected images are in focus at all distances from the projector — even on curved or angled surfaces, eliminating the need for a focus control.

Hoggarth has 25 years of experience in the displays industry. As head of Samsung's European LCD business unit, he built a multi-

disciplined sales & marketing team and increased annual revenue more than three-fold, creating a multi-billion dollar business. Previously, he managed the Display Devices and Components Division of Toshiba Electronics Europe.

"Chris has a proven track record in building successful sales & marketing operations and growing top-line revenues and is an excellent fit for our high-growth organisation," says LBO's CEO Dr Chris Harris. "His expertise will enable LBO to better understand and support customer requirements, deliver compelling products, and realise its goal of becoming the world's leading supplier of miniature projection systems."

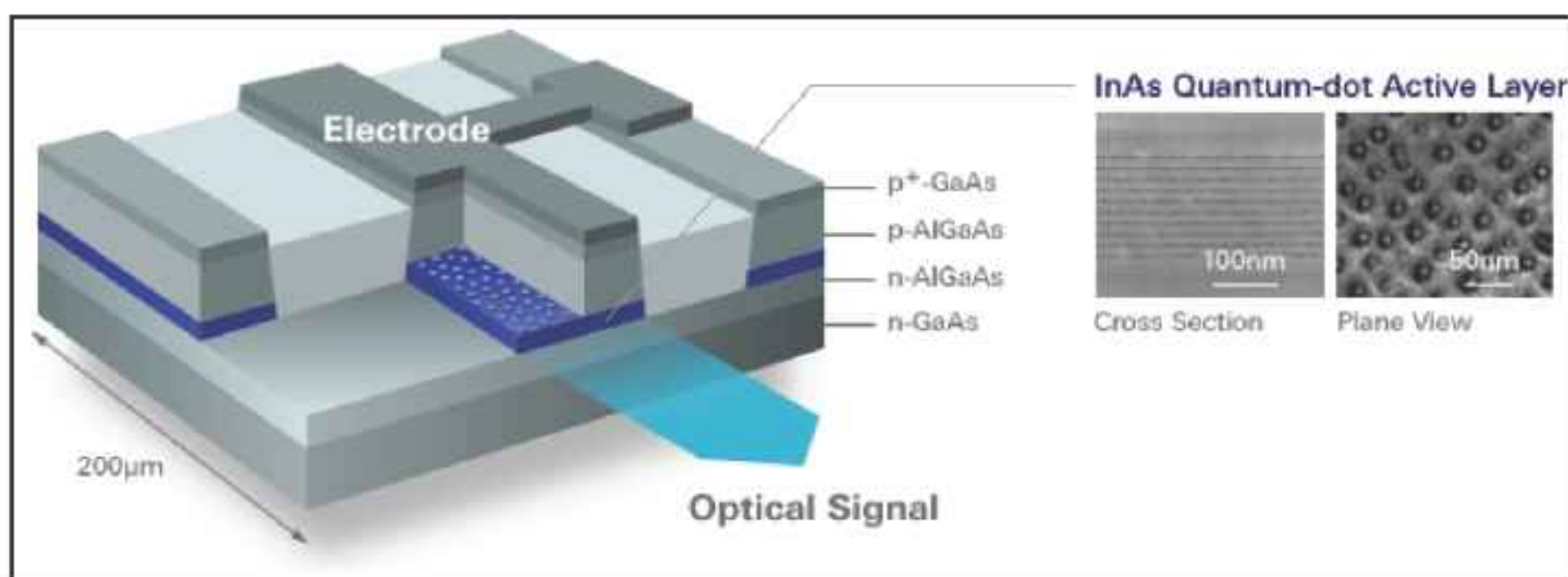
www.lightblueoptics.com

QD Laser raises ¥700m to ramp Fabry-Perot production

Tokyo-based QD Laser Inc has secured a new ¥700m (\$7.8m) round of financing led by Mizuho Capital Co Ltd and joined by Tokyo Leasing Co Ltd, along with Mitsui Ventures and Fujitsu Ltd's CVC Fund (the two founding investors in the joint venture in April 2006).

QD Laser develops quantum dot optoelectronic devices, based on more than 10 years of research by Fujitsu Laboratories Ltd and the University of Tokyo. Development of the lasers was driven as a joint effort by the research teams of professor Yasuhiko Arakawa (QD Laser's technical advisor and head of the University of Tokyo's Institute for Nano Quantum Information Electronics) and of Mitsuru Sugawara (QD Laser's president & CEO and vice-head of Fujitsu Laboratories' Nanotechnology Research Center).

In late February 2008, when the firm started shipping engineering samples transmitting at 1.25–10Gb/s data rates, QD Laser claimed at the Optical Fiber Communication (OFC 2008) conference in San Diego, CA that it was first to develop and commercialize temperature-insensitive quantum dot Fabry-Perot



Structure of QD Laser's quantum dot Fabry-Perot (QD-FP) laser.

(QD-FP) lasers operating at a wavelength of 1310nm, available in both a TO-CAN package and bare chip form for applications such as fiber-to-the-home (FTTH), optical local-area networks (LAN) and Fiber Channel optical communications.

The firm says results confirm that, compared to conventional lasers, the quantum dot technology can achieve the lower power consumption, smaller form factor and wider operational temperatures (up to 100°C) required for optical sub-assembly modules and telecom systems as transmission speed increases. Also, due to their temperature-insensitive characteristics, QD-FP lasers can enable the simpli-

fication or removal of the automatic power control (APC) function, cutting material and assembly costs.

QD Laser says that it will use the new funding to enhance production capabilities and R&D activities to expand the possibilities of optical devices for telecom and other applications generated by its quantum dot technology.

In addition, quantum dot distributed feedback (QD-DFB) lasers, which enable longer-distance transmission, have also been under development, for availability in both TO-CAN packaged and bare chip form (with engineering samples due to ship by the end of 2008).

www.qdlaser.com

Advanced Photonix to supply 40Gb/s receivers to transponder maker; 100Gb/s receivers anticipated

Picometrix LLC of Ann Arbor, MI, USA, a subsidiary of Advanced Photonix (which designs and makes silicon, InP- and GaAs-based photodetectors, subsystems, and terahertz instrumentation), has signed a multi-year agreement with what it describes as an industry-leading optical sub-system manufacturer to supply 40Gb/s receiver components for incorporation into subsystems for next-generation telecom networks. The first year of the agreement is expected to result in annual revenues in excess of \$1m for the firm.

Picometrix will supply client-side non-return-to-zero (NRZ) and line-side differential phase-shift keying

and quadrature phase-shift keying (DPSK and DQPSK) optical receivers, which use the firm's patented photodiode, amplifier and component packaging technologies. The optical receivers will be incorporated into the customer's 40Gb/s transponders, which in turn will be deployed throughout the networks of telecom service providers.

Network evolution to 40Gb/s is necessary to alleviate bandwidth bottlenecks and represents a significant growth opportunity

"The network evolution to 40Gb/s is necessary to alleviate bandwidth bottlenecks and represents a significant growth opportunity during the next several years," says Rob Risser, general manager of Picometrix and chief financial officer of API. "As bandwidth demand grows, 40Gb/s telecommunication networks will become widely deployed. These high-speed networks will be necessary to support the growing demand for high-definition audio and video to be delivered any time, anywhere."

Risser anticipates being able to support the customer with 100Gb/s optical receivers in the future.

www.advancedphotonix.com

Wavelength-stabilized high-power fiber-coupled diode lasers

DILAS of Mainz, Germany has introduced wavelength-stabilized technology for its high-power fiber-coupled diode lasers, available at wavelengths of 808, 940, 976 or 981nm (with others, e.g. 795nm, available on request) and starting from 25W output from a 200 μ m-diameter fiber core up to 400W output from a 400 μ m-diameter fiber core with a numerical aperture (NA) of 0.22.

The new fiber-coupled diode lasers deliver superior wavelength stability with respect to temperature, current and operating hours. With a narrow line-width of <0.5nm at full width half maximum, the typical wavelength-temperature drift is 0.01nm/K.

The new wavelength-stabilized technology suits the requirement for high power and spectral brightness (with a narrow absorption



DILAS' single-bar diode laser.

bandwidth) in both ideal and harsh operating environments for applications such as pumping solid-state lasers, fiber lasers and optical pumping of alkaline vapors.

Improving the diode laser wavelength stability can lead to higher system efficiency, higher reliability, longer lifetime, and lower overall operating costs, comments DILAS.

www.dilas.com

IN BRIEF

DILAS appoints ES as UK and Ireland distributor

DILAS of Mainz, Germany has appointed the UK's ES Technology as a distributor of its high-power diode laser components and modules in the UK and Ireland.

Founded in 1987, ES Technology distributes optical components such as acousto-optic tunable filters and modulators to the educational, scientific and industrial markets. The firm says that the addition of DILAS' products provides it with a complementary range of laser diode sources and systems. ES also manufactures industrial laser systems for laser marking, cutting and welding.

DILAS says the new partnership strengthens its distributor network and global supply chain.

www.estechology.co.uk

DILAS launches 500W 976nm fiber-coupled, multi-bar module

High-power diode laser maker DILAS has launched a fiber-coupled, multi-bar module that can deliver up to 500W of output from a 400 μ m fiber at a wavelength of 976nm.

The fiber-coupled, multi-bar modules deliver 500W through a cladding-mode-free quaternary buried heterostructures (QBH) high-power 400 μ m core diameter fiber with a low numerical aperture of <0.2 and a wall-plug efficiency (WPE) of >35%. Packaged in up to 12-bar configurations, the designs are based on industry-standard conductively cooled bars, which are optically stacked and polarization coupled. The laser requires only industrial water for cooling.

While achieving high brightness and efficiency, the new module has demonstrated a lifetime greater than 10,000 hours under 500W continuous wave (CW) operating condition.



Multi-bar module with 500W output.

The fiber-coupled, multi-bar modules are suited to direct-diode applications as well as fiber-laser and solid-state laser pumping. Custom wavelengths are available upon request.

● DILAS has also launched a high-power fiber-coupled module that enables 'truly' unpolarized optical output beam.

Within the fiber-coupled module architecture, the firm uses a polarization scrambler to achieve random polarization. With a

degree of polarization at <0.1, the product suits a wide array of OEM pumping applications, primarily diode-pumped solid-state laser OEMs demanding increased stability for next-generation products. Manufacturers can hence increase stability, leading to robust and cost-effective system designs.

Standard modules are available with power outputs of up to 40W at wavelengths of 808, 880, 915, 940 and 980nm with a numerical aperture of 0.22 from 400 μ m core fiber, making it the most reliable and highest-performing fiber-coupled module available, claims DILAS. Standard wavelength tolerances are \pm 3nm with spectral widths of less than 5nm.

In an industry-standard package measuring less than 100mm x 31mm x 20mm, the WPE is >35%. The modules typically operate at a current of 55A with a compliance voltage of 1.8V.

IN BRIEF

Opnext launches red laser for miniature display market

At the Photonics West 2009 show in San Jose, CA, optical module and component maker Opnext Inc of Eatontown, NJ, USA launched the HL6388MG laser diode, which can be built into next-generation miniature display systems (e.g. in PCs, mobile phones and other mobile equipment). The firm says that the new laser expands its addressable market by accelerating the commercialization of the miniature display market.

The HL6388MG incorporates a smaller 5.6mm package while retaining high reliability. Output power has been aggressively developed to achieve an upgraded image brightness for display applications. The packaged laser with multi-modal distribution and multi-lasing wavelength spectrum allows for 250mW continuous-wave operation.

High monochromaticity yields what is claimed to be excellent color reproducibility. "This new red-laser diode can improve color reproducibility in the display of a mobile phone or other portable device which, in turn, helps our customers deliver new applications in the miniature display market," says Tadayuki Kanno, senior VP Device Business Unit.

"The Opnext HL6388MG diode delivers the performance we need for our latest laser-based microprojectors," notes Dr Jay Wiesenfeld from Bell Labs business development at Alcatel-Lucent.

"Opnext's HL6388MG diode has the necessary output power, the high efficiency and the reliability we require to differentiate Explay's mobile projectors from our competitors," adds Golan Manor, executive VP Product Strategy at Explay.

www.opnext.com

Alfalight unveils surface-emitting DFB laser for low-cost, high-power systems

In the session 'Novel In-Plane Semiconductor Lasers VIII' at the Photonics West 2009 conference in San Jose, CA (29 January), Manoj Kanskar, VP R&D of high-power diode laser manufacturer Alfalight Inc of Madison, WI, USA, presented an invited talk 'High Brightness Surface-emitting Distributed Feedback (SE-DFB) Laser' giving the first details of the firm's new SE-DFB technology.

A significantly different approach to high-power semiconductor lasers at the wafer level provides what is claimed to be a lower-cost system solution with enhanced brightness and ruggedness compared to existing edge-emitting laser technology.

SE-DFB lasers are made of the same material used for Alfalight's edge-emitting lasers. But, whereas standard edge-emitting lasers emit through a small facet on the edge of the chip, SE-DFB lasers emit through a large optical window on the surface. A curved grating patterned on the base layer of the chip has four main functions:

- to form the laser cavity, providing optical feedback precisely at the design wavelength, locking the emission spectrum on a narrow peak for any combination of operating temperatures and currents;
- to couple the laser beam out of the laser chip, through an anti-reflection (AR)-coated optical window while collimating it in one direction without the aid of external optics;
- to shape the optical wavefront to enhance brightness and suppress filamentation; and
- to protect the device from external optical feedback.

The optical density at the emission window is four orders of magnitude lower than at the facet of edge-emitting lasers. This makes SE-DFB lasers immune to catastrophic optical mirror damage (COMD), which is the main reliability issue plaguing existing laser diode technology.

Several SE-DFB laser chips can be combined on a common heat sink and coupled into an optical fiber using simple optical elements. No micro-lenses or beam transformation optics are needed.

The lasers offer the same 0.07nm/°C wavelength stability as Alfalight's proven Wavelength Stabilization Technology (WST) — a factor of five more stable over temperature than standard semiconductor lasers, the firm claims. Consequently, there is no need to control the temperature of the chip precisely. SE-DFB diodes can also be driven by low-current supplies, further cutting system cost.

Alfalight says that the SE-DFB laser's key features — complete immunity to facet damage, on-chip integrated wavelength stabilization, and intrinsically high brightness that eliminates the need for expensive, precision optical elements — can benefit fiber-laser, solid-state laser and direct-diode laser applications (e.g. materials processing and infrared illumination).

"SE-DFB lasers have unmatched power scaling and wavelength stabilization capability besides a

The technology will reach beyond the capabilities of bar-based optical sources

singular brightness advantage over edge-emitting laser diodes," says Kanskar. The technology will reach

beyond the capabilities of bar-based optical sources, he claims. "This technology has the potential to displace ubiquitous laser diode bars in many important applications."

Kanskar's talk also discusses experimental results and outlines configurations for combining chips into high-power laser arrays. Prototype SE-DFB chips, and demonstrations of a SE-DFB-based array and a fiber-coupled module, were also on display at Photonics West.

www.alfalight.com

Jenoptik showcases TESAG epiwafer acquisition

At January's Photonics West event in San Jose, CA, USA, the Lasers & Material Processing division of optoelectronics group Jenoptik of Jena, Germany showcased its complete technology chain for manufacturing high-power diode lasers, including its newly integrated in-house epitaxial wafer manufacturing capability.

This follows Jenoptik Lasers & Material Processing division's Diode Lasers business unit (Jenoptik Laserdiode GmbH) in December completing its acquisition of pure-play epiwafer foundry Three-Five Epitaxial Services AG (TESAG) in Berlin-Adlershof (near to Jenoptik's high-power laser bar production site, which has been in operation since 2007). Spun off in 1999 from the Ferdinand Braun Institute for Ultra High Frequency Technology (Ferdinand-Braun-Institut für Höchstfrequenztechnik, or FBH), TESAG specializes in providing epitaxial structures (particularly for diode lasers) and is a long-established

supplier to Jenoptik.

Jenoptik claims that consequently it is now one of the few full-range, single-source service providers for high-power diode lasers, from producing epitaxial material in Berlin to the mounting of diode-laser bars, fiber coupling, and providing finished laser sources and systems (particularly pump sources for solid-state and fiber lasers as well as direct beam sources for medical technology and material processing). Advantages include short development times as well as flexibility in selection and configuration.

● At Photonics West, Jenoptik's Lasers & Material Processing division exhibited new developments in optics, micro-optics and laser technology, including the new JOLD-100-CPXF-2P A, which is a development of a previous fiber-coupled diode laser module but is now offered for the first time with the option of forced air cooling, with a power of 100W from a 400 μ m-diameter fiber (NA 0.22).

Cooling without water or even a thermoelectric cooler (TEC) simplifies handling.

With such improved technology, the same fiber-coupled module is also being introduced with a higher output power of 140W with passive cooling (using industrial water, for example).

The new diode-laser module can be used for direct material processing (quasi-simultaneous welding and other applications where increased power is needed) or for pumping solid-state and fiber lasers. Volume production is planned for second-quarter 2009.

Jenoptik has also expanded its range of high-power diode-laser bars with standard wavelengths 808, 915, 938, 976nm (and special wavelengths 792, 830 and 1060nm, available on request) by adding products with the standard wavelength 880nm (88x nm), which is used in the production of passively cooled diode lasers.

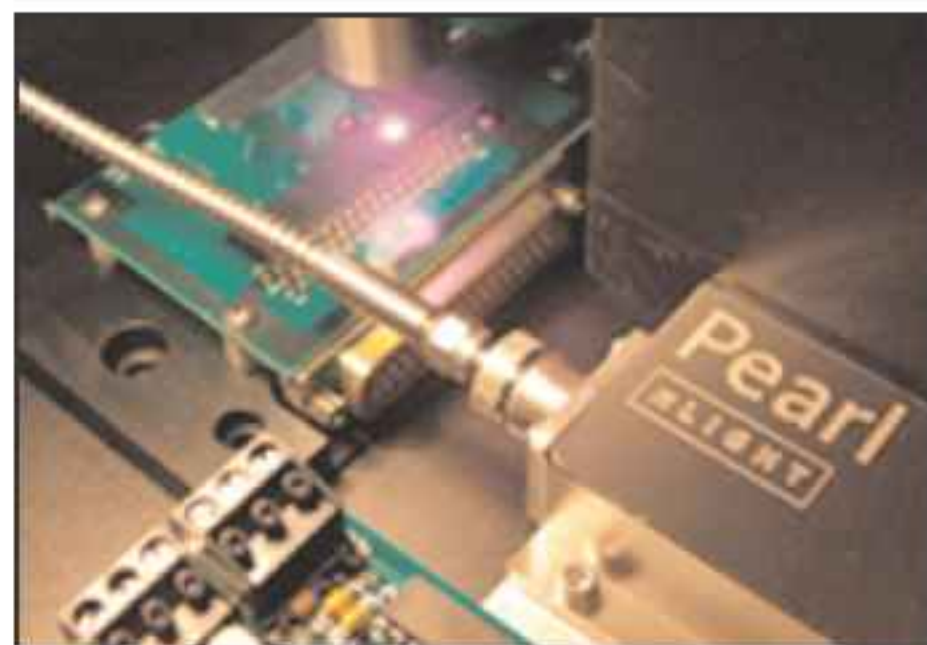
www.jold.com

Fiber-coupled lasers for low-power materials processing

High-power diode laser manufacturer nLight Corp of Vancouver, WA USA launched Pearl fiber-coupled diode laser products designed specifically for industrial materials processing applications such as plastic welding and soldering that require high power in a small, rugged package.

Configurations are available emitting at wavelengths of 915, 940 or 980nm with power output of up to 100W from PowerCore fiber with diameters of 200–800 μ m. An optional pilot beam is also available.

"Efficiency of greater than 50% significantly reduces system cooling requirements, minimizes costs, and increases reliability," says nLight's VP sales & marketing Joe DeBartolo. "Pearl enables energy-efficient laser systems with lower cost of ownership," he claims.



Pearl fiber-coupled diode laser in-situ.

● nLight has also expanded its Pearl solid-state laser platform to wavelengths of 879, 885 and 888nm. Output power levels of 20–100W with electrical-optical operating efficiency of 50–60% (resulting in significantly less heat) via proprietary 400 or 600 μ m-diameter PowerCore fiber enables a new class of air-cooled laser systems and penetration into new markets and applications, says the firm.

Using Pearl for upper-state pumping of Nd:YAG or Nd:YVO₄ allows the design and manufacture of air-cooled, diode-pumped solid-state laser systems. Due to its single-emitter architecture, narrow spectral widths of less than 3.5nm full width at half maximum (FWHM) can be maintained.

Many customers see the 879–888nm series as crucial to their development of next-generation laser systems, claims Rob Martinsen, VP of product development. Offering efficient sources optimized for upper-state pumping establishes a clear roadmap to air-cooled laser systems, he adds.

The Pearl solid-state laser pump series can be optimized for wavelengths spanning 795–888nm, and for various fiber core size and length options.

www.nlightphotonics.com

IN BRIEF

VCSEL halves power consumption for consumer apps

Bookham has launched a vertical-cavity surface-emitting diode (VCSEL) that uses its patented wide oxide aperture design and cuts power consumption to under 5mW (half that of previous offerings). The VCSEL is targeted at the optical computer mouse market, as well as other consumer, battery-powered applications where power consumption is a key factor in product design.

Available in a standard TO package interface, the single-mode 850nm VCSEL is polarization stable, and retains the reliability, robustness and ESD resistance of prior higher-power-consumption devices.

Bookham has now shipped more than 13 million polarization-stable VCSELs. In January 2008, the firm announced the transition of VCSEL manufacturing to its High Power Laser facility in Zurich, Switzerland to meet increasing demand from consumer applications.

"Power consumption is a major consideration for designers of any product that is battery powered, including mobile handsets, mobile sensing devices and, of course, optical navigation systems including computer mice, where we are seeing huge demand for high-performance, polarization-stable VCSELs," says Karlheinz Gulden, director VCSEL business. "Through optimization of the laser design, we have successfully reduced power consumption by over 50% and retained all the reliability and stability performance benefits of our unique, patented wide oxide aperture design that has been shipping for more than eight years," he adds. "Our state-of-the-art manufacturing facility allows us to meet volume demand for VCSELs for optical engines in a wide variety of markets."

Single-bar laser boosted to 200W and 30% fill-factor 808nm bar to 60W

At Photonics West 2009 (24-29 January), Bookham Inc of San Jose, CA, USA, which makes optical components for industrial

applications, unveiled what it believes is the most powerful commercially available continuous wave (CW) single-bar product: a 10mm laser diode bar with an output power of 200W (up 60% on its previous product with the same footprint). Available in wavelengths of 915-980nm, the higher-power bar is designed to enable manufacturers of direct diode laser systems to compete with fiber lasers and CO₂ lasers in multi-kilowatt material processing applications.

The new bar is designed on a micro-channel single-sided cooling configuration to allow a low pitch for the stack, and meets the need of direct diode and solid-state laser system manufacturers for increased power with discrete piece parts and reduced complexity of optics, says Bookham. In line with scaling the output to 200W, efficiency has been scaled to reduce heat dissipation, resulting in a wall plug efficiency of 65%.

"Bringing to market a diode bar capable of delivering 200W with such a small form factor is a major achievement," claims Gunnar Stolze, director High Power Laser marketing & sales. CO₂ laser systems have dominated the materials processing market in the 5-20kW range for applications such as metal cutting and welding. The new high-power, high-brightness bar will open up that significant market to the direct diode manufacturers, he adds.



200W laser diode bar.

Bookham has also launched its latest generation of high-power 808nm-wavelength laser diode bars. A capability of delivering 60W of output power with a fill factor of just 30% and an emitter pitch of 500µm suits fiber-coupled and pump laser applications, including defense, medical and material processing laser systems.

Retaining the existing small footprint of Bookham's 40W 30% fill-factor products enables existing customers to upgrade their laser system's power without altering current bar configurations, and without the need to replace expensive optics, says the firm.

"The new generation of 808nm bar products continues to meet customer demand for higher powers with greater fiber coupling efficiency," says Stolze. "We are already working closely with customers to offer further reduced fill factors," he adds.

Bookham says that, like all its High Power Laser products, the front facet of both new laser diode

bars is protected against catastrophic optical damage by the firm's proprietary E2 mirror passivation process.

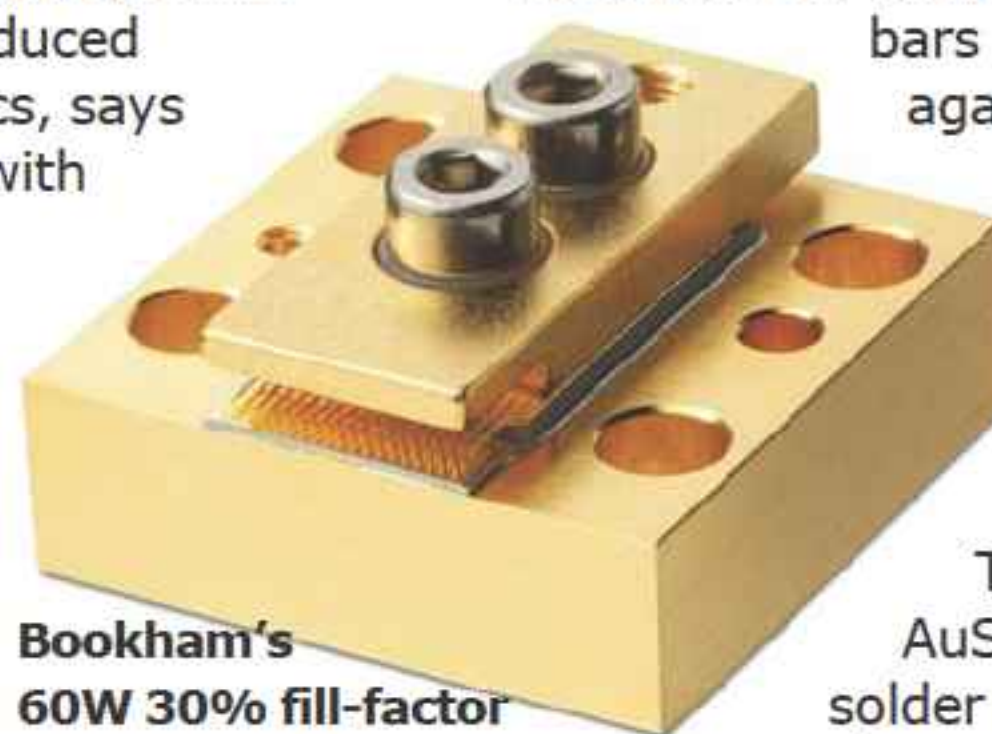
Telecom-grade AuSn (gold tin) hard solder makes the products suitable for

demanding industrial and defense applications in CW and hard pulse operation mode.

