

Wide-bandgap RF device market

CS MANTECH report

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Freescale closing Tempe fab • Finisar and Optium to merge
New M/A-COM owner to shed fab • AmberWave buys Aonex

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Editorial	2
News	
Markets	4
Q1 mobile shipments rise a higher-than-expected 14%	
Micro	6
Freescale closing GaAs fab • New M/A-COM owner to shed fab • RFMD halts cellular transceiver development; selling GPS unit	
Wide-bandgap electronics	22
Nitronex hires MMIC engineer • Fox licenses patents • Caracal on block	
Materials and processing equipment	24
AXT grows 57% year-on-year • EVG opening Korean subsidiary	
Nitride substrates	32
OIPT appoints TDI general manager • AmberWave buys Aonex	
LEDs	34
Luminus launches LEDs for lighting applications • Cree expands XR-C family to full range of colors • Epistar settles with Rothschild	
Optoelectronics	40
Modulight wins ESA pump laser contract • Consumer electronics drive QPC expansion • IPG overcomes diode laser production yield issues	
Optical communications	43
Finisar and Optium merging • JDSU and Bookham hit supply and capacity constraints	
Photovoltaics	48
CPV sales boost Emcore, but start-up costs widen losses • CPV market up to 6GW by 2020	
II-VIs	48
Xunlight establishes X26 for CdTe PVs • II-VI selling eV division	
Technology focus: Optoelectronics	54
First electrically pumped exciton-polariton light emission • First room-temperature source of coherent terahertz radiation	
Market focus: Wide-bandgap RF	56
Wide-bandgap RF devices: a \$100m market by 2010	
Yole Développement's Philippe Roussel asks what can displace the LDMOS monopoly.	
Conference report: CS MANTECH 2008	58
Consolidating on industry growth	
Technology developments at April's International Conference on Compound Semiconductor Manufacturing Technology in Chicago.	
Suppliers' Directory	62
Event Calendar	68
Advertisers' Index	68

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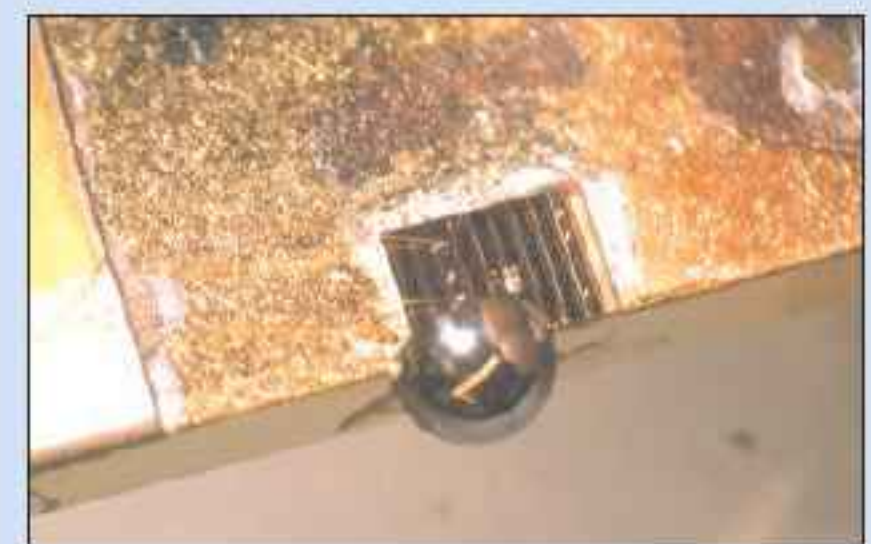
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p6 Freescale's CS-1 150mm GaAs fab in Tempe, AZ, which the firm is to close after failing to find a buyer.



p36 Cree has added to its existing white XLamp XR-C LED with new blue, green, amber, red-orange and red versions to offer a full range of colors.



p55 A bar with ten terahertz lasers, the first room-temperature electrically pumped semiconductor sources of coherent terahertz radiation.



Cover: At May's Lightfair International event in Las Vegas, Luminus Devices launched three new series of its PhlatLight LEDs for lighting applications, including the 12mm² CBT-120 LEDs, which are available in single-chip red, green and blue single-color versions. **p35**

Rationalization and restructuring

After consolidation over the last nine months between RFIC manufacturers (with RF Micro Devices acquiring Sirenza Microdevices and Filtronic, and TriQuint acquiring Peak Devices and lately WJ) and within RFIC makers (with RFMD consolidating production test for high-volume cellular products from Greensboro to its main test facility in Beijing), this issue sees further restructuring by RFMD. After recording a second consecutive quarter of lower revenues year-on-year and operating losses, RFMD has terminated product development on wireless systems such as cellular transceivers and put its GPS assets up for sale (see page 8). In addition to about 80 job losses from production test in Greensboro, the restructuring is projected to involve global staff cuts of about 350. However, while cutting back in wireless systems, RFMD says that the cost-cutting measure represents a focusing of investment on its core RF component and compound semiconductor activities, which bodes well for wafer fab operations.

Unfortunately, RFIC maker Freescale Semiconductor Corp of Austin, TX is cutting back on wafer fab activities in deciding to close its 'CS-1' 6-inch GaAs fab in Tempe, AZ (see page 6). With sales hit by the waning mobile handset market share of Motorola (see page 5) — from which Freescale spun off in 2004 — the fab had been on sale since the firm sold its high-volume GaAs-based RF power amplifier portfolio last October to Skyworks, but a buyer could not be found.

In addition, Tyco Electronics is selling the RF component and subsystem business of M/A-COM of Lowell, MA to UK defense firm Cobham (page 16). Cobham says that it will divest the non-core, non-defense commercial part of the business, which includes its GaAs RFIC and MMIC fabs. However, given the "encouraging level of interest expressed during the auction by Tyco Electronics and some direct approaches received", Cobham says it expects the business to be divested "expeditiously". So, it is to be hoped that the GaAs fab operations, which have a pedigree of over 20 years (incorporating the former ITT GaAsTEK) will not go the way of the Tempe fab.

In addition to the RFIC sector, the much-expected consolidation in the optical communications component manufacturing sector may be starting with the announcement on 16 May of a merger agreement between Finisar Corp of Sunnyvale, CA and Optium Corp of Horsham, PA (page 47). While the respective companies' portfolios are to some extent complementary (combining Finisar's storage and data networking and Optium's telecoms and CATV strengths), Finisar's chairman, president and CEO Jerry Rawls acknowledges that consolidation in the optical space is long overdue "given the scale required to be competitive in meeting global customer needs".

So, while rationalization is perhaps needed in some industry sectors, the result of restructuring activities such as those by Finisar/Optium should hopefully yield businesses with stronger, more comprehensive portfolios.

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North America FTTH connections double in last 12 months

Over the last year, the number of homes in North America connected via end-to-end fiber continued to almost double, growing 97% from 1.48 million in April 2007 to 2.91 million now, according to a study by RVA Market Research released by the Fiber-to-the-Home (FTTH) Council.

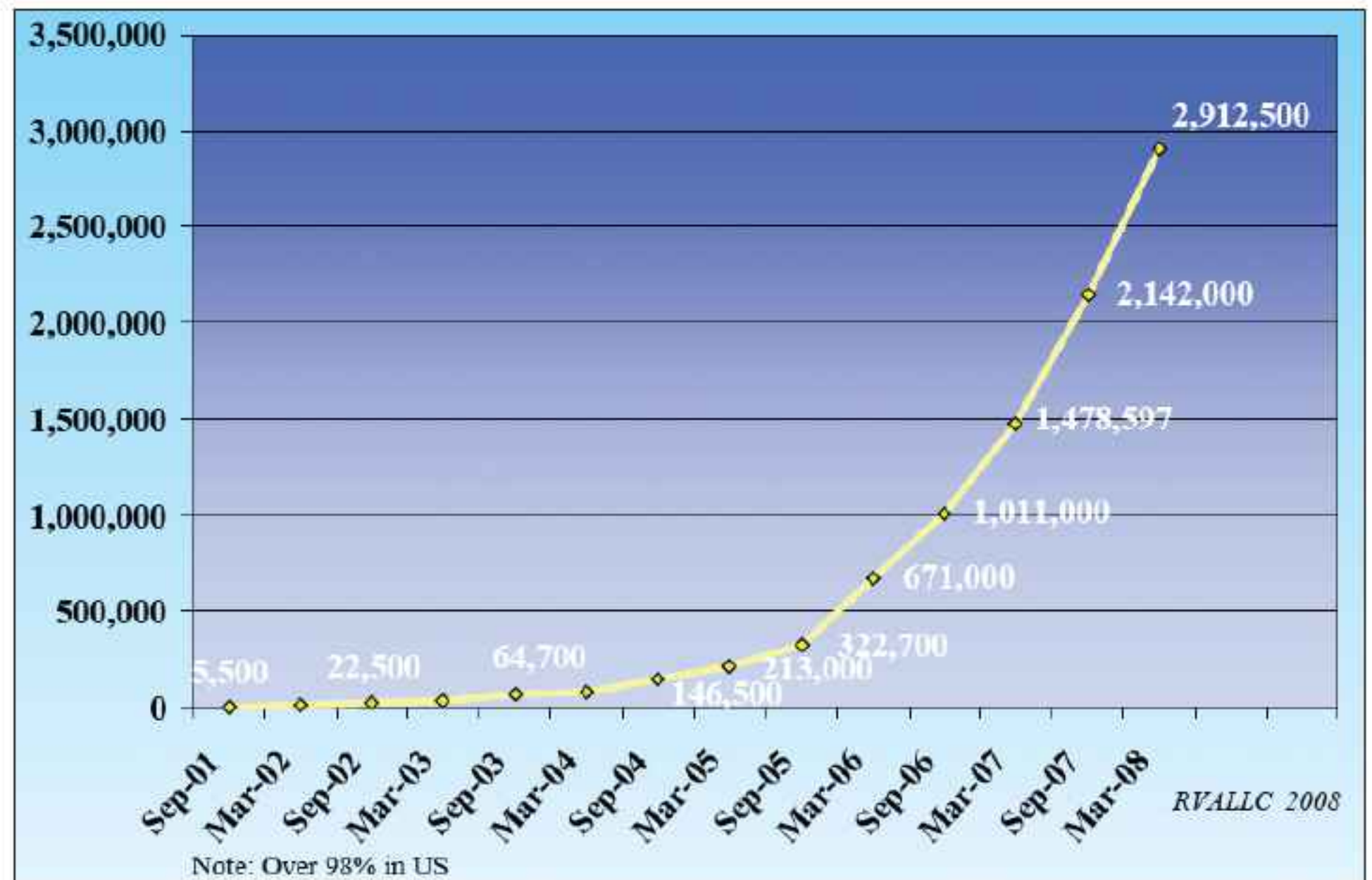
The study also shows FTTH networks now passing 11.8 million North American homes, up from 8 million a year ago, and that the overall 'take rate' — the percentage of those offered FTTH service who decide to subscribe — went up for the fourth straight six-month period.

In addition, the number of households receiving video services over their FTTH connections continues to increase sharply, with more than 1.6 million homes using video-enabled FTTH.

"Fiber to the home providers are going full speed ahead in their efforts to deploy advanced fiber networks capable of delivering a new generation of online services," said FTTH Council president Joe Savage. "This survey shows that next generation broadband is here and now, and that a growing number of people are deciding they have to have fiber to keep up with the latest Internet and video applications."

"While we are pleased with the continued high rate of growth," he added, "the FTTH industry will not rest until we deliver direct fiber connections to the other 90 million North American households that still don't have access to them."

The study showed that Verizon, having committed more than \$20bn to deploying its FiOS FTTH service, continues to set the pace in the number of connections, with more than 70% of the North American total. However, the study also showed growth in the number of subscribers reported by other FTTH service providers, including small and medium sized telephone



FTTH homes connected (cumulative — North America).

companies, municipal governments, developers of planned residential communities and cable television companies.

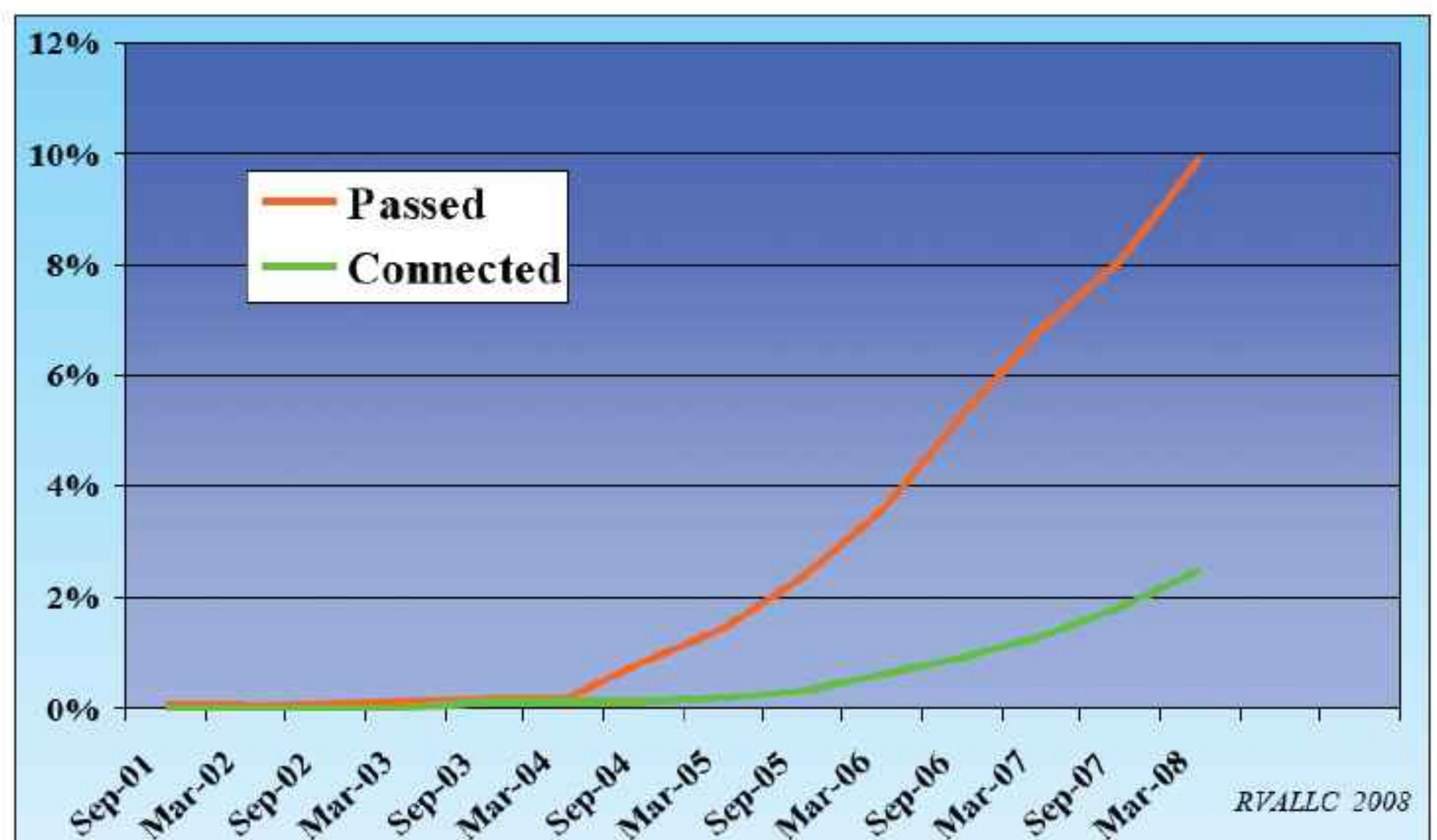
Mike Render of RVA LLC, who authored the study, noted that the number of homes receiving 100 Megabit service — some 30 times the speed of what is offered by most cable and DSL Internet services today — has risen to 17,000 from 12,000 a year ago. "The 100 megabit level of service is beyond

what most people would need or use today, but it's interesting to note that some FTTH providers do offer it and that a fairly large number of subscribers have it already," he said.

The FTTH Council has urged legislators and regulators to adopt a "100 Megabit Nation" policy and reduce barriers to next-generation broadband deployment.

www.rvallc.com

www.ftthcouncil.org



FTTH penetration (cumulative — North America).

Q1 mobile shipments rise a higher-than-expected 14%

Mobile device shipments rose a higher-than-expected 13.7% year-on-year to 289m units in Q1/2008 as operators and distributors continued to top up their inventories after a particularly strong Q4/2007, according to Jake Saunders, VP at analyst firm ABI Research. However, Q2/2008 is likely to be softer than in previous years, he cautions.

Shipment volumes in developed markets have softened slightly due to the credit crisis, but emerging markets such as Asia-Pacific, South America, and the Middle East/Africa are yielding growth rate percentages in the mid-20s.

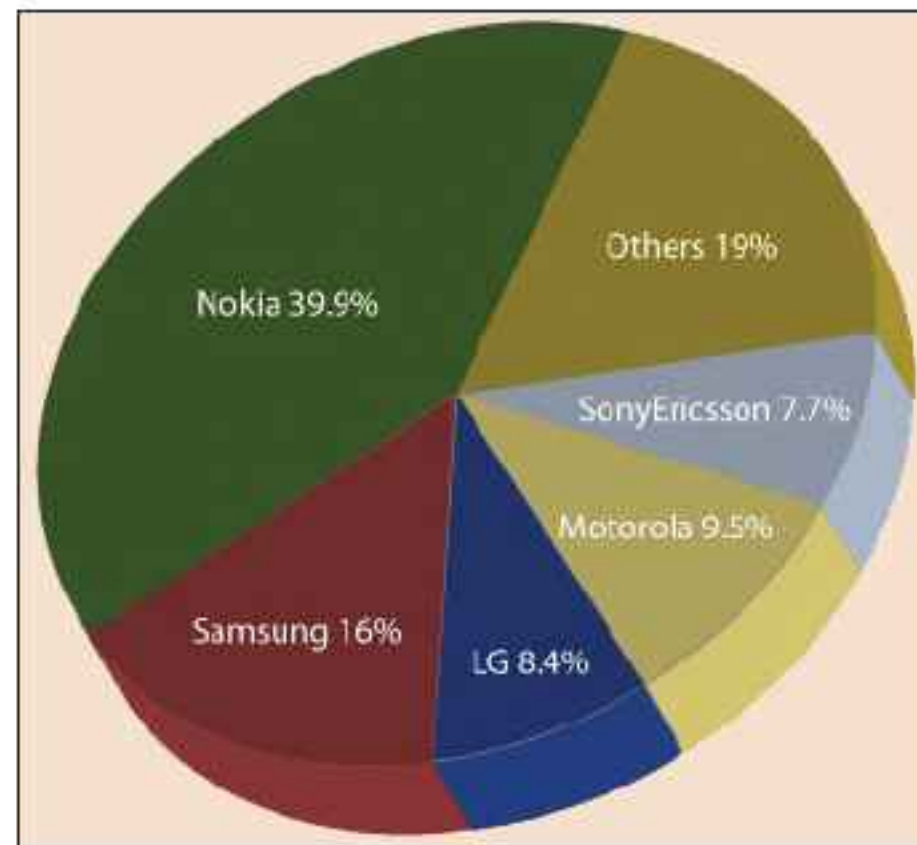
Mobile devices have proved to be a 'lifestyle necessity' rather than a mere luxury accessory. However, the average selling price (ASP) has shown comprehensive price erosion for all manufacturers.

Nokia grew market share to 39.9% while Samsung and LG rose to 16% and 8.4%. Motorola continued to lose share (falling 2.6% to 9.5%). More surprisingly, Sony Ericsson also lost market share (down to 7.7%). It may be that its Walkman and CyberShot lineups are in need of a substantial refresh, says ABI.

Additionally, WCDMA continues to build momentum, with shipment volumes up 44% year-on-year — but no one should count out GSM, says ABI, as GSM-enabled handsets grew 17% in the quarter.

The market is still dominated by the 'big five' manufacturers, but an innovative tier of manufacturers (RIM, HTC, Apple) has been stirring interest in smartphones. Also, MIDs (mobile internet devices) only made their debut last year, but vendors such as Lenovo, Aigo and Asus are expected to drive growth rapidly.

"Mobile device shipment volumes show no sign of abating in growth, despite the uncertain economy," says research director Kevin Burden. "ABI Research expects 2008 to top out at 1.28 billion devices shipped (a 12% increase year-on-year) but these volumes could be subject to the overall global economic climate."



Mobile device market share in Q1/2008 (source: ABI Research).

● According to market research firm Strategy Analytics in its 'Q1 2008 Global Handset Market Share Update', mobile handset shipments grew 14% year-on-year from 247m units in Q1/2007 to 282m units in Q1/2008. The growth rate is up from just 11% in Q1/2007 and 12.3% in Q4/2007.

"Emerging markets in Asia and Africa continue to surge, and they are compensating for the sluggish demand in developed regions of North America and Western Europe," says analyst Bonny Joy.

"Motorola, Sony Ericsson and Apple suffered downturns," adds Strategy Analytics director Neil Mawston. "Motorola and Sony Ericsson lost market share to rivals

with stronger handset portfolios, such as LG and Samsung." Motorola's market share has slumped further from 12.4% in Q4/2007 to just 9.7% in Q1/2008 and Sony Ericsson's has fallen from 9.4% to 7.9%, while Samsung's has risen from 14.1% to 16.4% and LG's from 7.2% to 8.6%.

Apple has been hit by stock-outs in North America and lackluster demand for

its overpriced iPhone in Western Europe," adds Mawston. The firm's market share fell for the first time, from 0.7% in Q4/2007 to 0.6% in Q1/2008, as its shipments

fell sharply, from 2.3m units to 1.7m.

Also, 2008 is shaping up to be the year of the Koreans, reckons Strategy Analytics. Improved handset portfolios enabled LG to grow at almost four times the annual industry average, while Samsung is growing more than two times faster.

www.strategyanalytics.com

www.abiresearch.com

Cell-phone shipments (in millions) and market shares.

Shipments	Q1/07	Q4/07	2007	Q1/08	Change (y/y)
Nokia	91.1	133.5	437.1	115.5	+27%
Samsung	34.8	46.3	161.1	46.3	+33%
Motorola	45.4	40.9	159.0	27.4	-40%
LG Electronics	15.8	23.7	80.5	24.4	+54%
Sony Ericsson	21.8	30.8	103.4	22.3	+2%
Others	38.3	53.9	181.5	46.4	+21%
Total	247.2	329.1	1122.6	282.3	+14%
Share	Q1/07	Q4/07	2007	Q1/08	Change (y/y)
Nokia	36.9%	40.6%	38.9%	40.9%	+4.0%
Samsung	14.1%	14.1%	14.4%	16.4%	+2.3%
Motorola	18.4%	12.4%	14.2%	9.7%	-8.7%
LG Electronics	6.4%	7.2%	7.2%	8.6%	+2.2%
Sony Ericsson	8.8%	9.4%	9.2%	7.9%	-0.9%
Others	15.5%	16.4%	16.2%	16.4%	+0.9%
Growth (y/y)	11.0%	12.3%	12.0%	14.2%	

Nasdaq stays Kopin delisting

On 19 May, Kopin Corp of Taunton, MA, USA, which makes GaAs heterojunction bipolar transistor (HBT) epiwafers and liquid-crystal CyberDisplays, received a Nasdaq Staff Determination letter indicating that it is not in compliance with Nasdaq Marketplace Rule 4310(c)(14) after failing to file its first-quarter 2008 Form 10-Q financial report in time.

Kopin has delayed the filing pending its review of a recently filed Request for Mediation made by a customer, a privately held company based in the European Union that has made claims relating to certain representations and actions of an employee of a Kopin subsidiary. Kopin is currently conducting an investigation relating to the claims.

Previously, Kopin received Nasdaq notifications for failing to file its Q3/2006 Form 10-Q, 2006 Form 10-K, and Q1, Q2 and Q3/2007 Form 10-Q financial reports. However, those delays were due to an investigation into the firm's past stock option granting practices by a special investigative committee (appointed by Kopin's board). The firm filed the delinquent reports with the US Securities and Exchange Commission in mid-March, lifting the threat of delisting.

The latest Nasdaq Staff Determination letter threatened the firm with delisting from The Nasdaq Stock Market on 28 May. So, Kopin appealed the determination at a hearing before a Nasdaq Listing Qualifications Panel.

On 29 May delisting was stayed pending the final outcome of a hearing scheduled for 17 July before the Nasdaq Hearings Panel, where Kopin must demonstrate its ability to regain compliance, as well as to sustain long-term compliance.

www.kopin.com

Freescale closing CS-1

Freescale Semiconductor Corp of Austin, TX, USA says that, over the next few months, it will close its 'CS-1' 150mm GaAs wafer fab in Tempe, AZ.

The 38,000ft² fab started production in 1991 and was one of the first GaAs fabs to migrate from 4" to 6" wafers. It makes mainly GaAs power amplifier (PA) products for cell-phone makers (predominantly Motorola, which at one point accounted for about 80% of Freescale's wireless IC revenues).

Freescale was formerly the Motorola semiconductor products sector (SPS) until being spun off in 2004. In late 2006, it was acquired for \$17.6bn by a private-equity consortium led by the Blackstone Group and The Carlyle Group, which took the company private. The firm has since been hit by declining sales at both Motorola and US car makers (for which it makes automotive ICs). In 2007, revenues fell 10% to about \$5.7bn, and about 700 of the firm's 23,000 workforce (in more than 30 countries) were laid off.

Last October Freescale sold its high-volume GaAs-based RF PA business (including the PA designs, intellectual property, inventory and some equipment from the plant) to GaAs component maker Skyworks

Solutions Inc of Woburn, MA. The firm retained assets including the buildings, property and some equipment, and continued to operate the fab for relatively low-volume GaAs product lines. It subsequently tried to sell the fab, but no buyers materialized. "With the amount of work we were doing there, we couldn't justify keeping it open," said Freescale spokesman Rob Hatley. The remaining product lines are now being outsourced to foundry partners. The Tempe fab's 100 or so staff will be offered severance packages or the opportunity to apply for jobs at other Freescale facilities, he added.

The firm's R&D facilities in Tempe are unaffected, Hatley says. The closure leaves it with six silicon wafer fabs: two in Austin, one in Chandler, AZ, one in East Kilbride, Scotland, UK, one in Toulouse, France and one in Sendai, Japan.

Freescale has also been trying to sell the East Kilbride 150mm silicon fab since last fall. However, the firm has now told the 1000 staff there that a sale is unlikely, and it is engaged in an open-ended "formal consultation" with workers to consider other options for the Scotland operations, including closing them.

www.freescale.com

Hittite grows 19% year-on-year

For Q1/2008, Hittite Microwave Corp of Chelmsford, MA, USA, which designs and supplies RF, microwave and millimeter-wave ICs, modules and subsystems, has reported revenue of \$43.3m, up 19.2% on \$36.3m a year ago and 1.9% on \$42.5m last quarter.

Gross margin has fallen slightly again, from 71.3% a year ago and 70.8% last quarter to 70.1%. Net income was \$13m, up from \$12m a year ago but down on \$13.4m last quarter. Nevertheless, total cash and short-term investments rose by \$16.5m to \$181.2m during Q1.

"During the quarter we introduced our 17th product line, launched 12 new products and published our 13th annual designers' guide," says chairman & CEO Stephen Daly.

For Q2/2008, Hittite expects slight rises in both revenue (to \$44-45m) and net income (to \$13.2-13.6m).

● To offset share dilution due to equity-based awards since its IPO in 2005, Hittite's board has authorized a program to repurchase up to 1.7m shares over three years, as well as offsetting future equity grants with additional stock repurchases.

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RFMD halts cellular transceiver development; selling GPS unit

Following the March quarter's \$31.6m operating loss, RFMD is focusing investment on core RF components and compound semiconductors — e.g. front ends and other components in its Cellular Product Group (CPG) and high-value RF components in its Multi-Market Products Group (MPG) — by eliminating all product development expenses related to wireless systems, including cellular transceivers and GPS solutions.

RFMD will still fully support current-generation cellular transceivers either in production or starting production (Polaris 2, Polaris 2 Radio Module, Polaris 3 and Polaris 3 Silver), and expects these products to contribute significant operating profit and cash flow over their multi-year product life-cycles. The firm anticipates revenue growth in cellular transceivers in fiscal 2009, with revenue continuing into fiscal 2010.

However, RFMD is engaged in discussions with strategic and financial buyers for some of its wireless systems assets (GPS).

The restructuring is projected to involve cutting global staffing by about 350 and incur \$40–50m in charges over the next two quarters.

However, it should eliminate \$75m in annual product development costs this fiscal year (starting in the June quarter, with the full benefit to be realized in the December quarter).

Ceasing wireless system product development should unleash the value of RFMD's very profitable core RF components business, highlighted by CPG's cellular front ends and other cellular components and MPG's multi-market RF, microwave and millimeter-wave components, says president & CEO Bob Bruggeworth. "Our RF components business consistently generates superior profitability and financial returns in excess of our cost of capital. We are increasing our focus on this core business and deploying the full force of our assets and resources behind it."

"These strategic actions will enable RFMD to deliver more predictable financial results and substantially higher profitability," says Bruggeworth. "We are investing in growing markets where we have a demonstrated track record of success."

Compared to transceiver modules incorporating components fabricated in CMOS silicon and SiGe, RFMD projects materially higher prof-

itability from focusing on compound semiconductors and RF components, where it claims to be the established industry leader. "We believe RFMD is positioned for the largest increase in profitability in our company's history," Bruggeworth says.

"We will measure our progress using operating income and return on invested capital (ROIC) as key performance metrics," he adds. "We currently expect at least 10% non-GAAP operating income and double-digit ROIC by the end of the calendar year," says Dean Priddy, CFO and corporate VP of administration. "In conjunction with our share repurchase program [including 30 million during the quarter], these actions demonstrate RFMD's commitment to improving shareholder value."

"While this is a difficult decision because of the impact on employees, these actions are the result of a comprehensive strategic review, including extensive market analyses and discussions with key customers and channel partners," says Bruggeworth. "We are confident the steps we have taken will increase shareholder value and provide significant long-term benefits to our global customers."

FSK transceiver launched for 2.4GHz ISM-band

RFMD is sampling the ML2726 low-power, low-IF, frequency shift key (FSK) transceiver, for operation in the license-free 2.4GHz industrial, scientific and medical (ISM) band.

The FCC part-15 compliant reference design enables consumer product OEMs to quickly bring to market products with wireless data connectivity for multiple applications.

The RF transceiver integrates a sigma-delta fractional-N synthesizer, voltage controlled oscillator (VCO), upconversion and downconversion mixers, data slicer and transceiver

configuration registers in a 7mm x 7mm x 1mm, 32-pin TQFP package. By offering a 'market-leading' 2Mb/s data transmission rate, the ML2726 minimizes average power consumption, yielding longer battery life. It also incorporates self-alignment of the low-IF receiver and phase locked loop (PLL) detection and control, easing implementation and eliminating the cumbersome mass-production tuning process of competing transceivers, RFMD claims.

Features include: closed-loop transmit FSK modulation; analog

and digital data output; digital transmit data input; digital received signal strength indication (RSSI) output; integrated power regulation enabling 2.7–4.5V operation; and –81dBm sensitivity at 0.1% BER.

"The highly specialized wireless data markets, such as meter reading and wireless game controllers, demand a high level of support and component flexibility to meet their individual application needs," says Alastair Upton, general manager of RFMD's Broadband and Consumer business unit.

Drop in Polaris 2 transceiver sales hits RFMD's profit

Including a partial quarter of results from Filtronic Compound Semiconductors Ltd (acquired on 29 February), for its fiscal Q4/2008 (to 29 March) RF Micro Devices Inc of Greensboro, NC, USA has reported revenue of \$221.9m, down 13.7% on \$257.3m a year ago and 17.2% on last quarter's \$268.2m.

Of total revenue, 23% (\$51m) came from the Multi-Market Products Group (MPG, up \$35.4m on last quarter) and 77% (\$171m) came from the Cellular Product Group (CPG, down from \$232.8m last quarter).

Consistent with guidance provided at the end of January, revenue reflected relative strength in MPG (with diversification efforts paying off as RFMD launched multiple high-value products for a customer list of thousands) and a mid-quarter rise in demand for GSM/GPRS cellular front ends, related mainly to starting high-volume shipments to a top-five handset OEM that is

ramping up a major new handset platform (so RFMD is now shipping in production volumes to all top-five handset OEMs). RFMD experienced increased design activity and estimates channel inventory levels have improved significantly, especially in Asia. "We experienced a rebound in demand among multiple handset customers based in China," says president and CEO Bob Bruggeworth.

Nevertheless, gross margin has fallen from 35.2% a year ago and 26.2% last quarter to 25.7%. Also, despite \$7m in annualized operating expense savings (in line with the previously identified 'hard synergies' from the Sirenza Microdevices acquisition), operating loss was \$31.6m (compared to \$24.4m last quarter and a profit of \$21.4m a year ago).

For the June quarter, RFMD expects revenue to rise just 4–10% sequentially to \$230–245m, reflecting sig-

nificantly reduced transceiver revenue at the firm's largest Polaris 2 customer. However, CPG cellular front-end revenue should rise 10–15% sequentially, with Polaris 3 revenue driven by new and existing handset models. "We are positioned for cellular front-end market share gains at additional top-five OEMs as new handsets commence production, including a popular music phone for EDGE networks and a highly anticipated WCDMA handset manufactured by a Korea-based OEM," says Bruggeworth. MPG is currently booked for sequential revenue growth of 15–20% due to strength in wireless infrastructure, CATV amplifiers, wireless LAN front ends, RF components for point-to-point digital radio applications and standard (catalog) RF components, and is on target for \$250m in fiscal 2009 (during which RFMD will release more than 100 new products).

www.rfmd.com

RFMD launches 2.4GHz to 5.8GHz frequency transverter

RFMD has launched the ML5825 frequency transverter, which is designed to upconvert transmitted 2.4GHz signals to 5.8GHz and downconvert received 5.8GHz signals to 2.4GHz. It is specifically optimized for streaming video applications.

RFMD says that the addition of frequency translation functionality to a pre-existing 2.4GHz ISM band radio allows original equipment manufacturers to quickly bring to market products for operation in the 5.8GHz ISM band, including digital cordless phones and custom wireless data systems, such as streaming audio and video appliances.

On a single die, the ML5825 incorporates a voltage controlled

oscillator (VCO), phase locked loop (PLL)-based synthesizer, low-noise amplifier (LNA), receive and transmit bandpass filtering and mixers, and a transmit pre-driver. By offering a digitally controlled 18dB gain step, the ML5825 allows radio designers to optimize third-order input intercept point (IIP3) performance and noise figure based on specific application needs, says the firm. Additionally, the ML5825 offers a low-power standby mode of 10 microamps.

"The movement of many data communications systems to the 5.8GHz ISM band presents an opportunity to leverage the existing system design know-how accumulated from 2.4GHz products," says Alastair Upton, general

manager of RFMD's Broadband and Consumer business unit. "The ML5825 gives OEMs the ability to rapidly bring new 5.8GHz products to market with low risk and a reduced total cost of implementation."

The ML5825 features:

- input voltage operation from 2.8V to 3.6V;
- selectable transmit output power;
- 4dB noise figure in high-gain mode;
- -14dBm IIP3 in low-gain mode;
- integrated VCO/PLL spurious content -60dBc or better.

Available in a 4mm x 5mm x 0.9mm, 28-pin QFN package, the ML5825 is priced at \$1.46 each in quantities of 10,000 units.

Skyworks exceeds \$200m quarterly revenue guidance

For its fiscal Q2/2008 (to 28 March), Skyworks Solutions Inc of Woburn, MA, USA, which manufactures linear products, power amplifiers, front-end modules and radio solutions, has reported revenue of \$201.7m, ahead of the \$200m guidance and much better than market seasonality (up 12% on \$180.2m a year ago).

Gross margin rose for a fourth consecutive quarter, from 38.3% to 40.3%. Net income has grown from \$12.2m a year ago to \$16.7m. During the quarter, Skyworks generated \$40m of cash flow from operations.

"Skyworks delivered a solid quarter of profitable growth through increasing diversification and market share gains," says president and CEO David J. Aldrich. "Our results demonstrate the strength of Skyworks' business model and progress towards realizing our

vision of enabling mobile connectivity in an increasingly diverse set of markets. To that end, we continue to leverage our technical expertise in analog and RF design to solve increasingly complex customer requirements through product innovation and manufacturing scale," he adds. "This technological and operational differentiation is positioning us to outperform the analog semiconductor industry."

During the quarter, Skyworks launched low-power RF solutions for industrial, scientific and medical bands; captured key design wins for special mobile radio, RFID, meter reading and industrial control applications; supplied wireless module provider Siemens with radio solutions for machine-to-machine applications (including transportation logistics, traffic systems and vending management); supported Samsung's award-win-

ning FEMTO cell base-stations with RF systems; ramped multimode Intermodulation front-end modules (FEMs) across all tier-one handset OEMs as well as two leading smartphone suppliers; introduced the industry's first FEM for 3.9G/long-term evolution (LTE) applications; unveiled new high-efficiency linear power amplifiers for WCDMA handsets; increased shipments of GPRS FEMs for system-on-chip (SoC) architectures; and won LG Electronics' 2007 Best Supplier Award.

"Based on continued end-market diversification and new product ramps at leading handset customers, we are experiencing healthy demand and accelerating growth," says VP and chief financial officer Donald W. Palette. For its fiscal Q3/2008, Skyworks forecasts revenue of about \$210m (up 4% sequentially and 20% year-on-year). www.skyworksinc.com

Kopin grows III-V product revenues 33% year-on-year

For Q1/2008, Kopin Corp of Taunton, MA, USA has reported revenue of \$29.2m, up slightly on last quarter's record of \$28.9m. This is also up 61% on \$18.1m a year ago (CyberDisplays up 89% from \$9m to \$17.1m; III-V products up 33% from \$9.1m to \$12.1m).

"In our III-V business, our strategy to improve efficiency, quality and cost by significantly expanding our 6" HBT wafer capacity drove strong year-over-year performance in the quarter," says president and CEO Dr John C.C. Fan.

Net income was \$1m, compared with a net loss of \$3.3m a year ago. "Our bottom line improved as a result of a favorable sales mix during the quarter which featured the sale of higher-margin products," Fan adds. Q1/2008 was also favor-

ably impacted by lower bad debt expense of about \$270,000 and foreign exchange gains of about \$400,000 (partially offset by higher expenses of about \$225,000 associated with Kopin's 2006 and 2007 US Securities and Exchange Commission filings).

In April, Kopin extended its HBT purchase and supply agreement with long-term customer Skyworks Solutions Inc of Woburn, MA to fulfill all of its 4" and most of its 6" HBT wafer requirements through July 2010. To accommodate III-V product demand, Kopin recently completed the installation of three new MOCVD reactors, boosting its capability for processing 6" GaAs wafers for HBTs used in both power amplifiers and new wireless and optoelectronic applications.

"We are optimistic that our momentum will continue in the quarters ahead," Fan says, highlighting longer-term opportunities for III-V products in areas such as solar cells and wireless broadband. "We have installed new capacity and capability for all of our product lines and we are actively improving the performance of our products as well as developing exciting new products," he adds.

Despite seeing some indications of a softening in the consumer electronics market segment, based on strength in other market segments Fan believes that Kopin is on track to achieve its revenue guidance of \$105-115m for 2008 (up 7-17% on 2007's revenue of \$98.1m).

www.kopin.com



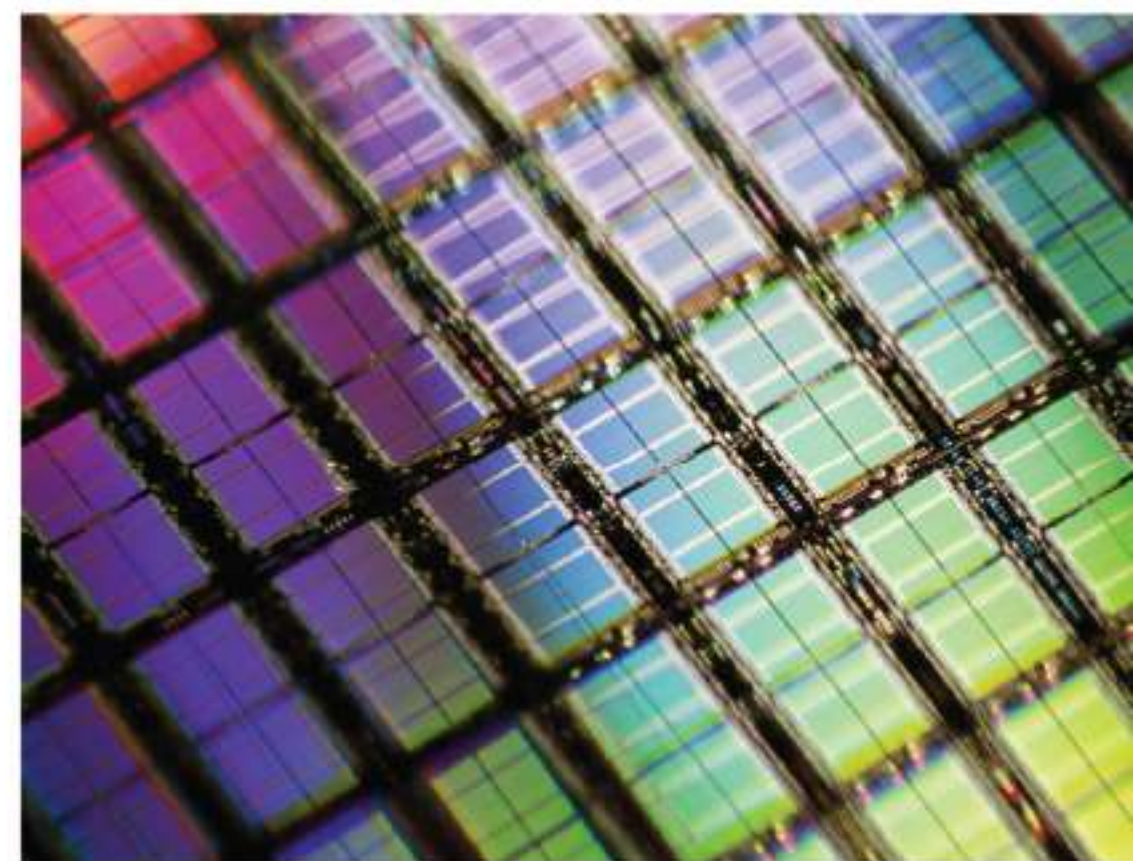
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SURFACE TECHNOLOGY SYSTEMS

Anadigics sales rise 10% to a record \$74.4m, up 50% annually

For first-quarter 2008, Anadigics Inc of Warren, NJ, USA has reported its 12th consecutive quarter of revenue growth, to a record \$74.4m. This is up 10% on the \$67.6m in the seasonally strong last quarter and up 50% on \$49.6m a year ago. It is also well above February's forecast of \$68-70m, due to stronger-than-expected revenue in 3G, CATV set-top box and cable infrastructure. In particular, set-top box revenue rose 10.2% sequentially, while CATV infrastructure revenue fell less than expected.

Wireless revenue was \$51.2m (up 21.1% sequentially and 105% year-on-year), with 3G comprising 98% of wireless revenue (up from 77% a year ago). EVDO (\$15.8m) represented 31.5% of 3G revenue.

Broadband revenue was \$23.2m (down 8.5% sequentially and 5.8% year-on-year). The top customers included Samsung, Intel, LG Electronics and Walway.

After expecting lower CATV infrastructure revenue and hence an unfavorable shift in product mix (and despite increased investments in manufacturing), gross margin unexpectedly rose, from 36.1% last quarter to 36.8%. This was due to higher-than-expected absorption rate coverage on fixed overhead in manufacturing as well as the deferral of certain fab personnel recruitment into Q2/2008.

However, since Anadigics has focused product development and marketing on advanced 3G EDGE, WEDGE, wideband, CDMA, HSPA and CDMA-EVDO technologies, 3G wideband CDMA EDGE products are ushering in higher gross margins, points out president and CEO Dr Bami Bastani; "it is not just broadband product mix that enhances our gross margin now," he adds.

Net income was \$3.9m, an improvement from \$2.9m the prior quarter and a net loss of \$1.2m a year ago. During the quarter, cash balance fell from \$176.8 to \$166.5m. Capital expenditure spending was \$21m, and depreciation was \$3.2m.

"Anadigics performance in the first quarter exemplifies our commitment to our business execution strategies," says Bastani.

"We continued our efforts in increasing manufacturing output and

manufacturing capacity." The firm reckons this should occur through:

- fab output reaching full capacity in second-half 2008;
- flexible wafer capacity being added through developing foundry relationships (this is currently underway, with product shipments expected by Q4/2008); and
- completing the build-out of Anadigics' new fab in Kunshan, China (which is due to come online in second-half 2009).

"We continue to implement our market-share expansion plans and have created deeper relationships with our customers and suppliers," Bastani adds. New product launches during the quarter included the ACA2604 RF amplifier for fiber-to-the-home (FTTH) applications in late February (see March issue, page 8) and the new AWT6309 linear power amplifier for AWS and KPCS CDMA/EVDO mobile equipment at the beginning of April (see April issue, page 8).

"Our business outlook remains positive," says executive VP and chief financial officer Tom Shields. With CATV infrastructure on track to resume growth in Q2/2008,

Anadigics expects a 13th consecutive quarter of revenue growth to \$77-79m (up 4-6% sequentially and up 43-47% from \$53.9m on a comparable basis year-on-year).

"We remain optimistic about the growth opportunities in our industry as a whole," says Bastani. "The power amplifier market is in a new phase of growth, with 3G requiring multiple amplifiers and Wi-Fi providing a second engine for growth," he adds, citing Strategy Analytics' market forecast that

the gallium arsenide IC market will exceed \$5bn by 2012. "We are building our company as a major player to secure healthy market share of that business," Bastani says. "We are equipped to achieve these goals, as we are on track with our capacity additions in New Jersey, our foundry developments in Asia [with 10-20% being the right mix in terms of dependence on foundries], and our building construction in China," he concludes. Total capital expenditure should be about \$50m in 2008.

"We believe, for the foreseeable future, that capacity and market demand for the industry will be at a tight balance as the demand for advanced multiple power amplifiers for 3G and Wi-Fi challenge the available capacity," reckons Bastani.

www.anadigics.com

Capacity and market demand for the industry will be at a tight balance as the demand for advanced multiple power amplifiers for 3G and Wi-Fi challenge the available capacity, reckons Bastani

It is not just broadband product mix that enhances our gross margin now

Anadigics launches dual-band HELP3 PA for EGSM

Anadigics Inc of Warren, NJ, USA has launched the AWT6224 dual-band HELP3 power amplifier (PA) module, which is designed specifically for use in 3G dual-band handsets for EGSM network deployments worldwide (especially Europe).

The latest member of Anadigics' rapidly growing family of WCDMA power amplifiers, the AWT6224 PA is a dual-band module that supports both IMT (UMTS2100) and EGSM (UMTS900) band operations, and is designed to meet the requirements for WCDMA and HSPA operation with Qualcomm's latest chipsets.

The power amplifier incorporates Anadigics' proprietary HELP3 technology without the use of an external DC-DC converter, reducing the number of external components required for an efficient design. This reduces average current consumption by 75% and provides up to 25% increased talk time in 3G handsets, the firm claims. It also includes a built-in voltage regulator and CMOS-compatible logic controls.

"Our new AWT6224 PA delivers the 3G HSPA performance required by two European bands in a single 3mm x 5mm package," explains



Anadigics' AWT6321 dual-band power amplifier, now being used in LG Electronics' new Voyager touch-screen multimedia phone .

Ali Khatibzadeh, senior VP and general manager of Wireless Products. "Its smaller size reduces the RF board area required for multi-band phone designs utilizing Qualcomm's latest generation chip-sets."

Like the AWT6281 linear PA launched in late April for EGSM, the AWT6224 incorporates Anadigics' proprietary InGaP-Plus technology for reliability, temperature stability and ruggedness.

Priced at \$3.07 each in 1000-unit quantities, the AWT6224 is sampling now, with volume production scheduled for the end of Q2/2008.

● Anadigics is shipping production volumes of its AWT6321 dual-band PA, which is based on InGaP HBT MMIC technology, for use in LG Electronics' new Voyager touch-screen multimedia phone (available through Verizon Wireless).

The first handset with both an interactive 2.8" touch screen and a QWERTY keyboard with widely spaced keys for easy messaging, Voyager provides VCAST Mobile TV and full HTML Internet browsing.

Anadigics' EV-DO HELP2 PA module enabled LG to design a more power-efficient phone that can provide not only enhanced multimedia and data services but also longer talk and multimedia playback times.

Through selectable bias modes, the AWT6321 achieves optimal efficiency across different output power levels, specifically at low- and mid-range power levels where the PA typically operates, dramatically increasing handset talk time and standby time. The AWT6321's built-in voltage regulator eliminates the need for external switches. Also, the 3mm x 5mm x 1mm SMT package incorporates matching networks optimized for output power, efficiency and linearity in a 50Ω system.

www.anadigics.com

Linear PAs for CATV set-top boxes and distribution systems

Anadigics has launched its ABA3101 and ABA3115 balanced low-noise linear power amplifiers (PAs), which are designed to generate exceptional signal integrity in CATV set-top box, distribution and drop applications.

"As demands on cable TV systems continue to increase, Anadigics' strategy is to provide equipment designers with a variety of PA solutions based on a common platform, to allow greater design flexibility while reducing production costs," says Ron Michels, senior VP and general manager of Anadigics' broadband business.

The ABA3101 is a +8V supply design that delivers +34dBmV per channel of highly linear output power, together with 12dB of RF gain. Housed in a thermally enhanced package, it maintains composite second order (CSO) and composite triple beat (CTB) distortion products below -69dBc, and provides a typical noise figure of less than 3.2dB across the 1GHz CATV band.

The ABA3115 operates from a +5V supply to provide +25dBmV per channel of linear output power and 15dB of RF gain. Operating at up to 870MHz, the GaAs IC maintains

CSO and CTB distortion products below -70dBc, and provides a typical low noise figure of 2.7dB. It also incorporates a shutdown feature under logic control, whereby power consumption is reduced to 15mW.

The ABA3101 and ABA3115, as well as the previously released ABA3100, ADA10000 and ADA10001, are each housed in a 16-pin surface-mount package, providing a common platform for CATV product designers.

The ABA3101 is available at \$6 each in quantities of 3500 units and the ABA3115 is available at \$5.60 each for 3500 units.

WJ launches 5V gain block amplifier

WJ is sampling the latest addition to its WJA family of +5V active bias InGaP/GaAs HBT gain block amplifiers. The WJA1021 is claimed to be one of the first 5V gain block amplifiers (not requiring any external matching components) that offers +37dBm OIP3 at 2GHz in a lead-free/RoHS-compliant industry-standard SOT-89 SMT package (using NiPdAu plating to eliminate any tin whiskering).

The new device is suited to general-purpose high-linearity broadband applications at 50–4000MHz (e.g. wireless technologies such as multi-carrier GSM, PCS, CDMA, W-CDMA, WiBro and WiMAX, repeaters, BTS transceivers, and RFID). With this new addition, the WJA family has a more complete selection of cascaded gain blocks offering a wide variety of performances that complement different gain, OIP3, and Icc levels, says the firm.

The WJA1021 has been optimized internally to offer high-linearity performance at 1.9GHz, while drawing very low current. At 1.9GHz, the WJA1021 typically provides 17.5dB gain, +37.5dBm OIP3, and +19dBm P1dB compression point, drawing only 90mA of current from a 5V supply. It also works in the 900MHz cellular band with 18.5dB gain, +40dBm OIP3, and +20dBm P1dB.

The WJA1021 consists of Darling-ton-pair amplifiers and is internally matched to 50Ω. An internal active bias is designed to enable stable performance over temperature and allow for operation directly from a +5V supply voltage. Only DC blocking/bypass capacitors and a bias inductor are needed for operation.

"The WJA1021 design incorporates an internal active bias to ensure ease of application implementation and stable performance," says Rufino Olay, director of worldwide marketing. "This dynamic range amplifier gives design engineers the flexibility to meet the complex requirements of wireless infrastructure applications in a cost-effective manner."

www.wj.com

Military/network R&D costs hit TriQuint profit

For Q1/2008, TriQuint Semiconductor Inc of Hillsboro, OR, USA has reported revenues of \$111.1m, up slightly on \$110.6m a year ago but down 14% on last quarter's \$128.5m.

Of total revenue, handsets accounted for 50%, networks 38% and military 12% (compared to 53%, 36% and 11% last quarter respectively, indicating a further shift from handsets to networks).

Of handset revenues, CDMA accounted for 39%, GSM 34%, WCDMA/EDGE 21%, and WLAN/other 6% (compared to 30%, 47%, 21% and 2% last quarter respectively, indicating a shift away from GSM and a rise in WLAN applications).

Of network revenues, base-station products accounted for 33%, broadband (WLAN) 24%, standard products 20%, broadband (optical) 12%, broadband (cable) 6% and groundstation (including satellite) 5% (compared to 42%, 13%, 23%, 8%, 5% and 9% a year ago, respectively, showing growth in WLAN).

"While revenue was seasonally down, we achieved better-than-expected earnings on strong gross margin performance," says president and CEO Ralph Quinsey. Gross margin of 34.6% is down from 36.7% last quarter, but up from 31.1% a year ago.

Net income was just \$4.5m, down from \$6.4m a year ago and \$13.8m last quarter. Nevertheless, during the quarter, cash and cash equivalents grew by \$15.9m to \$219.4m.

The drop in profits has been driven by operating expenses rising 21% from \$29.5m a year ago to \$35.8m, and R&D spending rising almost 40% from last year's \$14.3m to \$19.9m as TriQuint has been developing products for the military and networking markets (since TriQuint has gained market share in cell phones through integrating parts into a module, it is now

extending that strategy into other markets).

During the quarter, TriQuint launched the TQP13N (a high-performance/low-cost GaAs process for millimeter-wave applications) and ramped IEEE 802.11n wireless LAN (WLAN) module platform production to high volume. It will also ramp 3G Tritium modules to high-volume production in Q2/2008.

"I expect healthy revenue growth in the second quarter as we continue ramping our new WLAN and 3G products to high-volume production," says Quinsey. "We are implementing targeted capacity expansions in Oregon [the firm's 6" GaAs wafer fab] and Costa Rica [the assembly plant] to support anticipated customer demand for our new products," he adds.

For Q2/2008, TriQuint says it is 88% booked and expects revenue of \$130–135m (rebounding by 17–22% from Q1, and up from \$113.8m last year), excluding

partial-quarter results from the \$72m acquisition of WJ Communications Inc of San Jose, CA, USA (announced on 9 March), which designs and supplies GaAs-based RF products for wireless infrastructure, RFID and WiMAX markets. "Preliminary integration efforts for WJ Communications are underway," Quinsey concludes.

www.triquint.com

Since TriQuint has gained market share in cell phones through integrating parts into a module, it is now extending that strategy into other markets

Preliminary integration efforts for WJ are underway

TriQuint ships MMICs to Lockheed for battlefield radar

TriQuint has begun shipping production GaAs MMICs to Lockheed Martin Radar Systems for the manufacture of EQ-36 Counterfire Target Acquisition Radars being developed for the US Army. TriQuint devices are being used as chipset components in the new phased array radar, which is designed to identify, track and help neutralize threats posed by mortars, artillery and missiles under rapidly changing battlefield conditions.

The new devices are the latest products to be developed for Lockheed Martin Corp in a relationship that has also included work on radar programs for ship-borne and aircraft systems, according to TriQuint's director of Military Products Marketing, Dr Gailon Brehm. The die-level products in Lockheed's transmit/receive (T/R) modules will support the initial production of five mobile systems being developed along an aggressive timetable.

Lockheed Martin demonstrated a fully operational prototype of the EQ-36 Counterfire Target Acquisition Radar at last October's Association for the United States Army (AUSA) 2007 exposition. Lockheed Martin Radar Systems' VP Carl Bannar sub-

sequently said that the firm was on the 'fast track' to design and produce the system, having rolled out a field-tested, operational prototype within nine months. The first completed radar is expected to be delivered to the US Army by mid-2009.

The new phased array system (the US Army's Enhanced AN/TPQ-36 radar) contains T/R modules

described by Lockheed Martin as being at the heart of the overall system. "We've enjoyed the challenging work of optimizing TriQuint's advanced MMICs for Lockheed Martin's T/R modules," says

Brehm. "TriQuint has been a consistent technology leader in developing amplifiers and related devices for phased array radar systems and it's gratifying to see us extend such leadership into battlefield radars."

The new EQ-36 Counterfire Target Acquisition Radar is advanced compared to battlefield radars currently

deployed, which include TPQ-36 and TPQ-37 systems dating back to the Cold War era. A key difference in the new EQ-36 system is its ability to rotate, offering a 360° view that enables operators to more easily and rapidly identify hostile mortar, artillery and missile fire. Threats from any direction can therefore be detected and the danger neutralized more quickly than before.

TriQuint is now in its initial production phase for the EQ-36 program, which will deliver devices throughout a multi-year cycle. Lockheed Martin indicated last October that its first five production units were part of a contract worth about \$120m awarded by the US Army. While fulfilling its contract for MMIC products, additional TriQuint components are being reviewed for use in other phases of the on-going program, Brehm says. "Our products' performance has earned TriQuint an important role in the program and we look forward to other opportunities to work with Lockheed Martin Radar Systems."

www.lockheedmartin.com/capabilities/sfc/radar_systems

WJ's losses still rise, despite increasing gross margin

For Q1/2008, WJ Communications Inc of San Jose, CA, USA, which designs and supplies GaAs-based RF products for wireless infrastructure, RFID and WiMAX markets, has reported revenue of \$10.3m. This is down slightly on \$10.6m last quarter and down on \$10.8m a year ago.

"Our first quarter was highlighted by our first two production orders for our MCM [multi-chip module] chipset targeted at the TD-SCDMA rollout in China," says WJ's president and CEO Bruce Diamond.

Gross margin has risen from 44.3% a year ago and 44.8% last quarter to 45.2%.

However, though down from \$4.4m a year ago, net loss has risen from \$738,000 last quarter to \$2.9m. This included \$1.2m in expenses related to the agreement of 9 March for RF front-end component maker TriQuint Semiconductor Inc of Hillsboro, OR, USA to acquire WJ for \$1 per share (\$72m in total).

"We believe the enhanced scale that will result from the TriQuint transaction will lead to a greater level of market penetration for many of the innovative products that WJ has produced over the last several years," says Diamond.

www.wj.com

IN BRIEF

WJ stockholders approve acquisition by TriQuint

A special meeting of stockholders of WJ Communications on 22 May approved the firm's merger with TriQuint Semiconductor Inc (agreed on 9 March).

TriQuint has therefore completed the acquisition of all outstanding WJ shares, which have been converted into the right to receive \$1 per share.

WJ's common stock has now ceased trading on the NASDAQ Global Market, and the firm has become a subsidiary of TriQuint, with 132 WJ staff transferring.

M/A-COM's GaAs fab to be divested by new owner Cobham

Tyco Electronics has agreed to sell the RF components and subsystems business of M/A-COM Inc of Lowell, MA, USA to UK defense firm Cobham plc for \$425m. The acquisition is expected to complete in second-half 2008.

Microwave Associates was established in 1950 in Boston, MA to provide magnetrons to the US Army Signal Corps, and in 1978 became M/A-COM to reflect growing involvement in the communications market (wireless telecoms and private land-mobile radio).

For the year to end-September 2007, M/A-COM generated operating profits of \$37.9m on revenue of \$477.7m. Comprising just under 40% of revenue, M/A-COM's Aerospace & Defence (A&D) business designs and manufactures RF and microwave subsystems and components, and is complementary

to Cobham's Defence Electronic Systems business.

Cobham says that the remainder (the non-defense commercial business) will be run outside of its operating divisions as non-core to its strategy and therefore held as an asset for resale.

M/A-COM has over 20 years experience of manufacturing GaAs monolithic microwave integrated circuits (MMICs), including acquiring GaAs MMIC maker ITT GaAsTEK of Roanoke, VA in 2000, where 8000ft² of cleanroom space adds to M/A-COM's 24,000ft² wafer fab space in Lowell for manufacturing GaAs MESFETs, pHEMTs and silicon

Cobham expects that M/A-COM's commercial business can be divested expeditiously

LDMOS. Products include ICs, power transistors and diodes for wireless communications and industrial/military and consumer applications, infrastructure/components for wireless applications such as cellular base-stations and WiMAX infrastructure using RF, microwave and semiconductor-based components, and RFID components for inventory management and asset tracking applications.

Cobham expects that M/A-COM's commercial business can be divested expeditiously for a value that supports its business case for the A&D acquisition, given the "encouraging level of interest believed to have been expressed during the auction by Tyco Electronics and some direct approaches received".

www.macom.com

www.cobham.com

SPDT switches for WiMAX and WLAN applications

Tyco Electronics has launched a new dual SPDT switch die for broadband applications that require high linearity, low insertion loss and high isolation. The M/A-COM MASW-008206-000DIE is intended for 802.11a, 802.11b/g, PC Card and access point applications and is optimized for 2.4GHz as well as 5.8GHz operation. With its low leakage current, the chip maximizes system linearity performance while reducing DC power consumption, the firm claims.

"This new switch is designed to exceed the needs of our WiMAX customers while providing competitive prices for cost-sensitive and space-constrained applications," says product manager Mike Arrigo.

The new switch is suited to

802.11b/g applications with a 3V bias and is designed to have a low typical insertion loss of 0.7dB at 2.4GHz while achieving an isolation of 28dB and P1dB of 28dBm. Typical insertion loss at 5.8GHz is 0.9dB with an isolation of 25dB and P1dB of 28dBm. The new switch is fabricated using a low-cost 0.5µm gate-length GaAs process and features full passivity for increased reliability, the firm says.

The MASW-008206-000DIE is available in wafer form and is priced at \$0.19 for quantities of 100,000.

Tyco has also launched a low-cost SPDT switch for applications requiring fast settling time, low insertion loss and high isolation.

The M/A-COM MASW-008899 is designed for 802.11 and 802.16

WLAN and WiMAX applications with a bias voltage as low as 3V. With low leakage current and low gate lag, the firm claims that it offers excellent switch settling where multiple switches and high data rates are critical for optimal system performance.

The MASW-008899's versatility suits not only 802.11 and 802.16 applications but also test and measurement equipment applications, according to product manager Jim Dempsey.

Typical insertion loss is 0.4dB at 2.4GHz, while achieving an isolation of 27dB and P1dB of 28dBm. The switch is fabricated using a low-cost 0.5-micron gate-length GaAs process and offers full passivation for increased reliability.

The price is \$0.34 for quantities of 100,000.



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Agilent announces tenfold speed-up of planar 3D electromagnetic simulation RFIC and RF module design

Agilent Technologies Inc of Santa Clara, CA, USA has announced a tenfold speed-up of its planar 3D electromagnetic (EM) simulator, which is part of the Update 1 release of its Advanced Design System (ADS) 2008 electronic design automation (EDA) software platform.

The speed improvement can help RFIC, RF module and high-speed gigabit serial-link designers to take advantage of EM simulation for faster, more accurate design and signal integrity verification, says the firm.

"The cumulative effect of our EM technology improvements means our customers can use our Momentum simulator for accurate, interactive design, and not just for

limited sign-off verification," says Jan Van-Hese, EM R&D project manager with Agilent's EEsof EDA division, which provides RF mixed-signal circuit and system-design software. "The 10x speed improvement and meshing accuracy makes EM problem-solving possible for even very large and complex designs."

Momentum is the planar 3D EM simulator in ADS 2008. Significant enhancements to its speed and capacity for analyzing large multi-gigabit serial-link signal integrity, RFIC and RF module design include:

- a fast and memory-efficient solver based on the NlogN matrix compression techniques that tackle

problems up to six times larger than previously possible;

- multicore computer use through parallelizing the solve process across all available PC-processor cores;

- distributed simulation over networked computer clusters to perform multipoint EM simulation in parallel; and

- a robust mesher that intelligently pre-processes layouts imported from other systems to guarantee mesh-related simulation accuracy.

The ADS 2008 Update 1 is expected to be available for download in July, with prices starting at about \$10,000.

www.agilent.com/find/eesof-ads2008-update1

RF/mixed-signal simulation coverage expanded for wireless communications IC design

Agilent Technologies has also released the latest version of its GoldenGate RFIC simulation and analysis software, representing an expansion in RFIC simulation coverage for wireless communications products, with 5x transient simulation speed improvements and new mixed-signal simulation capabilities resulting in shorter RFIC product development times.