● At Photonics West's associated symposium 'LASE 2009', Bookham presented two technical papers: 'Improved brightness on broad-area single emitter (BASE) modules' and 'Power scaling of bars toward 80mW per 1µm stripe width reliable output power'.

www.bookham.com

<http://spie.org/photonics-west.xml>



Bookham's 60W 30% fill-factor laser diode bar.

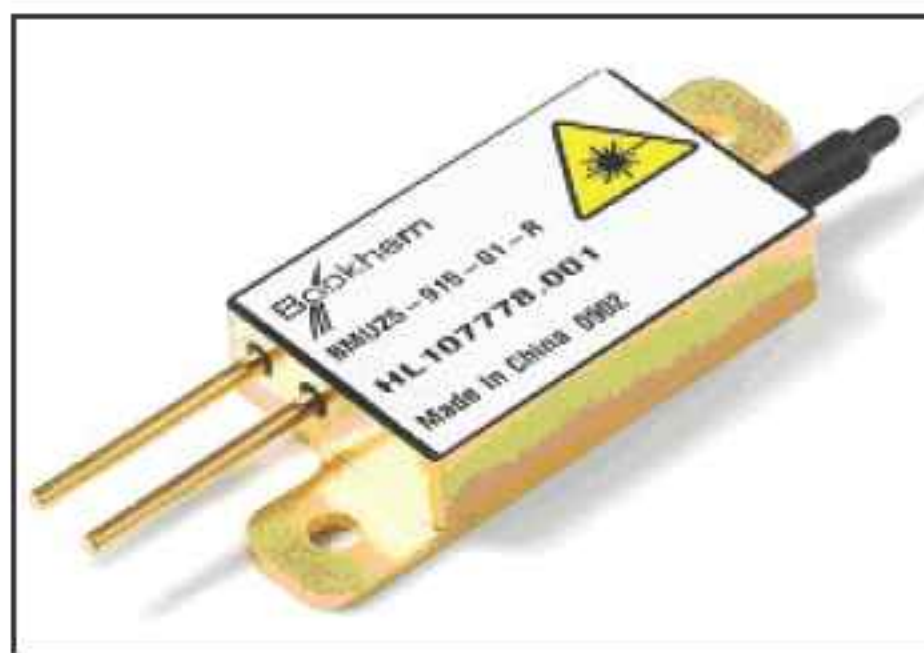
Bookham increases multi-emitter pump module power from 20W to 25W for fiber-laser applications

At the Photonics West 2009 show in San Jose, CA, USA, San Jose-based Bookham launched a high-power multi-emitter pump module that is capable of delivering 25W from a 105 μ m fiber with a numerical aperture (NA) of 0.15.

The module features the latest generation of multimode pump laser chips fabricated at Bookham's plant in Zurich, Switzerland, which enable a boost in power from the firm's 20W module (launched last September).

The new product meets fiber-laser manufacturers' demands for increased output power and brightness, compact pump configurations, and reduced overall system cost, the firm says.

Hermetically sealed and incorporating a floating anode and



Bookham's 25W multi-emitter pump module for fiber-laser applications.

cathode, the pump laser module's compact design reduces the footprint of fiber-laser pump stages.

The latest generation of multimode pump laser chips enables a boost in power from the 20W module

Bookham says that the new module is tailored for high-volume manufacturing in its packaging and assembly facility in Shenzhen, China.

The future-proof solution also allows for the scaling of output power through the integration of future-generation chips or increasing the number of chips used, allowing fiber-laser manufacturers to seamlessly upgrade pump stages or to reduce the number of pumps required in order to lower system costs.

"This is a significant evolution in the development of our portfolio of high-power pump modules for the fiber-laser market," says Gunnar Stolze, director of High Power Laser marketing & sales.

www.bookham.com

Bookham launches high-power 200mW version of New Focus single-wavelength laser for Raman spectroscopy and interferometry

Bookham has supplemented its New Focus SWL-7500 portfolio of single-wavelength lasers with the high-power SWL-7513-H laser, capable of delivering over 200mW of power in a stable beam that retains the same narrow linewidth and precision as the firm's long-standing 70mW version of the SWL-7513.

Demonstrated at the Photonics West 2009 show in San Jose, the high-power SWL-7513-H laser is designed to target process Raman spectroscopy and interferometric metrology (where high power, narrow linewidth and long coherence length are crucial) and can address industrial applications such as quality control, chemical analysis, and security. The laser can be produced with a range of wavelengths to meet customer demand, and has been tailored to reach the Raman legacy wavelength of 785nm.



The New Focus SWL-7500 200mW high-power laser.

The high-power laser uses GaAs chips fabricated at Bookham's plant in Zurich, Switzerland. The chip design also underpins the firm's market-leading terrestrial

and submarine telecom amplifier and pump portfolios, including the 750mW ultra-high-power pump and the OceanBright submarine pump.

The SWL-7513-H opens up new and significant industrial markets for Bookham's New Focus brand, says New Focus product line manager Michael Radunsky. "To be able to leverage the skills, experience and capabilities of the Zurich facility has given the New Focus brand a genuine edge; we are taking some of the world's leading high-power chips and combining them with a laser designed for extremely demanding, high-precision applications," he adds.

"This project has been an excellent example of vertical integration within Bookham and has extended both the New Focus product offering and the capability of the Bookham high-power chip team in Zurich."

www.newfocus.com

Enhanced 793nm mini fiber package laser

Intense Ltd has unveiled an enhanced version of its Series 8000 793-MFP high-power and fiber-coupled diodes (launched last year).

The Series 8000 793-MFP delivers up to 4W of stable continuous-wave (CW) output power from a 100µm-core 0.22NA fiber at wavelengths in the region of 793nm (with lower-NA fibers available on request). The devices are integrated in Intense's standard mini fiber package (MFP), providing a robust and cost-efficient solution for a range of applications.

The lasers are also available in a free-space configuration on C-mount with a FAC-lens and on isolating sub-mounts. The devices use the firm's patented epitaxial growth and wafer processing technologies, including asymmetric waveguides, increasing the product brightness and reliability.

The targeted wavelength, combined with a narrow beam divergence, suits application to next-generation eye-safe thulium-doped fiber pump lasers (which are used in defense and aerospace applications such as LIDAR and direct infrared countermeasures), where enhanced power and beam quality are essential, says Kevin Laughlin, VP global sales & business development. Laughlin adds that the new power level meets the growing demand that Intense is seeing for pumps, particularly for eye-safe thulium-doped fiber-laser systems, as well as replacements for existing solid-state technology (DPSS) in medical and industrial applications. In addition to the eye-safe solutions, thulium fiber lasers provide unique processing benefits for medical and industrial applications compared to DPSS and ytterbium (Yb) fiber sources.

The high power, reliability and compact design also deliver an alternative pump technology to expensive, fiber-coupled laser bar packages, Laughlin says.

www.intenseco.com

Intense broadens range of mil-spec QCW bars and stacked arrays

Intense Ltd of Glasgow, UK has expanded its range of high-power QCW (quasi-continuous wave) bars and stacked array products.

The Hermes stacked array product line now includes higher-power (1200–2000W) QCW products, qualified to military standards. Also, new, passively mounted QCW bars provide power of more than 300W.

All Hermes bar and stacked array products use Intense's patented QWI technology, enhancing device reliability, the firm claims.

"The bar and stack market is demanding higher power and improved efficiency levels," says Kevin Laughlin, VP of global sales & business development. "The expansion of Intense's QCW product line delivers these benefits to its customers across print, defense, industrial and medical sectors."

In addition to increased powers and reliability, Intense is launching a new 'H'-style mounted bar designed specifically for high-power, high-efficiency rod pumping applications. The 'H' mount can be used in its standard configuration or it can be lensed using either a slow or fast axis collimator lens, depending on customer requirements.

"As flash lamp pumped sources come under greater pressure and



Hermes stack.

scrutiny, the new 'H' mount pump diode assembly offers a very cost-effective solution for laser system manufacturers, enabling them to benefit from diode pumping solutions," says Laughlin.

Intense says the product launches bring new solutions to defense and other mobile applications where reliability and performance in harsh environments and operating conditions are essential.

The entire Hermes family is available in a range of wavelengths suitable for direct diode pumping, illumination and direct material processing applications. The bars and stacked arrays are available in standard 'G', 'CS' or 'H' mounts. Custom configurations, mounts and multi-color stacks are also available.

Intense can also provide bars and stacked arrays with a variety of macro- and micro-lenses as well as integrating drive electronics into higher-level diode modules or packs.

www.intenseco.com

Laser arrays for real-time label printing

Intense Ltd is developing a fully integrated module incorporating a high-performance laser diode array for the automatic fruit labeling systems of Sinclair Systems International LLC of Fresno, CA, USA.

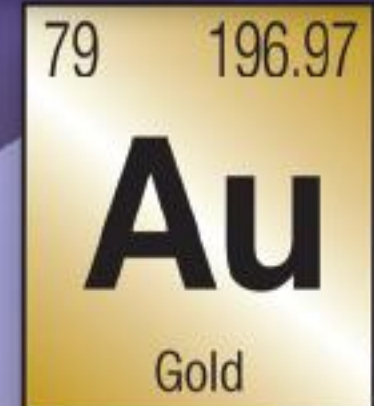
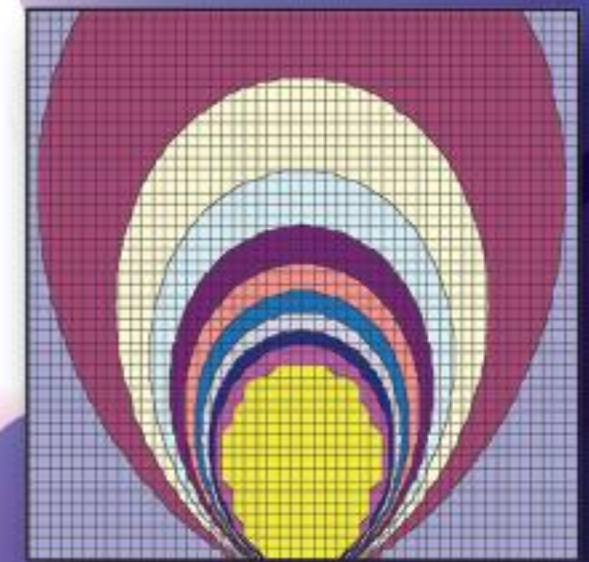
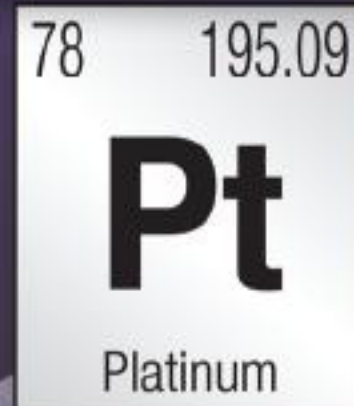
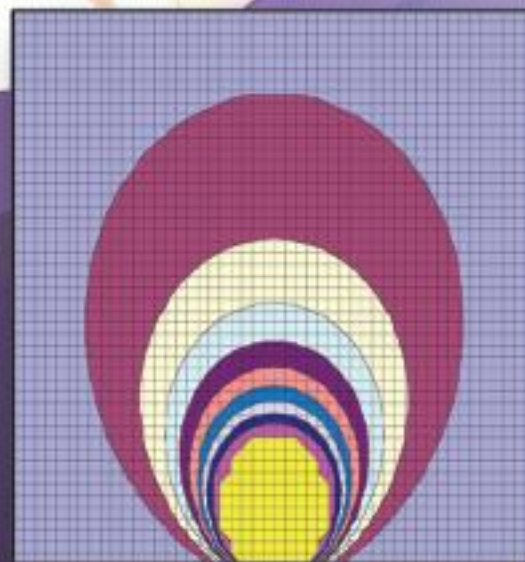
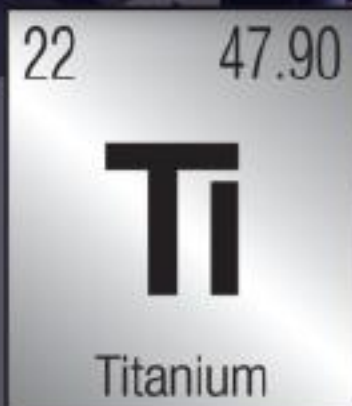
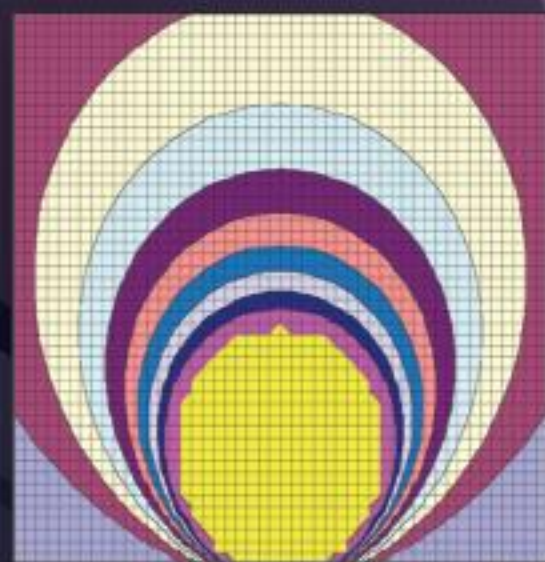
The laser print-head uses Intense's DLAM technology incorporating individually addressable lasers in an uninterrupted constant-pitch 'super-array', enabling construction of wide laser arrays from smaller monolithic arrays. Widths of more than 2" are possible, with each channel capable of delivering pow-

ers of several hundred milliwatts. In combination with advanced optics, this will allow Sinclair labeling products to print text and barcode information on to fruit labels in a single pass at high speeds.

"This product demonstrates the unique ability of Intense to provide integrated high-power OEM solutions based on our individually addressable laser array quantum well intermixing technology," says Berthold Schmidt, Intense's VP of product & market Development.

www.sinclair-intl.com

No Guesswork...



Problem Solved... Temescal

Compound Semi

Experts in [^] Metallization

Temescal process scientists have developed a library of *Elemental Knowledge™*. This has led to 3D modeling of metal vapor clouds that enables Temescal to build tools that will optimize your process. A Temescal tool is more than just an Evaporator: the TCS (Temescal Control System) provides the Process Engineer unique control transforming the tool into a simple push-button system.



We've done your EVAPORATION homework for you™

Temescal

www.temescal.net

Firecomms secures \$5m and long-term supply contract

Firecomms Ltd of Cork, Ireland, which manufactures high-speed plastic optical fiber (POF) transceivers and visible-wavelength vertical-cavity surface-emitting lasers (VCSELs), has closed a \$5m (€4.1m) funding round that includes investments from Swisscom Ventures (an investment wing of Switzerland-based telecom provider Swisscom) and electronic device maker Alps Electric Co Ltd of Japan (a major customer for Firecomms' automotive transceiver products) as well as London-based GP Bullhound Sidecar and existing investors Atlantic Bridge, ACT Venture Finance, and Enterprise Ireland.

Firecomms says that its home networking technology enables the quick and easy deployment of fiber-optic cable. Using low-cost, easy-to-use transceivers, like its proprietary OptoLock plugless transceivers, makes possible a reliable and future-proof connection between IPTV set-top boxes and home gateways. Plastic optical fiber technology is widely used in millions of cars, so the devices have achieved the low cost and high reliability required for home applications, the firm concludes.

"Already an adopter of Firecomms' IPTV interconnect technology, Swisscom has first-hand experience with the advantages of plastic optical fiber in the home," says Firecomms' CEO Declan O'Mahoney. "As Swisscom is an innovative leader in IPTV deployment, this investment is a huge validation of our home networking technology and it will enable us to continue to expand our business with telcos all over the world," he adds.

"Firecomms' technology has enabled us to offer a Swisscom-branded fiber-optic self-install solution today," says Swisscom investment partner Pär Lange. "Our engineers have recognized the advantage of Firecomms' Plastic Optical Fiber technology in reducing and simplifying the install time for our IPTV subscribers," he adds.

"Investment in Firecomms will lead to more collaboration between our companies, which will result in the widespread adoption of POF technology throughout the IPTV world."

Alps has also committed to a long-term supply contract of Firecomms high-end fiber-optic transceivers for its networking platforms. "By integrating Firecomms' innovative core technology into our communications

products, we will further our technology lead in this highly competitive marketplace," reckons Alps' board member Toshihiro Kuriyama. "Our investment in Firecomms is intended to accelerate its R&D programs to create even more of these opportunities," he adds.

"This investment by Alps is the next step in a fast-growing partnership," says O'Mahoney. Since beginning an R&D collaboration more than three years ago, Firecomms has developed various communication devices for Alps based on Firecomms transceiver technology. With its transceivers inside a significant number of Alps products, Firecomms says that it will be able to leverage Alps' global presence and marketing power to further expand its business.

Due to the new investment, Firecomms is expanding R&D staff by 10 over the next year.

The investment was announced as part of Firecomms' participation in a recent Enterprise Ireland trade mission to Japan, attended by the Irish prime minister as well as the minister for trade and commerce. Firecomms also has facilities in Japan as well as the USA.

OptoLock built into ST's IPTV set-top box reference design

Firecomms says that its OptoLock interconnect technology has been built into the STMicroelectronics STi7105 reference design for an IPTV set top box. An easy-to-use, low-cost housing for instant termination of bare plastic optical fiber, OptoLock enables the quick and easy connection of POF in home networks directly to the STB.

"This decision by STMicroelectronics to include OptoLock in its reference design demonstrates the inroads that POF has made in the home networking arena," says Hugh Hennessy, VP of sales & marketing. "With more and more device makers including POF ports directly in IPTV and other devices,

consumers will soon be able to realize all the advantages of this do-it-yourself networking technology."

"Our development kit exploits several of the most popular interconnect solutions to enable a quick and easy installation of a set top box," says Jean-Michel Goiran, STMicroelectronics' IPTV Set Top Box business development manager.

OptoLock suits 100 Megabit Ethernet applications with stringent Quality of Service requirements such as IPTV gateways, set-top boxes, and hubs. Its design enables the fiber to be cut and terminated to the exact required length on-site, allowing consumers to quickly and easily terminate bare optical fiber.

Firecomms leads the development of devices that drive POF, a low-cost optical alternative to copper cabling. Due to its ease of use, large core tolerances, and low costs, POF is enjoying significant growth in a wide range of applications. Created 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 used in millions of small-area networks (e.g. in cars) and is rapidly gaining ground in home network and point-to-point interconnections. The POF market is estimated to be worth over \$1bn per year beginning at the end of 2009.

www.firecomms.com

3S launches its first 1064nm pump laser module for non-telecom markets

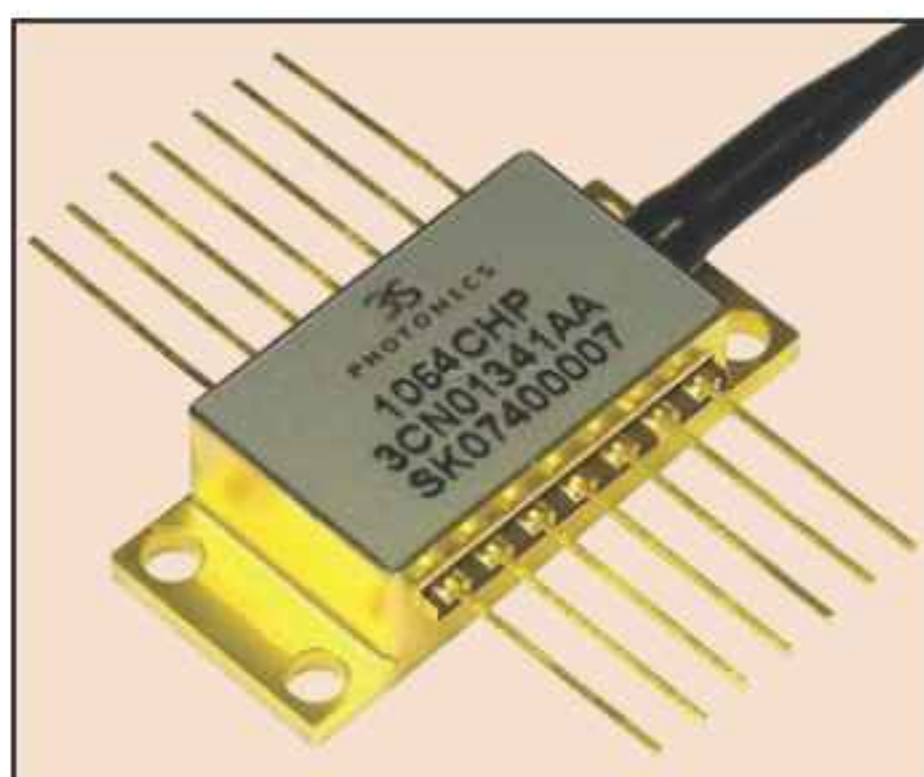
3S Photonics of Nozay (Essonne near Paris), France, which manufactures laser chips, optical discrete modules and components for telecom networks, has launched its first product for non-telecom applications: the 1064 CHP 1064nm-wavelength single-mode pump laser module (with an operating wavelength range of 1050–1070nm). Custom wavelengths are available upon request.

Specifically designed for non-telecom applications, the new technology represents the next step in 3S' strategy, manifesting its market diversification from its core activity — components for submarine and dense wavelength division multiplexing (DWDM) telecom networks.

"When purchasing Avanex's French subsidiary in April 2007 — renamed 3S Photonics from that time — we planned a three-step development," says managing director & CEO Alexandre Krivine. "The first stage was to recover the balance through the optimization of the existing product portfolio, made up of modules for the telecommunication market. The second phase consisted of entering new market segments in telecoms such as terrestrial pumps [with the launch of 980nm terrestrial pump laser modules in December 2007]." After completing these first two steps, 3S now aims to penetrate new markets. "The 1064 CHP precisely shows our will to diversify," adds Krivine.

The firm says that it has leveraged and broadened its technical expertise to design a new generation of powerful seed laser modules for fiber lasers deployed in industrial systems. The technology, developed to be the heart of next-generation fiber lasers, can be used for micro-machining applications as well as in microelectronics, medical and military applications.

The new product outlines 3S' ambition to tap such emerging fiber-laser markets. By focusing on



3S Photonics' 1064 CHP pump laser.

single-mode modules, the firm aims to engage niche markets which are highly demanding in terms of performance and reliability. With what is claimed to be best-in-class operating power (up to 400mW at 850mA and a peak power of up to 1W) and unparalleled reliability records

Specifically designed for non-telecom applications, the new technology represents the next step in 3S' strategy

(a mean time to failure of up to 100,000 hr), 3S says that the 1064 CHP module has been qualified by many customers for materials processing applications of fiber lasers.

Key features include:

- a low-profile hermetically sealed 14-pin butterfly package with polarization-maintaining fiber (PMF) pigtail;
- an integrated thermo-electric cooler (TEC), thermistor and back-facet monitor photodiode; and
- an operating temperature range of -5° to $+75^{\circ}\text{C}$.

Also, two options are also available for the 1064 CHP:

- an FBG-stabilized version, with a fiber Bragg grating for wavelength stabilization; and
- a high-PER version, with a polarization extinction ratio exceeding 20dB.

www.3Sphotonics.com

IN BRIEF

Civcom adds 12.5G RZ tunable transponder

Optoelectronic component, module and subsystem maker Civcom of Petach Tikva, Israel has launched a new 12.5Gb/s return-to-zero (RZ) tunable transponder. Complementing the Free-Light family of 300-pin MSA widely tunable 10Gb/s non-return-to-zero (NRZ) transponders, the RZ transponder offers equipment makers high performance for long-haul terrestrial and submarine applications, the firm says.

Designed specifically to work with 25% forward error correction (FEC) for long-reach dense wavelength division multiplexing (DWDM) applications, the RZ transponder contains both a 10Gb/s widely tunable transmitter (using a widely tunable laser covering the entire C-band) and a wide-band receiver. The module is compatible with the 300-pin MSA and I2C standard.

"Our newly launched RZ tunable 12.5G transponder is built specifically to address the challenging demands of ultra-long-haul terrestrial and submarine applications," says VP of sales & marketing Yair Itzhar. "Using this transponder, carriers can achieve stable transmission performance with low optical signal-to-noise ratio (OSNR) over virtually unlimited distances," he claims.

Although the RZ modulation format is less commonly deployed than its NRZ counterpart, RZ offers advantages in signal quality and non-linear effect handling (improving OSNR by up to 2dB in a simple receiver implementation). In long-haul and ultra-long-haul communications, for example, RZ is much more effective due to its high tolerance of non-linear distortions of the self phase modulation (SPM) type.

www.civcom.com

Opnext's revenues fall 12% from last quarter; XFP products only line not to decline

For its fiscal third-quarter 2009 (to end-December 2008), optical module and component maker Opnext Inc of Eatontown, NJ, USA has reported sales of \$70.5m. This is up 6.2% on \$66.4m a year ago (due mainly to increased sales of XFP, X2 and SFP products, partially offset by lower sales of 40G and XENPAK modules). However, it is down 12.1% on last quarter's \$80.2m.

"The market weakness that we saw at the end of last quarter continued to impact our performance throughout the December quarter," says president & CEO Harry Bosco. The sequential decrease affected all product lines except XFP products. Sales of 10Gb/s and above products fell 13.6% from \$65.6 to \$56.7m, while sales for less than 10Gb/s fell 6.7% from \$9m to \$8.4m, and sales of industrial and commercial product fell 3.6% from \$5.6m to \$5.4m.

Sales to Cisco and Alcatel-Lucent represented 35.2% and 15.9% of sales, respectively, compared to 38.6% and 14.6% last quarter. Sales to other top-ten customers grew 4.4% to 31.8% of revenue.

Gross margin has fallen from 32.8% a year ago and 30.5% last quarter to 22.1%, including a 7.5 percentage point negative effect from excess and obsolete inventory charges associated with reduced demand for communication products. Gross margin was also negatively impacted by lower sales volumes

(partially offset by the net benefit from foreign currency exchange fluctuations and hedging programs).

Operating expenses have risen 27.3% from \$24.4m last quarter to \$31.1m, due mainly to a \$5.7m goodwill impairment charge resulting from communications market weakness, a \$0.9m rise in bad debt expense from the bankruptcy filing by Nortel Networks, and the impact of foreign currency exchange fluctuations (partially offset by a drop in spending for R&D materials).

Excluding goodwill impairment, stock-based compensation expense, class-action-related litigation expenses and costs from the acquisition of StrataLight Communications Inc of Los Gatos, CA, USA (announced last July), non-GAAP net loss was \$6.8m (largely due to the \$5.3m rise in excess and obsolete inventory charges and \$0.9m of Nortel-related bad debt expense). This compares with net income of \$3m last quarter and \$5.6m a year ago.

Cash and cash equivalents fell from \$221.7m at the end of March to \$206m, due mainly to \$6.6m of short-term loan payments, \$6.5m of payments on capital lease obligations, \$2.2m of costs incurred in connection with the StrataLight acquisition, and \$2.5m of additional capital investments.

"We expect weakness to continue in 2009," says Bosco. Opnext is also experiencing increased pricing

pressure, an unfavorable product mix, and the impact of foreign currency exchange fluctuations.

"In this difficult demand environment, our focus is on continuing to serve our customer base, completing the integration of StrataLight, and reducing our expense structure while we continue to invest in R&D programs for our future," Bosco says. "Our goal remains to enhance our industry leadership at the higher network speeds and expand our customer relationships as we address the continuing need for greater bandwidth," he adds.

"We continue to take a cautious short-term view based on a challenging macro-environment and tempered customer views," Bosco says. For fiscal Q4/2009 (to end March), Opnext hence expect revenues of \$80-90m, including results from StrataLight (acquired on 9 January, which designs and makes 40Gb/s line-side optical subsystems and dispersion compensation modules). ● StrataLight stockholders received \$30m in cash plus 26.5m shares of Opnext common stock (29% of its outstanding capital stock). The firm's president & CEO Shri Dodani (who has been collaborating with Opnext's COO Gilles Bouchard on integration planning efforts) has joined Opnext's leadership team. StrataLight's Charles J. Abbe and Phil Otto have joined Opnext's board.

www.opnext.com

President & CEO Bosco to be chairman, replaced by COO Bouchard

Harry Bosco will retire as Opnext's CEO & president from 1 April (becoming chairman of the board). He will be replaced by chief operating officer Gilles Bouchard, who joined Opnext in November 2007. "His prior experience at Hewlett Packard as executive VP of operations and managing fast-growing, successful businesses has been

very beneficial as we position the company for the future," says Bosco.

"2009 will be a year of change for Opnext, organizationally and operationally," says Bouchard. "Optical network design complexity increases significantly



as we move to higher speeds, and the marriage of optical device and module technology with subsystems expertise will help our customers optimize their future network designs for superior performance and cost," he adds. "With much planning behind us, we look forward to a smooth and swift integration."

Mitsubishi first to ship XLMD-MSA compliant 43Gb/s devices for both transmit and receive ends of optical link

Tokyo-based Mitsubishi Electric Corp has begun sample shipments of two 43Gb/s optical devices compliant with the 40Gb/s miniature device multi-source agreement (XLMD-MSA, effective since March 2007 among Eudyna Devices Inc, Mitsubishi Electric Corp, NEC Electronics Corp, Oki Electric Industry Co, Ltd, Opnext Inc and Sumitomo Electric Industries Ltd). The devices were displayed at January's Fiber Optics Expo (FOE 2009) in Tokyo.

With increased Internet traffic in recent years, service providers have been rushing to expand the transmission volume of optical communications networks. To increase optical transmission speed between metropolitan-area networks and routers, there is hence growing demand for network replacements that achieve a transmission speed of 43Gb/s (up from the previous 10Gb/s).

In February 2008, optical device makers including Mitsubishi Electric

announced common specifications for pigtail-type optical devices based on the XLMD-MSA, but XLMD-MSA compliant transmitter and receiver devices have yet to be launched by a single manufacturer. Mitsubishi Electric reckons that it is the first optical device maker to ship XLMD-MSA compliant optical devices for both ends of optical transmission.

The FU-697SEA (costing 650,000 yen) is claimed to be the first XLMD-MSA compliant optical transmitter device. A package that is 15% smaller than that of the preceding model (the FU-642SEA) incorporates an external-modulation laser and

Mitsubishi Electric reckons that it is the first optical device maker to ship XLMD-MSA compliant optical devices for both ends of optical transmission

Mitsubishi Electric's original built-in bias circuit, which sends DC bias voltage to the modulator independent from the circuit connecting the driver IC. The output voltage of the built-in single-chip driver IC is hence effectively applied to increase the on/off extinction ratio performance in optical transmission, which should contribute to greater stability in network communications.

The FU-397SPP (costing 500,000 yen) is an XLMD-MSA compliant photodiode with a transimpedance amplifier (PIN-TIA) receiver device at the opposite end that has high reception performance with a wide dynamic range of over 9dB. Its size is 30% smaller than the previous model (the FU-342SPP, which was launched in April 2008).

Mitsubishi Electric reckons that the new devices should contribute to the spread of 43Gb/s optical transmission networks.

<http://global.mitsubishielectric.com>

Mintera claims first enhanced-DQPSK DWDM module

At the 9th Fiber Optics Expo (FOE 2009) in Tokyo, Japan in January, Mintera Corp of Acton, MA, USA, which provides optical transport systems enabling migration to 40-100Gb/s in metro-core, regional and ultra-long-haul networks, has launched what it claims is the industry's first enhanced-DQPSK module product.

Available in a standard 300-pin package, the MI 5000XM's enhanced-DQPSK modulation format allows it to deliver high polarization mode dispersion (PMD) tolerance, high launch power tolerance, support for reconfigurable optical add-drop multiplexers (ROADMs), and ultra-long-haul (ULH) reach.

Incorporating elements of Mintera's patent-pending Adaptive-DPSK technology, the MI 5000XM

supports channel spacing as small as 25GHz. Its modulation format also incorporates an enhancement to enable higher channel launch powers, resulting in increased transmission reach and greater system design flexibility.

The MI 5000XM conforms to the industry-standard footprint and OIF SFI-5 standards. In addition, its form and fit compatibility with the MI 4000XM Adaptive-DPSK 300-pin DWDM module (first shipped in December 2007, and now shipping in volume), allows fitting of either module on the same WDM system card. 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 addition of the MI 5000XM to our product portfolio enables Mintera to offer a unique product set," claims president & CEO Terry Unter. "Enabling Mintera's large customer base to utilize their existing card design for deploying the MI 5000XM means our customers can now provide a solution for any network deployment scenario with minimal incremental development cost while offering maximum route design flexibility and low pricing," he adds.

The MI 5000XM also incorporates control loops that continuously adapt the internal transmitter and receiver component settings to deliver what is claimed to be outstanding transmission performance under the most demanding signal degradation conditions.

www.mintera.com

Finisar cuts costs after worse-than-expected 14% sales drop

For its fiscal third-quarter 2009 (ended 1 February) Finisar Corp of Sunnyvale, CA, USA has reported revenue of \$137m. This is up 22% on \$112m a year ago, though due mainly to the merger with optical subsystem maker Optium Corp of Horsham, PA last August. Revenue is down 14% on last quarter's \$159m (below guidance of 5–10% due to shortfall across all product lines apart from products for 40Gb/s and short-reach 10Gb/s applications).

Finisar continued to make progress regarding additional new product customer qualifications including:

- 40Gb/s line-side transponder with one customer;
- 40Gb/s client-side transponders with four customers;
- XPAK-SR, X2-LRM and XENPAK-SR transceivers for short-distance 10 Gigabit Ethernet applications with two customers;
- X2-LR and XENPAK-LR transceivers for longer-reach 10 Gigabit Ethernet applications with a major customer;
- 50GHz 88-channel wavelength-selectable switch (WSS) reconfigurable optical add-drop multiplexer (ROADM) line-card with one customer.

However, in light of the current economic environment, Finisar

urges caution in assuming that additional revenues resulting from these product qualifications will be sufficient to offset a further drop in revenue from existing products in Q4/2009 (ending 30 April). Also, many customers are electing to carry less inventory, contributing to the current softness in orders.

Finisar has undertaken cost-cutting actions that are expected to result in annual savings of about \$40m compared to the cost structure of the combined firm for the full fiscal Q2 (ended 2 November 2008). A substantial portion of these savings (about \$28m on an annual basis) will begin to benefit the firm in the current fourth quarter, with the other \$12m following by fiscal Q2/2009 (ending 31 October). Extra savings are being evaluated that should be realized in fiscal second-half 2009 (ending 30 April 2010).

The recent actions that should have a near-term benefit include:

- further staff cuts of about 200 (17% of the headcount — excluding operations in Malaysia and Shanghai — after already cutting 120 jobs in the US last quarter);
- salary cuts of 10% for officers, directors and most staff; and

- elimination of 401(k) matching company contributions.

Other cost-cutting actions that are expected to benefit Finisar from fiscal Q1/2009 (ending 31 July) include: (i) the transfer of product manufacturing to the firm's lower-cost off-shore locations and (ii) cost savings from engineering changes to enable the broader use of internally manufactured components.

"Current economic headwinds make it difficult to achieve revenue growth regardless of the important progress we're making on the new-product customer qualification front," says executive chairman Jerry Rawls. "However, we are doing the one thing we can control in this environment, and that is aggressively reducing costs," he adds.

"We believe our non-GAAP earnings before interest, taxes, depreciation and amortization (EBITDA) can continue to remain healthy even at reduced revenue levels," says CEO Eitan Gertel. "We believe the actions we have undertaken recently to reduce costs will not significantly impact our product design activities, which should position us well for the future."

www.finisar.com

Oplink's revenue falls 12.5%; further 15-25% expected

For its fiscal second-quarter 2009 (to end-December 2008), photonic component, module and subsystem maker Oplink Communications Inc of Fremont, CA, USA has reported revenue of \$37.6m (down 12.5% on last quarter's \$43m and 23% on \$48.9m a year ago).

However, this excluded \$805,000 related to deferred shipments of products for Nortel Networks (which filed for bankruptcy protection on 14 January). Otherwise, revenue would have been \$38.4m (down 11% and 21%, respectively).

Net loss has grown from \$3.4m last quarter to \$10.5m. However, this included \$10.8m for the impairment of goodwill and other

costs associated mainly with the acquisition in October 2007 of Optical Communication Products Inc (OCP) of Woodland Hills, CA, USA.

Excluding this plus \$1.4m in stock-based compensation and \$954,000 in amortization of intangibles, non-GAAP net income was \$2.6m, down only slightly from \$3.2m last quarter (which excluded a \$4.1m provision for excess and obsolete inventory, \$1.6m in stock-based compensation and \$954,000 in amortization of intangible assets).

During the quarter, Oplink generated \$3.4m in cash from operations, repurchased \$2.3m in common stock, and closed the quarter with cash, cash equivalents and short-

and long-term investments of \$146.8m (down only slightly from \$142m at the end of June).

"With continued integration efforts and cost control measures, we are closely aligning our operating expenses with lower near-term revenue expectations," says president & CEO Joe Liu. "While we are cautious about near-term carrier spending and the overall economy, we remain optimistic about long-term demand for our products and services as well as maintaining our leadership in passive optics."

For its fiscal third-quarter 2009 (to end March), Oplink expects revenue of \$28–32m (down 15–25%).

www.oplink.com

Infinera makes loss but adds seven new customers

Infinera Corp of Sunnyvale, CA, USA, a vertically integrated manufacturer of digital optical network systems incorporating its own InP-based photonic integrated circuits (PICs), has reported adjusted revenue of \$353m for 2008, up 14% on 2007's \$309m of invoiced shipments.

On an adjusted GAAP basis (excluding non-cash stock-based compensation and warrant revaluation expenses), gross margin was 43%, up from 41% on an invoiced shipment basis. However, net income fell from \$24.1m to \$14.3m.

For Q4/2008, adjusted revenue was \$86.2m, up 7% on \$80.9m last quarter but down 8% on \$93.4m of invoiced shipments a year ago.

On an adjusted GAAP basis, gross margin has fallen from 47% a year ago and 42% last quarter to 36%. Net loss was \$9m, compared to break-even last quarter and net income of \$15.9m a year ago.

Nevertheless, Infinera has been selected by OTEGLOBE of Athens Greece (the international division of Greek incumbent national carrier

OTE) as the DWDM supplier for its 7000km Transbalkan Network (TBN), which was launched last year to connect Greece and the Balkans with central Europe and western Europe. This represents Infinera's fourth win with Tier 1 incumbent carriers, joining Deutsche Telecom and two others.

"In the fourth quarter we saw continued customer win momentum, with seven new customers added in the quarter [three European-based customers including OTE, three from the Americas, and one from Asia Pacific]," says president & CEO Jagdeep Singh. Of total revenue, 24% came from customers in the EMEA region. Total customer count is now at 56. The top 10 customers accounted for 72% of total revenue (the lowest concentration in the firm's history). Also, for the first time in a single quarter, the company had an internet content provider, a wholesale carrier, a cable MSO, and a tier-one incumbent all among its top 5 customers. In particular, the largest customer (at 23%) was an

internet content provider.

The new customer wins resulted in strong top-line performance. "We believe our ongoing success at winning new customers reflects our increasingly strong position as a strategic supplier of optical transport equipment to a diverse set of customers," says Singh. "However, the common equipment associated with these deployments and additional expected new customer shipments in Q1 put downward pressure on our gross margins in the quarter," he adds.

"While 2009 is shaping up as a challenging one for the optical industry, we believe it will also be a year of significant long-term business opportunities for Infinera as carriers grapple with the strategic challenge of scaling their optical networks," Singh reckons. "With a strong balance sheet and established technology lead, we intend to continue our R&D investments to advance our DWDM leadership position for years to come."

www.infinera.com

Global Access and Infinera complete Japan's first 100GbE demo

Tokyo-based Global Access Ltd (GAL) and Infinera have concluded Japan's first 100 Gigabit Ethernet (GbE) demonstration, involving 100GbE traffic sent over a live network between Tokyo and Osaka (a round trip of about 1200km).

The demonstration shows that GAL's existing network based on Infinera's DTN digital optical networking system can carry 100GbE traffic using Bandwidth Virtualization. The DTN is a digital reconfigurable optical add-drop multiplexer (ROADM) for long-haul and metro core networks, combining high-capacity DWDM transport, integrated digital bandwidth management, and GMPLS-powered service intelligence in a single platform.

"Completion of this 100GbE demo is an important milestone for us as we evaluate technologies and

services for the future, since our customers' bandwidth needs are increasing and GAL is willing to lead the market in offering the most advanced services with the greatest speed, reliability, and security," says Koichi Katagiri, deputy managing director, GAL Engineering Division.

GAL owns and operates a network linking Japan's major cities and cable landing points on the Japanese coast and provides telecom services to other service providers, enterprises, Internet service providers, cable companies, and academic institutions. Last year, the firm deployed an Infinera digital optical network. "Customers demand more services and more bandwidth more quickly than ever before, and the Infinera system, with its revolutionary pho-

tonic integrated circuits, enables GAL to meet those demands quickly and flexibly," says Katagiri.

"The ability of Infinera's Bandwidth Virtualization architecture to deliver any service, from 1 Gigabit to 100GbE, over today's network infrastructure is very attractive for carriers aiming to develop new capabilities and optical services to meet the growing need for bandwidth," says Manabu Nitta, group leader of Product Management Group1, Service Providers business unit, Nissho Electronics (a partner of Infinera). "The end result will be the delivery of practical, cost-effective, and widely deployable 100GbE solutions to the market."

The 100GbE demonstration is a key milestone for Japan, reckons Infinera's CEO Jagdeep Singh.

www.globalaccess.co.jp

JDSU sheds a third of workforce as sales decline accelerates

For its fiscal second-quarter 2009 (ended 27 December 2008), optical communications component maker JDSU of Milpitas, CA, USA has reported net revenue of \$357m, down 6.2% on \$380.7m last quarter and 10.5% on \$399.2m a year ago.

The decline was driven mainly by the economic downturn weakening demand in the Communication and Commercial Optical Products (CCOP) segment, as well as deferring about \$10m of revenue for products shipped to Nortel (for which payment was not received prior to its bankruptcy filing on 14 January). CCOP revenue was down 21% on last quarter to \$127.9m (36% of total revenue, versus 43%).

Specifically, Commercial Lasers revenue was \$18.4m (down 13.7% on last quarter due to declining demand from semiconductor equipment manufacturing and biomedical customers).

Optical Communications revenue was \$109.5m (down 22.2% on last quarter's \$140.6m, just partly due to the \$10m of deferred Nortel revenue). Revenue for reconfigurable optical add-drop multiplexers (ROADMs) grew by 30% to about 30% of optical revenue (having shipped over 30,000 units in total, and maintaining number-one market share, it is believed).

Communications Test & Measurement segment revenue was \$176.2m (49% of total revenue, versus 43% last quarter). This is down 10.8% on \$198m a year ago but up 6.6% on last quarter's \$165.3m due to demand in the Americas (including higher demand for cable products in Latin America).

Advanced Optical Technologies (AOT) segment revenue was \$53.1m (15% of total revenue, level with last quarter). This is down 0.8% on last quarter but up 6.6% on \$50m a year ago.

Non-GAAP gross margin of 43.5% was down from 46.3% a year ago but up slightly from last quarter's 43.3%, boosted by execution against lean initiatives as well as the Test & Measurement segment rising as a proportion of revenue. Also, progress is continuing with improving Optical Communications gross margin, which was 17.4% or (excluding the impact of revenue deferral) 24.6%, up on last quarter (despite the lower revenue). This has been achieved by pruning less profitable products and through lean initiatives and staffing cuts.

"During these challenging economic times we continue to make progress in improving the cost structure and operating model of the company," says president & CEO Tom Waechter. Operating expenses have been cut from \$144.6m last quarter to \$137m, reflecting reductions in discretionary spending, office consolidation, workweek shut-downs, job cuts, and the favorable impact from foreign exchange rates.

On a non-GAAP basis (excluding the impairment of goodwill and long-lived assets of \$699.6m due to the impact of the macro-economic business environment on JDSU's market capitalization) net income was \$24.8m, down

from \$50.2m a year ago but up slightly from \$23.4m last quarter.

During the quarter, the firm had positive operating cash flow. But (after being free cash flow positive

for the past seven quarters) it was free cash flow negative by \$4.6m due to investing \$14m in inventory from products transitioning to contract manufacturers and consuming \$3.7m for restructuring activity.

At the end of the quarter, JDSU's cash balance was \$689m. Net cash increased after reducing outstanding debt balance by \$125m (retiring substantially all remaining zero-coupon senior convertible notes and repurchasing \$50m of 1% senior convertible notes), resulting in a gain of \$22.3m. (The repurchase of an additional 50m of 1% senior convertible notes in January should result in a further gain of \$20m in fiscal Q3.)

JDSU says that it has seen a softening in bookings as customers are impacted by the current economic climate. Also, for fiscal Q3/2009 (ending 28 March), the decline in average selling price (ASP) is expected to be above JDSU's historical range, as the firm has just completed a set of competitive pricing negotiations. JDSU hence expects fiscal Q3 revenue to fall 16–23% to \$275–300m (with the CCOP and Test and Measurement segments declining by the same percentage).

Goals for Optical Communications include sustainable margins of 25–30% near term and greater than 30% longer term. Waechter reckons that JDSU now has a sustainable cost structure from which it can realize a 10% operating margin and a 46% gross margin on revenues of \$400m.

Gross margin improvement initiatives include continuing to simplify and scale the business model by reducing JDSU's overall complexity. This is being done by moving from a fixed-cost to a more variable-cost manufacturing model (transitioning more manufacturing to contract

Gross margin improvement initiatives include continuing to simplify and scale the business model... This is being done by moving from a fixed-cost to a more variable-cost manufacturing model

manufacturers, while retaining manufacturing processes unique to JDSU). As a result, more than 20% of JDSU's currently occupied real estate will be vacated.

In particular, JDSU is divesting its assembly plant in Shenzhen, China (which makes its optical communications transport and transmission products) to contract manufacturer Sanmina-SCI (see panel below). This involves transferring about 2000 staff (contributing to headcount of 6645 being cut by more than 2200 — almost a third — by the end of fiscal 2009). JDSU says it will benefit from the lower fixed-cost model, while Sanmina increases its capacity in the Shenzhen area and boosts its optical assembly & test expertise. JDSU is also undertaking last-time product builds at its submarine product assembly plant in San Jose: future assembly and services will be provided by Shenzhen.

JDSU began its 'lean manufacturing' productivity improvement program over 12 months ago (in advance of the downturn), giving the firm an advantage over its peers, Waechter

believes. Chief financial officer Dave Vellequette reckons JDSU will have cut its revenue breakeven point to \$300–310m by the end of the March quarter, then by a further \$15–20m (thanks to the Shenzhen transition) to \$290–295m by the end of the June quarter. In total, operating costs will be cut by \$28m per quarter during fiscal 2009.

Our strong balance sheet, aggressive cost-saving programs and strategic focus will allow us to weather the current global economic headwind

and our lean initiative activities, which I believe will uniquely position JDSU for future growth once market conditions improve."

www.jdsu.com

"Our strong balance sheet, aggressive cost-saving programs and strategic focus will allow us to weather the current global economic headwind," says Waechter. "We will continue to focus on innovation

Distinguished Partner Award from Fujitsu

Out of thousands of its suppliers, Fujitsu Ltd has granted one of 15 Distinguished Partner Awards to JDSU of Milpitas, CA, USA for its 'outstanding contribution' in the development and manufacturing of optical communications products — specifically, reconfigurable add/drop optical multiplexers (ROADMs) — enabling it to meet increased demand for key service provider network build-outs. JDSU was the only optical component and module supplier recognized.

"Network bandwidth will only continue to increase, and ROADMs are a key component that will allow optical networks to evolve to support that demand, while helping service providers reduce operating costs," says Alan Lowe, president of JDSU's Communications and Commercial Optical Products business segment. "We look forward to continuing our close partnership with the company," he adds.

www.fujitsu.com

JDSU divests Shenzhen plant to contractor Sanmina

Optical communications component maker JDSU of Milpitas, CA, USA has signed an agreement for electronics manufacturing services (EMS) provider Sanmina-SCI Corp to manufacture its products.

Sanmina-SCI will acquire certain manufacturing assets, inventories, and employees related to JDSU's 320,000ft² assembly & test operations in Shenzhen, China (opened in early 2001). The transaction is expected to close by 6 April. JDSU announced late last October that it aimed to consolidate its number of plants. The firm retains fabs in the San Jose area and in Colorado (formerly VCSEL manufacturer Picolight, acquired in mid-2007).

As part of the deal, Sanmina-SCI will build on the capabilities of JDSU's Shenzhen operations to offer telecoms firms access to new product introduction (NPI) and



JDSU's Shenzhen plant.

manufacturing services for optical products. Sanmina-SCI says that the transfer of staff and inventory should allow it to produce and deliver orders without any interruption to JDSU and its customers. JDSU will continue to maintain corporate functions and product development in the region.

"The new partnership represents an important part of JDSU's manufacturing strategy to leverage the skills of world-class EMS partners like Sanmina-SCI for products and

services where possible, while retaining key elements internally that provide a unique advantage to JDSU," says Alan Lowe, president of JDSU's Communications and Commercial Optical Products business segment. "Working with a leader like Sanmina-SCI provides JDSU with the flexibility to best support our customers and ensure joint success in today's economic climate," he adds.

"This collaboration fulfills our long-term strategic goal to expand and solidify our position in this field," says Sanmina-SCI's president & chief operating officer Hari Pillai. "The combination of our current capabilities and the expertise of the Shenzhen team will give Sanmina-SCI the strongest optical assembly & test resources of any major EMS company," he claims.

www.sanmina-sci.com

Bookham and Avanex merging

After years of speculation, optical component, module and subsystem makers Bookham Inc of San Jose and Avanex Corp of Fremont, CA have agreed to merge in an all-stock transaction (subject to the approval of both firms' shareholders).

Avanex shareholders will receive 5.426 shares of Bookham common stock for every share of Avanex common stock, valuing Avanex at \$35.4m (\$2.17 per share), a 67% premium over the closing price of \$1.30. Upon the deal being completed (expected within 3–6 months, when a new name will be adopted), Avanex shareholders will own about 46.75% of the combined firm and Bookham 53.25%. In the interim, both firms will continue to operate their businesses independently.