"RFIC designers have limited simulation coverage today — simulating a fraction of what they need to before the tape-out deadline," says Marc Petersen, product marketing manager with the EEsof EDA division. "They are missing design problems and incurring costly re-spins.

GoldenGate 4.2 enables more simulation coverage with increased speed and capacity, and takes advantage of new ways to uncover RF/mixed-signal problems early in the design cycle."

In RFIC design, transient (SPICE) simulations provide time-domain

results. GoldenGate 4.2 features improvements to transient simulations, achieving faster speeds of 2x to 4x on single-core computers and typically 5x for quad-core computers. The transient improvements also help speed up the frequency-domain simulation process. Faster simulations allow for more extensive use of statistical design throughout the RFIC design cycle, without compromising tight development schedules.

Digital State Sweeping (DSS), a new GoldenGate 4.2 feature, provides an automated solution to the problem of sweeping an RF design through its many digital control states. Performing the sweep manually is a tedious simulation task. DSS automates

RFIC designers have limited simulation coverage today — simulating a fraction of what they need to

operational verification of the control states and provides interface and connectivity testing as well as digital-RF connectivity debugging, allowing digital and RF teams to work concurrently.

GoldenGate 4.2 also includes:

- the ability to perform mixed-signal simulations on a combination of RF and digital circuits represented by Verilog-AMS blocks;
- new wireless sources from the Agilent Ptolemy simulator, including transmit/receive waveforms for 802.11(WiFi), 802.16 (WiMAX/WiMAN), TDSCMDA, 3GPPFDD, and custom, user-defined wireless sources, and;
- improved Monte Carlo algorithms (Latin Hypercube Sampling and Hammersley Sequence Sampling) for faster Monte Carlo coverage with 5–10x fewer trials.

Prices for GoldenGate Release 4.2 start at about \$42,000. A demonstration is available at:

www.agilent.com/find/eesof-goldengate-demo-pr

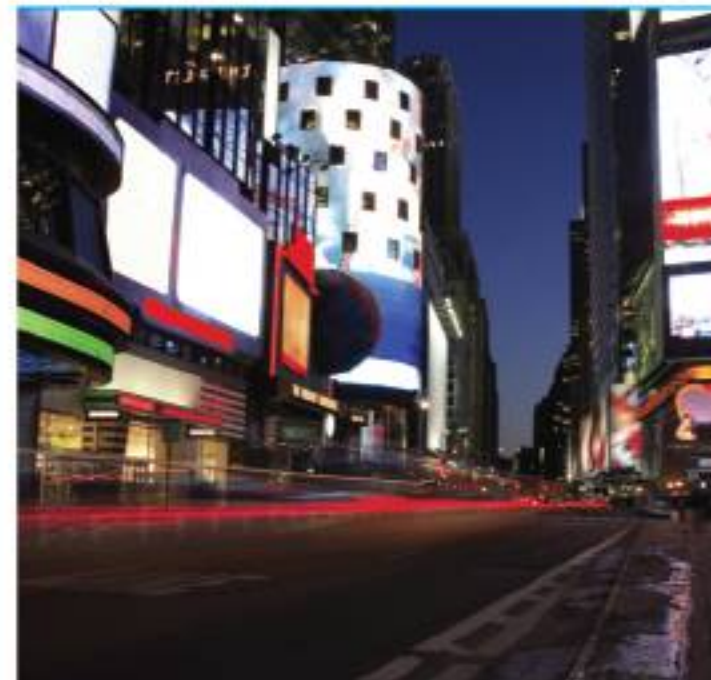


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SiGe ships its 250 millionth IC

SiGe Semiconductor Inc of Ottawa, Ontario, Canada and Andover, MA, USA, which supplies RF front-end solutions enabling wireless multi-media for consumer electronics, says it has now shipped more than 250 million ICs. SiGe has enjoyed 40% year-on-year growth, with 2007 revenues exceeding \$69m.

SiGe attributes this to its portfolio of wireless power amplifiers, RF front-end modules and GPS receivers, which enable next-generation wireless computing, home entertainment and mobile applications. The firm's ICs enable OEMs to deliver consumer electronic products with optimal performance and battery life at competitive prices.

These products are used by some of the world's largest consumer brands, and can be found in Wi-Fi-enabled laptop computers, wireless access points, game consoles, PC cards and peripherals. SiGe also provides GPS ICs that enable location services in personal navigation devices, cellular phones, and other handheld devices. The firm expects its emerging portfolio of WiMAX power amplifiers and front-end modules to fuel growth over the next 12-18 months.

"Shipment of 250 million ICs demonstrates SiGe's ability to deliver high volumes of quality products into the demanding consumer product markets," says CEO Sohail Khan. "We have collaborated with our customers to determine the critical feature set for next-generation products and translated that intelligence into designs that deliver the best in performance, battery life and cost," he adds.

SiGe's customer base includes leading companies such as HP, Apple, Lenovo, Nintendo and Samsung. SiGe has also expanded its network of sales, distribution, customer and applications support teams to provide local design assistance.

www.sige.com

Tower buys Jazz

Pure-play specialty silicon wafer foundry Tower Semiconductor Ltd of Migdal Haemek, near Haifa, Israel has agreed to acquire Jazz Technologies Inc of Newport Beach, CA, USA, the parent company of Jazz Semiconductor Inc (a wafer foundry focused on analog-intensive mixed-signal process technologies).

The stock-for-stock transaction valued at \$40m (with each outstanding share of Jazz common stock being converted into the right to receive 1.8 Tower ordinary shares, giving Jazz stockholders about 12.4% of the combined firm). Including net debt, the total value of the transaction is about \$169m. Jazz will become a Tower subsidiary. The merged firm will be headed by Tower CEO Russell Ellwanger.

The acquisition creates economies of scale that allow for improved margins, reckons Ellwanger. "We will realize significant benefits and synergies, including a comprehensive process portfolio which expands our addressable market and fuels a growing and more diversified customer base with highly differentiated product platforms."

The combined firm will pool Tower's strength in CMOS image sensors, non-volatile memory (NVM) and RF CMOS with Jazz's expertise in mixed-signal, power management (CMOS and BCD) and RF (RF CMOS, SiGe and BiCMOS) technologies to create what is claimed to be one of the broadest portfolios of specialty process technologies.

Tower was established in 1993 and has two fabrication plants: Fab 1 has 1-0.35 μ m process technology (with a capacity of 15,000 6" wafer starts per month) and Fab 2 has 0.18-0.13 μ m process technology (with a capacity of 30,000 8" wafer starts per month).

As well as its fab in the USA, Jazz (which was spun off from Conexant Systems in 2002) has manufacturing supply agreements for its process technologies to be used by China's Advanced Semiconductor Manufac-

turing Corp Ltd and Shanghai Hua Hong NEC Electronics Co Ltd. Tower has about 1400 staff and Jazz has about 700 (with no staffing cuts currently planned).

Jazz says that the merger should enhance its ability to access capital to fund its strategic initiatives, including potential expansions into new applications, executing a more ambitious product roadmap, and expanding manufacturing capacity.

The combined firm should have a capacity of 750,000 8"-equivalent wafer starts annually (making it the world's largest specialty foundry and seventh largest pure-play foundry), but the firms' believe this can be expanded further to over 900,000 wafers annually (about triple Jazz's current capacity).

Combined annual revenues in 2007 were \$439m. Excluding implementation costs, the firms believe that the merger could generate as much as \$40m in annual gross synergies resulting from the elimination of duplicate spending and overlapping functions, improved supplier pricing, avoidance of planned expenditures, and manufacturing scale.

The agreement has been unanimously approved by the boards of directors of both firms. The transaction is expected to close in fourth-quarter 2008 (subject to the approval of Jazz's shareholders).

www.towersemi.com

www.jazzsemi.com

The combined firm will pool Tower's strength in CMOS image sensors, non-volatile memory and RF CMOS with Jazz's expertise in mixed-signal, power management (CMOS & BCD) and RF (RF CMOS, SiGe and BiCMOS)

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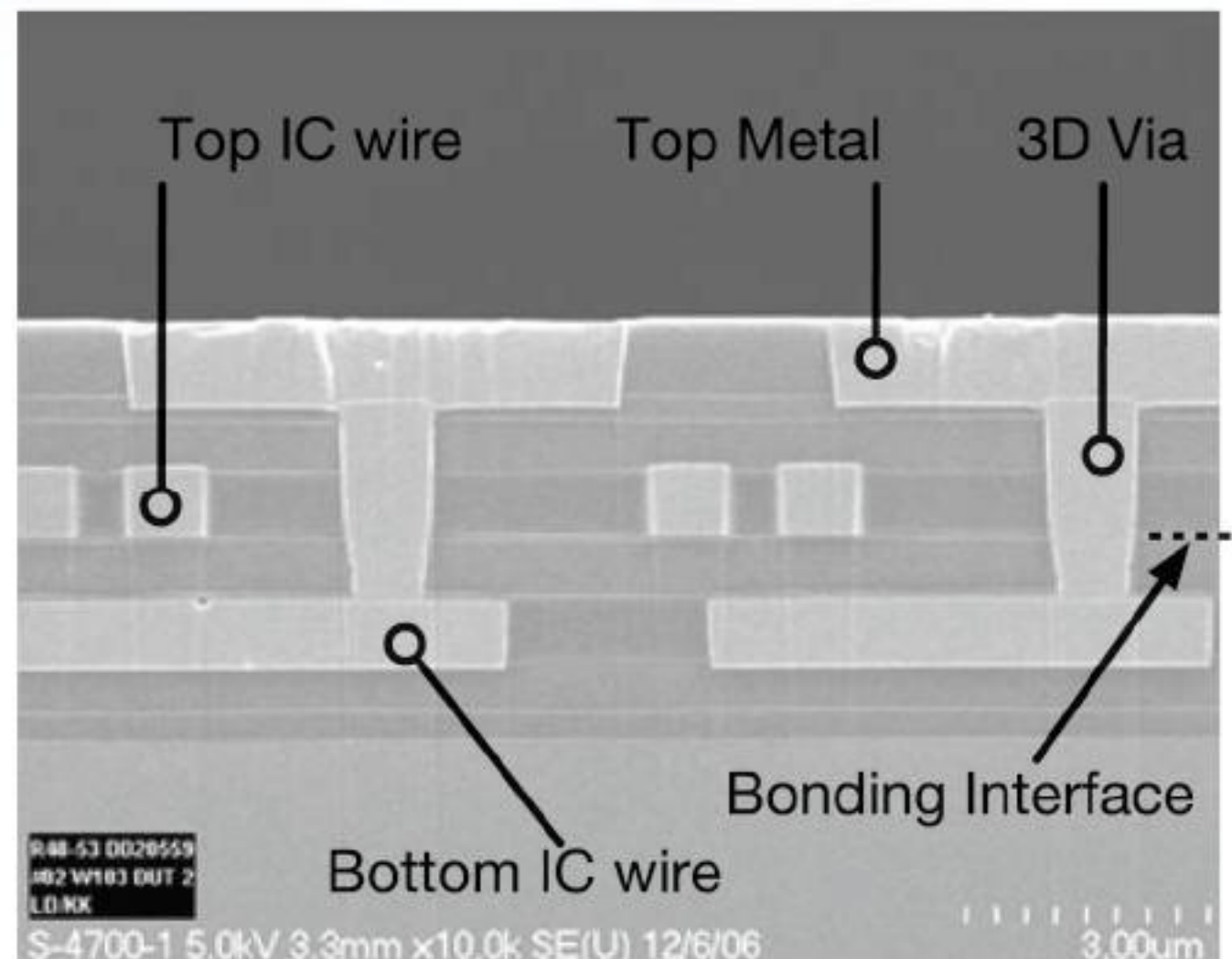
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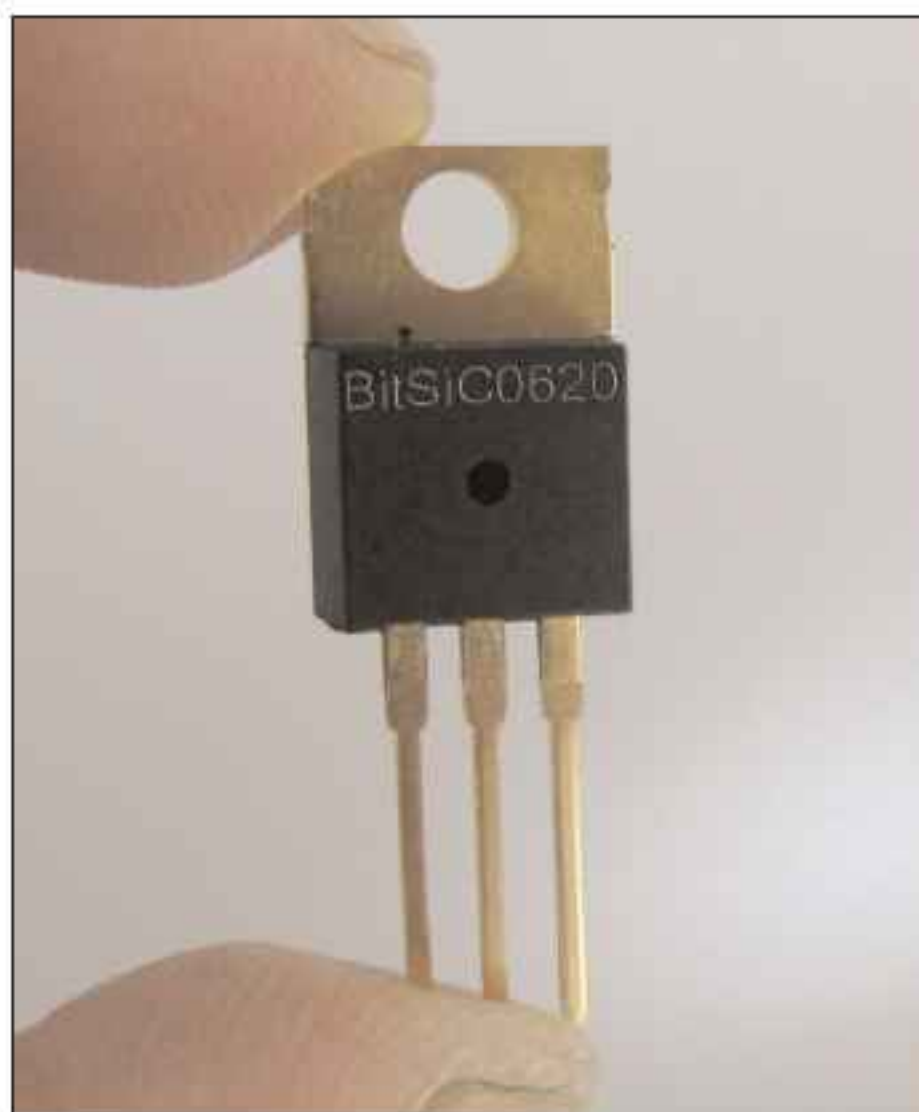
TranSiC launches SiC BJT & Schottky in TO-220 package

Silicon carbide power transistor maker TranSiC AB of Kista, Sweden has made available engineering samples of the first SiC switching power bipolar junction transistor (BJT) together with a SiC Schottky diode in a TO-220 package.

The BitSiC1206 switching power transistor (a 1200V 6 Amp device that can handle very high junction temperatures) is a 'normally off' transistor (much in demand in the power electronics industry).

The launch follows last November's introduction of engineering samples of the BitSiC1206 in a TO-220 package. There are currently no other 'normally off' power transistors available on the market for 1200V and high junction temperatures (e.g. more than 225°C), according to CEO Bo Hammarlund.

Together with its partners, TranSiC is now defining the possible specifications for high-temperature packages and trying to find the right combinations of materials that can stand the automotive industry's demands (e.g. for power cycling). A few applications are arising (e.g. hybrid electrical vehicles, and high-power electric motor controllers) where designers want to move from silicon power components. For



TranSiC's 600V, 20A BitSiC0620 BJT.

these applications, SiC can solve the problems associated with high-temperature environments, solar cell inverters, and switching losses.

TranSiC says that the first release of the BitSiC chip on DCB (direct copper bonded) was successful. One of the firm's partners demonstrated that BitSiC transistors, using high-temperature metal can packaging, are capable of switching more than 6A at 550°C.

The BitSiC has a negative temperature coefficient, so it also suits parallel coupling for higher currents.

● TranSiC is also now shipping engineering samples of what it claims is the first 20A, 600V SiC switching power BJT.

The BitSiC0620 is a 'normally off' transistor that can handle very high junction temperatures. Initial tests show good immunity to cosmic rays.

The BJT has a very low collector-emitter saturation voltage (V_{CEsat}), which enables a reduction in on-state power losses of more than 60% compared to silicon insulated-gate bipolar transistor (Si IGBT) technology with the same chip area.

The BitSiC0620 has a maximum current gain of about 30 and an open base breakdown voltage (BV_{CEO}) of more than 600V. Also, it exhibits fast switching due to the small amount of stored charge in SiC devices. The SiC BJT chip shows very good high-temperature capability, having been tested successfully up to more than 250°C as well as to -80°C.

TranSiC is promoting the SiC BJT as an alternative to Si IGBTs where low power losses, high switching frequencies, and high maximum junction temperatures are desired.

TranSiC offers SiC BJTs as single dies, as discretes in TO220 packages, or on DCB substrates.

www.transic.com

Nitronex recruits principal MMIC engineer

Nitronex of Durham, NC, USA, which manufactures gallium nitride on silicon (GaN-on-Si) RF power transistors for the commercial wireless infrastructure, broadband and military markets, has named Dr Thomas A. Winslow as principal monolithic microwave integrated circuit (MMIC) engineer.

Winslow received his doctorate, master and undergraduate degrees from North Carolina State University (Nitronex was subsequently founded by graduates of NCSU's wide-bandgap program in 1999). During his 15 years of industry experience in microwave circuit design at ITT-GTC and Tyco

Electronics/M/A-COM, he served as a principal member of the technical staff, principal engineer and, most recently,



senior principal engineer. Winslow holds eight patents (with three additional patents pending) and has authored more than 20 technical papers. He is also a senior member of the Institute of Electrical and Electronics Engineers.

"The addition of an industry veteran like Dr Winslow to our MMIC design team further enhances our

ability to push the technical limits of our technology," says Dr Isik C. Kizilyalli, Nitronex's VP of engineering. "Winslow will develop MMIC products to address challenges that our customers face and provide solutions not previously achievable without GaN-on-silicon technology," he adds.

"The Nitronex GaN-on-silicon process is uniquely positioned to combine the high performance of GaN technology with low-cost silicon substrates to achieve new levels of integration and performance," says Winslow, who aims to develop groundbreaking GaN-based MMICs.

www.nitronex.com

Caracal on block after Navy chop

On 21 April, Caracal Inc of Ford City near Pittsburgh, PA, USA filed for Chapter 7 bankruptcy protection from creditors.

Caracal was co-founded in 2003 by Olle Kordina from the SiC MS center of Sweden's Linköping University and president/CEO Rajiv Enand. Seed capital was provided in the form of a \$33,000 startup grant and a \$164,000 research grant from The Pittsburgh Digital Greenhouse (now the Technology Collaborative) plus three investments totaling \$600,000 and provided business assistance from Innovation Works (both organizations are state-sponsored by the commonwealth of Pennsylvania).

Caracal's objective was to develop and manufacture SiC substrates and epiwafers for the power, RF, and electro-optic markets.

Last year, Caracal was awarded US patent related to using methyl-trichlorosilane as a precursor to

speed epitaxial SiC growth rates from typically 5–10 $\mu\text{m}/\text{h}$ for conventional chemistry to more than 100 $\mu\text{m}/\text{h}$, while maintaining quality and doping, enabling the realization of very-high-voltage power devices.

In 2006 and 2007, the firm was awarded contracts from the Small Business Innovative Research (SBIR) program of the Office of Naval Research (ONR), enabling it to improve its crystal growth process for SiC wafers for the US Navy's project to develop an all-electric-powered warship. The Navy subsequently represented 90% of Caracal's custom. However, the firm's \$1.2m-a-year contract has now been terminated for 2008.

"Anything categorized as research or experimental by the Department of Defense has been under heavy cutbacks," said CEO Andrew Chomos. "The military has scaled back research programs in order to spend more on the war effort."

Caracal's product development team had tried to build sufficient commercial demand for the wafers (with applications ranging from lighting to hybrid electric vehicles), said Chomos, but without success. "Our commercial product sales were not enough for us to stay in operation." Under a 10-year lease (which has 7 years remaining), Caracal is paying \$228,000 in rent annually.

Caracal's owners therefore opted to begin the liquidation process to make its assets more attractive to buyers, rather than continuing to run up debts with vendors (which total about \$1.6m, associated with its wafer manufacturing equipment). Staffing has subsequently been cut from 12 early this year to seven and may be cut further, Chomos said. Investors hope someone will acquire Caracal's assets and continue operations.

www.caracalsemi.com

Fox licenses SiC patents to European firm

The Fox Group Inc of Deer Park, NY, USA says that it has signed a non-exclusive license agreement with a European company for certain of its patents related to silicon carbide and bulk growth of compound semiconductor crystals.

"With our focus on UV LEDs [at the firm's LED-making subsidiary in Montréal, Canada], Fox has ceased product development in SiC and has recently decided to offer rights to our SiC-related patents," says president and CEO Barney O'Meara. "Our scientists made significant R&D breakthroughs in the late 1990s that resulted in SiC with no micropipes and very low defect density," he adds. "Fox Group owns key patents covering low-defect single-crystal SiC material having less than a specific level of defects, that is, patents for the material itself, regardless of the method of manufacture or of the equipment used."

Fox's chief technology officer Dr Heikki Helava adds, "The SiC industry has steadily improved the quality of commercially available wafers so that the best SiC now being sold appears to fall within the scope of these patents, as determined by independent testing."

O'Meara continues, "We cannot divulge details of the license agreement, except to say that it is non-exclusive and includes sales-based royalties. We have been in contact with most SiC manufacturers worldwide, and have met and discussed terms with more than half a dozen companies," he adds. "Several of them have inquired about an exclusive license or outright purchase of this

The best SiC now being sold appears to fall within the scope of these patents

patent portfolio. We expect to conclude further patent rights agreements in the near future."

Low-defect-density SiC is being used in the production of high-performance power semiconductor devices, such as MOSFETs, HEMTs, JFETs, BJTs, and Schottky barrier and PIN diodes for applications including power control and correction (inverters, converters, etc).

While the RF, optoelectronics, and detector markets can currently tolerate higher defect levels, all SiC manufacturers are working to produce better material, the firm says.

"By the time the SiC-based device market reaches \$1bn annually — which is expected to occur within five years, for all applications combined — we believe that virtually all silicon carbide will be low defect and fall within the claims of our patents," comments O'Meara.

www.thefoxgroupinc.com

AXT's 57% year-on-year growth driven by SI GaAs and Ge

For Q1/2008, substrate maker AXT Inc of Fremont, CA, USA has reported revenue of \$19.6m, up 11% from \$17.6m last quarter and up 57% on \$12.5m a year ago.

While InP substrate revenue was just \$477,000 (up from \$330,000 last quarter but down from \$518,000 a year ago), the 'solid quarter of growth' included "strong increases in revenue from strategically important areas of our business such as 6" semi-insulating GaAs [for mobile handset applications] and germanium substrates [for solar applications]," according to chairman and CEO Phil Yin.

GaAs substrate revenue was \$13.7m, up 12% on last quarter's \$12.2m and 56% on \$8.8m a year ago. In particular, revenue for 6" semi-insulating GaAs has risen 37% sequentially from \$4.3m to \$5.9m (55% of total GaAs sales, versus 45% for semiconducting GaAs). This is being driven by the market for low-cost handsets (particularly in emerging markets such as India, China and other developing regions). "This market holds tremendous potential, and we're delighted to see companies such as Anadigics, Skyworks and TriQuint focusing on it as a priority," says Yin. "Further, continued strong growth in the video and smart-phone markets is fueling solid performance in the replacement handset market, as well as driving GaAs content as a result of their increasing feature-sets and functionality" he adds. As part of the growth in 6" GaAs substrate revenues, Yin singled out the \$18.6m order in Q4/2007 from epiwafer foundry IQE for its 2008 manufacturing requirements.

Demand also continues to be strong in semiconducting GaAs (thanks to increased penetration of LEDs in products such as digital cameras, notebook PC backlights

and automotive applications, and the 'strong push' towards use in LED lighting). "As in the case of semi-insulating GaAs, we're having renewed success with tier-1 customers that supply significant portions of the market," Yin says.

Much of AXT's overall revenue growth is attributed to market share gains as key customer qualifications are beginning to generate revenue, says Yin.

For example, Ge substrate revenue has almost doubled from last quarter's \$747,000 to \$1.4m, due to the volume ramp of existing customers as well as orders from new customers (with two of the five customers in qualification in Europe now having entered pre-production). "Europe continues to outpace the world in investment in solar technology," says Yin, citing the example of Emcore recently winning a \$4.6m follow-on production order for receiver assemblies for the 500x concentrator photovoltaic (CPV) systems of Spain's Concentration Solar la Mancha (for shipment from the September quarter through to early 2009). Chief financial officer Wilson Cheung expects Ge sales to ramp significantly, starting in second-half 2008, as qualifications complete with customers.

AXT says it is encouraged that CPV-related companies such as Solfocus, Emcore and Spectrolab are joining forces by creating a CPV Consortium [launched at May's 33rd IEEE Photovoltaic Specialists Conference in San Diego, CA] in order to raise the visibility of GaAs-based solar cells as a viable and efficient material for solar energy. "This is a good step towards CPV-related companies achieving greater penetration in the solar market," says Yin.

Yin is also pleased by recent announcements by Emcore and

Spectrolab that they are converting from 4" to 6" Ge substrates for III-V solar cells. "This is a significant step forward for the industry because it will allow CPV solar cells to become more cost-effective, as there are more die per unit area." AXT developed a process more than a year ago for manufacturing 6" Ge substrates in anticipation of an industry shift in this direction.

"Our customer engagement and qualification activity is very high and we are pleased to see progression with a number of key companies in our space as a result of significant competitive differentiators," says Yin. In particular, he cites AXT's ability to scale its manufacturing capacity according to demand (due to its vertical gradient freeze crystal growth method) and its access to critical raw materials (due to its China-based raw materials manufacturing joint ventures).

AXT's sales of raw materials (mainly 99.99%-pure gallium) were \$4m in Q1/2008, down from \$4.3m last quarter but up from \$2.6m a year ago. "We are once again seeing an increase in process for raw materials," says Yin. Year-on-year, the price of four-nines gallium metal has risen 37% from \$330 to about \$550 per kg, and arsenic 22% from \$130 to \$165 per kg. In particular, Ge is forecasted to increase from \$600 a year ago and \$1350 now to as much as \$1800 per kg (a further 44% rise).

The firm expects gallium and arsenic prices to stabilize in the coming quarters, but Ge could continue to rise. "While sharp rises in raw material pricing are detrimental to the margins of every company in our space, our joint venture agreements allow us to offset much of the impact through our ability to sell some materials on the open market," says Yin. "Most impor-

tantly these agreements protect our own ability to supply our needs as availability of these materials becomes tighter."

Overall gross margin was 31.7%, up from last quarter's 30.1% (though down from 43.2% a year ago). Net income has risen from \$1.3m a year ago and \$1.9m last quarter to \$2m. Cash and cash equivalents rose during the quarter from \$18.4m to \$23.2m (though largely due to closing the sale of property in Fremont on 28 March for \$5.1m).

"While we remain cautious in the way that we plan and forecast our business, we believe that industry trends support positive growth opportunities in the coming quarters," reckons Yin. For Q2, AXT expects revenue to rise slightly to \$19.7–20m but gross margin to fall to 30–31%. Chief financial officer Wilson Cheung cautions that AXT may continue to experience gross margin pressure in 2008 since raw materials prices are projected to increase, the firm's depreciation expenses are higher, and average selling prices may fall

slightly. However, some of this pressure will likely be offset by AXT's ongoing cost-reduction programs, as well as plans to increase overall manufacturing capacity. "We're preparing for the continued increased demand for semi-insulating GaAs with another 27% increase in our 6" GaAs capacity," he adds. Already, during Q1/2008, staffing (including joint ventures) has risen from 1057 to 1118 (mostly in production).

Regarding semiconducting GaAs (for LED applications), "due to competitive pressure, the margins can be very low, therefore we have adopted a policy of selectively accepting only the business opportunities that meet our corporate market and strategic goals," says Yin. "Our priority is to develop our ability to provide liquid-encapsulated Czochralski (LEC) crystal growth, where this process technology for producing small-diameter substrates will open up new markets for our products and allow us to further improve our cost structure."

Regarding Ge, AXT's plan to develop Czochralski (Cz) crystal growth processing will become increasingly important, allowing greater flexibility in providing optimal products for each application, as well as allowing an improvement in cost structure. "These capabilities will be essential as the solar market gains significant momentum," Yin believes, adding that AXT is pleased by the traction it is seeing in this emerging market.

Cheung adds that, during Q1/2008, AXT built up inventory from \$24.8m to \$29.1m. More than half of this increase is in anticipation of interruptions in the supply from its raw materials joint ventures to its Beijing substrate manufacturing plant due to the Chinese government moratorium on transporting goods around Beijing leading up to and during the summer Olympic games. The remaining rise is largely due to greater work-in-progress for increased production based on the higher sales forecast for the remainder of 2008.

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IN BRIEF

EVG opening Korean subsidiary

EV Group of St Florian, Austria, which supplies wafer-bonding and lithography equipment for semiconductor and packaging, MEMS, silicon-on-insulator (SOI) and emerging nanotechnology applications, is opening a subsidiary in Seoul, EV Group Korea Ltd. It will provide direct-to-customer sales, service and support, as well as process/application functions and administrative capabilities.

Until now, EVG's Korean presence was via both its distribution and R&D partners. The new subsidiary should position the firm to meet the growing demands for its technologies around the clock.

"The opening of our own subsidiary in Korea affords us a great opportunity to continue delivering on that commitment in this burgeoning market," says senior VP of sales Hermann Waltl. "The growth we've seen in our customer base thus far, coupled with the market potential, makes this move a clear and natural progression for us," he adds. "As Korea continues to increase its technological development efforts to aggressively compete in the global semiconductor and MEMS arenas, the region is a hotbed for adoption of the latest enabling manufacturing technologies. This creates significant market potential for EVG, particularly in areas such as 3D stacking, advanced chip-to-wafer integration, as well as wafer-to-wafer bonding."

EVG has already collaborated previously with Jinsan Scientific Co Ltd and Jinsan Micro-engineering Ltd to open a cleanroom facility (JML lab) designed to capture R&D efforts for MEMS, advanced packaging and nanoimprint lithography applications, as well as to serve as a demonstration center for EVG's Korean client base.

www.EVGroup.com

Curvature sensors for Euro R&D

LayTec says that its EpiCurve TT wafer curvature sensor (already its best-selling product among GaN LED makers) is gaining recognition at European research institutions, with three systems sold recently for MOCVD systems in Europe. One has already been installed at CNRS-CRHEA in Valbonne, France.

Philippe de Mierry and co-workers are using the sensor on a home-built MOCVD system for monitoring GaN and InGaN LED growth on sapphire substrates. de Mierry's team studies the effects of different backside polishing and coating, thicknesses, initial bowing and residual stress. Also, with the next generation of large 4" sapphire substrates, the homogeneity of the indium content in the active layer of LEDs is becoming an issue. This requires good control of the surface temperature and wafer curvature during InGaN deposition, de Mierry says. "EpiCurve TT will help us to under-

stand the role of these various substrate parameters on the evolution of the wafer curvature, and then to optimize the LED homogeneity."

A further EpiCurveTT has been sold to the University of Magdeburg in Germany. The team of professor Alois Krost will use it for GaN/Si growth control and, in particular, for in-situ monitoring of GaN-based Bragg mirrors and VCSEL structures.

Finally, Germany's Technical University of Berlin has purchased a Curve module as an upgrade for its spectroscopic reflectance sensor EpiR. Professor Michael Kneissl's team is applying the sensor on a Thomas Swan Close Coupled Showerhead reactor to optimize InGaN laser and deep-UV LED growth. The EpiCurve TT system allows the combination of full spectroscopic reflectance control with wafer curvature, temperature and growth rate measurements, all in real time, LayTec says.

www.laytec.de

Aviza's sales at low end of guidance

For fiscal Q2/2008 (ended 28 March), etch and deposition equipment maker Aviza Technology Inc of Scotts Valley, CA, USA has reported revenue of \$30.2m, near the bottom end of its \$30-35m guidance. This is down 11% on last quarter's \$34m and less than half the \$61.6m a year ago.