President & CEO of the combined firm will be Bookham's president & CEO Alain Couder. He will be joined on the board of directors by three directors from Bookham's board (Edward Collins, Lori Holland and Bernard Couillaud, who will be chairman), as well as Avanex's president & CEO Giovanni Barbarossa (who remains in a consulting capacity to assist with the merger) plus two directors from Avanex's board (Greg Dougherty and Joel Smith). Other executives include Jim Haynes as chief operating officer (COO); Jerry Turin as chief financial officer; Richard Smart and Adrian Meldrum as general managers of two Telecom business units; Yves Lemaitre as general manager of the Non-Telecom business unit; and Scott Parker as VP of sales.

Integration is expected to take 6–9 months. It is not expected that any manufacturing sites will be closed (although the merged firm will re-evaluate its assessment on a regular basis). Bookham has chip fabrication facilities in the UK and Switzerland (Zurich), as well as manufacturing sites in the USA and China. Avanex has facilities in Horseheads, NY (amplifiers and dispersion compensators); Shanghai, China; Villebon

Sur Yvette, France; San Donato, Italy (lithium niobate modulators); and Bangkok, Thailand (an administrative center near subcontract manufacturer Fabrinet).

In addition to having solid, long-standing, strategic relationships with the top 15 optical OEMs, the new firm reckons it will have one of the industry's broadest portfolios of optical products for long-haul and metro, covering both the line (amplifiers, pumps and passives) and terminal (transmit, receive, transponders) areas, as well as having vertical integration from chips to components, transponders and subsystems.

Bookham brings primarily chip and component expertise and tunable products. Avanex mainly brings expertise in modules such as controlled amplifiers and integrated subsystems. There is overlap in optical amplifiers, subsystems and optical modulators so, over time, the aim is to rationalize the benefits and best parts of both organizations.

Bookham brings primarily chip and component expertise and tunable products. Avanex mainly brings expertise in modules such as controlled amplifiers and integrated subsystems. There is overlap in optical amplifiers, subsystems and optical modulators

On the optical amplifiers side, the new firm will have access to internal pumps and passives as well as a broad customer base. On the transmit side, it reckons that it will have the internal technology and key differentiated technology required to grow transponder business and take advantage of the large addressable market at 10G and the growing market at 40G.

Key strengths of the new firm include:

- what is claimed to be best-in-class telecom chips based on InP, lithium niobate and GaAs;
 - being well positioned for 40Gb/s and reconfigurable networks;
 - leveraging new opportunities quickly within an expanded customer base;
 - the resources to enable leading R&D investment in key product lines (focusing spending rather than spreading it more thinly by pursuing the same opportunities as standalone firms);
 - the ability to leverage a mixed-model manufacturing strategy of both in-house and outsourced capacity, with decisions based on how best to achieve flexibility, efficiency and the lowest cost to maximize gross margin (Bookham has previously shifted much manufacturing from San Jose to its plant in Shenzhen, China, while Avanex has outsourced its manufacturing, largely to subcontractor Fabrinet).
- The firms reckon that the merger will take advantage of the merits of both business models. In-feed of components from Bookham into Avanex amplifiers and subsystems should improve gross margins and cost points, further improving vertical integration.
- "The combination of Bookham and Avanex creates synergies that we expect will significantly improve financial performance faster than either of the two companies could accomplish on a stand-alone basis," says Couder. "There is minimal product overlap between our businesses, allowing us to quickly expand sales opportunities and improve service to our customers. In addition, both companies have strong technology platforms and the best engineering teams that we expect will allow us to drive innovation and expansion for both existing and new growth areas," he adds.
- "The significant financial and technological advantages to combining

Telecom Metro and Long Haul Markets		Bookham	Avanex	Bookham & Avanex	JDSU	Finisar	Opnext
Transmission Components							
Tunable lasers	●	○	●	●	●	○	○
Fixed lasers	●	○	●	●	●	●	●
Modulators	○	●	●	●	●	○	○
Transmission Modules							
10G	○	○	○	○	○	●	●
40G/100G	○	○	○	○	○	●	●
Wavelength Management							
WSS ROADM	○	○	○	○	●	○	○
Micro-Optics and Filters	○	●	●	●	●	○	○
Amplification							
Modules	○	●	●	●	●	○	○
Components	●	○	●	●	●	○	○
Integrated Amplifier Solutions	○	●	●	●	○	○	○
Dispersion Compensation							
Fixed 10G	○	●	●	●	○	○	○
Tunable	○	●	●	●	○	○	○
Subsystems (software and hardware integration)							
	●	●	●	●	●	○	○

Legend: ○ → ●
Limited presence Market leader

Consolidation in telecom, metro and long-haul optical markets.

the two companies will benefit our customers, employees, and shareholders," comments Barbarossa. "The combination of Avanex's next-generation subsystem design and integration capabilities, enhanced with additional internal content from Bookham, will deliver end-to-end product offerings at competitive prices."

The combined firm is expected to be adjusted EBITDA accretive (compared to Bookham's standalone results) in its first full quarter. Synergies such as a combined sales

organization and single public company costs should generate \$7m of quarterly cost savings by the end of the fourth full quarter (\$28m annualized).

Merger-related restructuring costs are expected to be less than \$7m (mostly in the first year, with most work done in the first six months and costs to be covered by synergies over the same timescale).

The new firm should have a stronger balance sheet, benefiting from combined cash balances and no outstanding debt.

In the year to September 2008, Bookham and Avanex respectively reported gross margins of 24% and 28%, SG&A (selling, general and administration) expenses of 17% and 18%, and non-GAAP operating margins of -5% and -2%. The target operating model for the merged firm is for gross margin of 31%, SG&A expenses of 12%, and non-GAAP operating margin of +7% for its fourth full quarter and 35%, 12% and +10%, respectively, long term.

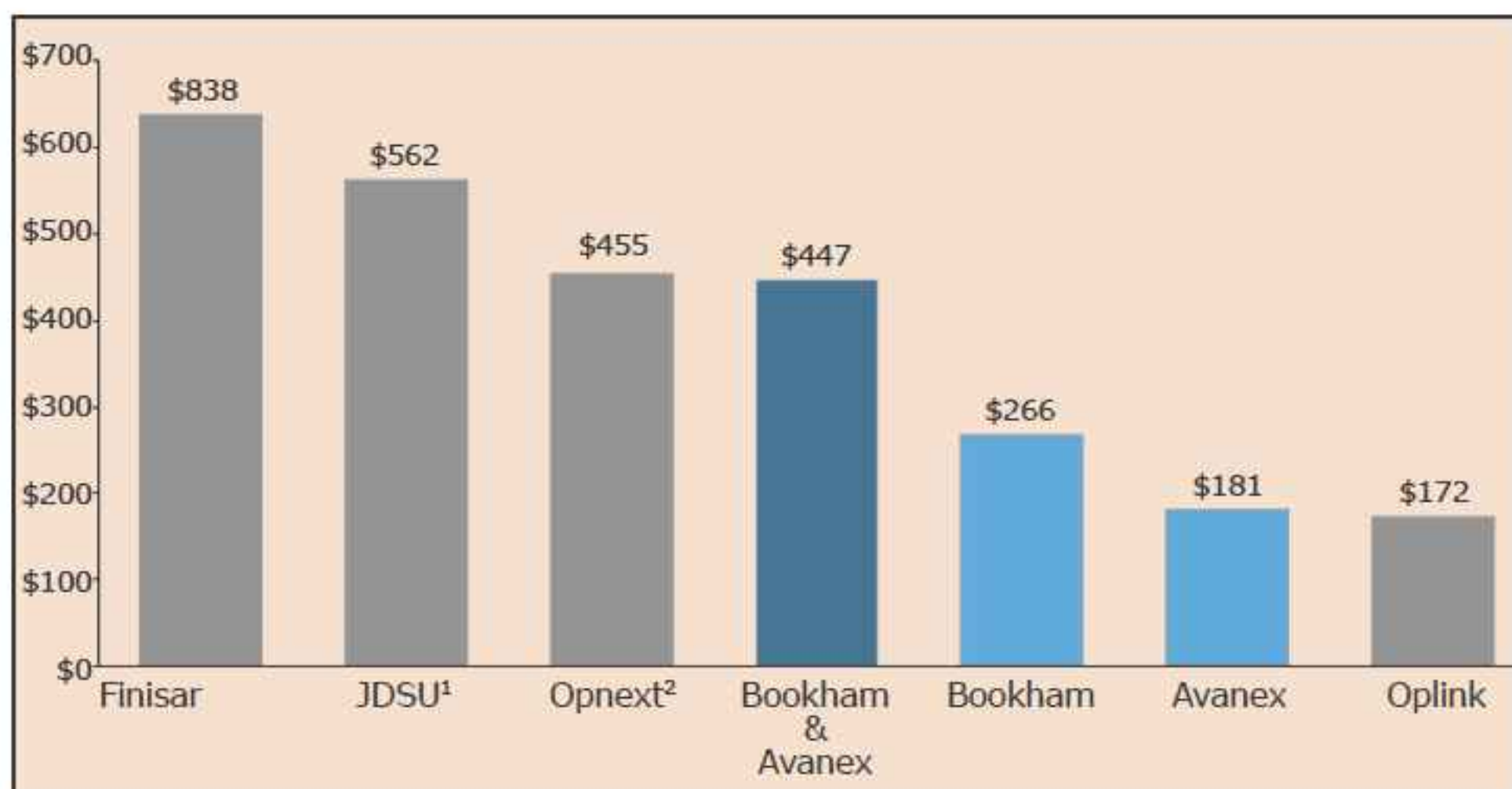
Both firms separately have been reaching critical mass to invest competitively in each key product line, and it would have been difficult for either alone to maintain the required level. The intention for the merged firm is for R&D spending to ultimately be 13% of revenue (perhaps exceeding any other competitor, reckons Couder), which is a level that is thought to be necessary to be a leader in the industry.

The new firm's main competitor will be JDSU, while Finisar, Sumitomo, Opnext and Emcore will compete in selected market segments. Last August's merger of Finisar and Optium created a direct competitor to JDSU, while Opnext's acquisition of StrataLight (completed earlier this month) pushed Bookham and Avanex to fourth and fifth largest optical communications component firms (by revenue).

This was despite Avanex previously acquiring Essex Corp's Commercial Communication Products Division (CCPD) in 2007, and Bookham acquiring optical components businesses of Nortel Networks and Marconi in 2002, Ignis Optics Inc, Cierra Photonics Inc, New Focus Inc in 2004, and Onetta Inc and VCSEL manufacturer Avalon Photonics in 2006.

The combined firm will be back on a par with Opnext as third largest. In particular, while Bookham and Avanex separately have lacked scale, together they reckon they will represent arguably the largest player within the metro and long-haul sector.

www.bookham.com
www.avanex.com



Annualized revenue (\$m) for September quarter (October quarter for Finisar):
¹ optical communication segment only; ² pro forma for StrataLight acquisition.

IN BRIEF

Pump laser chip hits 300m field hours

Bookham says that its flagship generation eight (G08) optical chip, designed for signal amplification in telecom networks, has achieved a combined total of 300 million field hours. This contributes to the 20 billion field hours generated by the firm's broader pump portfolio, which has demonstrated a FIT (failure in time) rate of <15FITs in the terrestrial market.

Manufactured at Bookham's plant in Zurich, Switzerland and fully qualified to Telcordia requirements and beyond for both terrestrial and submarine applications, the G08 chip has been an integral part of Bookham's portfolio of pump laser and amplifier products for four years, and underpins its 750mW pump laser module and the OceanBright submarine pump.

The 750mW pump laser module has been shipping in volume since March 2007 and has the highest power available, claims director of product management Mark Ives. It offers the opportunity to replace two pump laser modules with one, improving cost and performance and enabling a reduced footprint for amplifiers. Bookham claims that the module has the industry's widest operating temperature range at 750mW (from -20° to +75°, covering uncontrolled environments and central office under fault conditions) as well as the lowest-profile package available (just 7.6mm).

Bookham's OceanBright pump has been shipping in volume to major tier-1 submarine equipment makers since September 2007. The module is capable of exceeding 400mW at operating temperatures from 0°C to 45°C, and is the only submarine pump available in a small-form-factor Mini-DIL package.

Bookham improves cash balance despite 25% revenue drop

For its fiscal second-quarter 2009 (ended 27 December 2008), optical component, module and subsystem maker Bookham Inc of San Jose, CA, USA has reported revenue of \$50.2m (down 15% on \$59m a year ago and 25% on last quarter's \$66.5m).

However, this excluded deferred revenue of \$5.4m including: (i) \$4.1m for products shipped to major customer Nortel Networks, for which payment was not received prior to that firm's bankruptcy filing on 14 January; and (ii) \$1.3m for products shipped to a contract manufacturer for which payment may not be received as a result of the bankruptcy. Revenue would otherwise have been \$55.6m (down just 5.8% on a year ago and 16% on last quarter).

Gross margin has shrunk from 25% last quarter to 17%, although this would have been 25% including deferred revenue. Excluding \$0.3m of stock-based compensation and \$0.4m of one-time charges from the transfer of photonics manufacturing operations from San Jose to Shenzhen, China (now substantially completed), non-GAAP gross margin was 19%, or 27% including deferred revenue (up slightly from 26% last quarter).

Compared to +\$0.3m a year ago and +\$2.2m last quarter, adjusted EBITDA was negative \$3.6m. However, this would have been +\$1.8m including deferred revenue.

Compared to net income of \$2.2m last quarter, net loss was \$6.5m. However, on a non-GAAP basis, Bookham still reported a net income of \$3m, down slightly from \$4.7m last quarter and an improvement on a net loss of \$1.1m a year ago.

Despite the current challenging economic conditions, cash, cash equivalents, short-term investments and restricted cash rose by \$1.5m to \$44.7m.

During the quarter, Bookham cut expenses for R&D from \$7.9m last quarter to \$6.9m and for SG&A

(selling, general and administrative) from \$10.7m to \$9.3m, as well as cutting restructuring and severance charges from \$1.5m to \$0.5m.

"We will continue to actively manage our cost structure while maintaining our focus on product innovation and improved operational performance," says president & CEO Alain Couder.

For its fiscal third-quarter 2009 (ending 28 March), Bookham expects revenue of \$43-50m, non-GAAP gross margin of 15-22% (excluding stock-based compensation), and adjusted EBITDA of negative \$6.5-1.5m. Cash balance is expected to drop below \$40m due to significant doubt over the collection of any of the deferred revenue in the March quarter.

The March quarter is expected to be the low point in revenues due to the economic downturn. However, visibility is not good, cautions chief financial officer Jerry Turin regarding the June quarter.

Bookham has also announced a proposed merger with optical communications

The March quarter is expected to be the low point in revenues due to the economic downturn

component and module maker Avanex Corp of Fremont, CA, USA. "Upon completion, the new company will offer the largest product portfolio for the metro and

long-haul markets," says Couder. "We also expect the merger to result in improved financial performance quicker than if either company remained as a standalone entity," he adds. "We believe this combination represents a compelling value proposition for our customers, our employees and investors who will see a more competitive company better able to succeed even in a difficult economy."

www.bookham.com

Avanex cuts workforce by 5% as revenue falls 16%

For its fiscal second-quarter 2009 (to end-December 2008), optical communications component and module maker Avanex Corp of Fremont, CA, USA has reported revenue of \$38m, down 16% on last quarter's \$45.3m and 27% on \$52m a year ago. This is due mainly to a significant drop in demand in telecoms as a result of macro-economic issues.

Revenue for transmission products (transceivers, transponder and modulators) fell by 27% from last quarter to 31% of total revenues. However, the modulator product line was level with last quarter due to an increase in market share (involving three design wins, including one for cable TV and one for a tunable pluggable format).

Revenue from regeneration products (including control amplifiers, gain blocks, fixed-wavelength and tunable dispersion compensation modules, and integrated optical performance monitoring products) fell by about 10%, but still represented 55% of revenue. Sales of fiber-based dispersion compensator modules remained strong, while the tunable dispersion compensator product line has seen significant traction (having been designed-in at more than 10 customers).

Revenue for wavelength management products (both fixed- and reconfigurable-wavelength routing products) remained relatively flat, representing 14% of revenue.

CEO & president Giovanni Barbarossa also highlights significant

progress on introducing new subsystem platforms, including an integrated reconfigurable add-drop multiplexing (ROADM) subsystem incorporating Avanex's Wavelength Selective Switch (WSS) and amplifier model technologies.

North America comprised 33% of revenues (down from 43% last quarter), Europe 41% (up from 32%) and Asia 26% (versus 25%). Greater than 10% customers were Alcatel and (due to a couple of design wins) Infinera.

Excluding \$9.6m in one-time goodwill impairment and restructuring charges, operating expenses have been cut to \$12.9m (34% of revenue) from \$15.7m (35% of revenue) last quarter and \$16.9m (32% of revenue) a year ago. Gross margin has fallen from 31% a year ago and 17.2% last quarter to 15.4% (below the forecast 17-21%).

However, excluding the \$9.6m in one-time charges, non-GAAP net loss still rose to \$6.2m, compared with \$5.9m last quarter and net income of \$2.4m a year ago.

During the quarter, cash and investments fell by \$12.4m to \$37.3m (although Avanex expects cash outflows to be significantly lower in future quarters).

We are taking action by reducing our workforce by 5% and scaling back on other discretionary expenses

For fiscal Q3/2009 (to end March), Avanex expects revenue to fall 18-37% to \$24-31m (a broader guidance range than normal since, given the current recessionary macro-economic environment, there is less visibility than typical).

During the fiscal second-quarter, Avanex reduced its headcount by 29, from 515 to 486. In fiscal Q3, the firm is implementing further initiatives to reduce its cost structure. "While the company is continuing to face challenges in light of the current macro-economic environment, we are taking action by reducing our workforce by 5% and scaling back on other discretionary expenses [saving \$2.5m annually]," says Barbarossa. The firm is targeting a breakeven run rate of \$46-48m in quarterly revenue.

In addition, Barbarossa believes that the proposed merger with optical component, module and subsystem maker Bookham Inc of San Jose, CA, USA (which should be finalized within 3-6 months) will improve the firm's market position. "We have agreed to merge with Bookham, because we believe that the combined company can realize significant cost synergies [generating \$7m of quarterly cost savings by the end of the merged firm's fourth full quarter] and thereby create immediate value to shareholders of both companies," he says. "For a few quarters now we have believed industry consolidation is necessary in order to prosper."

www.avanex.com

Bookham's business with Nortel to continue on ordinary terms

Optical component, module and subsystem maker Bookham Inc of San Jose, CA, USA says that Nortel Networks confirmed to it that business would continue on ordinary terms during the course of Nortel's bankruptcy proceedings.

Nortel, directly and through Flextronics, is a key customer of Bookham's and important to its

success and growth. Bookham expects to sell product to Nortel and to be paid for future shipments on an on-going basis throughout the course of the bankruptcy proceedings and to maintain its relationship as a key supplier to Nortel.

Bookham says that it is pleased that Nortel has addressed its contract with Flextronics at the very

first stage of bankruptcy to ensure the viability of this important component of the Nortel supply chain as well as the relationship with Bookham. Bookham has about \$4.3m in open receivables from Nortel as of 14 January, and the firm will pursue its rights to be paid these amounts consistent with the applicable bankruptcy laws.

Emcore's photovoltaic growth tempers optical communications slump

For its fiscal first-quarter 2009 (to end-December 2008), Emcore Corp of Albuquerque, NM, USA has reported revenue of \$54.1m, up 15% on \$46.9m a year ago but down 11% on \$60.6m last quarter.

Fiber Optics contributed 72% of revenue (\$39.2m). This is up 15% on \$34m a year ago (due mainly to the acquisitions early last year of the telecom, datacom, and optical cable interconnects-related assets of Intel's Optical Platform Division). However, it is down 15% on \$46.1m last quarter (due mainly to a big drop in demand during the current macroeconomic environment, as well as continued pressure on selling prices as Emcore competes to maintain or increase market share).

Photovoltaics was 28% of revenue (\$14.9m). This is up 15% on \$12.9m a year ago (with growth in all three product lines: satellite solar power, terrestrial concentrating photovoltaic, and service contracts) and up 3% on \$14.5m last quarter.

Gross margin was 2.9%, down from 21.5% a year ago but an improvement on -0.8% last quarter. Fiber Optics gross margin fell from 8.9% last quarter to -1.1%, due to a drop in average selling prices (particularly telecom components), unabsorbed overhead expenses, and inventory valuation write-downs of \$4.8m. Photovoltaics gross margin was 13.7%, a big rise from -31.6% last quarter (which was hit by \$6.9m of inventory write-downs and product warranty accruals from the CPV-related business).

Due to the macroeconomic environment and a large reduction in the firm's market capitalization, Emcore impaired \$31.8m of goodwill for Fiber Optics plus \$1.9m related to in-process R&D acquired via the February 2008 acquisition of Intel's telecom-related assets (amounting to \$33.7m in non-cash charges).

Net loss has hence risen from last quarter's \$41.2m (which included

\$22.2m in charges) to \$53.4m. But excluding charges, non-GAAP net loss is level on last quarter, at \$8.9m.

During the quarter, cash, cash equivalents, restricted cash, and available-for-sale securities fell by \$5m to just \$18.8m, while working capital was \$75.4m. Outstanding loans under a \$25m secured line of credit with Bank of America (established in October) totaled \$15.4m. To boost funds, Emcore freed up \$2.6m of auction rate securities, and has since sold its remaining stake in Entech Solar Inc (formerly WorldWater and Solar Technologies Corp) for \$11.4m.

Emcore says that, during the quarter, it received interest from several parties about making a minority equity investment in the Photovoltaics subsidiary, which would act as an initial step towards its potential spin off. In January, Emcore also signed a letter of intent with an international investment group that involves both investment and operational agreements. The partner's role will be to organize equity and CPV project financing, and to serve as owner-operator of the project. "We are targeting to close one or more of these financing opportunities by late March or early April," says president & CEO Hong Q. Hou.

Also, over the last three months Emcore has enacted cost cutting including: 160 lay-offs (17% of staff) yielding annual savings of \$9m; a reduction in fiscal 2008 staff bonus plan payouts; the elimination of all fiscal 2009 staff merit increases; large cuts in capital expenditure; and restrictions on staff travel and other discretionary spending.

"In response to a very challenging macroeconomic environment, we will continue to aggressively focus on

improving our operational efficiency and working capital management in our Fiber Optics segment," says Hou.

"The situation in our Photovoltaics segment is much more encouraging as our satellite solar power business is experiencing relatively stable demand, is approaching profitability, and is on the cusp of developing some significant new business opportunities based upon our technology leadership position in inverted metamorphic (IMM) triple- and quadruple-junction solar cells."

In the December quarter, Emcore signed a \$70m long-term purchase agreement with a major satellite integrator. It is also finalizing a new deal with an existing customer for future demand totaling \$50m. "We expect to be sole and primary supplier of space solar cells for three out of the four major aerospace companies in the US," says Hou. Emcore has also been awarded a number of international geosynchronous orbit satellite programs.

Also during the quarter, Emcore signed supply agreements with two major customers for CPV systems qualified for the Spanish market. In addition, in mid-January, Emcore's terrestrial solar power division was short-listed for a major solar utility project in south-western USA worth 50-80MW. It is also making progress in developing its Gen-III CPV system, for launch in second-half 2009.

"We have fairly good visibility [through mid-2009] and believe that our Photovoltaics business will continue to grow," says Hou. At the end of December, order backlog was \$53.2m (\$30.2m Photovoltaics and \$23m Fiber Optics). In fiscal Q2/2009 (to end-March), Emcore expects Fiber Optics revenue to be flat to 15% down sequentially. Nevertheless, the segment continues to receive design wins from major customers, and should be well positioned for growth once the economy improves, reckons Hou.

The partner's role will be to organize equity and CPV project financing

Your premier choice for III-V and Ge substrates and related strategic raw materials.



VGF
STRENGTH.
PERFORMANCE.
INNOVATION.