The results reflect Aviza's plans to restructure its product strategy, served markets and internal operations (announced in early April). The firm is refocusing on its core strengths in atomic layer deposition (ALD) technology for the sub-45nm nodes, and etch and PVD technologies for the fast-growing 3D-IC market segments. Aviza is hence downsizing programs, products and spending related to trench capacitor technology for DRAMs, and decreasing its overall dependence on the DRAM market. This involves ceasing development of large batch thermal systems for the trench capacitor market.

"The most profound impact was the result of a \$20.8m restructuring charge [due to the write-down of assets as well as the 15% cut in staffing and contractors] which negatively impacted our gross margin and operating expenses," says president and CEO Jerry Cutini. Consequently, net loss was \$30.1m, compared to \$8.5m last quarter and a profit of \$1.4m a year ago. Cash and cash equivalents fell from \$23m at the end of September to \$15.2m at the end of March.

Restructuring is expected to result in annualized savings of \$16-20m. "As we continue to control and monitor our spending, our renewed focus moving forward will concentrate on the new initiatives we set forth," adds Cutini.

Assuming continued softness in DRAMs, for fiscal Q3 (to 27 June) Aviza expects sales of \$32-37m and an operating loss of \$3-7m.

www.aviza.com

WaferTronix launches to supply wafer products and consulting services

The beginning of May saw the launch of WaferTronix of Boca Raton, FL, USA, a supplier of materials and consulting services to the advanced semiconductor industry.

"WaferTronix is truly a global company with strong and reliable international suppliers and skilled worldwide representatives," says founder and CEO Donald J. Capo.

With more than 35 years experience in the semiconductor industry, Capo has held senior management positions at Wafer World, MBE Technology (which was acquired by IQE at the end of 2006), Freiburger USA, Quantum Epitaxial Designs, and Unilever. He has co-authored seven technical publications on compound semiconductors and electronic materials and holds a BS degree in Chemistry and MS in Materials Engineering & Science from the University of Rochester, along with an executive MBA.

Located in a 100,000ft² campus setting, WaferTronix plans to increase its technical staffing, as it partners with major OEMs.

The firm offers a portfolio of wafer products including III-V and II-VI compound materials, as well as sapphire and germanium.

Consulting services include materials selection, contract offsite specialty materials procurement, and strategic materials business development.

"We will also be involved in inhouse R&D on novel nano-materials research with both government-funded programs and private-sector joint activities," Capo told Semiconductor Today.

www.wafertronix.com



**Founder & CEO
Donald J. Capo.**

Johnson Matthey appoints Teratech as distributor in Korea

Johnson Matthey Gas Purification Technology (GPT) group of West Chester, PA, USA, which designs and manufactures bulk and point-of-use gas purifiers, has selected Teratech Co Ltd as its distributor in Korea.

Teratech is a manufacturer of vacuum gate valves for the semiconductor industry.

"Johnson Matthey selected Teratech because of their experience and knowledge of the Korean semiconductor market," says Moonho Kim, sales manager for Johnson Matthey in Korea. "This, in combination with their outstanding service expertise, gives us excellent representation in Korea."

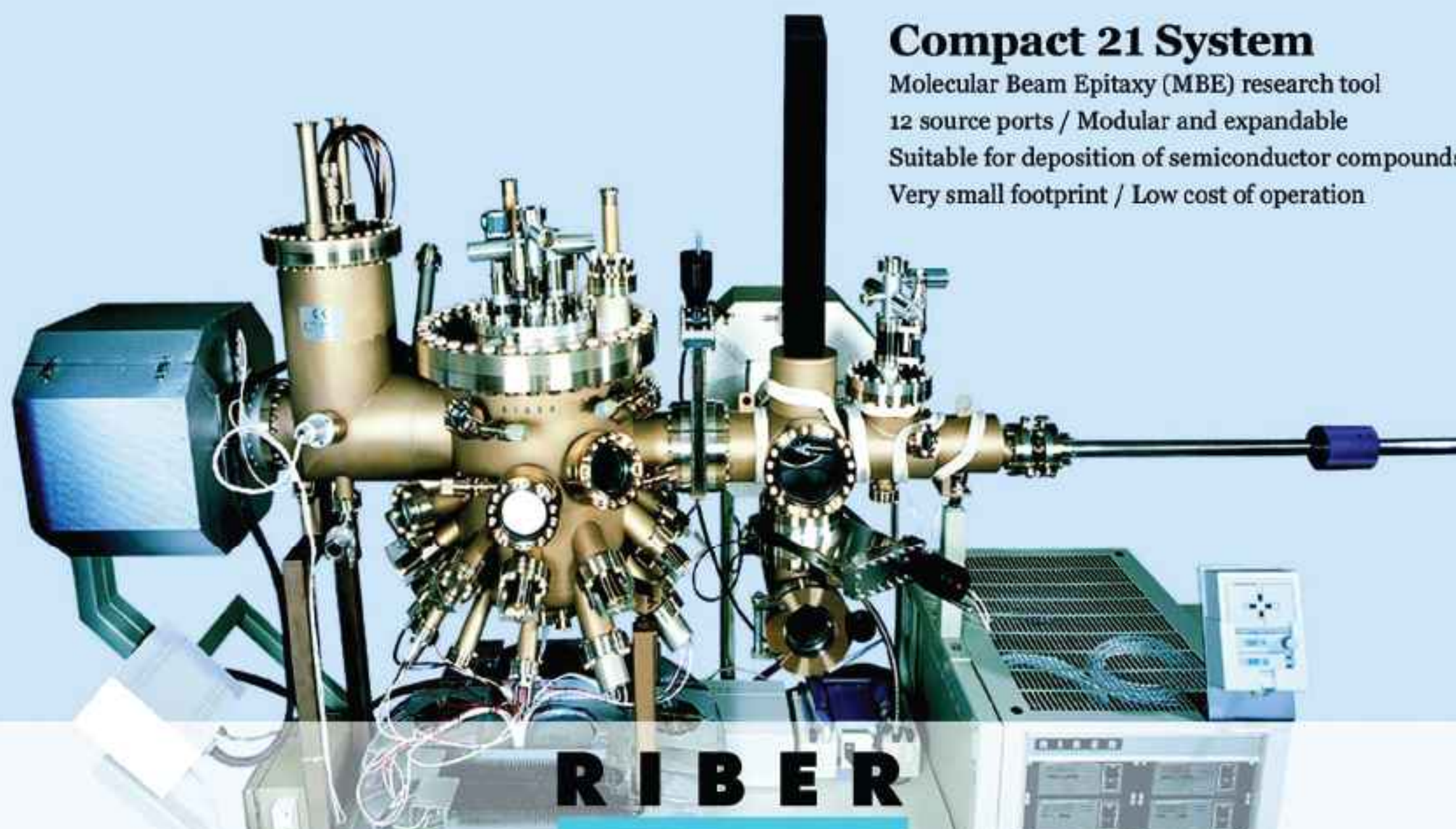
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Veeco's epi equipment sales rise 25% on last quarter

For Q1/2008, Veeco Instruments Inc has reported revenue of \$102.3m (41% from LED & Solar Process Equipment, 35% from Metrology, 24% from Data Storage Process Equipment). This is down from last quarter's \$106.8m but up on \$99.2m a year ago.

For the LED & Solar Process Equipment business (MOCVD and MBE epitaxial deposition systems) revenue was up a huge 90% from \$22.4m a year ago and up 25% on last quarter's \$33.7m, to \$42.1m (41% of total revenue, and now Veeco's largest segment). Earnings before interest, taxes and amortization excluding certain charges (EBITA) for the business have risen from \$1.8m a year ago to \$8.6m. Gross margin has risen from last quarter's 39.8% to 41%.

Growth comes mainly from demand from high-brightness LED makers. All of Veeco's newest-generation, high-throughput K-465 GaN MOCVD systems shipped to Asia-Pacific, Japan and Europe have now received field acceptance. The firm has received positive customer feedback on the high margin that the system delivers for HB-LED makers due to its automation, higher throughput and yield, says CEO John R. Peeler. "Our competitor's tools are producing either 138 or 90 wafers per day, depending on the system, while the TurboDisc K-465 produces over 200 wafers per day," he reckons.

During the quarter, Veeco also began shipping its first MBE thermal deposition sources for the copper indium gallium selenide (CIGS) solar cell market.

Data Storage Process Equipment revenue was weak (as expected), falling year-on-year from \$35.7m to just \$24.1m. Metrology business showed a sequential recovery in profitability, despite revenue falling year-on-year from \$41.1m to \$36.1m.

Overall, gross margin has risen from last quarter's 37.9% to a better-than-expected 41.7%

(ahead of guidance of 39%), despite lower revenues.

Compared to net income of \$0.3m a year ago, net loss was \$1.6m, but that included a restructuring and asset impairment charge of \$3.2m

related mainly to the consolidation of Veeco's headquarters from Woodbury into its ion-beam facility in Plainview, NY, USA (saving almost \$2m annually).

Bookings have risen year-on-year from \$105.9m to \$109.3m (with LED & Solar Process Equipment up 6% on \$36.4m a year ago to \$38.7m, including "several multi-unit orders at some key strategic penetrations of tier-1 LED customers", says Peeler). Backlog rose \$5.8m during the quarter to \$179.3m.

As well as MOCVD systems, bookings also included both MBE systems and CIGS sources, says Peeler. "The thin-film CIGS market offers a very promising growth opportunity for Veeco, given the potential for increased efficiency and lower-cost panels than silicon," he adds.

For Q2/2008, Veeco forecasts revenues of \$102-110m. Bookings should rise to \$110-118m, driven by sequential increases in both the Metrology and the LED & Solar Process Equipment segments.

End markets in HB-LEDs remain strong, with customers continuing to invest in capacity, says Peeler. Also: "In solar, our E-475 MOCVD system, with 50% more throughput than the competitor system, is helping the manufacture of some of the world's most efficient low-cost III-V solar cells," he claims.

In Q2/2008, Veeco expects continued improvements in gross margin (independent of sales volume), driven by better pricing, global supply chain initiatives, and outsourcing. Also, cost containment should cut operating spending from 38% of sales in 2007 to 36-37% in 2008.

For the 'recovery year' 2008, the firm reaffirms its guidance of revenue growth of at least 10%, from 2007's \$402m to \$440m. This should include \$140-145m for LED & Solar Process Equipment (up 20-25% on 2007's \$116m). Also, Veeco targets growth in gross margin from 40% to 42%.

www.veeco.com

The thin-film CIGS market offers a very promising growth opportunity for Veeco

Nominees sought for molecular beam epitaxy awards

System maker Veeco Instruments is once again co-sponsoring two awards recognizing individuals (from academic, government or commercial organizations) that have made significant advances in MBE technology.

Introduced in 2003, the MBE Innovator Award is co-sponsored by the International MBE Organization. The Al Cho Award, introduced in 2004, is co-sponsored by other participants within the MBE community.

Nomination forms can be found at www.mbe2008.ca (deadline 15 June). The International MBE Advisory Committee Officials will select each winner and present the awards at the International MBE Conference banquet on 7 August.

Aixtron orders peak

For Q1/2008, deposition equipment maker Aixtron of Aachen, Germany has reported revenue of €62.6m, down 2% from €63.8m a year ago but up 16% on last quarter's €54.1m.

Of total revenue, 76% was for compound semiconductor applications (€47.8m). This is up 10% on €43.5m a year ago (just 68% of total revenue) and up sharply by 25% from just €38m last quarter (70% of total revenue). Silicon applications (NAND flash and DRAM memory) yielded 13% of revenue (€8.3m). This is down 40% on €13.9m a year ago (22% of total revenue).

LED applications now represent 78% of total revenue, with silicon comprising 15%, consumer/optoelectronics 5%, and telecom/datacom 2%. Correspondingly, 83% of revenue came from Asia, 10% from the USA and 7% from Europe.

Reflecting a further increase in the proportion of common platform system revenues, paired with a favorable product mix (both offsetting the negative effect of a weak US dollar against the Euro), gross margin improved slightly year-on-year, from 38% to 39% (though down on last quarter's 42% due to the disproportionately high number of final acceptances of high-margin products and consequent lower cost of sales in Q4/2007). However, net profit has fallen from €7.6m a year ago to €5.9m, due mainly to a higher tax rate. Nevertheless, this represents a recovery from just €2.4m last quarter.

Equipment order intake has more than doubled, growing by 111% from €40.5m a year ago to €85.5m (almost equaling last quarter's record of €86.9m). Of this, 90% was for compound semiconductors (€77.3m, up 161% year-on-year) and 10% for silicon (€8.2m, down 25%).

The very high order intake reflects the strong demand, mainly for common-platform high-capacity MOCVD systems to produce LEDs for emerging display backlighting applications, as well as mobile

handset, automotive, lighting and consumer electronics laser product applications (e.g. Blu-Ray, HD DVD). Also, more orders have been received for multiple reactors for delivery over a scheduled period.

In contrast, silicon equipment orders are down, as expected, due to the depressed memory chip market conditions, constraining capital spending on CVD systems. Also, Aixtron's next-generation ALD and AVD systems are still under development and are yet to be qualified for mass production. However, these systems will still be ready for launch later in 2008, the firm says.

Order backlog was €157.3m at the end of Q1/2008, more than double €70m a year ago and up 19% on €132m at the end of 2007.

"We have seen some evidence of softening in inquiry level, which leads us to believe

that we are probably at the apex of the current demand cycle," says president & CEO Paul Hyland.

"However, speaking at the mid-way point in Q2, we already have a positive view of the order intake development in this quarter," he adds. "This is a very encouraging start to what we are projecting to become one of the most successful years in the company's 25 year history."

Aixtron has therefore reiterated March's full-year 2008 guidance for revenue of €270m-300m (up 26-40% on 2007's €214.8m). In addition to Q1/2008's €62.6m in revenue, this assumes €136m will come from the existing €157.3m order backlog and €21m from spares/non-system revenue in Q2-Q4/2008, leaving just €50-80m in new equipment orders needed to achieve the targeted guidance.

www.aixtron.com

IN BRIEF

Bridgelux orders multiwafer CRIUS reactors for GaN LED expansion

Bridgelux of Sunnyvale, CA, USA has ordered two Close Coupled Showerhead CRIUS MOCVD systems from Aixtron, both in 31x2" wafer configuration, to expand its volume production of AlInGaN-based HB-LEDs.

Founded in 2002, Bridgelux says it introduced the industry's first high volume ITO/InGaN power LED chip and delivers millions of chips every month to customers worldwide.

www.bridgelux.com

FBH adds MOCVD system for UV LEDs

Aixtron has received an order from the Ferdinand-Braun-Institut für Höchstfrequenztechnik (FBH) for an AIX 2600G3HT Planetary Reactor system with a capacity of 8 x 4-inch wafers.

FBH of Berlin, Germany will use the system to strengthen its R&D activities in GaN-based UV LEDs, laser diodes and GaN HFETs.

"FBH has accumulated considerable experience with a wide range of Aixtron MOCVD systems," says Dr Markus Weyers, head of the Materials Technology Department. "We already have an AIX 2600G3HT Planetary Reactor system with 8x3" and 11x2" capacity in operation... we can build on this to quickly and efficiently grow UV LEDs."

"The new tool will especially allow us to prepare high-temperature AlN thin films with high crystalline quality uniformly and reproducibly... the AIX 2600G3 system is especially suited for the uniform and reliable growth of such challenging semiconductor materials."

www.fbh-berlin.de

TEC module for high heat fluxes in small opto packages

Nextreme Thermal Solutions of Durham, NC, USA, which manufactures thermal and power management products, has launched the latest module in its OptoCooler family of thermoelectric coolers (TECs) designed for the photonics industry.

The OptoCooler UPF40 thin-film thermoelectric cooler module is designed for optoelectronic applications with high heat-flux requirements, and is suited to the cooling and temperature control of devices such as semiconductor optical amplifiers (SOA) and laser diodes.

The UPF40 can pump a heat density of up to $72\text{W}/\text{cm}^2$ at 25°C and, as a result, can move a maximum of 3.7W of heat with an active footprint of just 5.1mm^2 . "The new OptoCooler UPF40 module operates with heat fluxes 4 to 5 times greater than conventional thermoelectric coolers," reckons VP of engineering Dave Koester. "In addition, the module's extremely small



Nextreme's OptoCooler UPF40 thin-film thermoelectric cooler module.

footprint opens up new thermal management capabilities in electronics that were previously unavailable."

With Nextreme's thin-film thermal bump technology at its core, the UPF40 module can be integrated directly into electronic packaging to deliver cooling for a wide variety of thermal management applications (e.g. embedding in an SOA package to maintain proper operating conditions). SOAs are used in high-speed photonic networks to restore degraded optical signals to their

original quality without converting them into electronic signals.

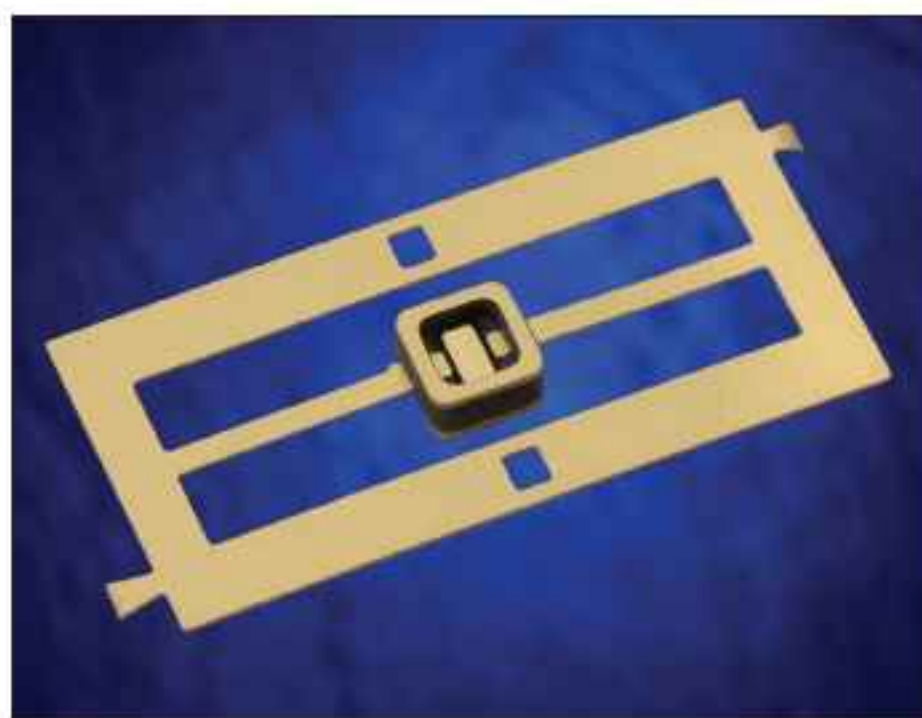
Nextreme's thin-film thermoelectric products are manufactured in volume with the thermal copper pillar bump process, an established electronic packaging approach that scales well into large arrays. The process integrates thin-film thermoelectric material into the solder bumped interconnects that provide mechanical and electrical connections for high-performance/high-density ICs. Unlike conventional solder bumps, thermal bumps function as solid-state heat pumps on the microscale. The stack-up of a thermal bump, including the thin-film material, solder and electrical traces, is only $100\mu\text{m}$ high and has a diameter of $238\mu\text{m}$. The thermal bumping process can be implemented at the package or wafer-level, and is currently used to fabricate Nextreme's discrete modules.

www.nextreme.com/optocooler

StratEdge launches small-outline thermally enhanced packages

StratEdge of San Diego, CA, USA, which designs and produces packages for microwave, millimeter-wave, and high-speed digital devices, has launched a family of small-outline thermally enhanced molded ceramic packages for power semiconductors, for use with silicon, silicon carbide, gallium nitride, and other compound semiconductors (e.g. amplifiers, discrete transistors, and diodes where greater than 0.5 Watt of power is consumed).

The thermally enhanced packages are designed for reliability and to mitigate the inherent stresses of brazing dissimilar materials together. All materials used in the packages have matched coefficients of expansion. They are assembled using a glass-to-metal seal process combined with gold germanium brazing, giving a rugged and reliable package. The packages can handle temperatures up to 360°C .



StratEdge's two-lead G1010M-2C package, supplied with copper insert.

A hermetic seal provides enhanced reliability and offers protection from harsh environmental conditions, meeting military standard requirements. Packages are sealed with metal or ceramic lids that have gold-tin solder preforms.

Copper composite bases or copper inserts give enhanced thermal dissipation. Devices are mounted directly to the metal bases, providing an electric ground to the

backside of the chip. StratEdge claims that the packages provide superior electrical performance for frequencies up to at least 6GHz. For controlled impedance devices, transition designs with higher-frequency performance can be used.

Packages are available in various shapes, sizes, and lead counts. All can be provided with gull-wing-shaped leads for surface mounting.

"These new packages, combined with our Power Package Series with thermally conductive beryllium oxide (BeO) ceramic, give our customers a variety of packages to choose from to package their high-power devices," said Timothy Going, president and CEO.

StratEdge's new thermal power package will be on show at the IEEE MTT-S International Microwave Symposium (IMS 2008) in Atlanta, GA, USA (17-19 June).

www.stratedge.com

Enhanced laser-based automated wafer processing

At July's Semicon West 2008 show in San Francisco, CA, J P Sercel Associates (JPSA) of Manchester, NH, USA will supplement its IX-4000 series of high-throughput, high-speed Class 1 laser-based workstations with two new systems: the IX-4100 ChromaDice and the IX-4600 ChromAblate. Both are designed for automated wafer processing with the ability to handle up to 300mm wafers.

Based on the IX-210 and IX-260 systems, the 4100 and 4600 feature automation and capability enhancements. In addition to 300mm wafer processing, these include automatic wafer loading, an integrated automated coating/cleaning station, and a vision system for automatic wafer alignment.

The IX-4100 ChromaDice is designed for wafer singulation applications and employs UV energy from a diode-pumped solid-state (DPSS)

laser in a fast, low-stress method of wafer scribing that minimizes chip breakage after cutting (for higher yields), with kerfs as narrow as 2.5µm and minimal debris generation in a vibration-free process.

The IX-4600 ChromAblate is a UV excimer-based laser system suited to applications including LED production, selective wafer annealing, micro-drilling, thin-film patterning, and 3D micromachining. It uses proprietary UV laser technology to produce high-brightness LEDs through a patented lift-off method that dramatically reduces the time and cost of the fabrication process



The IX-4100 system

as well as enabling manufacturers to grow vertical design LED devices that provide the highest light output.

JPSA says its IX-4000 series systems are designed and optimized for demanding 24/7 high-volume production but still have high accuracy.

The IX-4600 ChromAblate can micromachine features to 2µm or be configured for large-area exposure of up to 5mm x 5mm. The systems feature dual-cassette load ports, production-grade robotics, and other robust features characterizing industrial-grade systems. They are also compact, modular, fully automated and versatile, with large work areas and full accessibility.

www.jpسالaser.com

Obducat and Canon MJ win first joint NIL deals in Japan

Obducat AB of Malmo, Sweden has received two orders for nano imprint lithography (NIL) systems from Canon Marketing Japan (CMJ): a semi-automatic Sindre production system for manufacturing LED components, and a development system for display applications (both for delivery in third-quarter 2008). The total value of the orders to the end customers (both major international firms based in Japan) is about SEK10m (€1.07m).

The Sindre deal also entails agreed prices on expendable items; sales of these are expected to generate further revenues at the end customer in excess of SEK10m over the next 3–5 years.

Development using the system for displays is expected to result in products for field testing as early as this year, and high-volume manufacturing in 2009.

Obducat's CEO Patrik Lundström reckons that the firm is now cementing its position as a leading provider in NIL-based LED production, as well as gaining a strong foothold in displays. "Both applications are within Obducat's focus areas. With regard to the display application, it is the first industrial step towards imprint solutions for larger areas, presenting a significant market potential," he says.

"These two orders are the first outcome of a year of intensive collaboration between Obducat and Canon MJ," Lundström adds. Obducat signed an exclusive Japan distribution agreement with Canon MJ in January 2007 (around the time that Sindre was launched). "Both deals will now be vital endorsements for further activities in Japan," he reckons.

www.obducat.com

JPSA partners with ETSC in China

Photonics and semiconductor equipment distributor ETSC Technology Company of East Lake Hi-Tech Development Zone (China's 'Optics Valley') in Wuhan is to represent and service the laser systems and technology products of JPSA in China.

"ETSC is well established in China as a professional optics products and services provider to a broad and distinguished customer base," says president Jeffrey P. Sercel. "Their decade of experience in the China marketplace will be a tremendous asset."

As well as selling systems, ETSC will service JPSA equipment from their multiple service locations, stock spare parts, and assist customers in operation and process development, as well as provide customer training. ETSC engineers are traveling to JPSA for training.

www.etsc-tech.com

IN BRIEF

Rubicon prices public offering

Rubicon has announced the pricing of a public offering of 3,950,000 shares of its common stock at \$24 per share (to raise \$94.8m). To cover any over-allotments, the underwriters have an option to purchase up to an extra 592,500 shares (\$14m).

This follows an initial public offering of 6,700,000 shares on NASDAQ last November, when the firm's stock opened at \$14 per share, raising \$93.8m (\$77m for the firm, plus \$16.8m for early-stage investors).

Founded in 2000, Rubicon's revenues grew 2% in 2005, 27% in 2006 and 64% in 2007 (to \$34.1m), when the firm made its first annual profit.

A copy of the final prospectus can be obtained by contacting UBS Investment Bank of New York, NY, USA.

Rubicon grows 46% year-on-year as expansion runs ahead of schedule

For Q1/2008, Rubicon Technology Inc of Franklin Park, IL, USA, which manufactures sapphire substrates and products for LED, RFIC, semiconductor and optical window applications, has reported revenue of \$10.5m, up 10% on last quarter and 46% on \$7.2m a year ago. Net income has risen from \$283,000 a year ago to \$2.3m.

The firm continued the rapid build out of manufacturing capacity in its new crystal growth facility in Bensenville, IL (which opened in January). "We were able to start building out crystal growth furnaces in our new facility earlier than anticipated," said chief financial officer Bill Weissman. "As a result, our first quarter revenue and earnings per share came in better than expected."

"Rubicon had a very strong first quarter, in terms of our financial performance, the continued diversification of our revenue base across end markets, expansion of our pro-

duction capacity and the continued evolution of our technology," says CEO Raja Parvez. "We now have larger furnaces operational that are capable of producing next generation eight inch diameter sapphire material."

For Q2/2008, Rubicon expects revenue of \$11.5m. Full-year revenue and EPS estimates have been based on the expected added capacity throughout this year. "While we had a strong first quarter and expect our second quarter to be strong as well, we are not raising the top end of our earlier estimates until we are sure capacity can continue to come on-line ahead of schedule," says Weissman. However, the firm is tightening its range of anticipated revenue for 2008 to \$47-49m (excluding estimated costs of about \$400,000 to be incurred from a proposed secondary offering currently in registration).

www.rubicon-es2.com

OIPT names ops director and TDI general manager

Oxford Instruments Plasma Technology (OIPT) of Yatton, UK (a division of Oxford Instruments plc) has appointed Bernard Scanlan as general manager for its recently acquired Technologies and Devices International Inc (TDI) business in Maryland, MD, USA.

Prior to his appointment, Scanlan was operations director for Oxford Instruments Nanoscience, where he led, and implemented a number of key business improvements.

TDI develops and manufactures nitride materials (including GaN, AlN, AlGaIn, InN and InGaIn) using its patented hydride vapour phase epitaxy (HVPE) technology and processes, mainly for applications in solid-state lighting, short-wavelength optoelectronics and RF power electronics.

OIPT says it will provide TDI with additional R&D resources which will



allow the firm to continue the development of its HVPE technology further into commercially available tools, which can be used by HB-LED and

RF power electronic manufacturers. The addition of HVPE opens up the opportunity to deliver products to the epitaxy sector of the market, adds OIPT. TDI's HVPE technology offers HB-LED makers lower manufacturing costs and improved output compared to conventional MOCVD techniques, it is claimed.

OIPT also provides process tools based on core technologies in plasma-enhanced deposition and etch, ion-beam deposition and etch, atomic layer deposition (ALD) and molecular beam epitaxy (MBE).

OIPT has also appointed Dan Ayres as its operations director. He has already held a number of roles in operations and marketing in the Oxford Instrument Group at Oxford Instruments Analytical (most recently as director of operations).

Prior to joining Oxford Instruments, Ayres worked for a major Japanese car maker, where he was responsible for managing production suppliers and co-ordinating the supply chain for new product introductions.

As well as working on key challenges to ensure that OIPT maintains its standards, Ayres will also be instrumental in the firm's relocation within North Somerset in 2009.

www.oxford-instruments.com



AmberWave buys Aonex for opto and solar prospects

Arrowhead Research Corp of Pasadena, CA, USA has sold its majority-owned subsidiary Aonex Technologies to AmberWave Systems of Salem, NH for up to \$7.95m in shareholder earn-out payments, plus a running royalty on sales of solar products incorporating Aonex's technology.

Aonex was founded in 2004 by Arrowhead and professor Harry Atwater of the Pasadena-based Caltech to commercialize materials integration technology developed in Atwater's lab for high-efficiency solar cells. The firm later expanded its focus and product development efforts to address the LED and laser markets. Aonex's products (A-Sapph single-crystal sapphire and A-GaN single-crystal GaN, respectively, on polycrystalline AlN substrates) could enable the fabrication of higher-efficiency devices at lower cost and higher yields, it is claimed.

AmberWave, which was spun out

from Massachusetts Institute of Technology in 1998, undertakes R&D focused on integrating dissimilar semiconductor materials to enable high-performance devices at low manufacturing costs. It claims to have been first to develop sub-45nm and sub-25nm strained silicon FETs, and first to demonstrate economically feasible wafer-scale strained silicon and strained silicon-on-insulator wafers free of SiGe. Last August, together with the Rochester Institute of Technology, AmberWave was awarded a \$0.3m, three-year grant from the National Science Foundation (NSF) to integrate compound semiconductor devices on silicon using its aspect ratio trapping (ART) technology. In March 2006, it formed a cooperative agreement with Purdue University to jointly develop technologies for integrating devices on III-V materials (for III-V MOSFETs).

Aonex's technology should enhance AmberWave's technology

portfolio and enable it to move into new, high-growth markets.

"AmberWave's technical capabilities and business expertise make it the perfect company to bring Aonex's products to market," says Aonex CEO and co-founder Sean Olson. "There is a shared vision of using materials integration to develop better, more cost-effective semiconductor devices," he adds.

"Strong synergies between Aonex and AmberWave made selling Aonex the right decision," says Arrowhead's CEO Chris Anzalone. "AmberWave is well positioned to scale Aonex's prototypes and customer traction into compelling businesses in the optoelectronic and solar markets."

As part of the acquisition, Atwater will continue to support development of the technology. AmberWave will also take over Aonex's Pasadena operations.

www.amberwave.com

www.arrowheadresearch.com

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DOE announces Round 5 SSL funding opportunities

As part of its Solid State Lighting (SSL) program, the US Department of Energy's National Energy Technology Laboratory (NETL) has announced its fifth-round SSL Core Technology Research and Product Development funding opportunities.

The Office of Energy Efficiency and Renewable Energy (Building Technologies Program) is soliciting applications from research organizations (to perform Core Technology Research activities) and from industrial organizations (to perform Product Development activities for general lighting applications).

The DOE aims to make 5–10 Core Technology Research awards of up to

\$600,000 per year for up to 3 years. The application deadline is 19 June.

Core Technology Research supports applied research in key technical areas needed to advance SSL technologies by fostering a collaborative atmosphere favorable to providing problem-solving knowledge and data needed to overcome technical barriers identified in six defined Program Areas of Interest: three in LEDs (internal quantum efficiency; phosphors and conversion materials; and encapsulants and packaging materials) and three in OLEDs.

Product Development projects aim to develop or improve commercially viable materials, devices, or systems.

The Program Areas of Interest are: (1) LED-based integrated luminaires; (2) high-efficiency LEDs or arrays; (3) phosphors or encapsulants; (4) electronics development; (5) OLED lighting panels; (6) low-cost substrates and encapsulation for OLEDs; and (7) off-grid SSL products.

The DOE aims to make 2–5 two-year awards, of up to \$900,000 each per year for program areas of interest 1–6 and up to \$400,000 per year for 7, totaling \$7.5m. The DOE will notify recipients by the end of 2008 and make awards by April 2009.

www.netl.doe.gov/ssl

Luminus wins Display Component of the Year award

Luminus Devices' PhlatLight LED back-light unit (BLU) has won the 2008 Display Component of the Year Gold Award from the Society of Information Display (SID).

The other gold award winners are Apple's iPhone and Sony's OLED TV. This follows Luminus last year winning the 2007 Silver Award from SID for PhlatLight LEDs used in projection applications.

Luminus received the award on 21 May at Display Week 2008 (the SID International Symposium, Seminar & Exhibition) in Los Angeles. Luminus also demonstrated the PhlatLight BLU and other PhlatLight LED powered projection products in private demonstrations.

The PhlatLight 46" BLU is illuminated by eight light modules, each with a single red, green and blue PhlatLight (Photonic Lattice) LED. The LEDs illuminate the BLU from the edges, not the back, enabling thinner designs. "The PhlatLight BLU earned this distinction because it provides a low-cost and reliable solution that can finally enable RGB LED backlighting in mainstream, large-screen LCD TVs," said John Langevin, VP sales & marketing.

The PhlatLight BLU is the result of collaboration with Global Lighting



Langevin (right) and McCartney (left).

Technology, which specializes in MicroLens light guides for back-lighting and other applications. "We consider GLT a full partner in the product and in the honor of this award", added Langevin. More recently, Luminus and GLT engaged Jabil Corp as a design and manufacturing partner for integrating the technology and taking it to market.

The Display of the Year Awards commends the chief influential technologies across the global display community, reckons Dick McCartney, SID's DYA chair. "Among the significant number of nominations received from around the world, Luminus Devices' PhlatLight technology stood out for the second year in a row."

● Luminus has also been named a winner of a 2008 Small Business Association of New England (SBANE) Innovation Award, which recognizes firms that have transformed their ideas into a product or service (in this case PhlatLight LED technology) that delivers proven value to its customers. This year, 165 firms were nominated, and 15 semi-finalists were announced on 4 April, leading to final presentations before the judges on 8 April.

In addition to the display market, Luminus is also expanding PhlatLight LEDs into lighting applications. "In the months and year ahead it is obvious that Luminus has a business plan and strategy for impacting our local economy by providing a solid base of jobs while at the same time helping to revolutionize the solid-state lighting industry on a global scale," said SBANE president Bob Baker.

Luminus' CEO Udi Meirav sees the human capital of the greater Boston area as a competitive advantage. "Luminus' achievements would not have been possible anywhere else in the country," he reckons. Luminus was founded in 2002 on the basis of research conducted at the Massachusetts Institute of Technology (MIT).

www.luminus.com

Luminus launching PhlatLight LEDs for lighting applications

Luminus Devices Inc of Billerica, MA, USA unveiled its PhlatLight LED product line for lighting applications at the Lightfair International event (28–30 May) in Las Vegas, NV.

The firm is best known for supplying its patented PhlatLight LEDs for high-definition TVs and projectors to consumer electronics manufacturers like Samsung and LG Electronics. The firm claims that they are the only LEDs bright and efficient enough to replace arc lamps with a solid-state alternative.

PhlatLight LEDs are larger than standard LEDs, and are designed to operate at much higher power levels. Luminus is therefore now making the technology available to lighting manufacturers, providing a line of products that are able to replace conventional lamps in lighting applications previously thought impossible with LEDs.

"Luminus has taken several steps in recent months to support expansion into lighting, by expanding our product portfolio, sales and support organization, and distribution channel," said Christian Hoepfner, VP of products. "These products are already being designed into lighting fixtures in the entertainment, architectural and medical industries," he adds. "We expect our large, white PhlatLight LEDs to make an impact in high-brightness applications in the general lighting landscape."

The properties of PhlatLight LEDs include Luminus' Photonic Lattice technology efficiently extracting light from the chip surface. The firm says that the technology enables the manufacture of LEDs as much as 12 times larger than conventional LEDs, in various shapes, sizes and configurations for a wide range of applications.

Luminus' patented chip-on-board package technology gives the LEDs low thermal resistance ($<0.6^{\circ}\text{C}/\text{W}$),



Luminus' CBT-120 single-chip red, green and blue single-color (left) and CBM-270-RGBX multi-chip, four-color (right) PhlatLight LED modules.

allowing what is claimed to be the industry's widest reliable operating range, from 0.35A to over 30A, with some devices capable of producing over 3000 lumens from a single chip. Reliability testing at high current levels qualifies the products for over 100,000 hours of operation.

Three series of PhlatLight LEDs will be exhibited at Lightfair:

- The PhlatLight CBT series of single-chip, single-color LED modules comprises individual red, green or blue devices with various emitting areas: CBT-120 (12mm^2); CBT-85 (8.5mm^2); CBT-54 (5.4mm^2); CBT-40 (3.9mm^2). Products are available for sampling.
- The CBM family of multi-chip, multi-color PhlatLight LED modules will be debuted in three- and four-color configurations. With thousands of lumens emitted from a small area like an arc gap or filament, optics are simplified and color shadowing eliminated. Over 2000 lumens of multi-color or white light is produced from a single module. This performance enables applications not possible with conventional LEDs, it is claimed, such as spotlighting for entertainment, architectural or general lighting. A single CBM module can replace large arrays of conventional LEDs, while multiple modules can be tiled

for flux competitive with 575W arc-lamps. Sampling will start in September, with mass production in Q4/2008. The initial CBM series will consist of the following devices, with different emitting areas: CBM-220-RGB (22mm^2) and CBM-270-RGBX (27mm^2), with multiple fourth colors available in Q4/2008.

- A new family of PhlatLight white LEDs in various sizes offers output ranging from 1600 lumens for the CBT-90 and more than 4000 lumens for the CBM-360, providing an ultra-bright, point-source of white light with superior optical coupling that enables new applications with better optical system efficiency, it is claimed, overcoming the design limitations of conventional LEDs and LED arrays. Sampling is planned for September, with mass production in Q4/2008. The initial white LED product line will consist of the following devices (each in cool, warm and neutral versions): the CBT-90-W (9mm^2) and the CBM-360-W (36mm^2).

Luminus adds that PhlatLight LEDs are supported by eco-system partners for lighting including National Semiconductor and Maxim for drivers, Fraen for optics, NuVentix for thermal management and Cypress Semiconductor for color management solutions.

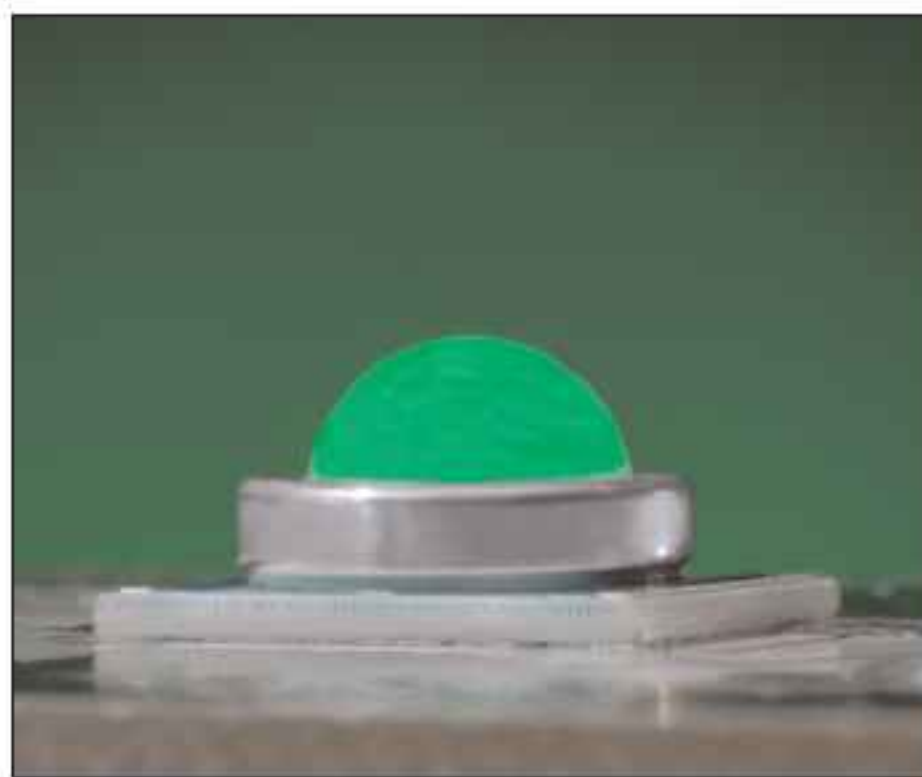
www.luminus.com

Cree expands XLamp XR-C family to full range of colors

Cree has expanded its family of XLamp XR-C high-power LEDs to include the full range of colors.

Standard flux order codes at 350mA are available up to: 350mW in royal blue, 23.5lm in blue, 67.2lm in green, and 51.7lm in amber, red-orange and red.

The XR-C color LEDs feature the same isolated thermal path, low thermal resistance and high reliability as the XR-C family's white LEDs, as well as a smooth upgrade path



Cree's green XLamp XR-C LED.

for customers looking to use the same footprint as XR LED products.

Paul Thieken, director of marketing for lighting LEDs, says that Cree is extending its XLamp LED portfolio with new, higher-performance, lower-price options in the XR family form factor. "Cree enables design flexibility for color LED applications with consistent drive currents and footprints throughout the XLamp XR-C and XR-E LED families," he adds.

www.cree.com/xlamp

Lynk Labs adds Cree to AC LED supplier network

Lynk Labs Inc has added Cree to its AC LED Technology Strategic Supplier Network as a second supplier of LEDs for its AC-driven LED light engines and system solutions, which are designed to provide OEMs with 'bulb and ballast' simplicity for LED-powered luminaires.

Lynk Labs is already partnered with Citizen Electronics to supply Lynk with LEDs for its SnapBrite and XyLite AC LED light engines. XyLite modules deliver flexible X- and Y-dimensional building blocks of light that enable OEMs to accelerate and simplify their product

design strategy for almost any LED lighting application, claims Lynk.

Lynk reckons its AC LED technology can help OEMs deliver products that are 'lighting infrastructure friendly' and better understood by architects, contractors, reps, distributors and end customers.

The firm recently launched its GeoLite linear AC LED system, which uses Cree's XLamp XR-E LED and is encapsulated in a low-profile linear casing that acts as the heat sink. Available in 14", 28" and 42" lengths, GeoLite is sold to OEMs and system integrators for display

case and other linear lighting applications in retail, display and architectural environments.

"Lynk Labs will be working closely and strategically with Cree to develop additional AC LED light engines and system solutions for OEMs and customers" says VP marketing & product development Bob Kottritsch. Integrating Cree's lighting-class LEDs into its AC LED light engines and systems will provide new opportunities for OEMs to reduce time to market and simplify their product offerings, the firm reckons.

www.lynkylabs.com

Cree shipping LR4 recessed LED down-lights in volume

Cree Inc of Durham, NC, USA has started volume shipments of its LR4 four-inch architectural recessed LED down-light for new construction and renovation projects. The LR4 has been specified in a number of significant projects, including corporate campuses, full-service hotels, and global restaurant chains.

"The eco-friendly LR4 lighting system helps create a warm and comfortable environment for our guests while reducing our energy and maintenance cost," says Steve Eckley, VP of operations at

Amerimar Inc, the developer of the Hutton Hotel in Nashville, TN, an early LR4 installation.

The LR4 delivers up to 540 lumens of high-quality light from less than 11W of power and features: a color rendering index (CRI) of up to 94; two available color temperatures — warm white (2,700K) and neutral (3,500K); two available shield angles (15° and 30°); and a dimmable design, including compatibility with Lutron Electronics products.

The LR4 also provides a wide range of application flexibility,

allowing designers to precisely deliver light to surfaces within the visual environment.

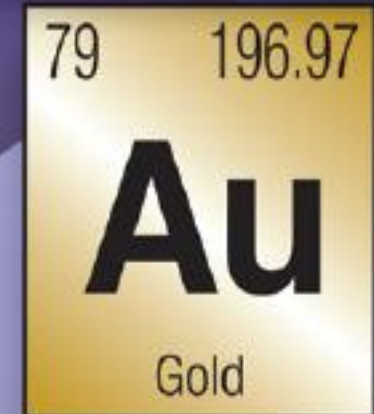
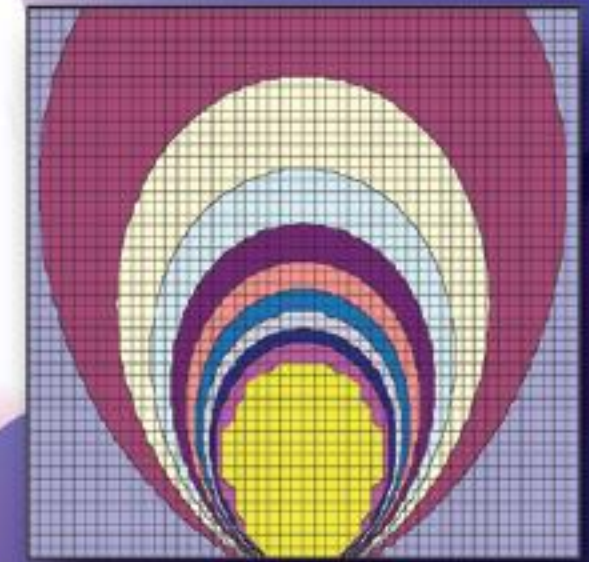
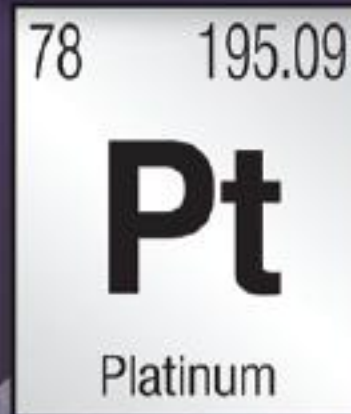
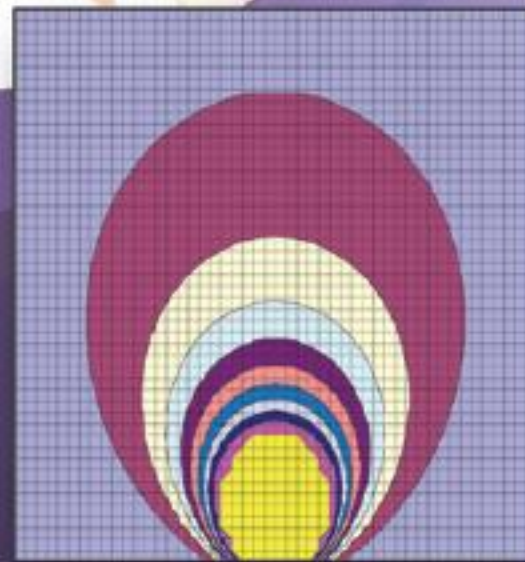
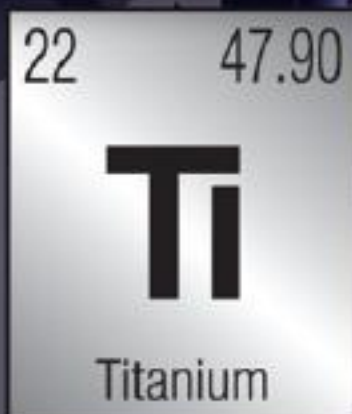
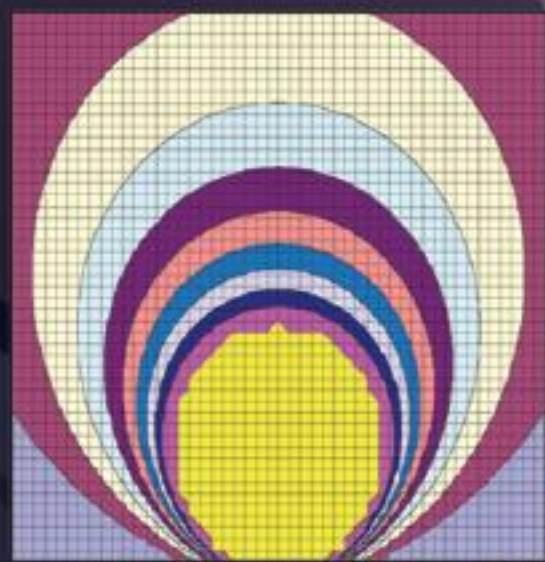
"Cree has demonstrated the LR4 to hundreds of customers throughout the world and the feedback has been exceptionally strong," claims Cree LED Lighting Solutions president Neal Hunter.

Cree demonstrated its full portfolio of LED Lighting Solutions products at Lightfair International in Las Vegas, NV (28–30 May).

www.CreeLLS.com

www.lightfair.com

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Epistar joins Everlight & Seoul in licensing Rothschild patents

LED chip-maker Epistar Corp of Hsinchu Science-based Industrial Park, Taiwan says it has obtained a worldwide license from Dr Gertrude Neumark Rothschild, professor emerita of Materials Science and Engineering at Columbia University, for her US Patents 5,252,499 ('Wide Band-Gap Semiconductors Having Low Bipolar Resistivity and Method of Formation', issued in 1993) and 4,904,618 ('Process for Doping Crystals of Wide Band Gap Semiconductors', issued in 1990), as well as their foreign counterpart patents.

The license agreement follows an investigation instituted on 20 March by the US International Trade Commission based on a complaint ('In the matter of Short-Wave Light Emitting Diodes') filed by Rothschild alleging infringement by 34 firms of patent 5,252,499 (covering a method of producing GaN-based semiconductors for LEDs and laser diodes emitting in the blue, green, violet and ultraviolet end of the spectrum).

The complaint sought to bar importation into the USA of a wide range of consumer electronics products incorporating infringing devices. These include DVD players using Sony's Blu-ray format, Motorola Razr phones and Hitachi camcorders, as well as instrument panels, billboards, traffic lights and data storage devices.

Other firms cited include Blu-ray DVD player makers Matsushita Electric Industrial Co (Panasonic), LG Electronics Inc and Samsung Group, and HD DVD player manufacturer Toshiba Corp, as well as Nokia Corp, Sony Ericsson Mobile, Pioneer, Sanyo Electric Co, and Sharp Electronics.

Customers that have been using or will use LED chips made or to be made by Epistar will be free from any patent infringement assertion

Under the license obtained by Epistar, customers that have been using or will use LED chips made or to be made by Epistar will be free from any patent infringement assertion under the patents.

Last month, licenses were also obtained by LED makers Everlight Electronics Co Ltd of Taipei, Taiwan and Seoul Semiconductor Co Ltd of South Korea.

After previous patent complaints filed elsewhere starting in 2002, LED makers including Germany's Osram Opto Semiconductors and Japan's Nichia and Toyoda Gosei have also previously settled with Rothschild over alleged patent infringement. Also, on 10 March, an action that had been brought before the US District Court for the Southern District of New York by Rothschild was settled by LED maker Philips Lumileds of San Jose, CA, USA, giving the firm a non-exclusive license. A separate case against LED maker Cree Inc of Durham, NC, USA is still pending.

www.epistar.com.tw

Lumileds launches online tools for solid-state lighting design

Philips Lumileds of San Jose, CA, USA has introduced new online tools to simplify development of general lighting and other solutions using its high-power Luxeon LEDs. Joining the existing extensive set of resources, the new Design Resources section of the firm's website includes optical, mechanical and electrical models for Luxeon LEDs that can be downloaded and used in software applications to reduce development time, speed time to market, and deliver the best possible solutions and products.

"Providing resources that support the development of solid-state lighting solutions is an ongoing



Luxeon Rebel LED 3-2 CAD image.

effort that we are fully committed to," says applications manager Rudi Hechfellner. Reliability data and application briefs, along with the Usable Light Tool and QLED Thermal Design and Simulation Software developed by Future Lighting Solutions, are on the firm's web-site.

The model files available now for Luxeon Rebel and Luxeon K2 include 100K, 500K and 5M ray-sets, optical source models, footprint files, 3D-CAD files, PCB layout tool library models to generate printed circuit board layouts, and Spice models for electrical simulations.

The files are available in a variety of formats, including ASCII, Zemax, ASAP, TracePro, LucidShape, Light Tools, IGS, STP, DWG, DXF, OrCad, Eagle, and Spice.

Additional file types will be supported over time.

www.philipslumileds.com/resources/design

Nichia sues Seoul in Japan and UK over white LEDs

At the end of April, Nichia Corp filed a lawsuit in the Tokyo District Court against Japan Seoul Semiconductor Co Ltd (the Japanese subsidiary of Korean LED maker Seoul Semiconductor).

This follows a lawsuit filed in Osaka District Court in May 2007 alleging that Seoul Semiconductor's 0.5 Watt Z-Power LED P9 series white-LED products infringe Nichia's Japanese patents 3511970 and 2778349 relating to GaN-based blue LED chips.

The latest complaint alleges that white LED products sold by Japan Seoul Semiconductor (BW104-S, WH104, WH104-C, TWH104-H, MPW104-F1, WH107, WH201, WH601, WH108-S, WH108, FCW100, FCW100Z, FCW101Z, WH1222) infringe Nichia's Japanese

patent no. 3900144, which relates to the production of a phosphor material and light-emitting devices such as blue LED chips (as well as the combination of them). The patent is applicable to white LEDs used in keypads and indicators. It does not cover side-view LEDs used as light sources in backlighting cell-phone LCD panels, says Nichia.

Nichia is also seeking monetary compensation for damages from past infringement as well as an injunction against any further infringing activity.

The firm says that, to contribute to the promotion of a fair market where intellectual property rights are respected, it will take measures continuously throughout the world against any company that infringes its intellectual property rights.

● In mid-May, Nichia also filed a patent infringement lawsuit in the UK against Seoul Semiconductor and its UK distributor Avnet EMG Ltd seeking injunctive relief and compensation for damages.

The subject of the lawsuit is the Acriche Series white LED product manufactured by Seoul Semiconductor, which Nichia believes infringes its two patents EP(UK) 599224 and 622858.

Nichia also has lawsuits in progress for injunctive relief and compensation for damages against Seoul Semiconductor (including its Japanese and US subsidiaries too in certain cases) in the US for design patent infringement of side-view white LEDs (see story below).

www.seoulsemicon.com

www.nichia.com

US court rejects Nichia's \$2.5m claim for fees vs Seoul

In the design patent infringement litigation between Korea's Seoul Semiconductor Co Ltd and Japan's Nichia Corp regarding side-view LEDs, judge Maxine M. Chesney of the US District Court for the Northern District of California has issued an order denying Nichia's 'Motion for a Finding of Exceptional Case and an Award of Attorney's Fees' filed on 21 February.

Nichia filed the original lawsuit in January 2006 alleging that Seoul Semiconductor's 902 series side-view LEDs (which are mostly used for liquid-crystal display backlight units in mobile phones etc) infringed its US design patents D491,538, D490,784, D499,385 and D503,388. Nichia was pursuing a claim for inducement of infringement that could have led to it being awarded damages of more than \$4m.

On 8 November 2007, the jury rendered a verdict that Seoul Semiconductor had willfully infringed Nichia's design patents. But the court determined that Nichia lacked evidence to prove its inducement claim, limiting damages to its claim

for direct infringement (whereby in 2005 Seoul Semiconductor had made two small sales of the accused products in the USA as samples, resulting in actual damages of \$62). Seoul Semiconductor has made no sales of the accused products in the USA since, and no future sales are likely. Consequently, Nichia was awarded damages of just \$250.

However, a court has discretion to award fees to a prevailing party in a patent case, if the case is 'exceptional'. So, in late December Nichia asserted that it should be awarded \$2.5m in attorney's fees against Seoul.

Chesney has now ruled that the case was not exceptional and that it "would not be appropriate" to award fees to Nichia. She also found that Nichia's motion against Seoul "imposed a significant burden on the jurors' time and the court's resources, not to mention the burden on defendants [Seoul], who expended approximately \$2m in fees and costs after obtaining a dismissal of the only claim of real substance" (when Chesney previously granted Seoul's motion for

summary judgment on Nichia's claim of induced infringement).

Although Nichia asserts that it needed to demonstrate that there is a cost to infringing its patents, and that it had to respond to Seoul's "attempt to take market share in the side-view LED market", such concerns, while perhaps pertinent to Nichia's now-dismissed claim for inducement, are insufficient to explain why the continued prosecution of the remaining claim was a reasonable choice under the circumstances presented, judged Chesney.

Chesney also stated that, to the extent that Nichia, in seeking a jury verdict, may have been attempting to obtain some unstated ancillary advantage over defendants in Asia, Nichia has failed to explain why its use of the US federal court system for a case having nothing of real substance to do with the US is justified, let alone that such an endeavor should be underwritten by Seoul Semiconductor.

www.patracr.com/the_patent_litigation_blo/files/nichia_order_fees.pdf

Modulight wins ESA pump laser development contract

Modulight of Tampere, Finland says it is continuing its close cooperation with the European Space Agency (ESA) by signing a \$1.1m, 2 year contract to develop high-brightness pump laser technology for Earth observation. The project aims to improve the brightness and reliability of high-power laser arrays that are generally used for pumping solid-state lasers in industrial and space applications.

The program is a continuation of efforts to develop lasers in the 800nm bandwidth range for space, defense and industrial markets. "We have already supplied space-qualified communications lasers to ESA for the SMOS mission in 2004 and worked together with ESA on several laser development programs," says president & CEO Dr Petteri Uusimaa.

The latest project aims to produce design and engineering models of space-qualifiable quasi-continuous-wave (QCW) laser arrays that have an output power of more than

200W and are stackable in laser modules of up to 1kW.

"This new contract helps us to further exploit our product offering in space application, and also opens interesting new business opportunities in commercial markets where higher brightness and more reliable pump lasers are continuously needed," says Uusimaa. "Modulight is proud to have the opportunity to improve the competitiveness of Europe in this strategically important technology area."

RangerLase provides up to 20W laser power at 1550nm

Capitalizing on its prior development in infrared lasers, in March Modulight launched the RangerLase family of lasers, operating in the 1530–1570nm band. With output powers between 100mW and 20W and a broad selection of packages, the RangerLase family targets applications needing medium- or high-power infrared beams, such as point-to-point communications, laser range finding and illumination.

The RangerLase family come in various shapes and packages, to suit a wide variety of pulsed and continuous wave applications in the eye-safe spectral region.

The key products are:

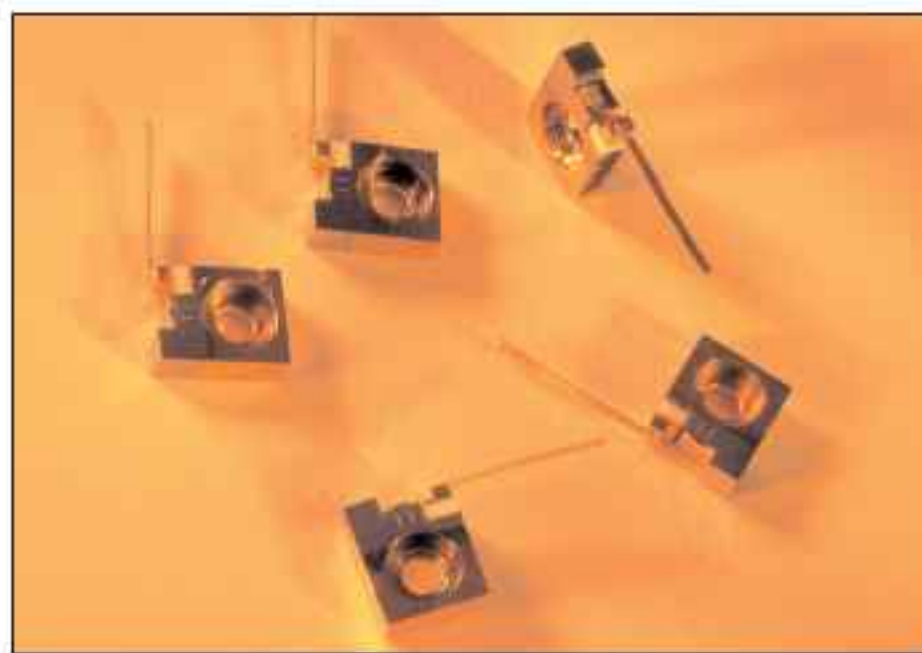
- Laser bar: producing up to 20W of output power and available as unmounted, CS-mounted, or pig-tailed package, the laser bar is the workhorse of high-power applications;
 - Multimode laser: delivering up to 1W of continuous and 4.5W pulsed power and available as an unmounted chip, mounted chip, or 9-mm TO-can, the laser chip suits use as a compact source of high-power infrared light for free-space applications;
 - Single-mode laser: offering 80mW of continuous light in a single-mode beam and available as unmounted chip, mounted chip, or 9-mm TO-can, this product suits applications requiring medium-level power in a small spot or a high-quality beam.
- www.modulight.com

High-power 808nm diodes for green laser pumping

Intense Ltd of Glasgow, Scotland, UK has announced the Series 6020-808 high-power 808nm single-mode laser diodes for green laser pumping.

With high beam quality up to 200mW of output, they provide high brightness with low astigmatism and a Gaussian far field, the firm says. Designed for pumping a variety of solid-state lasers (e.g. vanadate, YLF and Nd:YAG), the new diodes allow OEMs to directly couple their output to the crystal.

Vanadate is used to design green lasers, a key component in manufacturing RGB display sources, handheld picoprojectors, scientific instruments (including interferometers) and precision machining. Diode-pumped green lasers are also used for targeting in defense applications and for spectroscopic applications in the medical field.



Series 6020-808 single-mode lasers.

Part of the Series 6000 family of single-mode lasers, the 6020-808 diodes are based on the firm's patented quantum well intermixing (QWI) technology, which increases the brightness and reliability of laser diodes while avoiding the usual problems associated with catastrophic optical mirror damage, it is claimed. The diodes offer high electrical conversion efficiency at operating temperatures of 25–50°C.

The lasers are available in a selection of free-space packages, including 9mm, C-mount, and TO3. Custom packaging and wavelengths are available on request.

"The Series 6020-808 single-mode laser pumps provide OEMs with the optical tools they need to develop products with lower costs, higher efficiencies, and longer lifetimes," says Kevin Laughlin, VP HPL global business development.

"The Series 6020 allows OEMs to design products with powerful yet significantly less complex optical systems. Reduced component counts mean lower system costs," he adds. "These QWI-enabled Series 6020 also provide higher conversion efficiencies and longer lifetimes, especially when compared to higher-power multimode devices."

www.intenseco.com

QPC product revenue & gross margin more than double year-on-year

For Q1/2008, QPC Lasers Inc of Sylmar, CA, USA has reported revenue of \$1.6m, up 49% on \$1.1m a year ago (the 10th sequential quarter of year-on-year growth in what is historically the firm's softest quarter). This included product revenue of \$1.4m, up 114% on a year ago due to expanded product offerings including Generation III products, the firm's recent entry into the consumer electronics market, and continued strength in the medical market.

This is evidence that QPC's business opportunities in all four of the firm's target markets (aerospace/defense, consumer electronics, medical and industrial) are stronger than ever and growing, says co-founder and chief financial officer George Lintz.

"We were particularly encouraged by our product revenue growth, new Gen III orders [worth \$1.3m] for our medical lasers, and by tremendous new interest in our visible laser technology by consumer electronics manufacturers from around the world," says chairman and CEO Dr Jeffrey Ungar. During the quarter, QPC also shipped a high-power laser to a US Department of Defense customer for airborne directed energy weapon applications, and a 300W miniaturized Ultra BrightLock Laser to a US government prime contractor.

"To better capitalize on our high-growth target markets, we strengthened our global sales and marketing teams, adding key members in Europe, Asia and the US to help us to expand our international distribution channels and meet growing customer demands," Ungar says. QPC now has over 100 customers in 20 countries. "We are committed to increasing our worldwide customer base, our presence in our vertical markets and our revenues," adds Lintz.

Operating loss has risen from \$2m a year ago to \$3.3m, due to greater R&D spending for Generation III and consumer electronics developments. However, gross margin has more than doubled from 23% a year ago to 48%, due mainly to product revenue growth (specifically the higher-margin Generation III products) resulting in improved efficiencies as a result of allocating fixed costs over a higher number of units sold.

"We are very encouraged by the increasing interest in our Generation III lasers and we are committed to continued advancements of this product line," says Lintz. "We remain focused on our long-term goal of overall top-line growth and are currently targeting cash flow positive in 2009," he concludes.

www.QPCLasers.com

Mini RGB laser demoed for portable projector displays

At May's Society of Information (SID) Display Week 2008 in Los Angeles, QPC gave invitation-only demonstrations of its prototype BrightLase red-green-blue (RGB) laser, which is designed for high-resolution miniature projectors with output in the 100 lumen range for portable handheld consumer electronics.