AXT, Inc. is the only supplier in the world to offer materials for the inverted metamorphic, CIGS, and CPV Ge markets

We offer Ga metal for CIGS and Ge substrates for CPV applications

We also have GaAs and InP substrates as well as metamorphic and starting materials

USA Headquarters
4281 Technology Drive
Fremont, CA, USA 94538

T: 510-438-4700
F: 510-353-0668

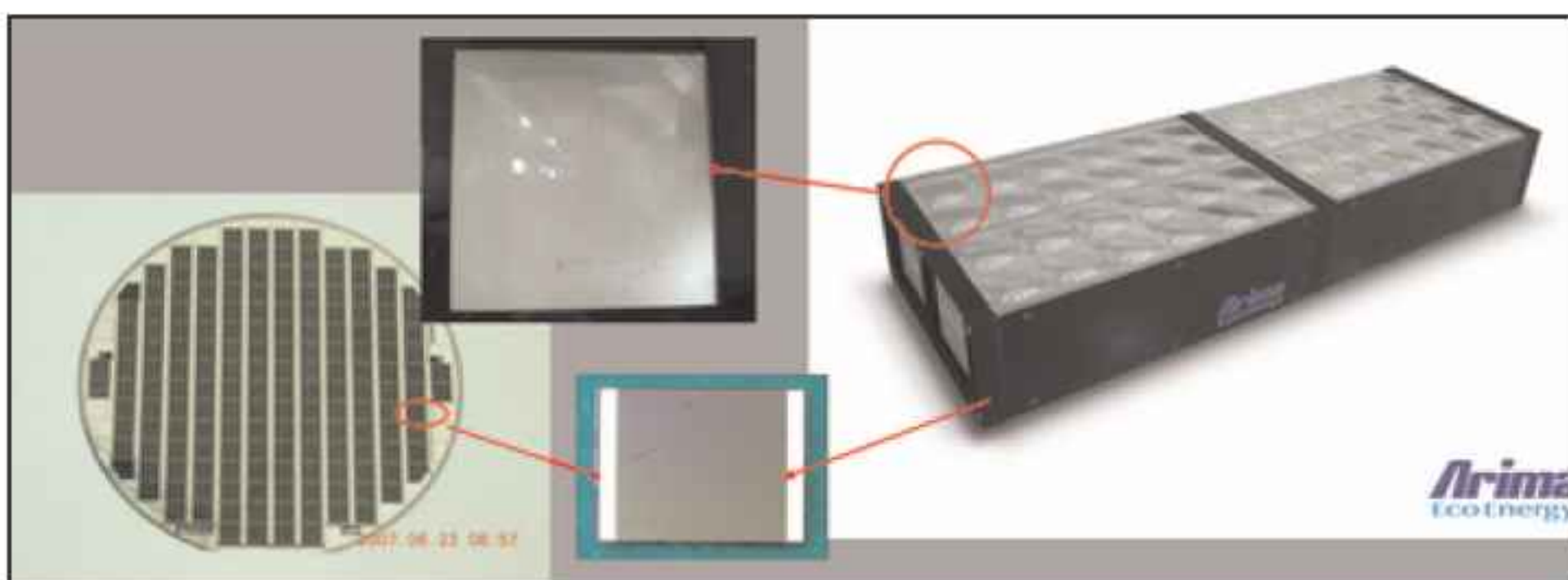
E: sales@axt.com
W: axt.com

ArimaEco ships CPV modules to Spain's ISFOC

After obtaining IEC (International Electrotechnical Commission) 62108 certification for its GaAs-based triple-junction high-concentration photovoltaic (HCPV) modules last November, in early February Taiwan's Arima EcoEnergy Technologies Corp began shipping 300kW of modules to the 3MW CPV project of the Instituto de Sistemas Fotovoltaicos de Concentración S. A. (ISFOC) in Puertollano, Spain.

ArimaEco will be responsible for installing the modules into a power-generating system, with installation to be completed in April. The contract will bring in revenues of about NT\$100m (US\$3.03m), says the firm's chairman Stephen Lee.

The 3MW ISFOC project was initiated in 2006 by the Castilla-La Mancha regional government's Department of Education and Science and the Institute of Solar Energy (IES) of Universidad Politecnica de Madrid (UPM), and is financed by Spain's Ministry of Education and Science. The pilot CPV plants have been created both as municipal power production facilities (to generate electricity for the local power grid) and as a proving ground for CPV



ArimaEco's CPV module, showing details of GaAs-based wafer, cell and lens.

technology (incorporating different concentrator technologies from several firms). The project aims to demonstrate that CPV technology, with higher efficiency and the potential for cost reduction, is an attractive alternative to other solar technologies in key high-solar-resource regions worldwide.

The first, 1.7MW phase of the ISFOC project in 2006 contracted 700kW from Isofotón of Madrid, Spain, 500kW from Fraunhofer ISE spin-off Concentrix Solar GmbH in Freiburg, Germany, and 500kW from SolFocus of Mountain View, CA, USA.

For the second, 1.3MW phase, in November 2007 ISFOC contracted 300kW from III-V cell manufacturer

Emcore of Albuquerque, NM, USA, 300kW from Spain's Concentración Solar La Mancha S.L., 400kW from Sol3g S.L. of Cerdanyola, Spain, and 300kW from Arima Eco (the only Asian awardee).

ArimaEco was founded in March 2007 by Arima Group, Unity Optoelectronics and PV specialist Dr Andrew Tzeng. It plans to expand annual production capacity for GaAs HCPV modules to 30MW and expects to ship 5MW of modules or power-generating systems for estimated revenue of NT\$700-800m in 2009. As well as Spain, ArimaEco is targeting the Portugal, Greece, Italy and Eastern European markets.

www.arimaeco.com

Fab management software tailored to PV production

Rudolph Technologies Inc of Flanders, NJ, USA, which provides process control metrology, defect inspection and data analysis systems for semiconductor device making, has launched Discover Solar, which it calls the first fab management software tool designed specifically to help photovoltaic (PV) manufacturers boost cell efficiency and cut costs.

"Increased competitiveness and demand in the solar industry requires PV manufacturers to focus on cell efficiency to maximize margins," says chairman & CEO Paul McLaughlin. The new fab management software was designed to help PV manufacturers accomplish this, while also producing cost reductions that will further help the industry reach grid

parity. "While it builds on our extensive experience and leadership in integrated circuit manufacturing, Discover Solar was specifically designed to accommodate the critically important differences in the PV fabrication process," he adds.

"Based on our success with Discover analysis and data management software for the semiconductor industry, Discover Solar incorporates a completely re-engineered database structure and analysis engine optimized for the unique requirements of high-volume photovoltaic production," says Mike Plisinski, VP & general manager of the Data Analysis and Review business unit. "It provides comprehensive analysis of process performance information,

allowing manufacturers to discover and act upon opportunities to improve the energy conversion efficiency of their products," he adds. "Using Discover Solar, PV process engineers can monitor the health of a complete production line and quickly identify tool and sub-component problems as well as incoming material issues that could impact the line. If even possible, this kind of analysis would take hours to perform without Discover Solar."

Discover Solar accepts all available data from each step in the solar manufacturing process. Also, statistical process control with automated reporting delivers critical information speedily, the firm adds.

www.rudolphtech.com

SolFocus raises \$47.5m to commercialize CPVs

Concentrator photovoltaic (CPV) system maker SolFocus Inc of Mountain View, CA, USA has raised \$47.5m in the first close of its Series C financing round, led by Apex Venture Partners with follow-on investment by New Enterprise Associates (NEA), NGEN Partners and others (increasing the total raised since the firm was founded in 2005 from \$95m to \$143m). SolFocus also said that it aimed to close a second tranche of funding (boosting the Series C financing round to \$60–70m).

The new funding will be used to accelerate expansion of its manufacturing operations and extend its early base of commercial CPV deployments, which it aims to grow from 0.5MW in 2008 to about 100MW by the end of 2010.

Also, Mark Crowley (president since August) has been appointed CEO to guide SolFocus in its transition from small-scale demonstration installations to large-scale commercialization. Former CEO & founder Gary D. Conley will continue as chairman of the board.

"We have developed and delivered 0.5MW of our high-efficiency, cost-effective CPV systems, and are now poised to roll out product in high volume," says Crowley. "Our C Round funding will allow us to invest rapidly to support our aggressive growth plans."

Crowley notes that this first close comes despite what is one of the most challenging funding environments in history. "Many good companies are going unfunded today; this close is strong validation from investors that our CPV systems are compelling today, and will help drive the growth of the solar industry," he believes.

SolFocus' CPV design uses a system of reflective optics (curved mirrors) to concentrate sunlight 500 times onto highly efficient gallium arsenide-

based solar cells on germanium substrates that have high solar energy conversion efficiency (approaching 40%, more than twice that of traditional silicon solar cells). Like its smaller SF-1000S system, the firm's second product (the SF-1100S, launched last November) uses about a thousandth of the active solar cell material compared to traditional silicon-based PV panels, but boosts panel conversion efficiency from 18% to more than 25%. In solar-rich regions of the world, such efficiency can accelerate the trajectory for solar energy to reach cost parity with fossil fuels, says SolFocus.

SolFocus integrates its CPV panels with its tracking system, which continuously aligns the solar array with direct sunlight throughout the day as the sun moves across the sky. The tracking capability results in energy generation matched to peak demand periods.

This first close comes despite what is one of the most challenging funding environments in history

In November–December, SolFocus (whose European operations are headquartered in Madrid) announced two customer deployments of 1100S CPV systems in Europe: a \$103m (€80m) utility-scale project in Southern Spain with EMPE Solar for more than 10MW (enough for 40,000 residents, and the world's largest CPV installation); and a 1.6MW deal with Concept, a division of renewable energy development firm Samaras Group of Thessaloniki, Greece, to jointly develop the first commercial installation of CPV technology in Greece (with installation beginning this spring, for the delivery of power in the summer).

www.solfocus.com

As time is money, knowledge is gold. The new **LayTec SolR inline monitoring system** opens the door to complete control of thin-film photovoltaic layer thickness.



sun
to
gold

Find out how you can ramp up your PV production processes and accelerate development cycles: info@laytec.de

LAYTEC
in-situ sensors

LayTec GmbH · Helmholtzstr. 13–14
10587 Berlin · Germany
Tel.: +49 (0)30-39 800 80-0
www.laytec.de

First Solar completes \$40m, 10MW CdTe thin-film photovoltaic power plant for Sempra Generation

First Solar Inc of Tempe, AZ, USA, which manufactures thin-film photovoltaic modules based on cadmium telluride (CdTe), has completed its first 10MW ground-mounted photovoltaic power plant for Sempra Generation near Boulder City, NV.

The \$40m project is said to be the largest thin-film solar power plant in North America, comprising 168,300 panels, installed at a cost of just \$3.17 per watt (including frames and installation, as well as the solar module).

Sited adjacent to Sempra's existing 480MW El Dorado Energy combined-cycle natural gas power plant (about 40 miles southeast of Las Vegas), the plant will serve customers in California and the western USA.

By co-locating it with existing infrastructure and the associated interconnection and transmission facilities, the firm aimed to optimize its use of land and transmission, so that the impact to the immediate environment would be minimal and the project completion timeline would be shorter. Construction only began in July.



Sempra Energy's El Dorado solar power plant near Boulder City, NV.

First Solar served as the engineering, procurement and construction (EPC) contractor, using modules produced at its manufacturing facility in Perrysburg, OH. Although the plant will be owned and operated by Sempra Generation, First Solar will also provide monitoring and maintenance services over its lifetime.

The build out of this 10MW solar power plant from start to finish in less than six months marks the successful completion of our first utility-scale EPC project

As well as being the biggest supplier of thin-film PV modules, the firm stresses its commitment to product life-cycle management, claiming the solar industry's first comprehensive module end-of-life collection and recycling program.

"The build out of this 10MW solar power plant from start to finish in less than six months marks the successful completion of our first utility-scale EPC project," says John Carrington, First Solar's executive VP marketing & business development.

"This is a significant step in the development and deployment of renewable solar power," claims Sempra Generation's president & CEO Michael W. Allman. "It reflects the commitment by Sempra Generation and western US utilities to meet the challenges posed by climate change with reliable, renewable energy," Allman adds. "The size and scope of this new solar generation facility clearly demonstrates that we can build projects on a scale that helps utilities meet their renewable energy goals."

www.firstsolar.com

First Solar to supply 5MW of CdTe solar modules for world's first carbon-neutral city

First Solar has been selected by Masdar Abu Dhabi Future Energy Company to supply 5MW of cadmium telluride (CdTe) thin-film photovoltaic modules as part of the largest grid-connected solar power system in the Middle East.

The system will supply power to Masdar City, which is planned to be the world's first carbon-neutral, zero-waste, car-free city powered exclusively by renewable energy sources.

The solar power plant is being designed and constructed by Abu Dhabi based solar power sys-



Artist's impression of Masdar City, which is planned to be the world's first zero-carbon, zero-waste city powered entirely by renewable energy sources.


tem integrator Enviromena Power Systems. Construction has begun, and the system is expected to be commissioned and producing power by the end of second-quarter 2009.

"We are pleased to be part of Masdar City's efforts to develop a blueprint for cities of the future," says First Solar's executive VP of marketing & business development, John Carrington. "We look forward to working with First Solar on future projects in the region," says Enviromena Power Systems' president & CEO Sami Khoreibi.

www.masdar.ae/en






Solar Innovation ASIA & Investment

CO-LOCATED WITH ASIASOLAR - THE MOST INFLUENTIAL SOLAR PV EXHIBITION IN ASIA

 **Shanghai, China, 31 March - 1 April 2009** 

Solar Innovation and Investment will run alongside the 4th Annual AsiaSolar Expo, an event that focuses on photovoltaics, solar system projects and solar architecture. More than 350 exhibitors will be presenting their products and services, and more than 20,000 visitors are expected to attend. Solar power in Asia is at the forefront of renewable energy. Solar Innovation and Investment Asia will provide you with the information needed to succeed in this growing industry.

Solar Innovation and Investment will provide the following:

-  An excellent platform for companies to learn the latest trends in concentrated solar power, concentrated photovoltaics, solar thermal and the exciting new developments in BIPV.
-  Case studies on regional and international developments in solar investment
-  Excellent networking opportunities
-  An insight into the policies and regulations in China and across Asia
-  In-depth analysis on market potential in solar manufacturing and investing in solar power generation

We have secured a very exciting professional lineup of speakers including:

-  **Zhao Yuwen**, Director, Solar PV Division, **China Renewable Energy Society**, China
-  **Tetsunari Iida**, President, **Institute for Sustainable Energy Policies (ISEP)**
& Chairman **World Council for Renewable Energy (WCRE)**, Japan
-  **Hu Run Qing**, Center for Renewable Energy Development, Energy Research Institute,
National Development and Reform Commission (NDRC), China
-  **Michael Williamson**, Renewable and Distributed Energy, **Sustainability Victoria**, Australia

DON'T MISS YOUR CHANCE TO LEARN AND NETWORK WITH THE BEST IN THE INDUSTRY!

QUOTE SCT20 WHEN BOOKING AND WE WILL GIVE YOU A 20% DISCOUNT!

Contact Victoria Adair for more details:

victoria.adair@greenpowerconferences.com | Tel: +44 20 7099 0600 | Fax: +44 20 7900 1853

ISE raises multi-junction solar cell efficiency record to 41.1%

After raising its European record for solar cell efficiency from 37.6% to 39.7% between last July and September, in mid-January the Fraunhofer Institute for Solar Energy Systems (FhG-ISE) in Freiburg, Germany achieved a new world record for multi-junction solar cells (exceeding the record of 40.8% set in August by the US Department of Energy's National Renewable Energy Laboratory).

Such high-efficiency multi-junction solar cells are targeted at use in concentrating photovoltaic (CPV) systems for solar power plants in countries that have a large fraction of direct solar radiation. At a sunlight concentration factor of 454 suns for the small 5mm² multi-junction solar cell, a record conversion efficiency of 41.1% was achieved. Even at a higher concentration of 880 suns, an efficiency of 40.4% was measured, as the cell shows an efficiency of more than 40% over a fairly broad range of concentration factors (Figure 2b).

Like FhG-ISE's previous record cells, the new cell uses a metamorphic (lattice mismatched) triple-junction Ga_{0.35}In_{0.65}P/Ga_{0.83}In_{0.17}As/Ge layer structure (gallium indium phosphide and gallium indium arsenide on a germanium substrate).

In contrast to conventional solar cells, the semiconductor materials in the separate layers do not have the same crystal lattice constant, and can only be combined by using metamorphic growth. This makes it difficult to grow layers with high crystal quality since, at the interface of materials with different lattice constants, strain is present that results in the creation of dislocations and other crystal defects.

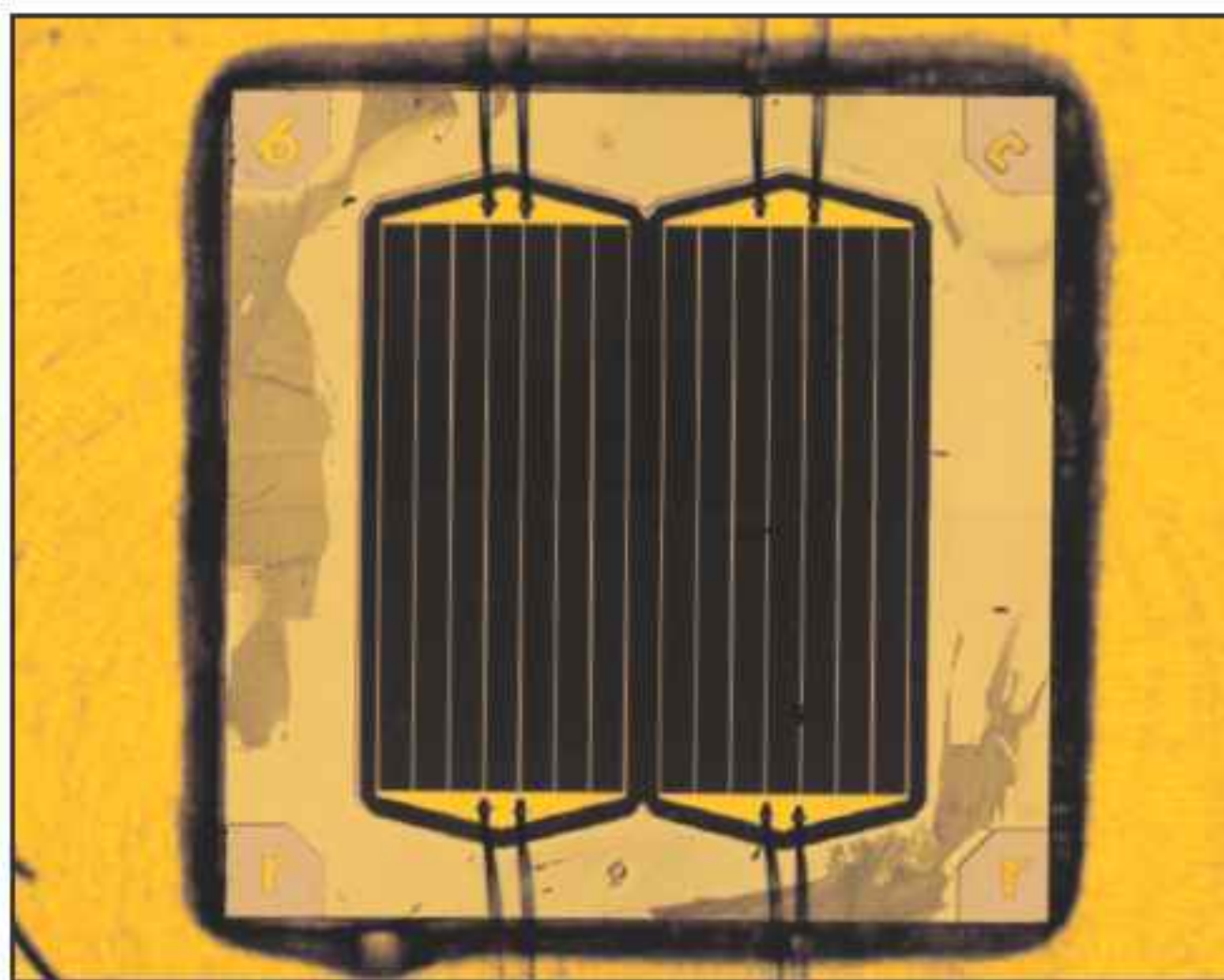


Figure 1. Photo of Fraunhofer ISE's record 41.1%-efficient Ga_{0.35}In_{0.65}P/Ga_{0.83}In_{0.17}As/Ge solar cell, which has a cell area of 5.09mm².

Led by Dr Frank Dimroth, head of its III-V-Epitaxy and Solar Cells group, Fraunhofer ISE has overcome this obstacle by localizing the defects in an electrically inactive region of the solar cell. The active regions hence remain relatively defect free – a prerequisite for achieving the highest efficiencies. “This is an especially good example of how the control of crystal defects in semiconductors can lead to a breakthrough in technology,” says Fraunhofer ISE's director, professor Eicke R. Weber.

Even at a higher concentration of 880 suns, an efficiency of 40.4% was measured, as the cell shows an efficiency of more than 40% over a fairly broad range of concentration factors

Metamorphic crystal growth enables use of a much larger range of III-V compound semiconductors for growing multi-junction solar cells. For these highly efficient structures,

the solar spectrum is divided into three equally large spectral regions by a suitable choice of light-absorbing materials.

The researchers say that this is an important argument in favor of a serial-connected solar cell, where the device current is limited ultimately by the smallest current generated by one of the subcells. By choosing the metamorphic Ga_{0.35}In_{0.65}P/Ga_{0.83}In_{0.17}As/Ge material combination, a solar cell structure could be chosen that is completely current matched under the terrestrial solar spectrum (i.e. all three subcells of the triple-junction

solar cell generate the same amount of current). This is a key reason for the achievement of the high efficiencies, Dimroth says.

Fraunhofer ISE raised the efficiency from 37.6% to 39.7% last year by improving the contact structures of the solar cells through using a front-side network of thin metal wires that transport large currents but with low resistance. Such cells are suited to inhomogeneous radiation, as occurs for concentration factors of 300–600 suns. Dimroth says that the latest efficiency of 41.1% has been achieved by again changing the grid layout and by improving the quality of the crystal layers.

To make the technology competitive with established technologies as quickly as possible, Fraunhofer ISE is working together with cooperation partner Azur Space of Heilbronn, Germany as well as ISE spin-off firm Concentrix Solar GmbH in Freiburg. “The high efficiencies of our solar cells are the most effective way to reduce the electricity generation costs for concentrating PV systems,” says Dr Andreas Bett, ▶

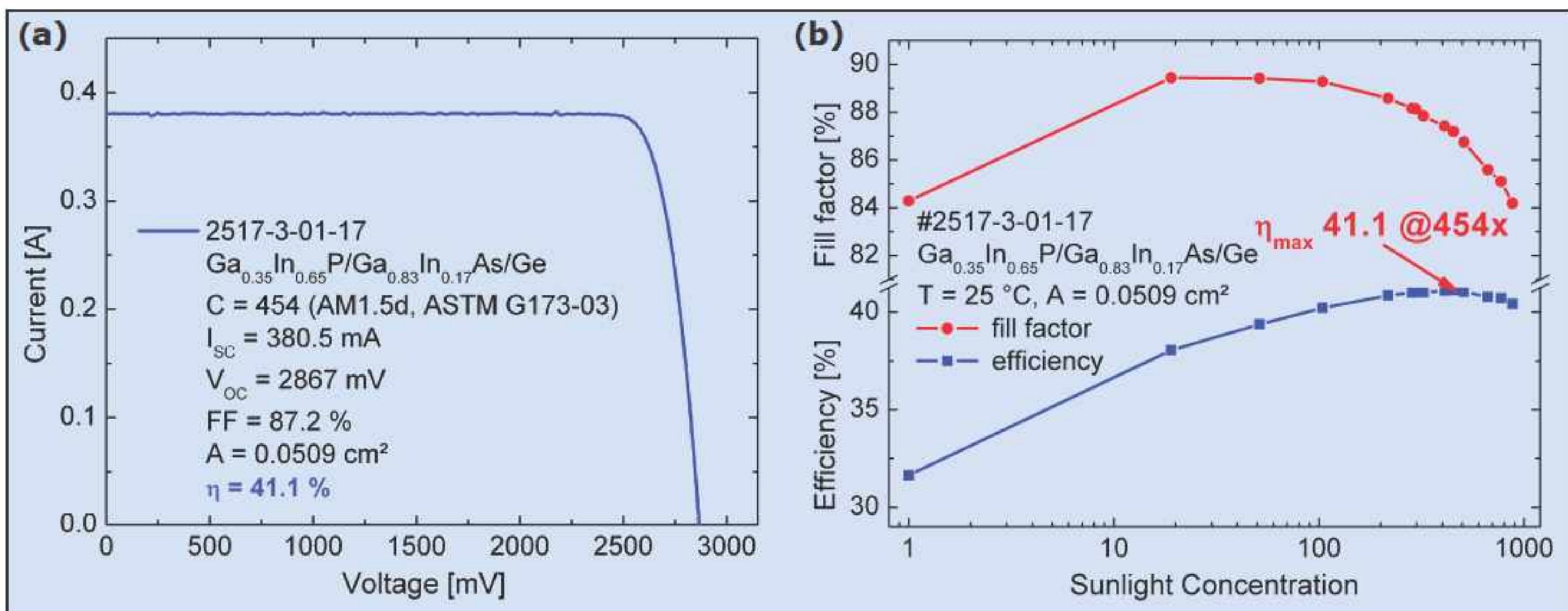


Figure 2. (a) Current–voltage (IV) characteristics of GaInP/GaInAs/Ge triple-junction cell at 454 suns concentration. (b) Efficiency versus concentration factor (measured by Fraunhofer ISE’s Callab).

who is department head at Fraunhofer ISE. Bett adds that Fraunhofer ISE wants photovoltaics to become competitive with conventional methods of electricity production as soon as possible. “With our new efficiency results, we have moved a big step further towards achieving this goal.”

Dimroth says that he sees further potential to improve the cell structure to achieve efficiencies up to the 42–43% range, e.g. by using dilute nitride materials to block dislocations in the buffer layers and by

improving the tunnel diode between the top and middle junctions.

Over the last 15 years, Fraunhofer ISE’s research on III-V multi-junction solar cells for concentrating photovoltaics has been sup-

Dimroth says that the latest efficiency of 41.1% has been achieved by again changing the grid layout and by improving the quality of the crystal layers

ported initially by the German Federal Ministry of Education and Research (BMBF) and later also by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). The Deutsche Bundesstiftung Umwelt (DBU) also contributed financially to the research by providing several grants for doctoral students.

The new results will be presented at the 34th IEEE Photovoltaic Specialists Conference in Philadelphia, PA (7–12 June).

www.ise.fraunhofer.de



Figure 3. The Fraunhofer ISE team celebrates its 41.1% efficiency record with director professor Eicke Weber (center), department head Dr Andreas Bett (left) and group leader Dr Frank Dimroth (right).