The fully integrated RGB laser offers an expanded color gamut, low power consumption, an ultra-compact footprint, and is designed for low-cost high-volume manufacture, says the firm. QPC offers visible laser technologies designed to be compatible with the micro-display technology including LCOS, scanning micro-mirrors, DLP and LCD.

"Advances in electronics technology provide hand-held consumer products such as PDAs with incredible computing and communications power," says CEO Jeffrey Ungar. "The small size and poor resolution of typical 2" display screens makes their use for applications such as Internet browsing, games and video sharing a frustrating experience. Mating consumer electronics with powerful projectors powered by compact, powerful RGB lasers offers a way around this bottleneck." QPC reckons the brightness, efficiency, compactness and low cost of its BrightLase technology can provide advantages in displays for PDAs, games, laptops, automobiles, and aircraft.

Consumer electronics drive capacity expansion

QPC plans to expand its facilities to meet growing production needs.

"As we endeavor to compete in higher-volume markets such as consumer electronics, we will require additional manufacturing and cleanroom space to meet increased production requirements," says chief financial officer George Lintz. "Manufacturing capacity is crucial to meeting and growing customer orders and thus is an

operational necessity we must proactively address. The ability to deliver in volume and on-time is an important underlying requirement to maintaining and growing long fruitful relationships with new and current customers alike."

To fund the build out, higher-powered additions to the Gen III product line and other corporate marketing and administrative needs, QPC has issued \$2.2m of debentures

that have a term of three years, pay 10% interest, and are convertible into common stock at \$1.05 (a premium on the current price). QPC has also issued five-year purchase warrants exercisable at \$1.05. The securities were privately placed with a mix of institutional and accredited investors.

The debentures were sold at a 10% discount to their principal amount, generating \$1.99m gross.

IPG overcomes diode laser production yield issues

For Q1/2008, IPG Photonics Corp of Oxford, MA, USA, which makes high-power fiber lasers and amplifiers, has reported revenue of \$52.9m (up 27% on \$41.8m a year ago), driven by sales of fiber lasers for materials processing applications (up 34% to \$44.2m) and strong sales to Europe and Asia. In particular, pulsed laser sales grew 73% year-on-year, driven by demand from marking and solar markets.

"Strong shipments in the European Union and continued expansion into the high-growth markets of Russia, India, China and South Korea more than offset the softness we experienced in the US, which accounts for only 18% of our sales," says CEO Dr Valentin Gapontsev.

Operating expenses grew from \$8.3m a year ago to \$11.9m (mainly due to sales and marketing expenses growing from \$1.9m to \$3.1m). Nevertheless, net income has grown from \$ 6.6m to \$8.1m.

"The growing acceptance of fiber lasers across a variety of applications, combined with our presence in the major markets for industrial lasers across the globe, resulted in another quarter of strong top- and bottom-line growth," says Gapontsev.

Gross margin has grown from 43% last quarter to 46%, due to higher absorption of fixed costs as a result of improved yields and increased production, part of which resulted in an increase in inventories. "We have overcome the production issues which impacted diode yields in the fourth quarter of 2007," adds Gapontsev.

IPG has been expanding production of its GaAs-based laser diodes using two GEN200 MBE cluster tools (in 4x4"-wafer configuration) ordered from Veeco Instruments in March 2007 (joining a GEN200 bought in 2006). The laser diodes were developed for use in IPG's

industrial fiber lasers, but the firm also started selling the PLD Series of fiber-coupled pulsed laser diodes (with an output power of over 20W) on a merchant basis to original equipment manufacturer (OEM) customers in January. The expansion is due for completion in Q3/2008.

"In international markets, we continue to see robust growth from existing OEMs, new customers and our presence in key high-growth Asian markets," says Gapontsev. "In the US and elsewhere, we are seeing substantially increased order flow in materials processing and telecommunications from the beginning of the year," he adds. Some of these orders will ship in the second quarter and the remainder is expected to ship during the following six to nine months."

For Q2/2008, IPG expects revenues of \$52-56m (up 23% year-on-year).

www.ipgphotonics.com

Bookham adds two new board members

Optical component, module and subsystem maker Bookham Inc of San Jose, CA, USA says that Dr Bernard Couillaud and Edward (Ted) Collins have been elected to its board of directors.

"Bernard and Ted have a wealth of experience in their respective industries," says chairman Peter Bordui. "Bernard has unparalleled background in the industrial laser market through his leadership experience at Coherent. Ted's broad legal background, along with his private equity expertise and knowledge of the China market, strengthens our capabilities in these important areas," he adds.

Couillaud has more than 25 years of executive level experience, mostly with laser manufacturer Coherent

Inc of Santa Clara, CA, where he was president and CEO until 2002 and chairman from October 2002 to June 2007, as well as chairman of the supervisory board of German public company Lambda Physik AG from 2000 to 2005. During his academic career in physics and laser technology, Couillaud was a full professor at the University of Bordeaux and a CNRS Fellow. He is also a member of the French National Academy of Technology.

Collins has extensive investment banking, management and legal experience. He is managing director and a partner at ChinaVest, where he is involved in private equity investments in China. He is also chairman of the California Bank of Commerce, director and

audit committee chairman of the Taiwan Greater China Fund, and a director of MedioStream of Los Altos, CA. Previously, Collins was a partner at law firm McCutchen, Doyle, Brown, & Enersen, responsible for the Greater China practice. He has served as counsel to investment groups, banks, and manufacturing firms in Hong Kong and Taiwan, and has been a member of the State Bars of California and Texas.

"I look forward to their contributions as we transition Bookham to reach positive cash flow from operations before the end of the calendar year and guide the company to consistent and profitable growth," says president & CEO Alain Couder.

www.bookham.com

Opnext rebounds from last-quarter dip

For its fiscal Q4/2008 (to end-March), optical module and component maker Opnext Inc of Eatontown, NJ, USA has reported revenue of \$72.7m, up 9.5% on last quarter's \$66.4m (when vendor quality and production problems limited shipment of 40Gb/s products) and up 11.2% on \$65.4m a year ago. The rise is due mainly to increased sales of 40Gb/s, X2, 300-pin tunable, and SFP and XFP data products, but was partially offset by lower demand for 300-pin fixed-wavelength modules.

Sales of 10Gb/s and above products grew 11.3% to \$60.1m, while sales of less than 10Gb/s products grew 9.3% to \$8.2m, and sales of industrial and commercial products fell 10.2% to \$4.4m.

Sales to Cisco rose to 45.7% of total sales (from 37.7% last quarter), while sales to Alcatel-Lucent fell from 19.9% to 14.3%.

Gross margin has fallen slightly from 33.9% a year ago to 32.9%, due mainly to increased sales of lower-margin SFP and 10Gb/s multi-mode fiber data products and the negative effect of foreign currency exchange fluctuations.

Operating loss (including \$1m of stock-based compensation expense) was \$0.8m, compared to operating income of \$1.8m last quarter, due mainly to higher R&D and marketing communication expenses, costs incurred to amend previously filed financial statements, non-cash charges related to the disposal of certain obsolete fixed assets and the negative effects of foreign currency exchange fluctuations. Consequently, net income has fallen from \$4.3m to \$0.9m.

"Following the bumps in the road encountered in the December quarter [for which revenue was down 13.3% on the September quarter's \$76.6m] we're particularly glad to be back on our growth plan," says president

and CEO Harry Bosco. This capped a strong fiscal 2008, as revenue rose 27% from fiscal 2007's \$222.9m to \$283.5m and net income grew from \$0.7m to \$17m.

"Deployment of broadband applications continues to drive demand for our products," says Bosco. In particular, sales of 40G products rebounded, and demand continues to build across Opnext's customer base (leading to the firm recently committing to expand manufacturing capacity).

While sales to main customer Cisco remained strong and well balanced across product lines, Opnext continues to increase its design wins with customers such as Huawei, Ericsson, and Nortel. Also, a pick-up in spending by certain Japanese customers suggests that telecom builds are progressing.

"We are encouraged by the market opportunities that we have before us as we broaden our product lines to address new markets in the highest-growth market segments," says Bosco. "We believe the 10G and above market segment should continue to grow faster than the overall market," he adds.

"However, there continues to be limited visibility in short-term customer demand, lumpiness in customer spending patterns, and uncertainty related to the broader economic downturn. For these reasons we believe it is prudent to remain cautiously optimistic for the upcoming June quarter, just as we were entering the March quarter."

For fiscal Q1/2009 (to end-June), Opnext expects a rise in revenue to \$74-77m. "For fiscal year 2009, we are well-positioned to continue our growth in the 10G and 40G markets, while expanding our 40G portfolio to address broader network applications," concludes Bosco.

www.opnext.com

IN BRIEF

Firecomms licenses OptoLock to APAC

Firecomms of Cork, Ireland has licensed its OptoLock interconnect technology to Taiwan's APAC Opto Electronics Inc, which makes fiber-optic transmission components for local-area networks, wide-area networks, storage-area networks, metropolitan-area networks and access networks.

An easy-to-use, low-cost housing for instant termination of bare plastic optical fiber (POF), OptoLock provides plugless terminations that allow for simpler, quicker connections of communications and infotainment network devices.

OptoLock can be used in Fast Ethernet ports directly, as it is fully compatible with the IEEE 802.3u Fast Ethernet data communications standard. The resonant-cavity LED operates at 660 ± 10 nm peak wavelength. The device is mechanically and electrically interchangeable with SMI (small media interface) connectors also enabled by Firecomms EDL300 transceivers.

"With the rapid adoption of OptoLock by an increasing number of equipment providers, we are happy to license our technology to APAC Opto Electronics Inc, a company that has been supplying transceivers to optical equipment companies worldwide since 1998," says Niall Keegan, general manager Asia Pacific. "APAC, like all suppliers of OptoLock products, will make product based on a common optical and electrical specification, footprint, and fiber interface."

"By combining Firecomms' technology with APAC's manufacturing expertise on OE transceivers, we are able to provide low-cost and short-lead-time products for POF networks," says APAC's president Hank Hung. "Our POF transceivers are currently ready for market, as we have been a licensee for OptoLock since late 2007."

www.firecomms.com

JDSU's margins hit by supply and capacity constraints

For its fiscal Q3/2008 (ended 29 March), JDSU of Milpitas, CA, USA has reported revenue of \$384.2m (44% Test & Measurement, 35% Optical Communications, 15% Advanced Optical Technologies, 6% Laser). This is down 3.8% on the prior quarter but up 6.2% on a year ago (driven by the Optical Communications and Advanced Optical Technologies segments). This has also contributed to year-to-date fiscal 2008 revenues of \$1.14bn being up 9% year-on-year.

Quarterly revenue was at the low end of the guidance range, due mainly to several large customers (service providers in North America and Europe) postponing orders in the Test & Measurement segment, for which revenue was \$169.3m, down 14.3% on the prior quarter's \$197.5m and up just 1.1% on a year ago.

In contrast, Optical Communications revenue was \$136.1m, up 4.9% on the prior quarter's \$129.7m and by 9.6% on \$124.2m a year ago, due to strength in telecoms (compensating for some softness in enterprise and datacoms).

In addition, Advanced Optical Technologies segment revenue was \$55.8m, up 12% on the prior quarter's \$49.8m (driven mainly by the ABNH acquisition, which closed in mid-February) and up 22.4% on \$45.6m a year ago (of which organic growth was 11.6%).

Commercial Laser segment revenue was \$23m, up 3.6% on the prior quarter but down 6.5% on \$24.6m a year ago.

The Americas represented 52% of total revenues, Europe 29% and Asia-Pacific 19%, showing "strong geographic diversity".

Gross margin was 42.6%, down from 46.2% the prior quarter. In particular, Optical Communications gross margin

was negatively affected by product mix due to:

average selling prices (ASPs) declining by more than the historical range of 2-4% per quarter (although a rebound is expected in fiscal Q4); increased demand from customers inducing supply constraints from several vendors as well as inhouse manufacturing capacity constraints; and a decrease in the mix of products manufactured inhouse.

On a non-GAAP basis, net income has risen from \$12.3m a year ago to \$31.2m. On a GAAP basis, net loss has been cut from \$14.2m a year ago to \$6.2m. JDSU was free cash flow positive for the fifth

Gross margin was negatively affected by... increased demand from customers inducing supply constraints from several vendors

consecutive quarter, generating about \$31m (aided by inventory reductions as a result of the firm's lean manufacturing initiative).

"We continue to see favorable end-market indicators for broadband services and network build out and we believe broadband capacity will continue to expand as higher data rates are delivered to the access edge, accompanied by video applications and high-definition network requirement," says president and CEO Kevin Kennedy.

Fiscal Q3 was the fourth consecutive quarter of increased bookings in Optical Communications. In particular, JDSU experienced continued strong order growth in the telecom segment, especially in reconfigurable optical add-drop multiplexers (ROADMs) and optical amplifiers in the transport sector, tunables and SFP+ and vertical-cavity surface-emitting lasers (VCSELs) in the transmission sector, and undersea communications in the photonics sector.

Overall, for its fiscal Q4/2008 (ending 28 June), JDSU expects revenue to be flat to slightly up, at \$381-403m.

For the optical communications market, JDSU continues to believe that the annual long-term growth potential is 5-15%, fuelled by the transition of telecoms to DWDM meshed architectures, concludes Kennedy.

JDSU announces \$200m stock repurchase program

The board of directors of JDSU has authorized a program to repurchase up to \$200m of common stock through open market or private transactions during a two-year period ending 14 May 2010. Timing of repurchases and the number of shares repurchased

will depend upon business and financial market conditions.

JDSU has reported five sequential quarters of positive free cash flow and currently has about \$1bn of cash on its balance sheet. Also, the firm is receiving more than \$60m in relation to a legal settle-

ment announced last quarter. "Based on these factors and current financial market conditions, the board has concluded that a stock repurchase program is appropriate," says CEO Kevin Kennedy.

www.jdsu.com

Bookham's tunable product growth hits constraints

For its fiscal Q3/2008 (ended 29 March), optical component, module and subsystem maker Bookham Inc of San Jose, CA, USA has reported revenue of \$59.7m, up 33% on \$45m a year ago and up 1% on last quarter's \$59m (compared to a fall from the December to March quarters the previous two years).

Of total revenue, the telecom division accounted for 73% (\$43.9m), including 13% each from Nortel and Huawei.

"Increased revenue came mostly from strategic products that are important to our long-term success. These include tunable products, 980nm pumps, and high-power lasers," says CEO Alain Couder.

"Tunables are turning into one of our chief products," he adds. After sequential growth of 66% in fiscal Q2/08, tunable product revenue grew 75% in Q3, to 16% of total revenue (from just 2% a year ago and 9% in Q2). "We are clearly gaining market share," Couder believes.

Revenue for 980nm pumps grew 8% on last quarter and 24% year-on-year. In February, Bookham shipped its 500,000th pump (the firm believes it is the leader in the number of pumps shipped to date). With just one other big competitor (JDSU), margins are good, says Couder. Bookham continues to ship pumps to Tyco, but has also started to ship to two more customers.

Revenue for non-telecom products (including high-power lasers) rose 11% sequentially and 22% year-on-year. Gross margins ranged from 24% to 40% (above the company average). "This is an area we want to build out, as it provides margin stability," says Couder.

Excluding stock compensation of \$380,000, overall non-GAAP gross margin was 23%, up from 11% a year ago but down slightly from 24% last quarter (due to increased

sales of new products with lower margins). Net loss of \$3.4m is down from \$18.7m a year ago but up from \$1.1m last quarter. Adjusted EBITDA was -\$1.1m, an improvement on -14.1m a year ago (though down from +\$0.3m last quarter).

"The year-over-year financial improvement is very significant and the result of the initiatives implemented last year to increase revenue and lower costs," says Couder. Cost-reduction measures have yielded about \$9m in quarterly infrastructure savings from the levels of the December 2006 quarter and have reduced product costs.

However, Bookham expects a slowdown in revenue growth of tunable products as a result of supply and capacity constraint in back-end processing (not the front-end fab in Caswell, UK, which has moved successfully from 2" to 3" InP wafer processing). Also, over the last few quarters, improvements in gross margin have leveled off as revenue growth (in tunables) has moderated and overhead reductions have been completed, adds CFO Steve Abely.

For its fiscal Q4/2008 (ending 28 June), excluding restructuring and other non-recurring charges, Bookham expects relatively flat revenue of \$58-63m, non-GAAP gross margin of 21-25%, and adjusted EBITDA of -\$3m to +\$1m.

However, Bookham expects to resolve the constraints on tunables and resume rapid growth in the September quarter. "Plans to reduce product cost [for tunables]

are fully in place, and will deliver improvements by the September quarter, when the tunables' margin will no longer be a drag on the average total telecom margin." Margin for tunable products is expected to rise by 20 percentage points over the next two quarters.

"Our outlook for the remainder of calendar 2008 is positive," Couder says. "We continue to see increasing demand for our newer telecom products, and we are reducing our non-telecom product manufacturing overheads through leveraging our low-cost Shenzhen manufacturing facility [in China]." Bookham is building up R&D in Shenzhen to focus on quality and manufacturing cost improvements. "Major innovation will come from chips and packaging and lead to breakthroughs in cost reduction over the next 2-3 years," reckons Couder.

Bookham is transferring most of the photonics tools and solutions manufacturing done in San Jose to Shenzhen over the next six months, saving \$3-4m per year (recording about \$1m in restructuring charges and incurring \$1m in manufacturing overhead costs, spread over the next two to three quarters).

For all products, Bookham is also shifting more raw material sourcing to Far East suppliers (expecting 40% to come from lower-cost sources by the end of 2008).

"These cost improvements should translate into better margin results," reckons Couder. Abely targets gross margin approaching 30% overall in the December quarter.

Continued revenue growth, margin improvement on new products, and overhead cost management during second-half 2008 should result in a transition to positive cash flow from operations (at quarterly revenue of \$65m) by the end of 2008.

www.bookham.com

Bookham expects a slowdown in revenue growth of tunable products as a result of supply and capacity constraint in back-end processing

Oplink hit by dip in ROADM and European sales

For its fiscal Q3/2008 (to end March), photonic component, module and subsystem maker Oplink Communications Inc of Fremont, CA, USA has reported revenue of \$40.8m, up 47.8% on \$27.6m a year ago (which did not include results from subsidiary Optical Communication Products Inc, acquired at the end of October) but down 17% on last quarter's \$48.9m. This is slightly higher than the revised guidance of \$39–40m (given in late March) but lower than the previous guidance of \$41–45m (provided at the end of January).

The sequential decline in revenue is due to reduced sales of reconfigurable optical add-drop multiplexers (ROADMs), softness in orders from Europe, and the transfer of OCP's

manufacturing to China (where Oplink has facilities in Zhuhai and Shanghai).

Net loss was \$3.9m, compared to net income of \$4.3m a year ago. Excluding one-time charges including \$6.4m in provision for excess and obsolete inventory and \$547,000 in transitional costs for contract manufacturing, non-GAAP net income was \$2.5m, down on \$5.3m a year ago.

"We continued to make significant progress transitioning OCP's business to Oplink's model," says president and CEO Joe Liu. During the quarter, Oplink completed its sale of OCP's facility at Woodland Hills, CA, USA and sold the wafer fab equipment from OCP Asia in Taiwan, contributing \$26.2m to cash,

cash equivalents and investments rising from \$117.3m to \$138.3m. "Transferring OCP's production to China and other measures we have taken to reduce OCP's cost structure contributed to our sequentially higher gross margins."

Reduced ROADM sales, softness in orders from Europe, and the transfer of OCP's manufacturing to China will continue to affect revenue in fiscal Q4/2008 (to end June), believes Liu. Oplink expects revenue to fall again to \$33–37m. "However, we remain optimistic about our broader product portfolio and long-term opportunities once we complete the transition and release new product designs in the coming quarters," he adds.

www.oplink.com

Oplink appoints president and general counsel

Oplink has appointed Thomas P. Keegan as president and Stephen M. Welles as VP and general counsel.

Keegan, who has been VP business development and general counsel for the past year, will be responsible for business development and worldwide operations, completing the integration of subsidiary Optical Communication Products Inc (acquired at the end of October), and complementing the role of CEO Joe Liu.

Before joining Oplink, Keegan had 18 years of experience as a private practice attorney in California and Taipei, Taiwan.

"Over the past year, Tom has been a key contributor to our acquisition and integration of OCP and has been an integral part of our senior management team at Oplink," says CEO Joe Liu. "Tom's breadth of experience across industries and transactions has contributed to our management expertise at Oplink."

Welles brings with him more than a decade of technology law experience with leading law firms, most recently with Wilson Sonsini Goodrich & Rosati in Palo Alto, CA and previously with Ropes & Gray in Boston.

"He [Welles] has also been an integral part of our progress over the past few years, having advised us as our external counsel," says Liu. "Stephen's legal perspective and capabilities will be a key addition to our senior management."

Avanex grows profits despite falling revenues

For its fiscal Q3/2008 (to end March), optical communications component and module maker Avanex Corp of Fremont, CA, USA has reported revenue of \$49.6m, down 5% on \$52m last quarter and 10% on \$55.1m a year ago.

Gross margin was 32%, up on 31% last quarter and 19% a year ago.

Net income was \$3.3m, compared with \$86,000 last quarter and a net loss of \$6.7m a year ago.

"We saw significant strength in design wins, illustrating the success of our new products," says Avanex's president and CEO Jo Major.

"With our strong operating model, we are well positioned for profitable

growth as we capitalize on our expanding market opportunities," he adds.

For fiscal fourth-quarter 2008 (to end June), Avanex expects revenue to rebound to \$50–53m, with gross margin flat to slightly down, at 29–32%.

www.avanex.com

Finisar and Optium to merge

Finisar Corp of Sunnyvale, CA and Optium Corp of Horsham, PA have agreed to merge, creating what is claimed to be the world's largest supplier of optical components, modules and subsystems (with the broadest product portfolio) in the communications industry.

The combined company will leverage Finisar's position in the storage and data networking market and Optium's position in the telecoms and CATV industries.

"Optium has strong product technologies addressing some of the fastest-growth markets in our industry," says Finisar's chairman, president and CEO Jerry Rawls. Optium designs and manufactures optical subsystems supporting core to the edge applications for use in telecoms and cable TV network systems. Its optical transport solutions features fixed and wavelength-agile 10Gb/s and 40Gb/s transceivers and subsystems, 10Gb/s pluggable transceivers, cable TV trunking and distribution subsystems and Optium's next-generation wavelength-selectable switch reconfigurable optical add/drop multiplexer (WSS ROADM) product line. The firm also has offices in Sydney, Australia (from the acquisition of WSS module maker Engana Pty Ltd in March 2006) and Nes Ziona, Israel (from the acquisition of 40Gb/s transceiver maker Kailight Photonics Inc in May 2007).

Finisar manufactures fiber-optic components and subsystems as well as network test and monitoring systems. Applications include high-speed data communications for networking and storage applications over Gigabit Ethernet local-area networks (LANs), Fiber Channel storage-area networks (SANs), and metropolitan-area networks (MANs) using Fiber Channel, IP, SAS, SATA and SONET/SDH.

The firms reckon the merger should broaden core customer relationships with complementary product portfolios; enhance global

manufacturing flexibility (combining low-cost/high-volume and mass customization expertise); create unparalleled combined R&D resources with enhanced ability to innovate and bring new products to market; and generate new growth opportunities in attractive end-markets.

"This combination leverages the unique strengths of both companies," says Optium's chairman and CEO Eitan Gertel.

"In combining with Finisar, we will unleash a powerful opportunity to create added shareholder value through

breadth of product, enhanced customer support and manufacturing flexibility," he adds. "With little product overlap, the proposed combination will complement both companies by providing more choice for customers, best-in-class technologies, focused technology innovation and cost efficiencies to meet our customers' requirements," Gertel reckons.

Together, the combined company will offer the broadest portfolio of optical communications products to equipment manufacturers, it is claimed. As a result of having complementary product portfolios with substantial cross-selling opportunities, the merger is expected to generate revenue synergies.

Based on the 12 months through January 2008 reported by each firm, the combined firm had revenues of about \$554m. Also, for their most recent quarters, both firms expect to report record revenues. For its fiscal Q4/2008 (to end April), Finisar expects its revenues to be a record of about \$120m (to be announced on 12 June). For its fiscal Q3/2008 (ended 2 May), Optium expects its revenues to be a record of about \$45m (to be announced on 5 June).

Based on these estimates, annualized revenues for the combined firm should total about \$660m.

"Given the scale required to be competitive in meeting global customer needs, consolidation in the optical space is long overdue," says Rawls. "Optium's fabless manufacturing model will allow us to more readily capture the benefits of scale, while maintaining effective resources to serve customized technology requirements," Rawls says. Finisar has over 4500 staff and Optium 400 or so, therefore combined staffing will approach 5000. Economies of scale associated with a larger purchasing base, rationalization of the combined infrastructure, and manufacturing flexibility driven by Finisar's vertical integration and Optium's highly automated in-house manufacturing capabilities are all expected to contribute to annualized pre-tax cost synergies of \$10-15m, with most expected on a run-rate basis one year after closing the transaction. The transaction should then be accretive to earnings per share on a non-GAAP basis.

Under the terms of the agreement (approved by the boards of both firms), Optium stockholders will receive 6.262 Finisar shares for each Optium share. Finisar is expected to issue about 160m common shares. Upon completion (expected in Q3/2008), Finisar shareholders will own 65% of the combined firm and Optium shareholders 35% (with shares continuing to trade on the NASDAQ Select Market under the symbol FNSR).

Also, Finisar's board of directors will be reconstituted to include three new directors who are currently members of Optium's board. Finisar's chairman, president & CEO Jerry Rawls will remain as executive chairman of Finisar's board. Optium's chairman, president & CEO Eitan Gertel will become Finisar's president & CEO and will join the board, along with Morgan Jones and Chris Crespi.

www.Finisar.com

Given the scale required to be competitive in meeting global customer needs, consolidation in the optical space is long overdue

CPV sales boost Emcore, but start-up costs widen losses

For its fiscal Q2/2008 (to end March), Emcore Corp of Albuquerque, NM, USA has reported revenue of \$56.3m, up 20% on \$46.9m last quarter and 42% on \$39.6m a year ago.

Fiber Optics revenue was \$37.6m, up 11% on \$34m last quarter. The rise was due to a significant boost from datacom products (particularly parallel optics) as well as the acquisition in late February of the telecom-related assets of Intel's Optical Platform Division (including tunable lasers, tunable transponders, 300-pin transponders, and integrated tunable laser assemblies), which has since performed better than expected.

Photovoltaics revenue was \$18.6m, up 44% on \$12.9m last quarter, due mainly to new product launches driving concentrator photovoltaic (CPV) component and system revenue up ten-fold to \$4.4m.

"This quarter represents the first significant revenue from this new line of business [terrestrial solar]," says Dr Hong Q. Hou, Emcore's CEO. After investing \$9.6m in CPV manufacturing equipment over the last year, PV GaAs fab capacity rose 35% during the quarter (to support over 250MW of annual terrestrial business, as well as supporting satellite solar cell business). Revenue also grew for satellite solar cells, from about \$13m last quarter to \$14.2m.

Excluding stock-based compensation expense, Fiber Optics gross margin has grown from 17% a year ago and 24% last quarter to 24.3%, due mainly to the increased revenue, facility consolidation (into Emcore's low-cost plant in China), and lower overhead costs (from restructuring completed last year).

PV gross margin was 22% (up from last quarter's 17%), excluding non-recurring charges of \$6.3m. These included \$2.5m for inventory

write-downs in the satellite PV business due to contaminated wafers from a supplier, \$2.3m in start-up costs for the solar cell receiver line and CPV system manufacturing unit, and \$1.5m for the GaAs fab capacity expansion. Accounting for these charges adjusts Emcore's overall gross margin from 23% down to just 12% (down on 18% a year ago).

Operating expenses have risen \$2.9m on last quarter, including \$1.6m from the acquisition of Intel's telecom-related assets and \$1.3m from terrestrial CPV product and business development.

Net loss has therefore widened from \$13.4m a year ago and \$14.5m last quarter to \$17.5m.

During the quarter, despite the increased shipments (e.g. for CPVs), order backlog rose again, from \$156m to \$158m (\$25m for Fiber Optics and a huge \$133m for PVs: \$41m satellite and \$92m terrestrial).

"Business development in the terrestrial solar power area continues to be very successful," says Hou. "We continue to broaden our customer base and book new orders."

Also, after raising \$100m in a private placement of shares in February to complete the \$75m acquisition of the telecom assets of Intel's Optical Platform Division, in late April Emcore also announced the acquisition of the division's enterprise and storage assets (including XENPAK, X2, SFP, and SFP+ optical transceivers) as well as the Intel Connects Cable (ICC) business for high-performance computing clusters. Representing investment of more than \$1bn by Intel over the last 7 years, the two acquisitions strengthen Emcore's

presence in the fiber-optics component/subsystem and local-area and storage-area network markets, the firm reckons. The enterprise business is being consolidated into the same location as the telecom business in the San Francisco Bay area. Combined staffing is about 100. This is just a third of the staffing level under Intel, which had duplicated manufacturing inhouse for components sourced from Emcore. Incorporating the businesses yields a "tremendous amount of operating leverage" and a more nimble operating model, says Emcore.

"With the added and existing product portfolio, Emcore is poised as a major player in broadband, telecom, enterprise and high-performance computing markets with leading products and technology for sustainable and profitable growth in the future," Hou reckons.

In early April, Emcore's board of directors authorized management to prepare an operational and strategic plan for the previously announced separation of the Fiber Optics and PV businesses into separate corporations. Emcore believes this allows it to maximize the potential of both business segments, says former CEO Reuben F. Richards Jr (who was also elected executive chairman, and succeeded by Hou as CEO). "We will be working closely with investment, accounting and legal advisors over the coming months to develop a structure for this separation that will maximize operating efficiencies as well as maximizing shareholder value," he adds.

The PV division's spin off will be eased by Emcore's agreement (announced at the end of January) with holders of about 97.5% (\$83.3m worth) of its outstanding 5.5% convertible senior subordinated notes (due in 2011) to convert them into about 11.9m shares

This quarter represents the first significant revenue from terrestrial solar

of common stock (at \$7.01 per share). The conversion should also save about \$4.8m annually in interest expense through 2011, which should accelerate Emcore's path to profitability, Richards says.

"Our debt conversion and equity financing activities strengthened our balance sheet and provided enough capital to execute our current business plan," says Hou.

"The business fundamentals remain strong for continued growth," he adds. In response, in addition to the GaAs PV fab's nine existing reactors, a tenth reactor is due for installation imminently and a further two are scheduled, says Hou. Also, after the delayed start-up of Emcore's first automated CPV receiver assembly line in March, CPV revenue is expected to rise dramatically in the June quarter. A second manufacturing line is now in operation and a third should start shipments in June (giving a total monthly capacity of 600,000 units,

or 20MW). A fourth line is being set up in Emcore's facility in China, for production by August (giving a total annual capacity of 300MW).

Correspondingly, Emcore is increasing its revenue guidance for both the June quarter and the rest of fiscal 2008, says Hou. Due to the increase in CPV sales and the Intel acquisitions, for fiscal Q3 (to end June) Emcore expects an operating profit on revenues of \$77-80m (up 75% year-on-year): \$53-55m in Fiber Optics and about \$25m in PVs. The latter includes CPV revenue more than tripling to \$15m, boosted by shipping in high volume to a further three new customers. Satellite PV revenue is expected to fall to about \$10m. However, Emcore is in the final stage of negotiations

A tenth reactor is due for installation imminently and a further two are scheduled

with a 'major aerospace company' for a supply agreement worth \$35m over four years, so the satellite PV business is still 'pretty robust', reckons Hou. In addition, all available GaAs solar cell fab capacity will be used for CPV customers. Currently, about two thirds of the fab capacity is used for satellite business. "It would not break our heart to reduce that percentage," says Hou, explaining that the CPV business has a higher gross margin.

For fiscal Q4 (to end September), Emcore expects net profitability for both the Fiber Optic and PV units on total revenue of \$100m (including \$10-15m from satellite PVs and \$30m from CPVs, with the latter driving gross margin up to 24-25%).