Polarization-matched GaInN cuts LED efficiency droop

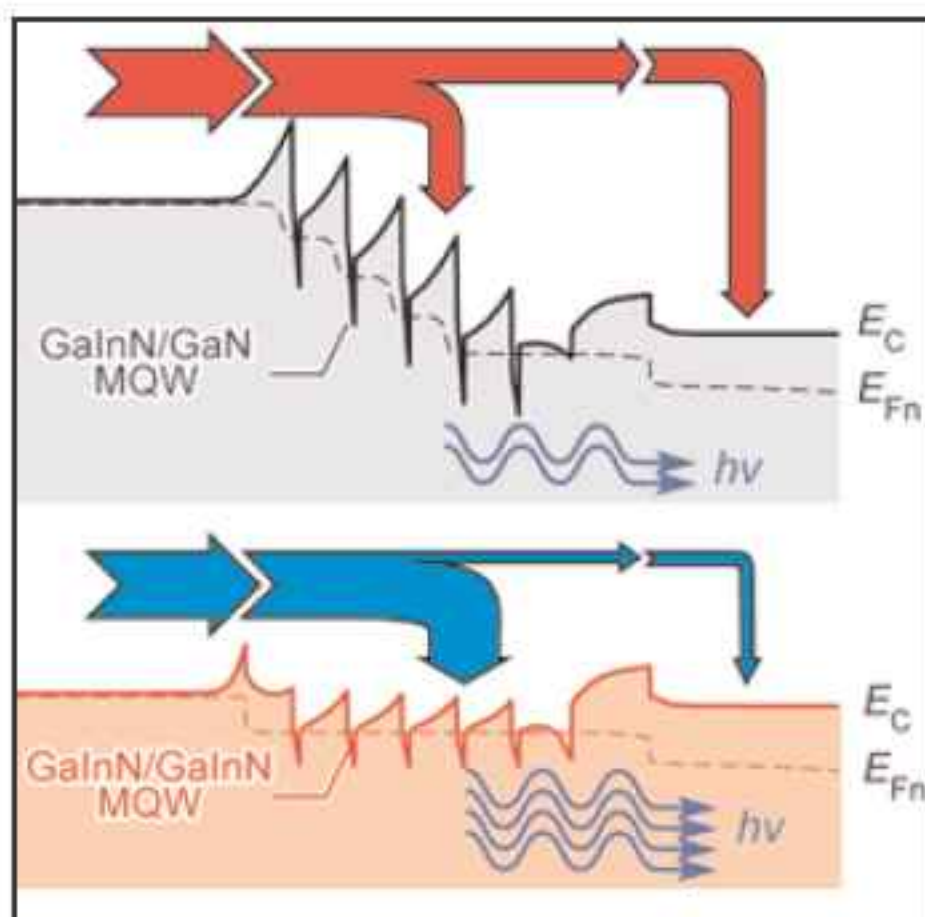
In collaboration with South Korea's Samsung Electro-Mechanics Co, Rensselaer Polytechnic Institute (RPI) of Troy, NY, USA has demonstrated a blue multi-quantum-well (MQW) LED that reduces the droop in efficiency seen in conventional InGaN-based MQW LEDs at injection current densities above $10\text{A}/\text{cm}^2$ (Jiuru Xu et al, Appl. Phys. Lett. vol.94 (2009), 011113).

"Today's high-brightness LEDs are operated at current densities far beyond where efficiency peaks," says project leader E. Fred Schubert, the Wellfleet Senior Constellation professor of Future Chips at RPI, and head of the its National Science Foundation-funded Smart Lighting Engineering Research Center. "This challenge has been a stumbling block, because reducing the current densities to values where LEDs are more efficient is unacceptable," he adds.

The efficiency droop is due to a non-radiative carrier loss mechanism that is not yet fully understood. However, studies show that a likely cause is electron leakage at high current densities across the electron-blocking layer (EBL), followed by them recombining with holes outside the MQW light-emitting region. This indicates that the conventional design of the conduction band is inadequate to prevent electrons entering the p-side of the LED's pn junction.

Schubert's team found that the likely cause is that the active region contains materials with mismatched polarization at their heterointerfaces: conventional blue MQW LEDs have an active region consisting of GaInN quantum well layers separated by GaN barrier layers.

The polarization mismatch leads to the formation of large sheet charges, modifying the energy bands to form large triangular barriers in the active region and EBL (see figure, top). The barriers create obstacles for charge carriers and hence require high forward voltages for significant current to flow. The conduction band on the n-side of the pn junction is hence significantly higher than that



Simulated conduction-band diagram of conventional (top) and polarization-matched (bottom) GaInN/GaN MQW active regions at $100\text{A}/\text{cm}^2$ forward current density.

on the p-side, making it energetically favorable for electrons to escape to the p-side. Novel conduction-band engineering to reduce polarization mismatch can hence improve electron confinement and lower current leakage from the active region.

The researchers discovered that the polarization mismatch between the GaInN/GaN well and barrier materials in the active region can be strongly reduced by introducing a new design of quantum barrier. Already, last July, RPI reported MOCVD-grown blue MQW LEDs emitting at a wavelength of 440nm with GaInN quantum wells but AlGaInN barriers that have the same energy bandgap as GaN but match the polarization of the GaInN quantum well (Schubert et al, Appl. Phys. Lett. vol.93 (2008), 041102). However, growing this structure with good crystal quality is difficult because the barrier layer demands great control of the aluminum and indium content.

Now, AlGaInN has been replaced

At $300\text{A}/\text{cm}^2$ the polarization-matched GaInN/GaN MQW LED exhibits an 18% increase in light output power

by GaInN in the barriers of what are now GaInN/GaN active layers (maintaining the Al-free characteristic of the conventional GaInN/GaN MQW active region). This allows better matching of the polarization fields and hence much lower triangular barriers (see figure, bottom). Also, the conduction bands on both the n- and p-sides are about the same height, reducing the driving force for electron leakage out of the active region and hence reducing efficiency droop (with test results confirming theoretical simulations).

In tests, the external quantum efficiency (EQE) of a reference 440nm-wavelength blue LED with a GaInN/GaN MQW active region peaked at just $4\text{A}/\text{cm}^2$, and fell 50% by $300\text{A}/\text{cm}^2$. By comparison, the EQE of polarization-matched GaInN/GaN MQW LEDs peaked at $22\text{A}/\text{cm}^2$ and outperformed the reference GaInN/GaN MQW LED above $34\text{A}/\text{cm}^2$. In addition, its peak EQE was 84% of the conventional GaInN/GaN LED's peak EQE, which (due to the Al-free active region) is up on less than 70% for RPI's previous GaInN/AlGaInN MQW LED.

Also, compared to the reference GaInN/GaN MQW LED, at the maximum forward current density of $300\text{A}/\text{cm}^2$ the polarization-matched GaInN/GaN MQW LED exhibits an 18% increase in light output power. In addition, it has a lower forward voltage (increasing the wall-plug efficiency by 22%) and the ideality factor in the intermediate current range is reduced from 2.0 to 1.7. The electroluminescence wavelength shift as the forward current changes from 10mA to 500mA is also reduced, from 4.9nm to 3.3nm.

"Matching polarization materials makes a big difference; it's not perfect yet, but we know we are definitely increasing the output power of LEDs at high current levels, which is exactly where it matters because for solid-state lighting we want to use LEDs for high-power illumination," says Schubert.

<http://smartlighting.rpi.edu>

LEDs to save \$1.8tr over 10 years

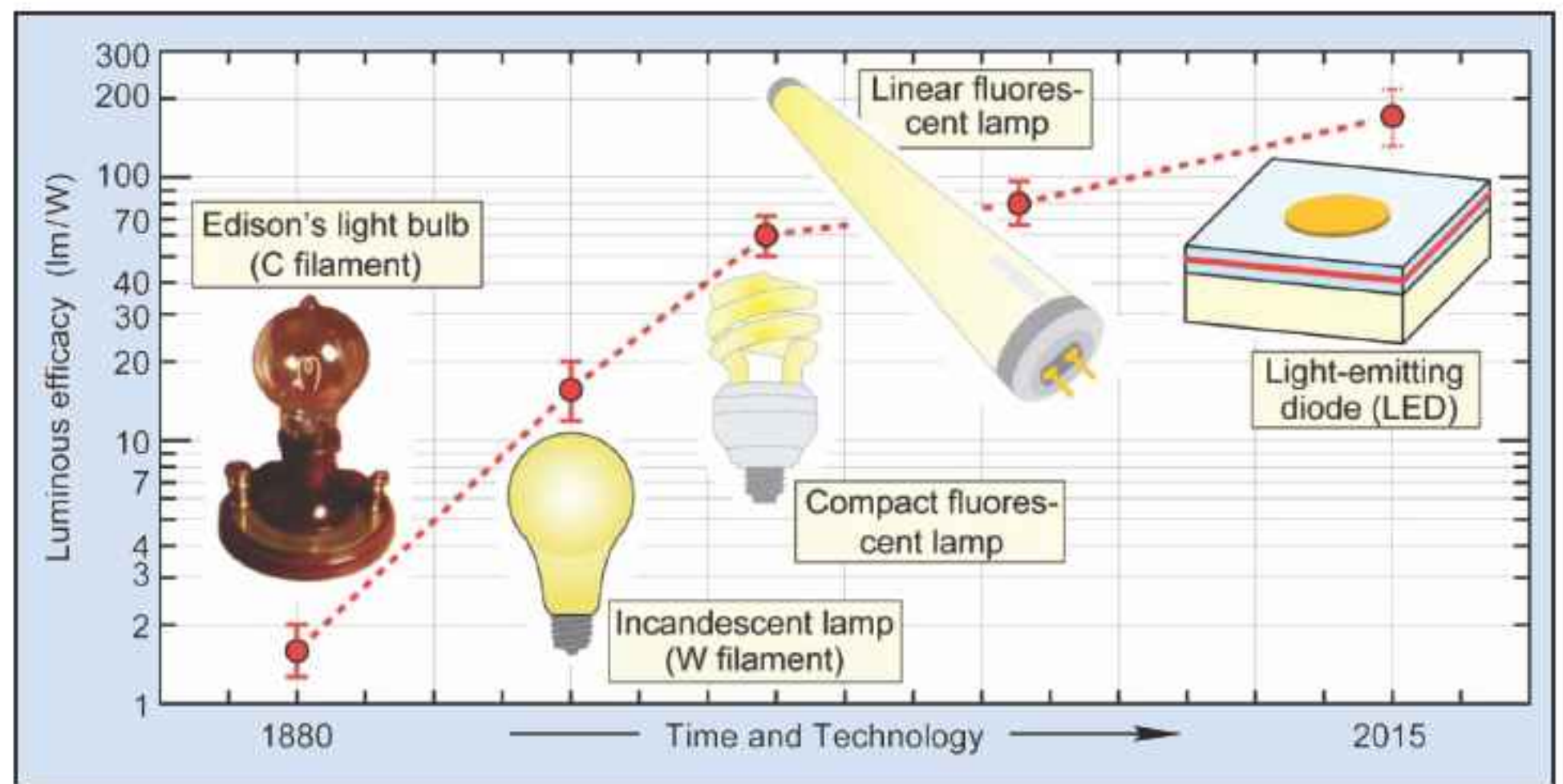
The control of spectrum, polarization, temporal and spatial modulation in LEDs can enable applications to extend beyond mere light bulb replacement, says RPI.

Replacing traditional incandescent and fluorescent bulbs with solid-state lighting (using LEDs) will enable enormous savings in cost, natural resources and pollution, according to a study 'Transcending the replacement paradigm of solid-state lighting' by Rensselaer Polytechnic Institute in Troy, NY, USA (Optics Express, Vol 16, Issue 26 (22 December 2008), p21835).

Simple replacement results in energy efficiency improvements of 20 times compared to conventional incandescent bulbs and five times compared to compact fluorescent bulbs. Over a period of 10 years, the consequent global savings of \$1.83 trillion would cut crude oil consumption by 962 million barrels and reduce the number of power plants needed by 280, eliminating 10.68 gigatons of carbon dioxide emissions, reckon co-authors Jong Kyu Kim (research assistant professor of electrical, computer, and systems engineering) and professor E. Fred Schubert (head of RPI's Smart Lighting Engineering Resource Center).

"Deployed on a large scale, LEDs have the potential to tremendously reduce pollution, save energy, save financial resources," the researchers say. The technology presents a solution to many global challenges, which will be yet more serious in the years to come, they add.

However, it is important not to pigeonhole or dismiss smart lighting technology as a mere replacement for conventional light bulbs, say Schubert and Kim. LED technology is starting as a simple replacement but, beyond that, it will evolve into integrated lighting systems with functions as diverse as transistors have provided for ICs, promising new applications, they add. "Transcending the replacement paradigm will open up a new chapter



Evolution of luminous efficiency of light sources over time.

in photonics: smart lighting sources that are controllable, tunable, intelligent, and communicative."

After receiving an \$18.5m five-year award in October from the National Science Foundation (NSF) Generation Three Engineering Research Center Program, the Smart Lighting Engineering Resource Center, together with Boston University and the University of New Mexico, aims to develop novel optical materials, device technologies, and system applications for smart lighting technologies.

"Besides replacement, there are also new capabilities possible in this lighting revolution," Kim adds. The three top candidates being developed by RPI are: control of the light spectrum for medical applications, control of temporal modulation for wireless optical networking, and control of the polarization of light for improved display technologies.

Transcending the replacement paradigm will open up smart lighting sources that are controllable, tunable, intelligent, and communicative

Spectrum control can enable lighting to change color during the day, positively influence the mood of workers, as well as curing some medical problems that are caused today by poor lighting conditions.

Modulating LEDs at rates too fast to see will enable light fixtures to also serve as wireless access points that directly link different data streams to individual devices, instead of forcing all devices to share the same channel like RF-based wireless technologies do currently.

Controlling the polarization of the light coming from LEDs can enable liquid-crystal displays to eliminate the passive polarization filters that they currently use, greatly increasing the brightness of displays while simultaneously lowering the amount of power they consume.

Other possible smart lighting applications include rapid biological cell identification, interactive roadways, boosting plant growth, and better supporting human circadian rhythms (to reduce an individual's dependency on sleep-inducing drugs or to reduce the risk of certain types of cancer), conclude the researchers.

www.opticsinfobase.org/oe/abstract.cfm?uri=oe-16-26-21835

III-Vs from a logical point of view

Low-cost mass-consumer electronics products are based on the performance boost enabled by shrinking transistor sizes. To continue progress in this direction, changes in the structure and composition of these devices will be needed in the next few years. One proposal, III-V channels, has been the basis of much recent work. **Dr Mike Cooke** reports on research presentations on this theme at December's **IEEE International Electron Devices Meeting (IEDM 2008)**.

As silicon becomes more difficult to shrink, new channel materials are being considered. In the near term, strained silicon or silicon germanium — possibly in new structures (e.g. fully depleted, silicon-on-insulator, FinFET) — are likely to be used, but longer term a whole gear shift is probably needed. Devices made with III-V compound semiconductors such as InGaAs and InSb deposited on silicon have already been successfully demonstrated.

These efforts are designed to enable continued use of the scaling formula of the complementary metal oxide semiconductor devices (CMOS) that dominate the mass electronics markets: mobile phones (apart from the transmit power amplifier), entertainment, video and still imaging, PCs and peripherals, etc. Improvements are sought in the directions of higher speed, higher functionality and lower power dissipation.

Carrier boosts

Antoniadis and Khakifirooz from MIT [1] surveyed the present use of uniaxial strained silicon, and of prospective alternatives, for maintaining the carrier velocity enhancement needed to scale down electronic technology. The two main alternatives are germanium and/or some compound semiconductor consisting of III-V material combinations.

The main effect of straining silicon is to modify the conduction and valence band structures (Figure 1). These modifications alter the way electrons and holes respond to electric fields. CMOS devices use both electron and hole transport to achieve their tasks in NMOS and PMOS transistors. Traditional local strain

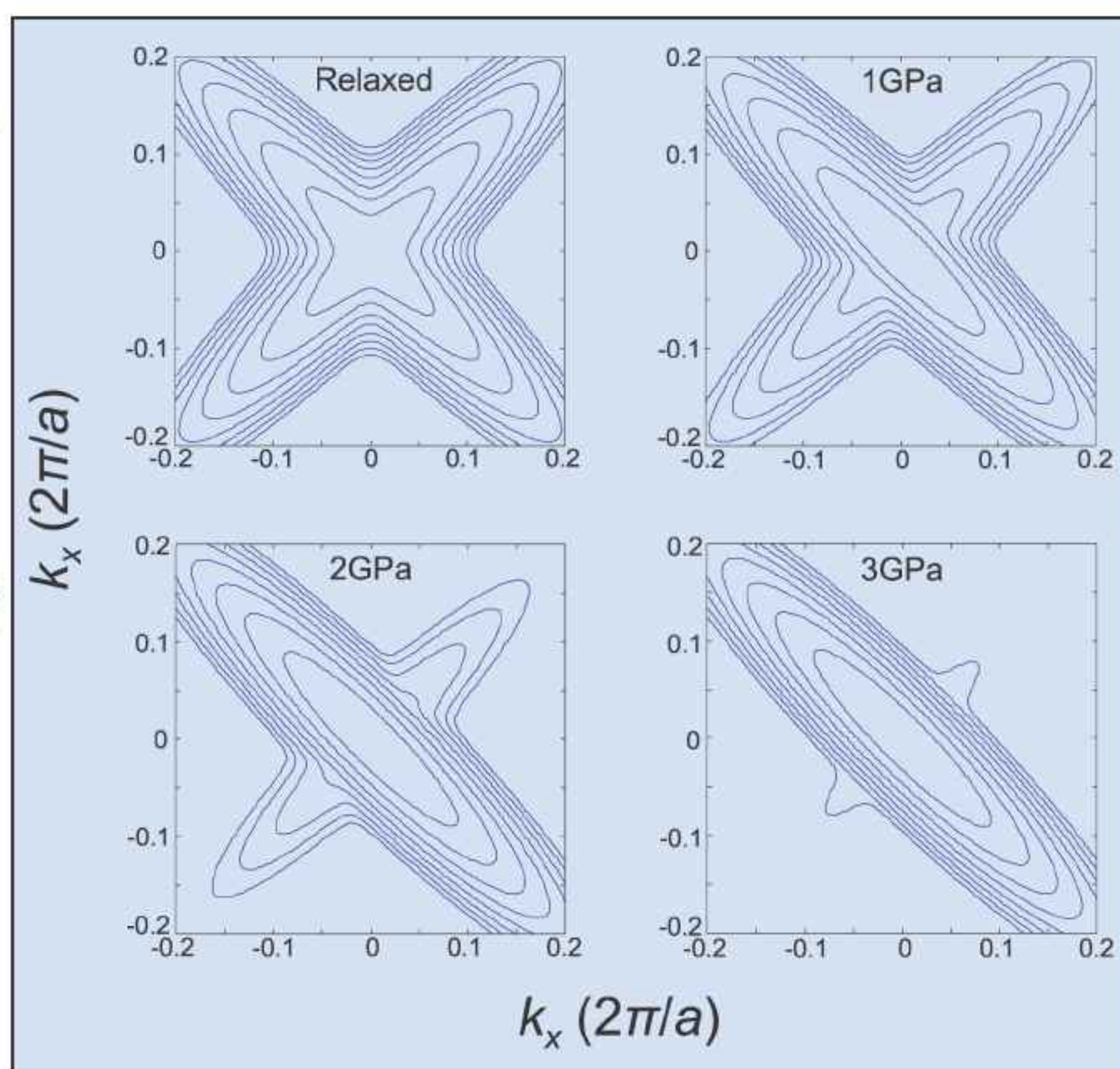


Figure 1. Energy-contours for holes in k-space for differing values of compressive stress in Si.

engineering methods can create strains up to about 0.5%. This can be increased to 1% with the use of preferential relaxation of biaxial strain. This creates a mobility enhancement of about 100%; a value that is maintained at low temperatures, suggesting that it is the velocity of the carriers that is increased (reduced effective mass) in the mobility formula. The other main factor in increased mobility — reduced scattering — is usually temperature dependent. Short-channel transistors based on the biaxial relaxation technique have yet to be built.

However, short-channel transistors built using uniaxial techniques can show mobility increases of up to 4x for holes and 8x for electrons, but the virtual source velocity of the carriers seems limited to a 2x improvement. For the hole velocity, this is explained by theoretical calculations showing that the critical region for determining the effective mass — the top of the valence band — does not change much once the stress reaches 2GPa (Figure 1). The increased mobility here is explained as being due to a reduction in inter-band scattering.

These factors are already impacting the improvements achieved at the 65nm and 45nm technology nodes. Intel, for example, is already producing devices for the market at 45nm, and the next stages are in the lab pipeline. To maintain development it is likely that drastic changes in the channel material will be needed.

The germanium option is mainly being developed with a view to its higher performance of hole transport. However, this will also need to be strained to achieve significant improvement over silicon. III-V channels are being developed for electron transport enhancement.

Unfortunately, the small effective mass needed for velocity enhancement usually comes with a narrow band gap, limiting the supply voltage that can be used. Antoniadis and Khakifirooz believe that special device design will be essential to realize the intrinsic electron transport benefits of III-V options. These designs will need to combine the reduced-drain electric field of the high-electron-mobility transistor (HEMT) architecture with the reduced resistance of source/drain self-alignment techniques.

A further problem to overcome will be the reduced inversion capacitance compared with silicon — this could limit potential drive currents and device performance. The researchers also point to previous work [2] showing that it will be parasitic rather than inversion capacitance that will be the main cause of switching delays in such devices. The conventional metric based on inversion capacitance is thus not relevant to the assessment of these structures.

Power dissipation is a further concern, particularly in highly dense devices. Antoniadis and Khakifirooz see reducing the supply voltage as being the main way to take advantage of enhanced carrier velocity materials and technologies. For some applications, but not all, the combination of low supply voltage (low power) and high performance is what is wanted. This is true for both battery-operated mobile and power-conserving devices.

Oxides for InGaAs

At the experimental level, the most recent stage in developing III-V MOSFETs has been to develop gate dielectric materials to reduce gate leakage while maintaining performance [3]. If the IEDM 2008 presentations

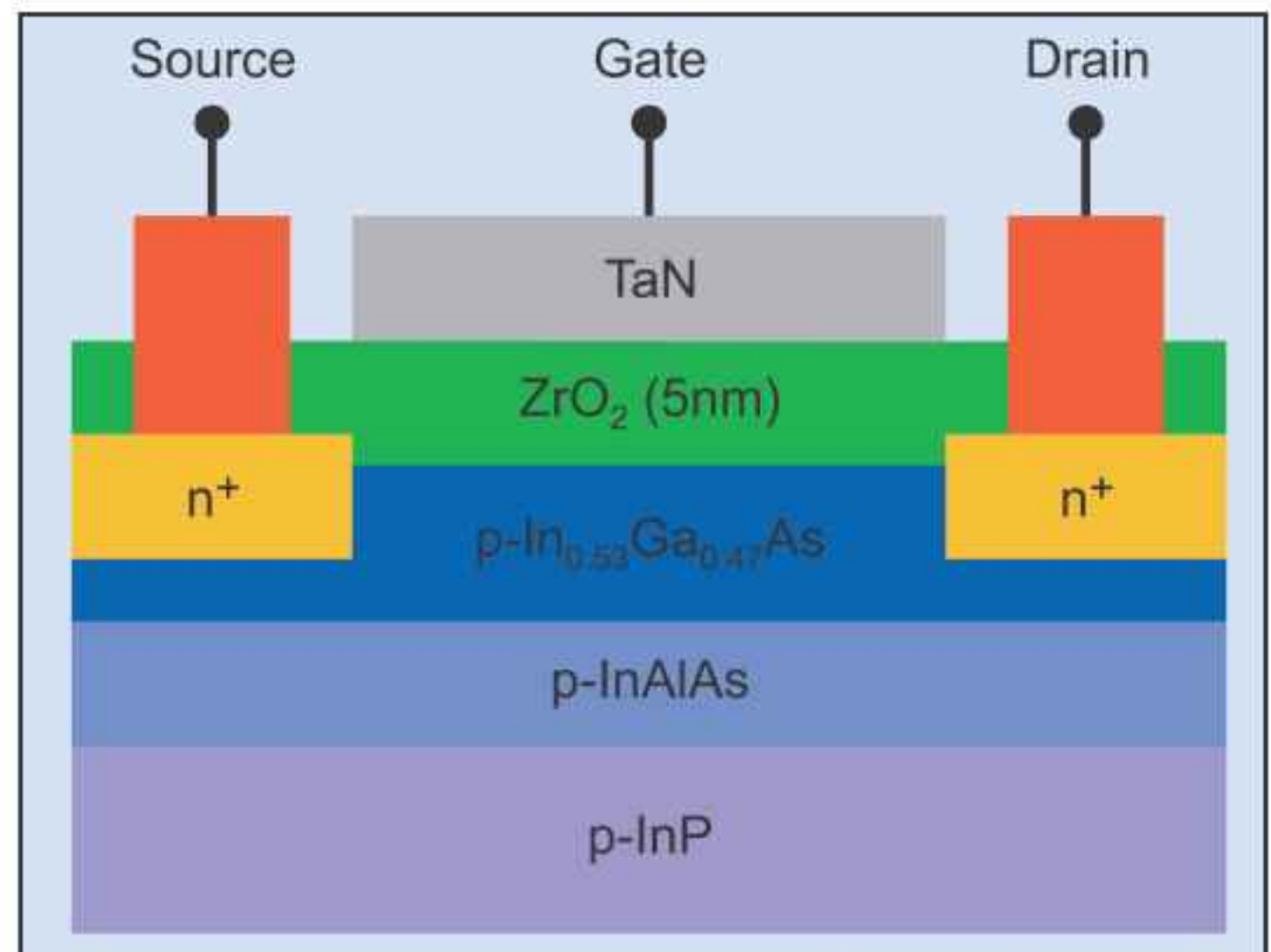


Figure 2. Schematic for an InGaAs device with ZrO₂ dielectric.

are any indication, most emphasis in the past year seems to have been placed on the indium gallium arsenide solution. Only one of the six papers in session 15 on 'III-V MOSFETs with High K Dielectrics' was not InGaAs based. Since the emphasis is on finding a decent oxide, the experimenters generally make life easier for themselves by using indium phosphide substrates, rather than adding the complicating factor of depositing InGaAs on silicon.