For full-year fiscal 2008, the firm has therefore raised its revenue guidance to \$280-295m, from February's forecast of \$265-285m (which itself had been raised from October's guidance of \$210-230m).

www.emcore.com

Korea's ES orders \$28m of Emcore's CPV receivers

Emcore has entered into a \$28m supply agreement with South Korean concentrator photovoltaic (CPV) system maker ES System Co Ltd for solar cell receivers, for deployment in fully licensed and funded solar farms.

The agreement incorporates an advance deposit to ensure production priority, and will enable the installation of 70MW of solar farms. Production has started, for shipments over the next 24 months, with provisions for accelerated deliveries as well as future purchase options under the same terms.

Emcore recently launched a line of integrated CPV solar cell products optimized for operation at 500-1000x concentration, providing terrestrial systems integrators with a complete photovoltaic solution (since Emcore's CPV receiver can be integrated into existing CPV systems).

"This purchase order further diversifies our growing terrestrial component backlog, which now

exceeds \$110m," says David Danzilio, VP and general manager of Emcore's Photovoltaics Division. "Our second automated receiver assembly line has entered into volume production and we expect to commence shipments from the third receiver line in June," he adds. "Combined with the recently completed CPV solar cell capacity expansion, this assembly capability positions Emcore as the only vertically integrated CPV receiver manufacturer to the global CPV industry," he claims.

"Our long-standing record of low-cost manufacturing and deployment of complex PV systems, including our previous success in the silicon solar power fields, assures our significant contribution in meeting the growing need for affordable renewable energy," reckons ES' chief operating officer James Park.

The Korean Government recently announced an increase in the total installed capacity target from

100MW to 500MW while maintaining the solar power feed-in tariff at 677 won per kw-hr for systems deployed before October, stimulating an acceleration of solar farm installation in the country. ES is responding to robust sales of their solar CPV systems and currently is also procuring Emcore receivers under an existing supply agreement from Green and Gold Energy (GGE) of Adelaide, Australia (in late February, GGE ordered \$39m of Emcore's receiver assemblies for deployment in its SunCube CPV systems through its worldwide licensees).

GGE has recently encouraged direct supply relationships between their major licensees (such as ES) and Emcore. So, all the Emcore solar cell receivers now ordered directly by ES are being integrated into its CPV units at their manufacturing facilities in Gwang-Ju, South Korea. Emcore expects more orders from GGE's licensees under similar terms in the near future.

CPV market up to 6GW by 2020

Over the past six months alone, over \$30bn in investment has been proposed for concentrating solar thermal (CST) and concentrating photovoltaic (CPV) plants to be constructed in the next several years, according to the 145-page report 'Concentrating Solar Power - Technology, Cost, and Markets' from online media firm Greentech Media Inc and The Prometheus Institute for Sustainable Development. Accumulated investment could rise to as much as \$200bn in total for installations through 2020.

"The dawn of large-scale concentrating solar power is here, and the forecasts show very few clouds in the sky," the report reckons.

However, although concentrating solar power (CSP) will remain a growing market (particularly for utility-scale installations), a fore-

cast of through 2020 suggests that, of the 288GW in total projected solar installations, CSP (CST and CPV combined) will make up less than 10% (12GW and 6GW, respectively), with the remaining 90+% going to standard flat-plate PVs and tracking PVs.

The report predicts that CPVs will have the smallest market in 12 years, becoming a 'niche technology' that will do well in applications that need high efficiency in a limited space, for example. For utility-scale applications, CPVs (which includes systems based on both multi-junction III-V cells and silicon-based cells) will have trouble competing with

For utility-scale applications, CPVs will have trouble competing with solar-thermal

solar-thermal, which has the advantage of thermal storage, while in commercial applications standard PV will have lower costs. However, CPV will pick up some business in the 100kW-100MW markets, the report predicts.

"CPV technologies will suffer from slower ramping and scale, but should become competitive at the utility scale within the next decade," the report states.

"CSP has quickly become one of the most heated market segments in all of renewable energy, but its important to step back and understand how it will grow along with the evolution of PV," says Travis Bradford, executive director of the Prometheus Institute.

The CSP report is priced at \$2495.

www.prometheus.org

www.greentechmedia.com

Kopin awarded phase II NASA STTR contract to develop indium nitride quantum dot solar cell technology

Kopin Corp of Taunton, MA, USA, which makes III-V heterojunction bipolar transistor (HBT) epiwafers and CyberDisplay LCDs, has been awarded a \$600,000 solar cell development contract from NASA.

The contract is the second phase of a Small Business Technology Transfer (STTR) program to develop indium nitride (InN)-based quantum-dot solar cell technology. Kopin's partners on the NASA STTR project include groups at Virginia Tech and Magnolia Optical Technologies.

"The goal of this STTR program is to develop high-efficiency solar cells that are resistant to extreme conditions while achieving high solar electric power conversion efficiency," says Dr Roger Welser, Kopin's director of technology and new product development. "The advanced patent-pending solar cell structure incorporating InN-based nanostructures can harness a very large frac-

tion of the solar spectrum while minimizing the effects of high temperatures and high-energy radiation," he adds. "This technology will enable photovoltaic power systems of future NASA space exploration missions to operate in extreme environments with high temperature and radiation exposures."

Quantum-dot nanostructures allow the spectral response and operating voltage of a solar cell to be tailored in ways that are not possible with bulk semiconductor materials, explains the firm. In particular, the wide range of energies accessible to InN-based materials provides unique flexibility in designing quantum-dot solar cell structures.

Phase I of the STTR program demonstrated device-quality InN-based quantum dots exhibiting strong room-temperature photoluminescence, with peak emission

energies ranging from the infrared to the ultraviolet. During phase II, InN-based quantum dots will be embedded within a higher-bandgap GaN barrier material to demonstrate high efficiency and immunity to extreme environments.

"This STTR project is part of Kopin's long-term goal to address the emerging terrestrial renewable energy market by realizing the ultimate objective of high conversion efficiency at low costs," says Dr John C.C. Fan, Kopin's president and CEO. Kopin is currently exploring a number of options for synthesizing high-performance photovoltaic materials. "Ultimately, our approaches can provide pathways for realizing solar cells with power conversion efficiency approaching 60%, well beyond the current state-of-the-art efficiency of 40%," Fan reckons.

www.kopin.com

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II-VI seeks buyer for eV division

II-VI Inc of Saxonburg, PA, USA, which makes laser optic materials, components and electro-optical products, says it has retained Roth Capital Partners to sell its x-ray and gamma-ray radiation sensor division, which trades as eV Products Inc and operates as a business within II-VI's Compound Semiconductor Group (whose Wide Bandgap Materials group makes single-crystal SiC substrates). eV's revenues for the fiscal year to end-June 2007 were \$8.5m.

"II-VI has made significant investments in eV Products during the past 15 years that have enabled eV to become the industry leader in cadmium zinc telluride [CdZnTe] radiation detection systems," claims president and CEO Francis J Kramer. "We believe the time is right for eV Products to be owned by a company which can achieve significant competitive advantages by maximizing the value of eV's differentiated capabilities in medical and homeland security imaging, and in industrial, scientific and space applications."

The firm believes that the sale will enable II-VI to concentrate on its core strengths and focus its efforts on integrating recently acquired businesses (e.g. last October's acquisition — completed in January — of 75% of HighYAG Lasertechnologie GmbH of Stahnsdorf, Germany, which makes fiber-delivered beam transmission systems and processing tools for industrial lasers). "This decision comes after careful and deliberate evaluation of our long-term strategy for creating sustained shareholder value," says Kramer.

Excluding about \$2m from eV (now classified as a discontinued operation), II-VI's revenue for fiscal Q3/2008 (to end-March) was \$81m (up 25% year-on-year). This included \$13m from the Compound Semiconductor Group (up 21%), for which orders were \$26m (up 63%). Total revenue for fiscal Q4 should rise to \$85–88m.

www.ii-vi.com

First Solar hires executive managers

First Solar Inc of Tempe, AZ, USA, which makes thin-film photovoltaic modules based on cadmium telluride (CdTe), has appointed Ken Schultz as executive VP of advanced development, John Carrington as executive VP of global marketing & business development, and Jim Miller as executive VP of product & global supply chain management.

Schultz has led the firm's marketing & business development efforts for more than five years and now, in the newly created position of executive VP of advanced development, will drive innovation and commercialization of new products.

Replacing Schultz as executive VP of global marketing & business development, Carrington will direct First Solar's global sales & marketing function, including targeted expansions in Europe and the launch of First Solar's entry in the USA. He brings extensive global marketing experience from leadership positions with General Electric spanning more than 15 years.

Carrington was most recently general manager and chief marketing officer of General Electric Plastics (recently sold and re-named SABIC Innovative Plastics), where he also served as general manager of automotive marketing in Tokyo, Japan; Pacific marketing director in Tokyo; and commercial director for GE's Noryl resin business in Selkirk, NY, USA.

Miller will oversee product management and supply chain activities including material sourcing, product management, and logistics for product delivery and take-back as part of First Solar's end-of-life module collection and recycling program. Miller has in-depth supply chain and product management experience, most recently at Cisco Systems as VP of Product Operations and as VP of global supply chain management. Previously, he was with Amazon.com as VP of global supply chain. He has also held management positions at Intel, Teledesic and IBM.

● First Solar has also appointed Larry Polizzotto to the new post of VP investor relations, liaising with stockholders and reporting to chief financial officer Jens Meyerhoff.

"The scope of our investor relations requirements has grown significantly since our IPO in November of 2006," says Meyerhoff. "Larry brings 23 years of experience developing investor relations capabilities."

Prior to joining First Solar, Polizzotto gained financial, technology and business experience at IBM and Dell where he held director and senior management roles in investor relations, corporate and strategic planning, finance, and business and technology development.

Previously, in January, First Solar appointed Kathy Weiss as VP of government relations (based in New York and reporting to John Gaffney, executive VP and general counsel) to oversee the development and advocacy of its public policy positions and to manage state and federal affairs activities. The firm aims to expand its advocacy outreach efforts and strengthen relationships with policymakers and the communities it serves, says Gaffney.

Gaffney was also recruited in January, leading First Solar's legal, corporate development, government affairs and corporate communications activities and reporting to CEO Mike Ahearn. Gaffney, a partner at Cravath, Swaine & Moore LLP, had previously been a key advisor to First Solar, including representing it in its \$459m initial public offering.

● For first-quarter 2008, First Solar reported revenue of \$196.9m, down from \$200.8m last quarter but up from \$66.9m a year ago.

Net income was \$46.6m (\$0.57 per share on a fully diluted basis), down from \$62.9m (\$0.77 per share) last quarter but up from \$5m (\$0.07 per share) a year ago.

www.firstsolar.com

Xunlight establishes X26 to commercialize CdTe PVs

Xunlight Corp of Toledo, OH, USA, which develops low-cost and flexible thin-film silicon solar modules, and University of Toledo physics professor Alvin D. Compaan have established Xunlight 26 Solar LLC (X26) to develop and commercialize lightweight and flexible solar cells based on cadmium telluride and other II-VI compound semiconductors.

Compaan, along with Xunlight's president and CEO Dr Xunming Deng and VP of corporate development and strategies Matthew

Longthorne, have been elected to the new firm's board of directors. Longthorne will be president and Compaan chief technology officer.

X26 has received a \$997,000 grant from the State of Ohio under the Alternative Energy Program to continue development of flexible CdTe solar cells. The project will be carried out in collaboration with the University of Toledo and Akron Polymer Systems of Cleveland, OH.

Compaan has more than 20 years of experience in CdTe solar cell

research, leading a PV research program funded by various federal and State of Ohio programs and collaborating with a variety of industries.

"Al [Compaan] and I worked closely together at the University of Toledo in building a strong thin-film photovoltaics research program," said Deng.

Compaan highlights the potential impact of X26 in the building-integrated, flexible PV market.

www.xunlight.com

Xunlight raises \$22m in Series B financing

Xunlight has raised \$22m in a Series B funding round led by Trident Capital and joined by existing investors NGP Energy Technology Partners and Emerald Technology Ventures (which led a \$7m Series A funding round last year to build a roll-to-roll pilot production line). The firm has also received major R&D funding from the US Department of Energy, US Department of Commerce and Ohio Department of Development to develop its products and manufacturing process.

Founded as a spin-off from the University of Toledo, Xunlight commercialized its technology with assistance from the State of Ohio's Third Frontier Project.

The latest proceeds will be used

to build commercial manufacturing capacity for the production of lightweight and flexible thin-film silicon solar modules. "The new investment allows Xunlight to accelerate its commercial manufacturing ramp-up," says Chris Sorrells, managing director of NGP Energy Technology Partners. "The new round of investment will allow the company to build a roll-to-roll production line and produce commercial PV products in high volume," said CEO Dr Xunming Deng.

● Xunlight has boosted its senior management team by appointing Dr Masat Izu as senior VP of engineering and Matthew Longthorne as VP of corporate development and strategies.

Izu has worked in PVs for over 30 years, previously at Energy Conversion Devices Inc. As VP of its machine division, Izu led it to develop a highly automated roll-to-roll amorphous silicon PV manufacturing process. "Masat brings to Xunlight a proven track record of commercializing R&D into large-scale manufacturing", says Deng.

Longthorne will lead business development. "Matt's extensive business experience will be an invaluable addition to our team, since it complements the strong experience of Xunlight's team in technology development and equipment building," says Deng. He will develop relationships with strategic customers, partners and vendors."

General Electric takes stake in Sofradir subsidiary Ulis

At the end of April, Sofradir of Veurey-Voroize, near Grenoble, France, which manufactures cooled infrared (IR) detectors based on mercury cadmium telluride (MCT) for military, space, and commercial applications, said that General Electric Company (GE) was to become a minority shareholder in its subsidiary Ulis. GE has acquired a 15% stake and replaces CEA Valorisation, an equity investor for the French Atomic Energy Agency (Commissariat à l'Énergie Atomique).

Founded in 2002, Ulis develops and manufactures low-cost uncooled long-wave infrared imagers for commercial applications (e.g. building inspection, firefighter equipment, night-vision enhancements for drivers, and industrial maintenance and surveillance). The subsidiary has experienced an average annual growth of 50% since 2002. Sales for 2007 were \$60m, contributing to total Sofradir revenue of €110m (\$165m).

Ulis has a manufacturing facility of

2400m², including 500m² of clean-rooms. The production capacity enables the site to manufacture 100,000 microbolometers per year. Sofradir and Ulis employ 450 staff together.

CEA Valorisation's exit is in accordance with the 2002 shareholder agreement to allow an exit after a five-year period. Sofradir remains the principal shareholder in Ulis, with 85%.

www.sofradir.com

www.ge.com

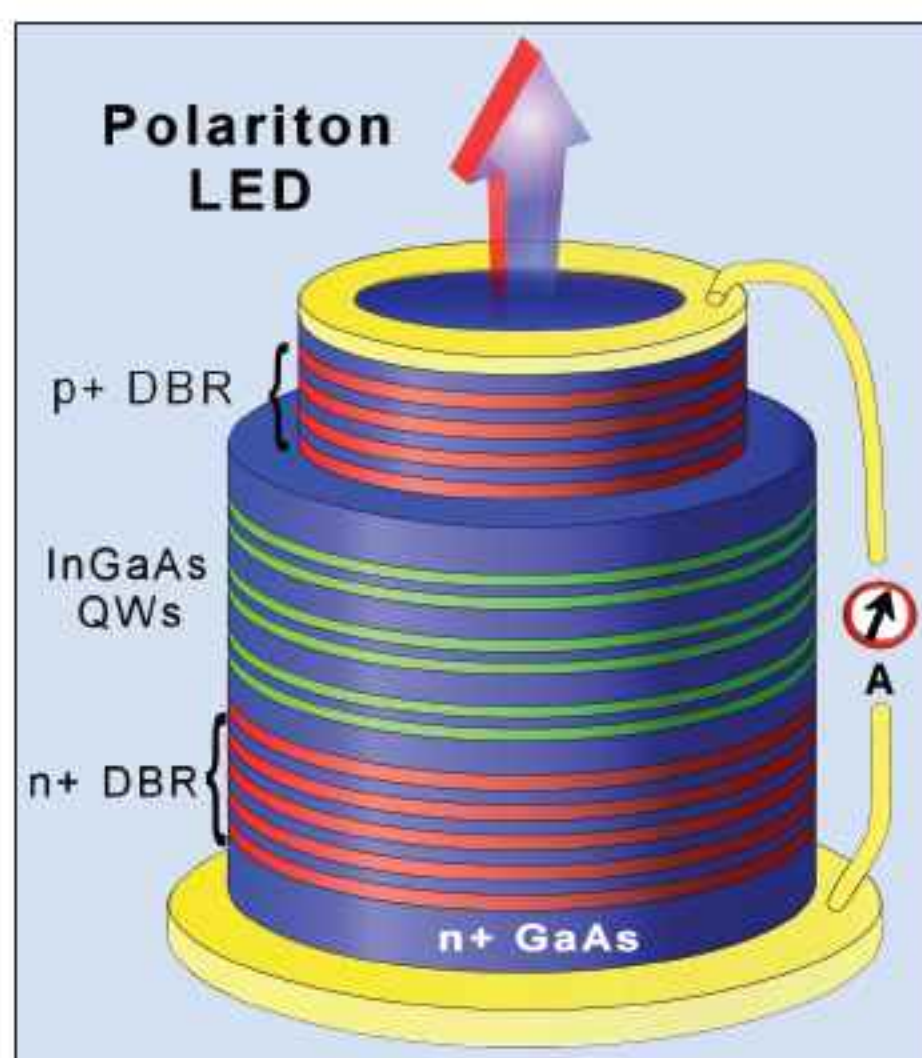
First electrically pumped exciton-polariton light emission

Researchers at the University of Crete have managed to create a light-emitting exciton-polariton device on a GaAs substrate using electrical pumping [Tsintzos et al, *Nature*, p372, 15 May 2008]. Previous reports of polariton emission have been in optically pumped studies. While the operating temperatures of the electrically pumped devices reach up to a slightly chilly 235K (-38°C), this is much higher than the usual temperatures (10–100K) used to manipulate exciton-polaritons in GaAs, bringing into view room-temperature ($\sim 300\text{K}$) devices.

The microcavity LED structure was grown using molecular beam epitaxy, and sandwiches three pairs of InGaAs quantum wells between two GaAs/AlAs distributed Bragg reflectors (DBRs). The ohmic contact to the n-type material is gold-germanium alloy, and to the p-type material a titanium-platinum ring contact is made. The microcavity is five half-wavelengths in length. Measurements were made around the emission energies of 1.33–1.37eV, representing near-infrared wavelengths of around 900–930nm.

Electroluminescence was also measured as a function of angle to further study the polariton relaxation dynamics. This revealed a bottleneck or suppressed relaxation of the lower polariton branch, as commonly seen in such systems.

Some exciton-polariton studies (optical pumping) have been carried out at room temperature in a bulk GaN microcavity [Christopoulos et al, *App. Phys. Lett.*, **98**, 126405, 2007]. However, a GaAs-based system has the attraction of a mature growth technology. Also, the light emitted by these systems is very different: near-infrared for GaAs and visible ($\sim 3.4\text{eV}$, 360nm wavelength) for GaN.



Layer structure of the polariton microcavity LED.

Exciton-polariton states offer a wide range of opportunities for developing new devices that emit laser light more easily (i.e. with lower thresholds, maybe up to two orders of magnitude lower). Some of the effects that may lead to this include stimulated scattering, parametric amplification, Bose-Einstein condensation and superfluidity.

Exciton-polaritons are states resulting from strong coupling of electron-hole bound states, or excitons, with photons. Near where the wavelength and frequency properties of the exciton and photon states would cross without interaction, the coupling combines the states into an 'upper' and 'lower' branch that do not cross (anti-crossing). Continuing away from this point, the lower branch becomes effectively more photonic at long wavelengths and more excitonic at short

Exciton-polariton states offer a wide range of opportunities for developing new devices that emit laser light more easily

wavelengths, while the situation is reversed for the upper branch [for more details and a diagram, see Cooke, *Semiconductor Today*, p42, April 2007]. Other polaritons exist involving other excitations such as phonons and surface plasmons strongly coupled to photons.

Further studies of the University of Crete device suggest that "the present injection scheme is unlikely to yield a polariton laser, owing to inefficient polariton relaxation down the polariton branch".

However, the research could lead to devices with "dramatic enhancement" of spontaneous emission, even compared with resonant-cavity LEDs (RCLEDs). Using this, future polariton-based emitters could have unprecedented quantum efficiencies with ultra-low power consumption, the researchers reckon.

Further, in another configuration, the stimulated emission needed for lasing is encouraged by the extremely low density of states of the polaritons (four orders of magnitude compared with normal laser diodes), potentially lowering lasing thresholds by an order of magnitude.

www.nature.com/nature/journal/v453/n7193/abs/nature06979.htm
www.materials.uoc.gr/materials_en
www.iesl.forth.gr

The author Mike Cooke is a freelance technology journalist who has worked in the semiconductor and advanced technology sectors since 1997.

The research could lead to devices with "dramatic enhancement" of spontaneous emission, even compared with resonant-cavity LEDs

First room-temperature source of coherent terahertz radiation

Led by research associate Mikhail Belkin and professor Federico Capasso of the School of Engineering and Applied Sciences (SEAS), researchers at Harvard University have demonstrated the first room-temperature electrically pumped semiconductor source of coherent terahertz (THz) radiation (Belkin et al, *Applied Physics Letters*, **92**, 201101). Co-authors are Feng Xie and Alexey Belyanin of Texas A&M University's Department of Physics and Milan Fischer, Andreas Wittmann and Jérôme Faist of the Institute of Quantum Electronics at ETH Zürich, Switzerland.

Quantum cascade lasers (QCLs) emitting in the mid-infrared region of the spectrum were first demonstrated by Capasso and his team at Bell Labs in 1994. The compact millimeter-long lasers operate routinely at room temperature with high optical powers and are increasingly used in the commercial sector for a wide range of applications in chemical sensing and trace gas analysis. The devices are variable and tunable, allowing adjustment of the energy levels in the structure.

Extension of the emission wavelength from the mid-infrared to the 'T-ray' terahertz region (30–300 μm) allows the radiation to penetrate efficiently through paper, clothing, cardboard, plastic and many other materials, suiting many applications. A device emitting T-rays could therefore be used to image concealed weapons, detect chemical and biological agents through sealed packages, see tumors without causing any harmful side effects, and spot defects within materials such as cracks in the Space Shuttle's foam insulation.

However, using lasers in the terahertz spectral range (e.g. for imaging and sensing) has long presented a major hurdle, especially



A bar with ten THz laser sources. One of the lasers is connected to the contact pad (on the left) by two thin gold wires. A 2mm-diameter silicon hyper-hemispherical lens is attached to the facet of the device to collimate the output. The emission frequency is 5THz (a wavelength of 60 μm). Photo: Capasso Lab, Harvard SEAS.

regarding electrically pumped THz semiconductor lasers. Such devices have required cryogenic cooling, greatly limiting their application.

To overcome the temperature limitations of current laser designs, the researchers have developed a QCL that operates in the mid-infrared at the dual wavelengths of 8.9 μm and 10.5 μm simultaneously, with its active region engineered to possess giant second-order nonlinear susceptibility.

The consequent process of difference-frequency mixing within the laser cavity material then leads to the generation of terahertz radiation at a frequency of 5THz (a wavelength of 60 μm , equating to the difference between the two mid-infrared QCL frequencies). Output power is 7 μW at 80K, about 1 μW at 250K, and still about 300nW at 300K (room temperature).

Difference-frequency mixing within the laser cavity material leads to the generation of terahertz radiation

"Our device emits T-rays with several hundreds of nanowatts of power at room temperature and microwatts of power at temperatures easily achievable with commercially available thermoelectric coolers," says Belkin. "Further, there is the potential of increasing the terahertz output power to milliwatt levels by optimizing the semiconductor nanostructure of the active region and by improving the extraction efficiency of the terahertz radiation," he reckons.

"Terahertz imaging and sensing is a very promising but relatively new technology that requires compact, portable and tunable sources to achieve widespread penetration. Our devices are an important first step in this direction," reckons Capasso. "We believe our THz source has great development potential because the nanoscale material used was grown by molecular beam epitaxy."

As it is based on such commercially available technology, the laser has the potential to become a standard THz source to support applications ranging from security screening to chemical sensing, it is reckoned. The researchers have hence filed for US patents covering the room-temperature electrically pumped terahertz semiconductor lasers.

The research was supported by the Air Force Office of Scientific Research and the US National Science Foundation (NSF). The researchers also acknowledge support from two Harvard-based centers: the Nanoscale Science and Engineering Center and the Center for Nanoscale Systems (a member of the National Nanotechnology Infrastructure Network).

<http://link.aip.org/link/?APPLAB/92/201101/1>

www.seas.harvard.edu/capasso

Wide-bandgap RF devices: a \$100m market by 2010

Yole Développement's Philippe Roussel asks what can displace the LDMOS monopoly.

The call for high-power, high-frequency transistors is rising along with the huge demand for wireless telecoms. More power, more frequency bands, better linearity and improved efficiency are driving development of RF devices able to handle all these specifications at a reasonable price.

The main market segments are:

- base-stations for cell phones (3G, 3G+);
- base-stations for WiMAX (fixed and mobile) and/or LTE (long-term evolution) future 4G wireless datacom standards;
- defense & military applications (radar, jamming, counter-measures, communications, guided weapons...);
- broadcast and communication satellites (VSAT, SatCom) can also benefit from solid-state transistors replacing vacuum tubes.

Up to 2005, silicon LDMOS covered about 90% of high-power RF amplification applications in the 2GHz⁺ frequency range; the remaining 10% market share was addressed by GaAs pHEMT technology. However, this equilibrium is on the way to being turned around by the introduction of wide-bandgap (WBG) materials and related RF devices such as silicon carbide (SiC) MESFETs and gallium nitride (GaN) HEMTs.

WBG devices offer an impressive list of added-values over the solutions currently in use:

- Higher efficiency:
 - lower operating costs;
 - improved module power density and hence size;
 - reduced cost of ownership.
- Higher bandwidth and linearity:
 - more versatile devices;
 - fewer devices to cover the entire frequency spectrum;
 - cost saving at the development stage.
- Higher polarization voltage:
 - lower current level for the same power output;
 - fewer losses from the joule effect, leading to cost savings in thermal management.
- Higher junction temperature:
 - more robust devices, leading to improved expected lifetime and mean time to failure (MTTF);
 - reduced cooling system demands, leading to cost savings at the system level (BTS).

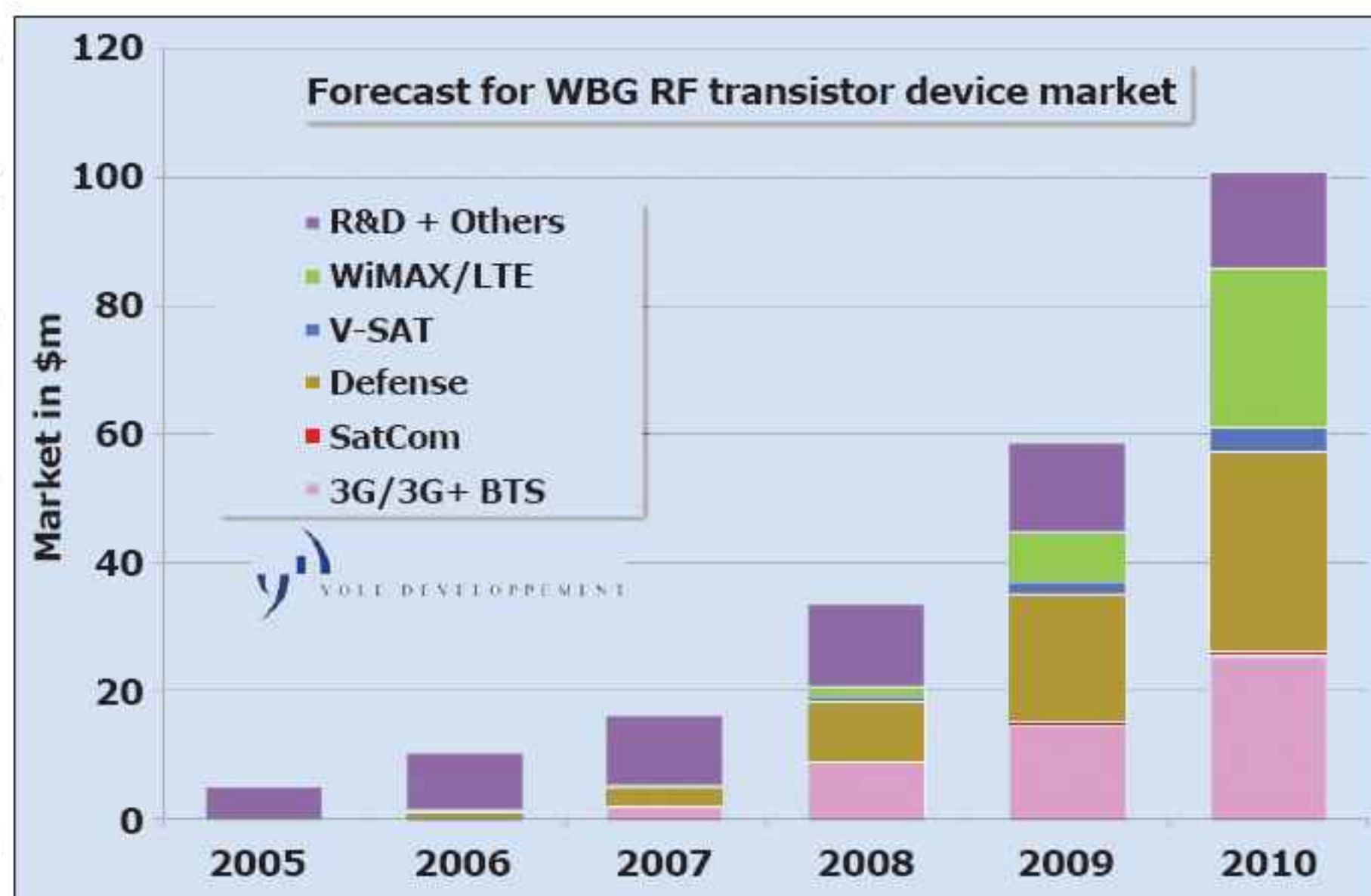


Figure 1: 2005–2010 wide-bandgap RF transistor device market.

These WBG devices are now challenging silicon's dominant position in the industrial arena, for which a power amplifier (PA) market of \$890m is forecasted for 2008.

As shown in Figure 1, military applications were first to use the possibilities of WBG devices, especially with SiC MESFETs being developed through widespread funding from DARPA and Department of Defense programs in the USA. Then, in 2006, Eudyna and NTT jointly announced that the first 3G network using GaN HEMTs had been deployed in Tokyo for test purposes. This first commercial application led to more than 250 wafer starts over 2006. Commercial offerings from Cree, RFMD and Nitronex have followed, targeting both base-station (3G, WiMAX etc) and general-purpose applications. In parallel, R&D for space applications has stayed very strong, and the first products are expected to be implemented in the next few years. Recent announcements have shown that key players are focusing increasingly on WiMAX/LTE markets, overlooking the current 3G/3G+ market, for which they claim the time-to-market for WBG devices has passed.

With strong penetration of WiMAX/LTE applications, we forecast that the market size for WBG RF transistors could reach a level of approximately \$100m by 2010. The duality between WiMAX and LTE technologies should not widely impact this growth.

	<i>Epi-wafers</i>	<i>Devices, MMIC & PA</i>	<i>Systems</i>
<i>USA</i>	<ul style="list-style-type: none"> • Nitronex • RFMD • Oxford Instruments/TDI • Cree • Kyma • Kopin • IQE 	<ul style="list-style-type: none"> • Nitronex • Raytheon • Northrop Grumman • RFMD • TriQuint • Cree • Freescale 	<ul style="list-style-type: none"> • Lockheed Martin • L3Com • Lucent • Motorola • Flarion Technologies • Celerica • Arraycom
<i>Europe</i>	<ul style="list-style-type: none"> • QinetiQ (UK) • Picogiga (F) • Azzurro (D) • Saint-Gobain/Lumilog (F) • IMEC (B) • Alcatel-Thales 3-5 Lab (F) • CRHEA (F) • IAF (D) 	<ul style="list-style-type: none"> • QinetiQ (UK) • MicroGaN (D) • UMS (F/D) + 3-5 Lab (F) + IAF (D) • RFMD/Filtronc (UK) • NXP (NL) • FBH (D) • Selex (IT) 	<ul style="list-style-type: none"> • BAE Systems (UK) • Selex (IT) • MBDA (UK) • EADS (D) • Ericsson (SW) • SAAB Microwave (SW) • Alcatel-Lucent (FR) • Thales (FR) • Nokia-Siemens (FI)
<i>Asia</i>	<ul style="list-style-type: none"> • Samsung (K) • Sumitomo SEI (J) • Powdec (J) • Tocera (J) • NTT (J) • Hitachi Cable (J) • ITRI (TW) • Toyoda Gosei (J) 	<ul style="list-style-type: none"> • Eudyna (J)/Fujitsu (J) • OKI (J) • NEC (J) • Furukawa (J) • RFHIC (K) • Mitsubishi (J) 	<ul style="list-style-type: none"> • NTT (J) • Mitsubishi (J) • Samsung (K)

Typical RRH power ranges from 20W to 50W, which matches WiMAX and future LTE requirements perfectly.