Collaborative work between Intel, SEMATECH, and the universities of Texas at Austin, New York at Albany, Stanford, and Oklahoma looked at 'Addressing the Gate Stack Challenge for High Mobility In_xGa_{1-x}As Channels For NFETs' [4]. Various dielectrics were evaluated to determine equivalent oxide thickness (EOT) scalability for high performance and electrostatic control with acceptable leakage for a low off-current; the impact of charge trapping; thermal stability on InGaAs; and the impact of indium concentration on the interface quality for surface channel MOSFETs. Atomic layer deposition (ALD) techniques were used and the need for cleaning was shown to be minimal, in line with recent suggestions that ALD is self-cleaning.

MOS capacitor measurements on various gate stacks were carried out to assess the options: ZrO₂, HfO₂, Al₂O₃, and Hf_xAl_{1-x}O (with x = 0.5 and 0.8). The ZrO₂ structure (Figure 2) was chosen for further study as having the most promise in scaling to a capacitive equivalent thickness (CET) of 0.5nm with low gate leakage current. It is also suggested that the ZrO₂ may undergo a phase change from its usual monoclinic structure to a tetragonal formation during the anneal process that increases its k value to 30. The gate stack also appears stable up to the temperatures required to activate the doping after implantation (~700°C).

Previous work with ZrO₂ suggests that the Fermi level is not strongly pinned at the dielectric-channel interface,

which is another prerequisite for effective MOSFETs. This is confirmed by the turn-on characteristics of transistors built in the new work (CET $\sim 0.78\text{nm}$). However, detailed characterization of interface states and charge trapping in the dielectric that can adversely impact performance has yet to be carried out and is considered 'imperative' to evaluating the potential of these stacks. It is found that a high indium concentration ($>70\%$) reduces the transistor performance, suggesting degradation of the interface. It is believed that new passivation techniques will need to be developed to realize higher-mobility NMOSFETs from the material structure.

Purdue University has used ALD Al_2O_3 as a high-k gate dielectric in high-performance surface channel $\text{In}_{0.75}\text{Ga}_{0.25}\text{As}$ NMOSFETs [5]. The devices operate in inversion/enhancement mode — i.e. they are the normally-off type of MOSFET, as used in the mainstream CMOS industry.

Although the InGaAs layers were grown using molecular beam epitaxy (MBE) on InP substrates, the high-k gate stack was deposited using ALD to bring the process closer to that seen in CMOS manufacturing. ALD processes favor Al_2O_3 or HfO_2 compared with more complicated combinations such as $\text{Ga}_2\text{O}_3(\text{Gd}_2\text{O}_3)$ that can be accessed with MBE deposition.

The devices demonstrated a maximum inversion current of 1.0A/mm and an electron velocity of $1.0 \times 10^7\text{cm/s}$ with a $0.75\mu\text{m}$ gate length and a source-drain voltage of 2V . The peak extrinsic transconductance was $430\mu\text{S}/\mu\text{m}$. A systematic study of various indium concentrations ($\text{In}_{0.53}\text{Ga}_{0.47}\text{As}$, $\text{In}_{0.65}\text{Ga}_{0.35}\text{As}$ and $\text{In}_{0.75}\text{Ga}_{0.25}\text{As}$) suggests that indium-enriched InGaAs could be an ideal channel material for CMOS high-speed low-power logic application, the team says. The highest-indium-content device gives the best performance due to its narrow band gap of 0.52eV .

The $I_{\text{on}}/I_{\text{off}}$ ratio is 10^6 , which is a rather low value. The team attributes this to a large drain junction leakage current and believes this could be improved with more sophisticated junction engineering.

The Purdue team has also been studying the interface traps set up in the Al_2O_3 dielectric [6]. These are found to be at a relatively high level, but do not seem to affect the transistor performance unduly. It is suggested that the low impact of interface traps is due to their donor-like behavior, which does not pin the Fermi level.

Passivation

Singapore researchers have created a high-mobility enhancement-mode InGaAs NMOSFET using phosphine (PH_3) passivation and a TaN/ HfO_2 /InGaAs gate stack [7]. Experiments were also performed using devices with an HfAlO dielectric. Participants in the research included researchers from Singapore's National University (NUS) and the institutes of Microelectronics and of Materials Research and Engineering.

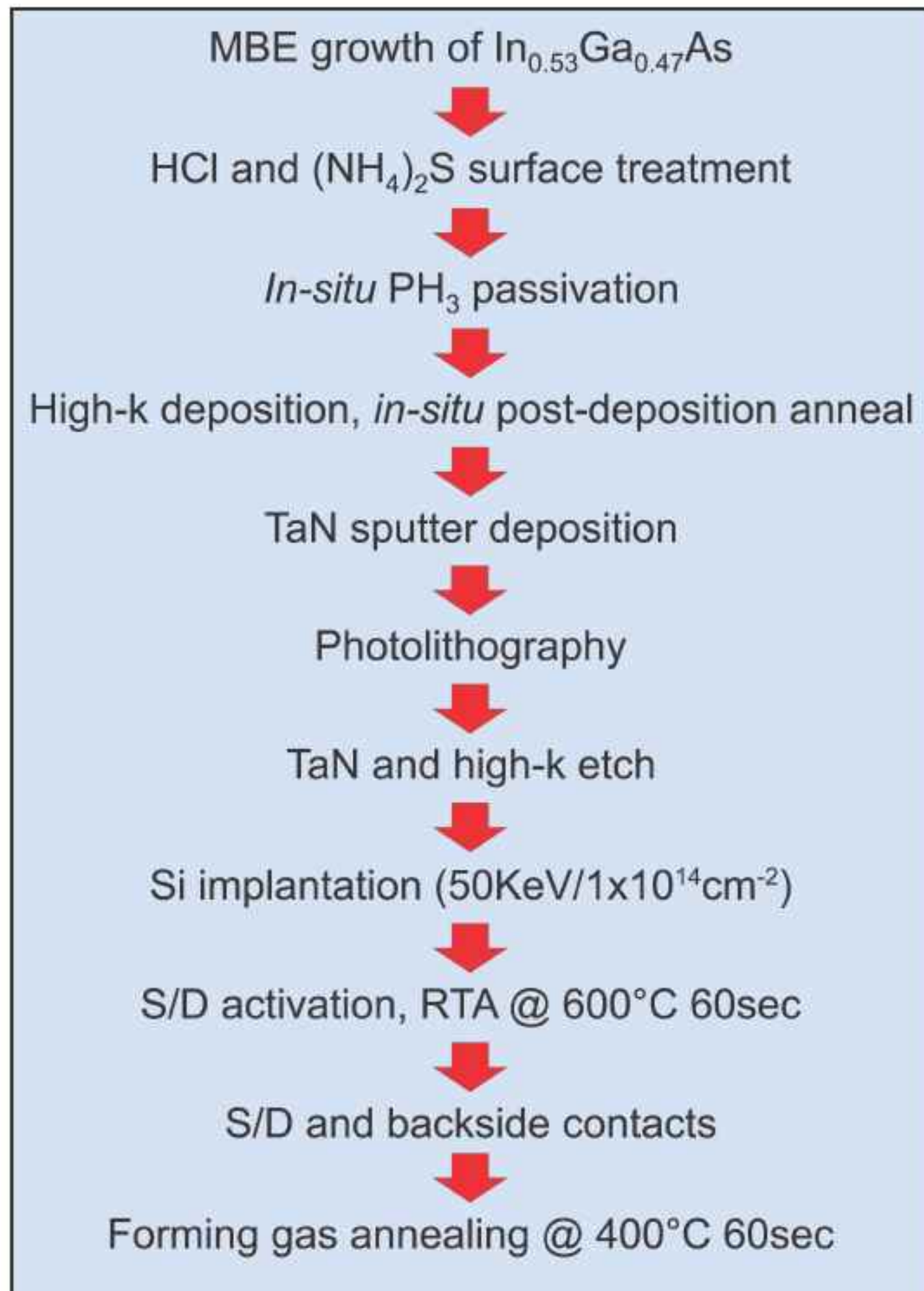


Figure 3. Process steps in Singapore's plasma PH_3 -passivated high-mobility inversion InGaAs MOSFET with self-aligned gate-first process.

Of particular note is the use of a self-aligned process where the source-drain regions are formed by implantation after the gate stack is deposited, as used in traditional CMOS manufacturing (Figure 3). The success of such process flows depends on the stability of the gate stack during the high temperatures of the anneal process (600°C rather than $>750^\circ\text{C}$, as used more normally) required to repair the implantation damage so that the silicon n-type doping chemicals can become activated. The p-type channel doping comes from Zn incorporated during initial InGaAs deposition.

Devices with and without PH_3 passivation were produced. One effect is to suppress the formation of arsenic oxide on the InGaAs surface, a factor believed to degrade the quality of the interface with the gate stack. High-frequency C-V measurements show that the interface trap density is reduced using PH_3 passivation ($D_{\text{it}} = 8.6 \times 10^{11}\text{cm}^{-2}\text{eV}^{-1}$ with passivation, and $4.3 \times 10^{12}\text{cm}^{-2}\text{eV}^{-1}$ without).

Capacitance measurements on PH_3 -passivated MOS structures give an effective oxide thickness (EOT) of $1.7\text{--}3.0\text{nm}$ and a gate leakage current of $2 \times 10^{-5}/\text{cm}^2$ at a gate potential of 2V . The lower EOT was achieved

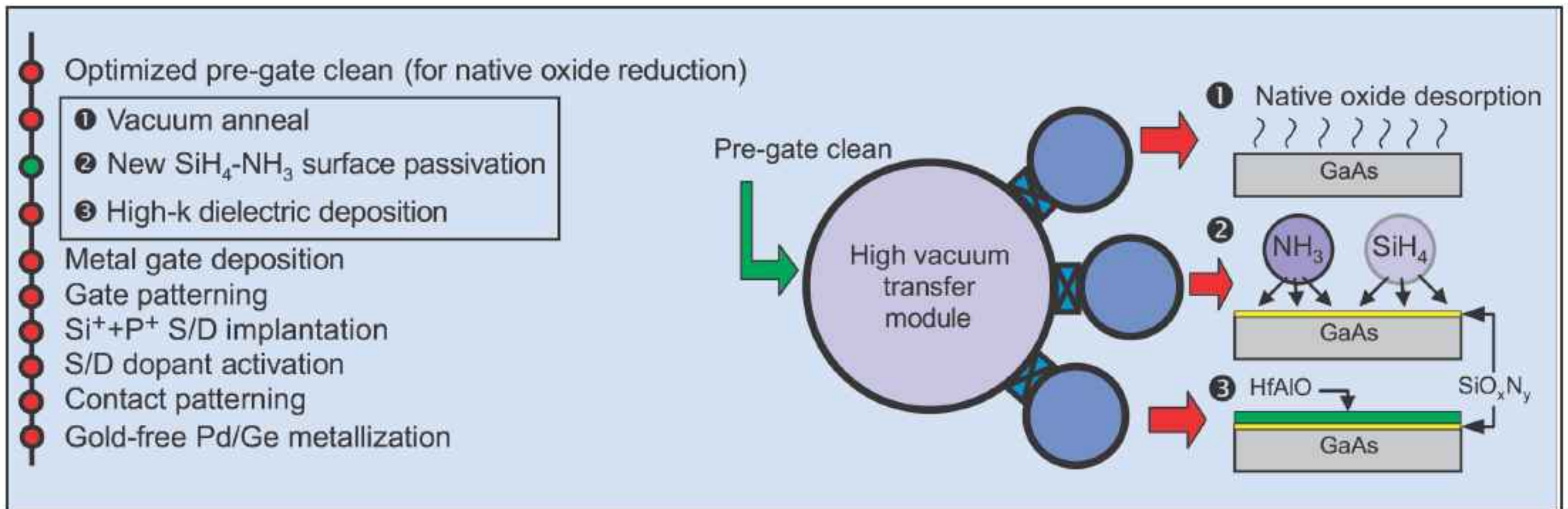


Figure 4. Process for fabricating inversion-type n-channel GaAs MOSFETs with $\text{SiH}_4\text{-NH}_3$ surface passivation.

by using a 5.5nm layer of HfAlO, while the higher figure came from a thicker 10nm layer of HfO₂. The gate stack maintains its stability through the rapid thermal anneal (RTA) step, showing a frequency spread of 1.3% in C-V measurements. The n⁺ source/drain regions are created using silicon implantation. The effective mobility of the channel is 1600cm²/Vs. A 95nm MOSFET was demonstrated with the gate-first technology, but without PH₃ passivation. This is claimed to be a first for the self-aligned gate-first technology that was used.

IBM's TJ Watson research center has been studying sub-100nm short-channel In_{0.7}Ga_{0.3}As MOSFET scaling characteristics down to 80nm for both depletion- and enhancement-mode devices [8]. The researchers report good scaling of on-current, transconductance and virtual source velocity. A high current of 960μA/μm was achieved and a record transconductance of 793μS/μm is claimed.

National Tsing Hua University of Taiwan (together with two scientists from Intel and one from Purdue) has performed C-V measurements under light illumination and under a wide range of temperatures in order to study the interface quality of Al₂O₃/Ga₂O₃ stacks on n- and p- In_{0.2}Ga_{0.8}As/GaAs [9]. The interface is said to be of very high quality with a free-moving Fermi-level near the band-edges (the regions close to E_C and E_V).

Apart from InGaAs, another group from Singapore [10] reported on the use of a silane-ammonia gas mixture to passivate HfAlO high-k dielectric on GaAs (Figure 4). TaN was used as the metal gate. An interface state density D_{it} of ~1x 10¹¹eV⁻¹cm⁻² is claimed, which is the lowest reported value for a high-k dielectric formed on GaAs by CVD, ALD, or PVD techniques. The technology was used to realize a 160nm gate-length enhancement-mode surface channel GaAs MOSFET. The peak electron mobility was measured at a high value of ~2100cm²/Vs. The dielectric reliability was characterized by using bias-temperature instability (BTI) techniques.

Quantum wells

Intel and Qinetiq continue to promote InSb quantum well (QW) technology for logic applications [11]. This year, the QWFET structure was a 40nm compressively strained p-channel FET (Figure 5). The f_T cut-off was 140GHz with a 40nm gate length and 0.5V supply. This is claimed to be the highest f_T ever reported for III-V p-channel FETs. The transconductance (G_m) is 500μS/μm, which is also the highest reported value for such a device.

While III-Vs have impressive performance enhancements over Si MOSFETs for n-channel (both in terms of MOSFETs and for quantum well structures) the p-channel side tends to drag behind. As seen above, Ge is a promising candidate for filling the MOSFET gap, but for QWFETs parasitic conduction by different carriers (parallel conduction) is difficult to control in creating useful Ge-based devices. In III-Vs, p-channel QWFETs struggle to meet the performance of existing Si technology. ➤

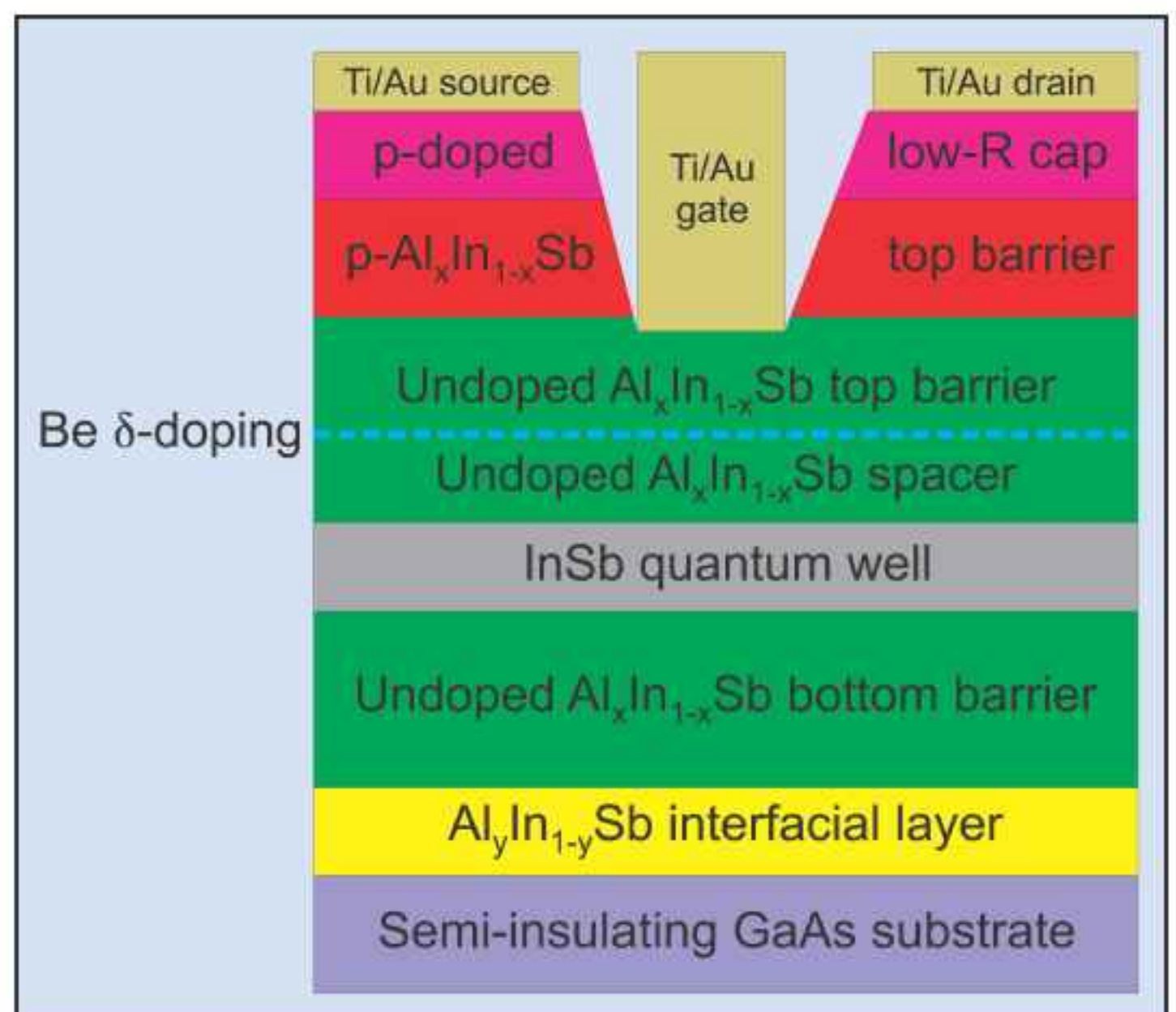


Figure 5. Intel/Qinetiq structure for p-QWFET built using InSb technology.

Intel and Qinetiq are attracted to indium antimonide (InSb) for this, given that this compound has the highest hole mobility of any III-V material. Theoretical investigations suggest that this compressive strain can significantly reduce the in-plane effective mass of the holes, thus increasing speeds and hence mobility in the material.

After some simulation work, the researchers have produced various structures with compressively strained InSb QWs. The strain is introduced by growing the InSb on $\text{Al}_x\text{In}_{1-x}\text{Sb}$. By varying the Al concentration, different biaxial compressive strain values can be produced. Beryllium delta-doping above a spacer layer provides the carrier source for the QW channel (Figure 5). The advantage of using such remote doping is that there are then no ionized scattering centers to reduce the mobility in the channel. Using these techniques, the team has achieved a p-QW mobility of $1230\text{cm}^2/\text{Vs}$ at a carrier density of $1.1 \times 10^{12}/\text{cm}^2$ by using a biaxial compressive strain of 1.9% (InSb on $\text{Al}_{0.35}\text{In}_{0.65}\text{Sb}$). This is about 5x the mobility for suitably strained silicon. ■

References

- [1] Antoniadis and Khakifirooz, IEDM 2008, session 10.6, 'MOS-FET Performance Scaling: Limitations and Future Options'
2. Khakifirooz and Antoniadis, IEDM Tech. Dig., 2006, p667
3. See e.g. Mike Cooke, Semiconductor Today, August 2008
4. Goel et al, IEDM 2008, session 15.1
5. Xuan et al, IEDM 2008, session 15.3, 'High-Performance Surface Channel In-Rich $\text{In}_{0.75}\text{Ga}_{0.25}\text{As}$ MOSFETs With ALD High-K As Gate Dielectric'
6. Varghese et al, IEDM 2008, session 15.5, 'Multi-Probe Interface Characterization of $\text{In}_{0.65}\text{Ga}_{0.35}\text{As}/\text{Al}_2\text{O}_3$ MOSFET'
7. Lin et al, IEDM 2008, session 16.4, 'Plasma PH_3 -Passivated High Mobility Inversion InGaAs MOSFET Fabricated with Self-Aligned Gate First Process and HfO_2/TaN Gate Stack'
8. Sun et al, IEDM 2008, session 15.2, 'Scaling of $\text{In}_{0.7}\text{Ga}_{0.3}\text{As}$ Buried-Channel MOSFETs'
9. Chiang et al, IEDM 2008, session 15.4, 'Approaching Fermi Level Unpinning In Oxide- $\text{In}_{0.2}\text{Ga}_{0.8}\text{As}$ '
10. Chin et al, IEDM 2008, session 15.6, 'A New Silane-Ammonia Surface Passivation Technology for Realizing Inversion-Type Surface-Channel GaAs N-MOSFET with 160nm Gate Length and High-Quality Metal-Gate/High-k Dielectric Stack'
11. Radosavljevic et al, IEDM 2008, session 30.3, 'High-Performance 40nm Gate Length InSb P-Channel Compressively Strained Quantum Well Field Effect Transistors For Low-Power ($V_{\text{CC}}=0.5\text{V}$) Logic Applications'

REGISTER

for *Semiconductor Today*

free at

www.semiconductor-today.com



**2009 International Conference on
Compound Semiconductor Manufacturing Technology
May 18 - 21, 2009, Marriott – Waterside, Tampa, Florida**

The Program

The focus of the annual CS MANTECH Conference will be on optimum manufacturing processes for all compound semiconductor (CS) device technologies – the practical 'nuts and bolts' of the CS device production. Topics covered include design; materials; fabrication; and reliability.

The program includes practical *Technical Sessions* including invited papers presented by technologists from around the world; an intensive *Workshop*; and an *Exhibit* featuring leading equipment, substrate, epitaxy, process chemical vendors and special service providers for CS device technologies (RF, Power, LEDs, Solar...).

The *Interactive Forum* gives attendees the chance to have informal discussions with Technical Session authors and the popular *Rump Sessions* enable small groups with like interests to convene and converse in a friendly setting.

The Venue

Tampa is a city with everything. From white sand beaches to a cosmopolitan downtown to world class attractions.

The Tampa Marriott Waterside is in downtown Tampa, steps from the marina and walking distance to many great restaurants and attractions. So if you want a hand rolled cigar in Ybor City, a cruise in the bay, or a visit to the world class aquarium, Tampa is for you.



For information on Registration, the Advance Program or Exhibiting, please visit
www.CSMANTECH.org

Index

- | | |
|--|-------------------------------------|
| 1 Bulk crystal source materials p88 | 14 Chip test equipment p92 |
| 2 Bulk crystal growth equipment p88 | 15 Assembly/packaging materials p92 |
| 3 Substrates p88 | 16 Assembly/packaging equipment p92 |
| 4 Epiwafer foundry p89 | 17 Assembly/packaging foundry p93 |
| 5 Deposition materials p89 | 18 Chip foundry p93 |
| 6 Deposition equipment p90 | 19 Facility equipment p93 |
| 7 Wafer processing materials p91 | 20 Facility consumables p93 |
| 8 Wafer processing equipment p91 | 21 Computer hardware & software p93 |
| 9 Materials and metals p91 | 22 Used equipment p93 |
| 10 Gas & liquid handling equipment p91 | 23 Services p93 |
| 11 Process monitoring and control p92 | 24 Consulting p93 |
| 12 Inspection equipment p92 | 25 Resources p93 |
| 13 Characterization equipment p92 | |

To have your company listed in this directory, e-mail details (including categories) to mark@semiconductor-today.com
 Note: advertisers receive a free listing. For all other companies, a charge is applicable.

1 Bulk crystal source materials

Mining & Chemical Products Ltd

1-4, Nielson Road,
 Finedon Road Industrial Estate,
 Wellingborough,
 Northants NN8 4PE,
 UK

Tel: +44 1933 220626
 Fax: +44 1933 227814

www.MCP-group.com

Umicore Indium Products

50 Simms Avenue,
 Providence, RI 02902,
 USA

Tel: +1 401 456 0800
 Fax: +1 401 421 2419

www.thinfilmproducts.umicore.com

United Mineral & Chemical Corp

1100 Valley Brook Avenue,
 Lyndhurst,
 NJ 07071,
 USA

Tel: +1 201 507 3300
 Fax: +1 201 507 1506

www.umccorp.com

2 Bulk crystal growth equipment

MR Semicon Inc

PO Box 91687,
 Albuquerque,
 NM 87199-1687,
 USA

Tel: +1 505 899 8183
 Fax: +1 505 899 8172

www.mrsemicon.com

3 Substrates

AXT Inc

4281 Technology Drive,
 Fremont,
 CA 94538,
 USA

Tel: +1 510 438 4700
 Fax: +1 510 683 5901

www.axt.com

Supplies GaAs, InP, and Ge wafers using VGF technology with manufacturing facilities in Beijing and five joint ventures in China producing raw materials, including Ga, As, Ge, pBN, B₂O₃.



Crystal IS Inc

70 Cohoes Avenue
 Green Island, NY 12183, USA

Tel: +1 518 271 7375

Fax: +1 518 271 7394

www.crystal-is.com

The Fox Group Inc

200 Voyageur Drive,
 Montreal, Quebec H9R 6A8,
 Canada

Tel: +1 925 980 5645

Fax: +1 514 630 0227

www.thefoxgroupinc.com

Epistone Comp-Semi Materials Inc

2371 Marion Ave., Fremont,
 CA 94539, USA

Tel: +86 755 28968489

Fax: +86 755 89724120

www.epistone.com

Freiberger Compound Materials

Am Junger Loewe Schacht 5,
 Freiberg, 09599,
 Germany

Tel: +49 3731 280 0

Fax: +49 3731 280 106

www.fcm-germany.com

Kyma Technologies Inc

8829 Midway West Road,
Raleigh, NC, USA
Tel: +1 919 789 8880
Fax: +1 919 789 8881
www.kymatech.com

Nikko Materials

125 North Price Road,
Chandler, AZ, USA
Tel: +1 480 732 9857
Fax: +1 480 899 0779
www.nikkomaterials.com

SiCrystal AG

Guenther-Scharowsky-Str. 1
D-91058 Erlangen, Germany
Tel: +49 (0) 9131 / 73 33 97
Fax: +49 (0) 9131 / 73 22 37
www.sicrystal.de

sp3 Diamond Technologies

2220 Martin Avenue,
Santa Clara, CA 95050, USA
Tel: +1 877 773 9940
Fax: +1 408 492 0633
www.sp3inc.com

**Sumitomo Electric
Semiconductor Materials Inc**

7230 NW Evergreen Parkway,
Hillsboro, OR 97124, USA
Tel: +1 503 693 3100 x207
Fax: +1 503 693 8275
www.sesmi.com

TECDIA Inc

(see section 16 for full contact details)

III/V-Reclaim

Wald 10, 
84568 Pleiskirchen,
Germany
Tel: +49 8728 911 093
Fax: +49 8728 911 156
www.35reclaim.de

III/V-Reclaim offers reclaim (recycling) of GaAs and InP wafers, removing all kinds of layers and structures from customers' wafers. All formats and sizes can be handled. The firm offers single-side and double-side-polishing and ready-to-use surface treatment.

Wafer Technology Ltd

34 Maryland Road, Tongwell,
Milton Keynes, Bucks, MK15 8HJ, UK

Tel: +44 (0)1908 210444
Fax: +44 (0)1908 210443

www.wafertech.co.uk

Wafer Technology Ltd is a UK-based producer of III-V materials and epitaxy-ready substrate: the widest product range in the business.



WAFER TECHNOLOGY LTD.

4 Epiwafer foundry

Spire Semiconductor LLC

25 Sagamore Park Drive,
Hudson, NH 03051, USA
Tel: +1 603 595 8900
Fax: +1 603 595 0975
www.spirecorp.com

Cambridge Chemical Company Ltd

Unit 5 Chesterton Mills,
French's Road, Cambridge CB4 3NP,
UK
Tel: +44 (0)1223 352244
Fax: +44 (0)1223 352444
www.camchem.co.uk

The Fox Group Inc

(see section 3 for full contact details)

Intelligent Epitaxy Technology Inc

1250 E Collins Blvd, Richardson,
TX 75081-2401, USA
Tel: +1 972 234 0068
Fax: +1 972 234 0069
www.intelliepi.com

IntelliEPI is a leading supplier of GaAs and InP based epiwafers for the electronic and optoelectronic industries. Product line includes HEMT, HBT, laser and photodetector.

**IQE**

Cypress Drive,
St Mellons,
Cardiff CF3 0EG, UK
Tel: +44 29 2083 9400
Fax: +44 29 2083 9401
www.iqep.com



IQE is a leading global supplier of advanced epiwafers, with products covering a diverse range of applications within the wireless, optoelectronic, photovoltaic and electronic markets.

OMMIC

2, Chemin du Moulin B.P. 11,
Limeil-Brevannes, 94453,
France
Tel: +33 1 45 10 67 31
Fax: +33 1 45 10 69 53
www.ommic.fr

Picogiga International S.A.S.

Place Marcel Rebuffat, Parc de
Villejust, 91971 Courtabouef,
France
Tel: +33 (0)1 69 31 61 30
Fax: +33 (0)1 69 31 61 79
www.picogiga.com

SemiSouth Laboratories Inc

201 Research Boulevard,
Starkville, MS 39759,
USA
Tel: +1 662 324 7607
Fax: +1 662 324 7997
www.semisouth.com

5 Deposition materials

**Akzo Nobel High Purity
Metalorganics**

525 West Van Buren Street,
Chicago, IL 60607,
USA
Tel: +1 312 544 7371
Fax: +1 312 544 7188
www.akzonobel-hpmo.com

Cambridge Chemical Company Ltd

Unit 5 Chesterton Mills,
French's Road, Cambridge CB4 3NP,
UK
Tel: +44 (0)1223 352244
Fax: +44 (0)1223 352444
www.camchem.co.uk

Matheson Tri-Gas

6775 Central Avenue
Newark, CA 94560,
USA
Tel: +1 510 793 2559
Fax: +1 510 790 6241
www.mathesontrigas.com

Mining & Chemical Products Ltd
(see section 1 for full contact details)**Power + Energy Inc**

(see section 8 for full contact details)

Praxair Electronics
542 Route 303,
Orangeburg, NY 10962, USA
Tel: +1 845 398 8242
Fax: +1 845 398 8304
www.praxair.com/electronics

**Rohm and Haas
Electronic Materials**
60 Willow Street,
North Andover, MA 01845, USA
Tel: +1 978 557 1700
Fax: +1 978 557 1701
www.metalorganics.com



ELECTRONIC MATERIALS

Leading manufacturer of high-purity MOCVD precursors, including for Ga, In, Al, As, and several dopants. Ge precursors for SiGe films have now been added. Sales professionals have direct experience of epi-growth and device fabrication, giving superior technical service value.

SAFC Hitech
Power Road, Bromborough, Wirral,
Merseyside CH62 3QF, UK
Tel: +44 151 334 2774
Fax: +44 151 334 6422
www.safchitech.com

SAFC Hitech™
Enabling Technology

SAFC Hitech provides a unique chemistry service translating application understanding into performance materials worldwide.

Williams Advanced Materials
2978 Main Street,
Buffalo, NY 14214, USA
Tel: +1 716 837 1000
Fax: +1 716 833 2926
www.williams-adv.com

6 Deposition equipment

AIXTRON AG
Kackertstrasse 15-17, Aachen 52072,
Germany
Tel: +49 241 89 09 0
Fax: +49 241 89 09 40
www.aixtron.com

AIXTRON

AIXTRON is a leading provider of deposition equipment to the semiconductor industry. AIXTRON's technology solutions (MOCVD, ALD, AVD®, CVD, OVPD) are used by a diverse range of customers worldwide to build advanced components for electronic and optoelectronic applications based on compound, silicon, or organic semiconductors. Several system configurations of AIXTRON, Epigress, Genus or Thomas Swan are available.

EMF Semiconductor Systems Ltd
Mitchelstown, Co. Cork, Ireland
Tel: +353 (0) 2586324
Fax: +353 (0) 2586331
www.emfsemi.com

ETC (LPE subsidiary) etc
Via Falzarego, 8,
20021 Baranzate (Mi), Italy
Tel: +39 02 383 41 51
Fax: +39 02 383 06 118
www.lpe-epi.com

ETC (Epitaxial Technology Center) developed and customized a SiC process for LPE ACiS M8 and ACiS M10 systems in order to perform the full range of epitaxial layers required for high-power and high-frequency applications, with low cost of ownership.

LPE S.p.A.
Via Falzarego, 8,
20021 Baranzate (Mi), Italy
Tel: +39 02 383 41 51
Fax: +39 02 383 06 118
www.lpe-epi.com



LPE is a world leading Epitaxial Technology Company. Based on its silicon epitaxial reactor experience, LPE provides state-of-the-art SiC epitaxial reactors. Two systems are available: ACiS M8 and ACiS M10.

**Oxford Instruments
Plasma Technology**
North End, Yatton,
Bristol, Avon BS49 4AP, UK
Tel: +44 1934 837 000
Fax: +44 1934 837 001
www.oxford-instruments.co.uk

We provide flexible tools and



processes for precise materials deposition, etching and controlled nanostructure growth. Core technologies include plasma and ion-beam deposition and etch and ALD.

Riber
31 rue Casimir Périer, BP 70083,
95873 Bezons Cedex, France
Tel: +33 (0) 1 39 96 65 00
Fax: +33 (0) 1 39 47 45 62
www.riber.com

Riber is a **RIBER** leading supplier of MBE products and related services for the compound semiconductor industry.

SVT Associates Inc
7620 Executive Drive,
Eden Prairie, MN 55344, USA
Tel: +1 952 934 2100
Fax: +1 952 934 2737
www.svta.com

**Temescal, a part of
Edwards
Vacuum Inc**
4569-C

Las Positas Rd,
Livermore, CA 94551, USA
Tel: +1 925 245 5817
Fax: +1 925 449-4096
www.temescal.net

Temescal, the expert in metallization systems for the processing of compound semiconductor-based substrates, provides the finest evaporation systems available. Multi-layer coatings of materials such as Ti, Pt, Au, Pd, Ag, NiCr, Al, Cr, Cu, Mo, Nb, SiO₂, with high uniformity are guaranteed. Today the world's most sophisticated handsets, optical, wireless and telecom systems rely on millions of devices that are made using Temescal deposition systems and components.

Veeco Instruments Inc
100 Sunnyside Blvd.,
Woodbury, NY 11797, USA
Tel: +1 516 677 0200
Fax: +1 516 714 1231
www.veeco.com





Veeco is a world-leading supplier of compound semiconductor equipment, and the only company offering both MOCVD and MBE solutions. With complementary AFM technology and the industry's most advanced Process Integration Center, Veeco tools help grow and measure nanoscale devices in worldwide LED/wireless, data storage, semiconductor and scientific research markets—offering important choices, delivering ideal solutions.

7 Wafer processing materials

Air Products and Chemicals Inc

7201 Hamilton Blvd.,
Allentown, PA 18195,
USA

Tel: +1 610 481 4911

www.airproducts.com/compound

MicroChem Corp

1254 Chestnut St. Newton,
MA 02464, USA

Tel: +1 617 965 5511

Fax: +1 617 965 5818

E-mail: sales@microchem.com

www.microchem.com

Power + Energy Inc

(see section 8 for full contact details)

Praxair Electronics

(see section 5 for full contact details)

8 Wafer processing equipment

EV Group

DI Erich Thallner Strasse 1,
St. Florian/Inn, 4782,
Austria

Tel: +43 7712 5311 0

Fax: +43 7712 5311 4600

www.EVGroup.com

Technology and market leader for wafer processing equipment.



Worldwide industry standards for aligned wafer bonding, resist processing for the MEMS, nano and semiconductor industry.

Logitech Ltd

Erskine Ferry
Road,
Old Kilpatrick, near Glasgow G60 5EU,
Scotland, UK

Tel: +44 (0) 1389 875 444

Fax: +44 (0) 1389 879 042

www.logitech.uk.com

Logitech Ltd is a leading designer and manufacturer of precision bonding, cutting, lapping, polishing and CMP equipment.



Oerlikon Wafer Processing

10050 16th Street North, Suite 100,
St. Petersburg, FL 33716,
USA

Tel: +1 727 577 4999

Fax: +1 727 577 3923

www.oerlikonoc.com

Oxford Instruments Plasma Technology

(see section 6 for full contact details)

Power + Energy Inc

(see section 8 for full contact details)

SAMCO International Inc

532 Weddell Drive, Sunnyvale, CA,
USA

Tel: +1 408 734 0459

Fax: +1 408 734 0961

www.samcointl.com

Surface Technology Systems plc

Imperial Park, Newport NP10 8UJ,
Wales, UK

Tel: +44 (0)1633 652400

Fax: +44 (0)1633 652405

www.stsystems.com

A leading manufacturer of plasma etch and deposition



SURFACE TECHNOLOGY SYSTEMS

equipment, including DRIE, ICP, RIE & PECVD technologies used in the fabrication and packaging of semiconductor devices.

Synova SA

Ch. de la Dent d'Oche, 1024 Ecublens,
Switzerland

Tel: +41 21 694 35 00

Fax: +41 21 694 35 01

www.synova.ch

TECDIA Inc

(see section 16 for full contact details)

Tegal Corp

2201 S McDowell Boulevard,
Petaluma, CA 94954, USA

Tel: +1 707 763 5600

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, UK

Tel: +44 (0) 1480 424800

Fax: +44 (0) 1480 424900

www.goodfellow.com



Goodfellow supplies small quantities of metals and materials for research, development, prototyping and specialised manufacturing operations.

TECDIA Inc

(see section 16 for full contact details)

10 Gas and liquid handling equipment

Air Products and Chemicals Inc

(see section 7 for full contact details)

Cambridge Fluid Systems

12 Trafalgar Way, Bar Hill,
Cambridge CB3 8SQ, UK

Tel: +44 (0)1954 786800

Fax: +44 (0)1954 786818

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

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

Power + Energy Inc
106 Railroad Drive,
Ivyland, PA 18974,
USA
Tel: +1 215 942-4600
Fax: +1 215 942-9300
www.powerandenergy.com

SAES Pure Gas Inc
4175 Santa Fe Road,
San Luis Obispo,
CA 93401,
USA
Tel: +1 805 541 9299
Fax: +1 805 541 9399
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

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

Optical Reference Systems Ltd
OpTIC Technium,
St Asaph Business Park,
St Asaph, LL17 0JD,
UK
Tel: +44 (0)1745 535 188
Fax: +44 (0)1745 535 186
www.ors-ltd.com

WEP (Ingenieurbüro Wolff für Elektronik- und Programmentwicklungen)
Bregstrasse 90, D-78120
Furtwangen im Schwarzwald,
Germany
Tel: +49 7723 9197 0
Fax: +49 7723 9197 22
www.wepcontrol.com

12 Inspection equipment

Bruker AXS GmbH
Oestliche Rheinbrueckenstrasse 49,
Karlsruhe, 76187,
Germany
Tel: +49 (0)721 595 2888
Fax: +49 (0)721 595 4587
www.bruker-axs.de

KLA-Tencor
160 Rio Robles, Suite 103D,
San Jose,
CA 94538-7306,
USA
Tel: +1 408 875 3000
Fax: +1 510 456 2498
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

Lake Shore Cryotronics Inc
575 McCorkle Boulevard,
Westerville, OH 43082,
USA
Tel: +1 614 891 2244
Fax: +1 614 818 1600
www.lakeshore.com

14 Chip test equipment

Keithley Instruments Inc
28775 Aurora Road,
Cleveland, OH 44139,
USA
Tel: +1 440.248.0400
Fax: +1 440.248.6168
www.keithley.com

SUSS MicroTec Test Systems
228 Suss Drive,
Waterbury Center,
VT 05677,
USA
Tel: +1 800 685 7877
Fax: +1 802 244 7853
www.suss.com

15 Assembly/packaging materials

ePAK International Inc
4926 Spicewood Springs Road,
Austin, TX 78759,
USA
Tel: +1 512 231 8083
Fax: +1 512 231 8183
www.epak.com

Gel-Pak
31398 Huntwood Avenue,
Hayward,
CA 94544,
USA
Tel: +1 510 576 2220
Fax: +1 510 576 2282
www.gelpak.com

Williams Advanced Materials
2978 Main Street,
Buffalo, NY 14214,
USA
Tel: +1 716 837 1000
Fax: +1 716 833 2926
www.williams-adv.com

16 Assembly/packaging equipment

Ismeca Europe Semiconductor SA
Helvetie 283,
La Chaux-de-Fonds, 2301,
Switzerland
Tel: +41 329257111
Fax: +41 329257115
www.ismeca.com

J P Sercel Associates Inc
220 Hackett Hill Road,
Manchester,
NH 03102,
USA
Tel: +1 603 518 3200
Fax: +1 603 518 3298
www.jpسالaser.com

Kulicke & Soffa Industries
1005 Virginia Drive,
Fort Washington,
PA 19034,
USA
Tel: +1 215 784 6000
Fax: +1 215 784 6001
www.kns.com

Palomar Technologies Inc

2728 Loker Avenue West,
Carlsbad,
CA 92010,
USA

Tel: +1 760 931 3600

Fax: +1 760 931 5191

www.PalomarTechnologies.com

TECDIA Inc

2700 Augustine Drive, Suite 110,
Santa Clara,
CA 95054,
USA

Tel: +1 408 748 0100

Fax: +1 408 748 0111

www.tecdia.com

Tecdia is a **TECDIA**
manufacturer of
single-layer chip capacitors,
chip resistors, DC boards, bias-Ts,
diamond scribing tools and
dispensing nozzles.

**17 Assembly/packaging
foundry****Quik-Pak**

10987 Via Frontera,
San Diego,
CA 92127,
USA

Tel: +1 858 674 4676

Fax: +1 8586 74 4681

www.quikicpak.com

18 Chip foundry**Compound Semiconductor
Technologies Ltd**

Block 7, Kelvin Campus,
West of Scotland, Glasgow,
Scotland G20 0TH,
UK

Tel: +44 141 579 3000

Fax: +44 141 579 3040

www.compoundsemi.co.uk

**United Monolithic
Semiconductors**

Route departementale 128,
BP46, Orsay, 91401,
France

Tel: +33 1 69 33 04 72

Fax: +33 169 33 02 92

www.ums-gaas.com

19 Facility equipment**MEI, LLC**

3474 18th Avenue SE,
Albany, OR 97322-7014,
USA

Tel: +1 541 917 3626

Fax: +1 541 917 3623

www.marlerenterprises.net

20 Facility consumables**W.L. Gore & Associates**

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

Tel: +1 410 392 4440

Fax: +1 410 506 8749

www.gore.com

**21 Computer hardware
& software****Ansoft Corp**

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

Tel: +1 412 261 3200

Fax: +1 412 471 9427

www.ansoft.com

Crosslight Software Inc

121-3989 Henning Dr.,
Burnaby, BC, V5C 6P8,
Canada

Tel: +1 604 320 1704

Fax: +1 604 320 1734

www.crosslight.com

**Semiconductor Technology
Research Inc**

10404 Patterson Ave., Suite 108,
Richmond,
VA 23238,
USA

Tel: +1 804 740 8314

Fax: +1 804 740 3814

www.semitech.us

22 Used equipment**Class One Equipment Inc**

5302 Snapfinger Woods Drive,
Decatur, GA 30035,
USA

Tel: +1 770 808 8708

Fax: +1 770 808 8308

www.ClassOneEquipment.com

ClassOne
Equipment

ClassOne
EQUIPMENT

specializes in

buying and selling high quality
reconditioned equipment to the
Semiconductor and
Nanotechnology Industries.

23 Services**Henry Butcher International**

Brownlow House,
50-51 High Holborn,
London WC1V 6EG,
UK

Tel: +44 (0)20 7405 8411

Fax: +44 (0)20 7405 9772

www.henrybutcher.com

M+W Zander Holding AG

Lotterbergstrasse 30, Stuttgart,
Germany

Tel: +49 711 8804 1141

Fax: +49 711 8804 1950

www.mw-zander.com

TECDIA Inc

(see section 16 for full contact details)

24 Consulting**WSR Optical Device Solutions**

P.O. Box 248, Flemington,
NJ 08822, USA

Tel: +1 908 428 4986

www.wsr-ods.com

25 Resources**SEMI Global Headquarters**

3081 Zanker Road,
San Jose, CA 95134,
USA

Tel: +1 408 943 6900

Fax: +1 408 428 9600

www.semi.org

Yole Développement

45 rue Sainte Geneviève,
69006 Lyon,
France

Tel: +33 472 83 01 86

www.yole.fr

event calendar

If you would like your event listed in *Semiconductor Today's* Event Calendar, then please e-mail all details to the Editor at mark@semiconductor-today.com

4–6 March 2009

PHOTON's 4th Photovoltaic Technology Show 2009 Europe

Munich, Germany

E-mail: ticket@photon-expo.com

www.photon-expo.com/en

8–11 March 2009

15th European Molecular Beam Epitaxy Workshop (Euro-MBE 2009)

Zakopane, Poland

E-mail: mbe09@unipress.waw.pl

www.unipress.waw.pl/mbe09

17–19 March 2009

SEMICON/SOLARCON China

Shanghai, China

E-mail: semichina@semi.org

<http://semiconchina.semi.org>

22–26 March 2009

OFC/NFOEC 2009: Optical Fiber Communication Conference and Exposition and National Fiber Optic Engineers Conference

San Diego Convention Center, CA, USA

E-mail: info@ofcconference.org

www.ofcnfoec.org

31 March – 2 April 2009

LED Asia 2009

Eaton Hotel, Kowloon, Hong Kong

E-mail: michael.robert@pira-international.com

www.ledsasia.com

1–3 April 2009

5th Photovoltaic Science Application and Technology (PVSAT-5) Conference

Glyndwr University, UK

E-mail: info@uk-ises.org

www.pvsat.org.uk

7–8 April 2009

Photovoltaics Beyond Conventional Silicon Europe

Dresden, Germany

E-mail: a.foreman@IDTechEx.com

www.IDTechEx.com/peEUROPE

8–10 April 2009

International Green Energy Expo Korea 2009

EXCO, Daegu, Korea

E-mail: green@energyexpo.co.kr

www.energyexpo.co.kr

13–15 April 2009

6th China International Solar PV Exhibition

Shanghai International Exhibition Center, China

E-mail: nuogaisi2004@126.com

www.ch-solar.com

14–16 April 2009

2009 MRS Spring Meeting

Moscone West and San Francisco Marriott, CA, USA

E-mail: info@mrs.org

www.mrs.org

advertisers' index

Advertiser	Page no.	Advertiser	Page no.
Aixtron AG	3	Riber	31
AXT	73	SAFC Hitech	21
CS MANTECH	87	Solar Innovation & Investment	77
EV Group	37	Surface Technology Systems Ltd	25
III/V-Reclaim	17	TDI	41
IntelliEPI	95	Temescal	59
LayTec	75	Veeco Instruments — MBE	IFC
Oxford Instruments Plasma Technology	27	Veeco Instruments — MOCVD	11

20–23 April 2009

SPIE Europe Optics + Optoelectronics 2009

Prague Congress Centre, Czech Republic

E-mail: info@SPIEeurope.org

http://spie.org/x25077.xml

20–23 April 2009

Photonics '09: 4th International Specialized Exhibition for Laser, Optical and Optoelectronic Technologies

Moscow, Russia

E-mail: es@expoentr.ru

www.photonics-expo.ru

26–30 April 2009

IEEE International Reliability Physics Symposium (2009 IRPS)

Montreal, Canada

www.irps.org

3–7 May 2009

LightFair International 2009

New York, NY, USA

E-mail: info@lightfair.com

www.lightfair.com

10–14 May 2009

IPRM'09: 21st Annual IEEE Conference on Indium Phosphide and Related Materials

Marriott Hotel & Spa, Newport Beach, CA, USA

E-mail: s.blodgett@ieee.org

www.ieee.org/organizations/society/leos/LEOSCONF/IPRM2009/index.html

17–20 May 2009

WOCSDICE 2009: 33rd Workshop on Compound Semiconductor Devices and Integrated Circuits

Málaga, Spain

E-mail: wocsdice2009@die.upm.es

www.wocsdice2009.org

17–22 May 2009

ICSI-6: 6th International Conference on Silicon Epitaxy and Heterostructures

Los Angeles, CA, USA

E-mail: organizers@icsi-6.org

www.icsi-6.org

18–19 May 2009

4G World Summit 2009

Boston Park Plaza Hotel, MA, USA

E-mail: info@trendsmidia.com

www.4gworldsummit.com

18–20 May 2009

OPTOmism: Photonics for the Green Revolution

Santa Clara, CA, USA

E-mail: OPTOmismAbstract@oida.org

http://opt09.events.pennnet.com

18–21 May 2009

CS MANTECH (2009 International Conference on Compound Semiconductor Manufacturing Technology)

Tampa, FL, USA

E-mail: csmantech@csmantech.org

www.gaasmantech.org

20–23 May 2009

LED EXPO 2009

KINTEX, Seoul, South Korea

E-mail: led@exponu.com

www.ledexpo.com

24–28 May 2009

APWS 2009: 4th Asia-Pacific Workshop on Wide gap Semiconductors

Zhang Jia Jie, Hunan, China

E-mail: Apws2009@pku.edu.cn

www.apws2009.com.cn



The Right Choice
The Intelligent Choice

Intelligent Epitaxy Technology, Inc.

- ◆ Pure-Play Epi Foundry
- ◆ Industry's First Production 7 x 4inch InP Epi Capabilities
- ◆ Real-Time In Situ Growth Sensor Technology
- ◆ Your Partner in Production and Advanced Epitaxy

We supply the following best-valued epi wafers

- GaAs-based (7 x 6inch available)
 - PHEMT (AlAs, InGaP Etch-stop)
 - MHBT
 - MHEMT
- InP-based
 - HBT (C-doped, Be-doped, & GaAsSb)
 - HEMT
 - RTT, RTD
- Opto-electronics
 - PIN (GaAs, InP)
 - Laser (Short to long wave, power, & VCSEL)
 - QWIP
- SiC
 - GaN HEMT

1250 E. Collins Blvd. Richardson, TX 75081
Tel: 972-234-0068 • Fax: 972-234-0069 • E-mail: info@intelliepi.com • www.intelliepi.com



Register now
for your FREE subscription to

semiconductorTODAY
COMPOUNDS & ADVANCED SILICON

For more information on
editorial or advertising opportunities,
please visit

www.semiconductor-today.com