Company involvement

Nitronex, Cree and RFMD (in the USA) and Eudyna (in Japan) were the first companies to propose WBG RF devices. These were based on either GaN on silicon (Nitronex), SiC on SiC (Cree) or GaN on SiC (Cree, RFMD, Eudyna). Such devices are now in full production and implemented in complete RF systems in

Table 1: Companies involved in manufacturing GaN HEMT epi, devices and systems.

Remote radio head configuration will help WBG penetration in RF base stations

With standard architecture (where the amplifier is at the base of the radio tower), a large part of the signal is lost on the cable link (typically about 3dB of losses).

However, in the remote radio head (RRH) configuration, RF equipment can be relocated from a cabinet to a remote location, where signals can be transmitted as close as possible to the antenna. Thus, from an efficiency of 13–15% traditionally, up to 30% can now be obtained with RRH. The key issue now is linked to accessibility for maintenance (i.e. someone has to climb the radio tower).

In the RRH configuration, there is a need to reduce the size of the PA to enable it to be near the antenna. In addition to its smaller size compared to LDMOS, WBG technology also provides a high operating temperature and better efficiency. These are strong drivers for the use of GaN or SiC in the growing RRH market. We forecast that RRH systems will increasingly be used in future thanks to their high efficiency.

both defense and civilian applications.

The value chain for WBG devices is now being established. As detailed in the table, an impressive number of players are now involved in the WBG RF sector at various levels (materials, devices, and systems) and new challengers (Oki, NEC, NXP, UMS etc) should soon enter the field (Fig. 2).

Conclusion

With a forecasted size of \$100m by 2010, the WBG transistor market is at the start of the growth curve. Military and space applications are strong drivers for technology development. However, WBG technology penetration in base-stations (for cell phones, WiMAX) remains a little unclear, as silicon performance and related cost seems compatible with the current market demand. This could slow down the emergence of WBG devices in this very cost-sensitive market segment, even if the intrinsic characteristics of WBG devices have now largely been proven. The battle will take place not only at the performance and reliability level

but also at the cost level. Thus, innovating, GaN-based substrate manufacturers have a key role to play in helping to reduce the price of devices. ■

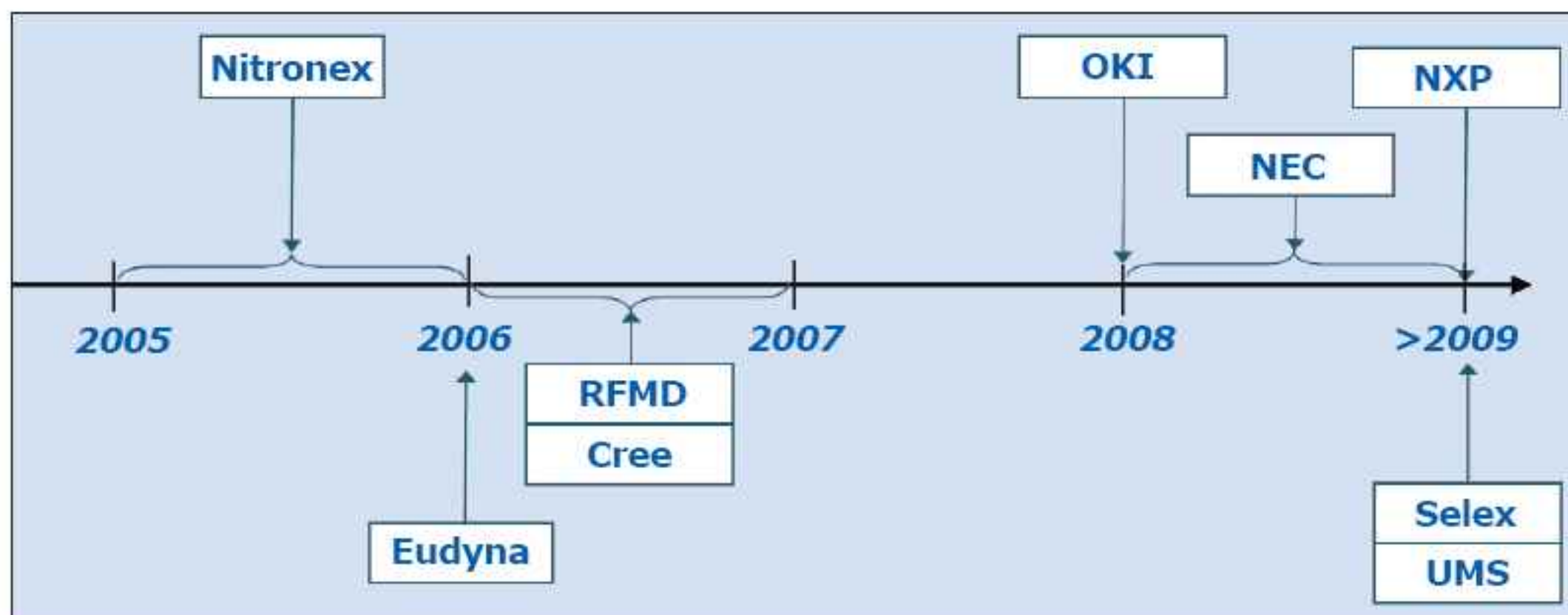


Figure 2: Tentative roadmap for wide-bandgap products introduction.

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France.
Yole Développement is publishing
its GaN RF'08 report in June.

www.i-micronews.com

Consolidating on industry growth



Mark Telford reports on manufacturing and technology developments presented at April's CS MANTECH 2008 event in Chicago

April's 23rd annual International Conference on Compound Semiconductor Manufacturing Technology (CS MANTECH 2008) in Chicago, IL drew a healthy attendance of over 420 delegates (exceeding the number for last year's event).

The technical program also showed an increase on the total of 73 papers at last year's conference, rising to 18 invited and 62 contributed papers.

Conference chair Marty Brophy of TriQuint Semiconductor opened the conference by overviewing how 2007 had been a 'tumultuous' year, showing signs of growth again after some quiet years, as the use of GaAs ICs has continued strongly in cell-phone handsets while also expanding rapidly in WiFi applications. In addition, GaN and SiC are addressing burgeoning markets for high-power RF electronics and optics, Brophy commented.

However, the long-predicted industry consolidation (e.g. RF Micro Device's acquisition of Sirenza Microdevices and, in late December, of GaAs foundry Filtronic, and TriQuint's of Peak Devices and, more recently, WJ) has brought uncertainties, he notes. Subsequently, in March, RFMD decided to postpone its \$100m construction of a second 6" GaAs wafer fab at its base in Greensboro, NC (which would employ 300 new staff) and shift the planned production and jobs to the Filtronic plant in Newton Aycliffe, UK (see March issue, page 6).

The long-predicted industry consolidation has brought uncertainties, says TriQuint's Marty Brophy

Then, during MANTECH, news broke that, to "reduce manufacturing cycle time, improve customer service, and improve overall profitability", RFMD was consolidating its production test facilities for high-volume cellular products from Greensboro to its main production test facility in Beijing, China (see April issue, page 7).

Since MANTECH, RFMD has also said that it is ceasing development of wireless systems (cellular transceivers and GPS solutions). However, it says that this represents a focusing of investment on its core RF components and compound semiconductors (see this issue, page 8).

Unfortunately, the same cannot be said of Freescale Semiconductor Corp of Austin, TX (formerly Motorola's Semiconductor Products Sector until being spun off in 2004). Still dependent heavily on the fading mobile handset business of Motorola, last October Freescale sold its high-volume GaAs-based RF power amplifier business to Skyworks Solutions Inc of Woburn, MA, and in mid-May it announced that, over the next few months, it will close its CS-1 fab in Tempe, AZ (the industry's first 150mm GaAs fab) after failing to find a buyer (see this issue, page 6).

Despite the commercial fates of Motorola and Freescale, Chicago provided an opportunity to highlight the technical excellence in the Illinois region.

The opening plenary session was book-ended by speakers from Illinois-based Motorola (former MANTECH chair Bruce Bernhardt, who founded the CS-1 fab) and the University of Illinois at Urbana-Champaign (Ilesanmi Adesida, dean of UIUC's College of Engineering). Adesida reviewed past alumni John Bardeen, Nick Holonyak, Greg Stillman, Hadis Morkoç, George Craford and Russ Dupuis (co-author of a paper at this year's event on a surface treatment technique using UV-enhanced electrode-less wet etching to reduce roughness and surface leakage paths in ICP-etched for III-N devices), as well as Milton Feng (whose group presented four papers — see below). Adesida also co-authored a later paper on the first non-recessed short-gate-length enhancement-mode AlGaIn/GaN HEMTs using solely fluorine plasma treatment alone.

In between Bernhardt and Adesida were overviews on compound semiconductors on silicon from DARPA's Mark Rosker (on the COSMOS program) and Robert Chau of Intel's Components Research, Technology and Manufacturing Group, as well as presentations from Dylan Kelly of CMOS-on-sapphire RF switch maker Peregrine Semiconductor Corp of San Diego, CA and RFMD's Curt Barratt who, in 'Compound Semiconductors: From Oddity to Commodity', described the GaAs RF semiconductor industry as now being on the 'plateau of productivity' of the 'Gartner Hype Cycle' (beyond the 'technology trigger', 'peak of inflated expectation', 'trough of disillusionment' and 'slope of enlightenment').

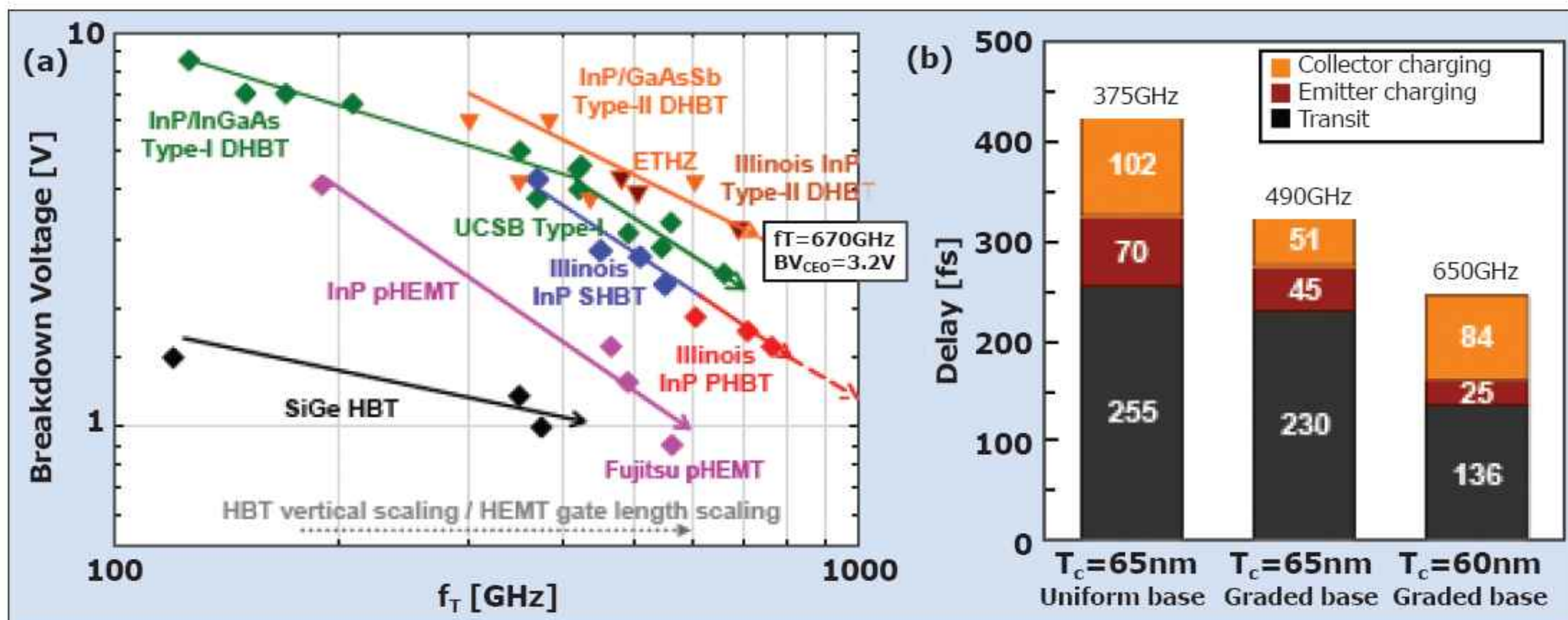


Figure 1. (a) Breakdown voltage (BV_{CEO} at $1\text{kA}/\text{cm}^2$) versus current gain cutoff frequency f_T for InP HBT, InP pHEMT and SiGe HBT devices. (b) f_T delay, partitioned into base-collector RC charging, emitter-base RC charging, and electron transit delay components, for three different type-II DHBT structures.

In particular, in 'III-V on Silicon for Future High Speed and Ultra-Low Power Digital Applications: Challenges and Opportunities', Chau reviewed recent progress (reported at December's IEDM 2007 conference) in:

- the fabrication of depletion-mode InSb and InGaAs QW transistors on silicon substrates;
- heterogeneous integration of enhancement-mode InGaAs quantum-well transistors on a silicon substrate using a thin ($1.3\mu\text{m}$) composite buffer architecture for high-speed, low-power logic applications at supply voltages of just 0.5V;
- atomic layer deposition (ALD) of high-k gate dielectrics (e.g. Al_2O_3 , HfO_2 and HfAlO) on InGaAs MOSFETs;
- the improvements in hole mobility in III-V materials (to more than $1000\text{cm}^2\text{V}^{-1}\text{s}^{-1}$ at a sheet carrier density of $1.6 \times 10^{12}\text{cm}^{-2}$) by using bi-axial strain; and
- the fabrication of 40nm InAs HEMTs for logic applications with an I_{on}/I_{off} current ratio of more than 10,000 with a 0.5V gate voltage swing.

Chau concludes that, although we are still far away from solving all the technical issues, the above-mentioned research results represent important milestones that are helping to drive towards the goal of making III-Vs on silicon technology practical for future high-speed and ultra-low-power digital applications.

RF Micro Device's Curt Barratt, in his presentation 'Compound Semiconductors: From Oddity to Commodity', described the GaAs RF semiconductor industry as now being on the 'plateau of productivity' of the 'Gartner Hype Cycle'

Towards terahertz electronics

In a presentation on 'Terahertz Electronics' in the session on 'Innovative Electronics Applications', Michael Shur of Rensselaer Polytechnic Institute in Troy, NY overviewed how, at last December's IEDM conference:

Milton Feng's research group at the University of Illinois reported Type II GaAsSb/InP double heterojunction bipolar transistors (DHBTs) with a record f_T of 670GHz and simultaneous f_T and f_{max} values of more than 400GHz using compositional grading to enhance electron velocity; Seoul National University reported 610GHz InAlAs/In_{0.75}GaAs MHEMTs with ultra-short 15nm gates; and Northrop Grumman reported a sub-50nm InP HEMT with an f_{max} of greater than 1THz, and an amplifier with 15dB gain at 340GHz (predicting that the technology will allow fabrication of MMICs operating at 600–700GHz).

At MANTECH, Feng and William Snodgrass detailed GaAsSb/InP type-II DHBTs with a 20nm-thick base and 60nm collector, yielding an off-state collector-emitter breakdown voltage (BV_{CEO}) of 3.2V and an f_T of 670GHz at a $10.3\text{mA}/\text{m}^2$ emitter current density (since raised to 690GHz at $12.8\text{mA}/\text{m}^2$), compared with a 765GHz f_T but a BV_{CEO} of just 1.65V for InP/InGaAs PHBTs (Figure 1(a)).

Snodgrass added that, when devices are aggressively scaled, it is no longer true that f_T is dominated by the transit delay time, since it becomes comparable to the charging delay time. Such low transport delays and high breakdown voltage show potential for next-generation devices with cutoff frequencies of more than 1THz using a practical, manufacturable material design. To continue to benefit from vertical scaling, small-signal modeling is used to extract delay terms and to identify material design and device fabrication requirements, e.g. advanced process technologies resembling those used for SiGe HBTs to control parasitic charging delays.

Wide-bandgap devices

In the session on 'Wide Bandgap Power Amps and Switching', Henry Xin of Tyco Electronics Inc's Power Hybrids Operation in Torrance, CA reported the firm's initial development of AlGaIn/GaN HEMT power amplifiers on GaN/SiC epi materials.

A 10mm gate-periphery device showed 40W CW output at 1.75GHz, 12.6db linear gain and more than 80% drain efficiency with a drain bias of 28V. Xin said that results of ongoing work on optimizing the fabrication process and layout design, as well as initial reliability testing, will be reported in the future.

In the session on 'Emerging Devices', Huili Grace Xing of the University of Notre Dame reported the MBE growth on sapphire substrates of HEMTs based on alloy-free, binary AlN/GaN heterostructures (rather than traditional AlGaIn/GaN heterostructures). High-frequency characterization shows that, through the reduction of access resistances, very high-frequency performance is achievable. Alloy-free AlN/GaN heterostructure technology therefore offers critical advantages over competing AlGaIn/GaN and AlInN/GaN technologies for vertical and lateral scaling to push the high-frequency limits of nitride HEMTs.

In a nitride two-dimensional electron gas (2DEG), optical phonon scattering limits room-temperature electron mobilities to 1000–2000cm²/Vs. So, the key to achieving low sheet resistance is to increase the carrier density.

Xing explained how, compared to other HEMT technologies, the high carrier density in a 2DEG in nitride heterostructures originates from the difference in spontaneous and piezoelectric polarization between the barrier (typically AlGaIn) and the underlying GaN. The polarization-induced 2DEG carrier densities are the highest of all known semiconductor heterostructures, and scale with the barrier's Al composition and thickness. However, strain relaxation occurs if the AlGaIn barrier exceeds a critical thickness and, if the barrier does not relax, then the carrier density saturates beyond another critical thickness.

Hence, for a ~30% AlGaIn barrier, the carrier density is limited to about 10¹³/cm² (in existing AlGaIn/GaN HEMTs). Also, for an Al proportion of less than 40%, alloy scattering reduces the mobility, increasing sheet resistance to more than 250Ω/square. The alternative of an AlInN barrier produces more alloy scattering, making it difficult to achieve a mobility of more than 1500cm²/Vs.

Alloy-free AlN/GaN heterostructure technology offers critical advantages over competing AlGaIn/GaN and AlInN/GaN technologies for vertical and lateral scaling to push the high-frequency limits of nitride HEMTs

For a sheet resistance of less than 200Ω/sq, an AlN barrier is needed. Due to the maximum difference in polarization between an AlN barrier and the underlying GaN, an AlN barrier layer can therefore yield the maximum 2DEG carrier density in Al(Ga)N/GaN heterostructures (2–6x10¹³/cm²).

Unfortunately, the 2.4% lattice mismatch with GaN and consequent elastic strain in the AlN layer restricts its thickness to about 6nm before strain relaxation and cracking. However, for AlN thicknesses less than 6nm, very smooth surface morphologies are seen, with atomic steps clearly discernible. AlN layers are coherently strained for thickness in the 2–5nm range. Controlled growth and hence the absence of alloy scattering can therefore achieve high electron mobility (>1000cm²/Vs — see Figure 2), yielding record low channel sheet resistances (<150Ω/sq), current density of 2.3A/mm and transconductance of 480mS/mm for a 12.5μm gate-width device.

With a contact resistance of 1.1Ω.mm, the calculated intrinsic transconductance is as high as 1S/mm. This shows that both high current density and transconductance can be achieved in a single AlN/GaN HEMT with insulated gates, say the researchers.

It was also found that interface roughness scattering has a measurable impact on the room-temperature 2DEG mobility. So, by increasing the growth rate, the AlN/GaN interface roughness was reduced and the electron mobility increased, lowering sheet resistance to less than 130Ω/sq. Current density of 5A/mm has been observed in the heterostructures, albeit on TLM (transmission line method) patterns and not yet HEMTs.

It is reckoned that further optimization of the growth conditions and layer structures should yield sheet resistances of 100Ω/sq (comparing very favorably with other III-V HEMT technologies).

The unity-gain and power-gain cutoff frequencies are lower than expected (f_T and $f_{max} = 52\text{GHz}$ and 60GHz , respectively, for a 0.25μm x 60μm-gate HEMT). However, reducing the contact resistance and gate leakage (due to tunneling and defects) should increase these.

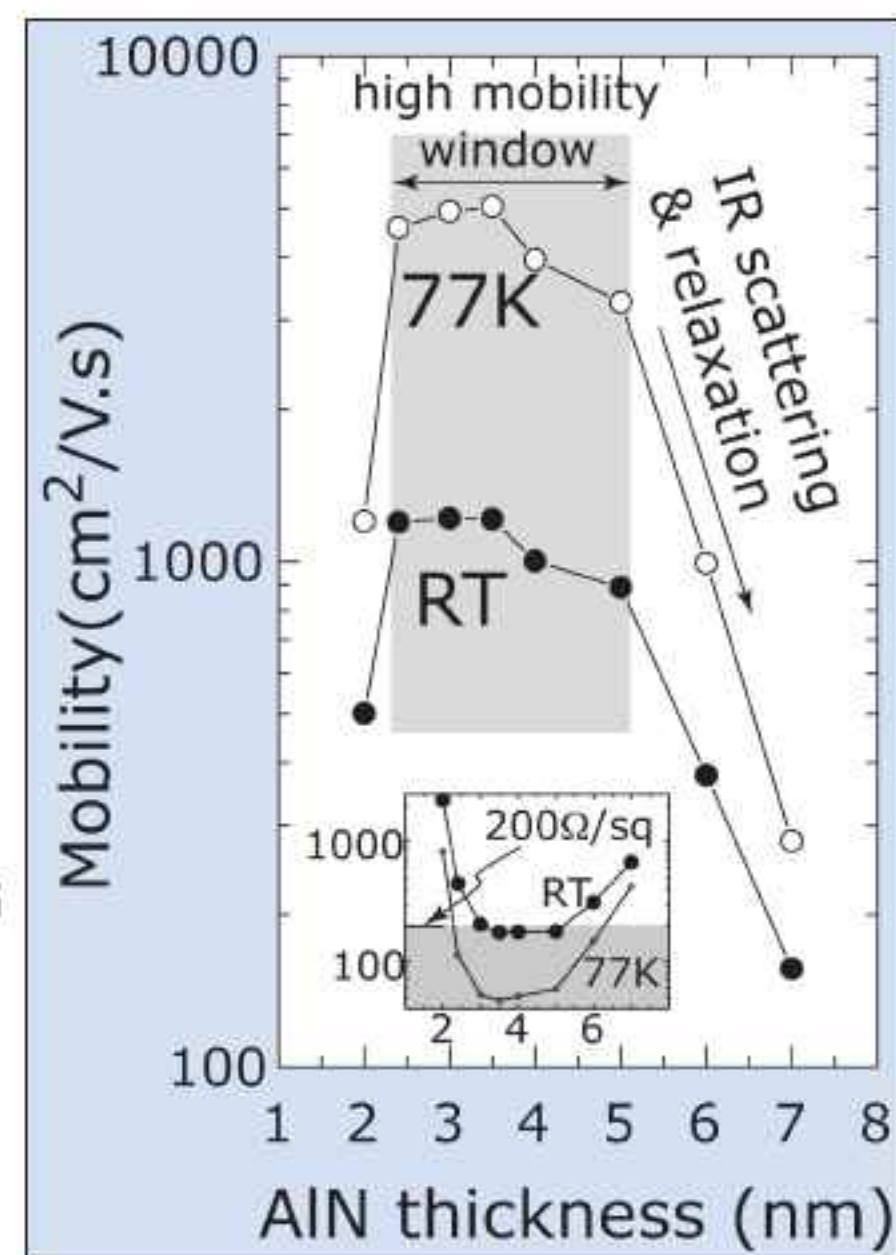


Figure 2. Window of high electron mobility of the 2DEG at the AlN/GaN heterojunction, greatly reducing the sheet resistance.

In 'Process and Performance Improvements to InGaN/GaN HBTs' by Chao-Hsin Wu et al, Feng's group reported transistors with different p-type metal stacks.

In contrast to GaN-based FETs, III-nitride HBTs have shown few impressive experimental results due to the challenge of achieving high-quality p-type ohmic contacts and reducing the plasma-induced base surface damage caused by dry etching (since there is a lack of a good wet-etching process for GaN-based materials).

The group's baseline p-type contact (used for light-emitting GaN devices) is a two-layer NiO-Au contact. However, experiments showed that this is not ohmic to etched GaN, with an undesirably high contact resistance due to the surface damage and type conversion caused by ICP dry etching. The high resistance causes a large transfer length for the base contact, necessitating a large base mesa to achieve low base resistance.

Now, devices with a new base metal contact of Ag + Mg in combination have shown a six times improvement in current gain.

Also, the surface damage caused by dry etching was investigated by varying the thickness of the ledge that is widely used to reduce surface recombination in the exposed base region. By implementing a 5nm ledge (rather than a 15nm or 25nm ledge), a 14 times improvement in current gain was achieved relative to the baseline process, even using the baseline metal contact stacks rather than the new metal stack.

InP DHBTs for 100Gb/s

In the session on 'Devices', R. Driad, R.E. Makon, F. Benkhelifa and R. Lösch of Fraunhofer Institute for Applied Solid State Physics in Freiburg, Germany reported 'InP DHBT technology for 100Gbit/s applications', detailing a manufacturable InP DHBT technology suitable for medium-scale mixed-signal and monolithic microwave integrated circuits (MMICs).

The MBE-grown InP-based DHBTs (with an InP emitter area of $1\mu\text{m} \times 4\mu\text{m}$, a graded InGaAs base, and a compositionally graded InGaAs/InGaAsP/InP collector) exhibited a current gain of 90, peak cutoff frequencies (f_T and f_{max}) of more than 300GHz, and a breakdown voltage (BV_{CEO}) of about 5V.

The potential of the technology was first assessed by the realization of a voltage controlled oscillator (VCO), exhibiting a high output power and a large tuning range. Subsequently, a 1:2 demultiplexer (DEMUX) suitable for 100Gb/s fiber-optic links was fabricated and operated up to 110Gb/s.

The researchers say that the results are promising for the development of receiver modules for future optical transmission systems operating at 100Gb/s and beyond, and next aim to design a monolithically integrated CDR/DEMUX. ■

● Next year's CS MANTECH 2009 will take place on 18–21 May in Tampa, FL. See www.gaasmantech.org

GaAs foundries to be challenged by smarter designs

Glen Riley, VP of the Commercial Foundry business unit of TriQuint Semiconductor in Hillsboro, OR (the world's biggest GaAs foundry, as well as an integrated device manufacturer) in his presentation 'How to Succeed as a GaAs Foundry' recounted how the number of GaAs foundry suppliers grew steadily in the late 1990s. But, since the telecoms market bubble burst in 2001, Suntek has foundered, GCTC was acquired by WIN Semiconductor in 2004, and Filtronic has been acquired by RFMD, leaving four main players (TriQuint, WIN, AWSC, and GCS), which is "about right," says Riley.

He points out that the GaAs foundry market overall is relatively small, so criteria for success are different from those for silicon. Compared with \$2–4bn for silicon, investment in a new fab is \$200–250m for GaAs. "It is not about making multibillion dollar investments in new fab capacity, but rather about providing the right technology with great support and establishing trusting relationships with customers," he adds. There are a limited number of GaAs designers, and they talk to each other, so successful GaAs foundries go to great lengths to build solid, long-lasting relationships. In addition, such knowledge gives a view to making acquisitions, says Riley, citing TriQuint's takeover of WJ.

A foundry must develop trust with its customers, but Asian foundry suppliers are typically unfairly white-washed with the brush that says IP is not respected in Asia, says Riley. New entrants will find it difficult, since such a relationship is developed over several years. Existing suppliers with questionable pasts may need even more time to rebuild trust.

However, relationships alone are not enough to grow business, says Riley. Foundries also need to develop an approach for identifying and pursuing new market opportunities.

New wireless applications are appearing such as WiMAX, WirelessHD, and automotive radar. Typically, the first firms to exploit these new markets are start-ups, which need foundries to realize their products.

For addressing these new applications, GaAs can offer value versus silicon (with mask-set costs of less than \$50,000, compared to up to \$1m for silicon). Also, GaAs foundries can proactively engage startups, providing product design kits, applications assistance, and access to high-performance process technologies.

However, Riley cautions that he expects foundry demand to dip as technology evolves (e.g. as designers figure out how to use GaAs in a smarter way).

Index

- | | |
|--|-------------------------------------|
| 1 Bulk crystal source materials p62 | 14 Chip test equipment p66 |
| 2 Bulk crystal growth equipment p62 | 15 Assembly/packaging materials p66 |
| 3 Substrates p62 | 16 Assembly/packaging equipment p66 |
| 4 Epiwafer foundry p63 | 17 Assembly/packaging foundry p66 |
| 5 Deposition materials p63 | 18 Chip foundry p66 |
| 6 Deposition equipment p64 | 19 Facility equipment p66 |
| 7 Wafer processing materials p64 | 20 Facility consumables p66 |
| 8 Wafer processing equipment p65 | 21 Computer hardware & software p67 |
| 9 Materials and metals p65 | 22 Used equipment p67 |
| 10 Gas & liquid handling equipment p65 | 23 Services p67 |
| 11 Process monitoring and control p65 | 24 Consulting p67 |
| 12 Inspection equipment p66 | 25 Resources p67 |
| 13 Characterization equipment p66 | |

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CS CLEAN SYSTEMS AG

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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,
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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

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Ann Arbor, MI 48103,
USA

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Fax: +1 734 668 4663

www.k-space.com

LayTec GmbH

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Germany

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Fax: +49 30 3180 8237

www.laytec.de

Optical Reference Systems Ltd

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www.wepcontrol.com

12 Inspection equipment

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Fax: +49 (0)721 595 4587
www.bruker-axs.de

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SUSS MicroTec Test Systems
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VT 05677, USA
Tel: +1 800 685 7877
Fax: +1 802 244 7853
www.suss.com

15 Assembly/packaging materials

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Fax: +1 512 231 8183
www.epak.com

Gel-Pak
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Tel: +1 510 576 2220
Fax: +1 510 576 2282
www.gelpak.com

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Fax: +1 716 833 2926
www.williams-adv.com

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Fax: +1 603 518 3298
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Kulicke & Soffa Industries
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Fort Washington, PA 19034,
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Palomar Technologies Inc
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USA
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Fax: +1 760 931 5191
www.PalomarTechnologies.com

17 Assembly/packaging foundry

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10987 Via Frontera,
San Diego, CA 92127,
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Fax: +1 8586 74 4681
www.quikicpak.com

18 Chip foundry

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United Monolithic Semiconductors
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Taipei World Trade Center, Taiwan

E-mail: pamela@mail.pida.org.tw

www.optotaiwan.com

15–20 June 2008

IEEE MTT-S International Microwave Symposium (IMS 2008)

Atlanta, GA, USA

E-mail: tt.lee@ieee.org

www.ims2008.org

16–17 June 2008

Projection Summit 2008

Las Vegas, NV, USA

E-mail: dian@insightmedia.info

www.projectionsummit.com

17–18 June 2008

Photovoltaics Beyond Conventional Silicon USA 08

Denver, CO, USA

E-mail: s.lee@IDTechEx.com

www.idtechex.com/photovoltaicsusa08

18–20 June 2008

6th All Russian Conference 'Gallium, Aluminum and Indium Nitrides'

St Petersburg, Russia

E-mail: Nitrides2008@mail.ioffe.ru

<http://nitrides-conf.ioffe.ru/index.en.html>

18–20 June 2008

Photovoltaics Summit 2008

Hilton San Diego, CA, USA

E-mail: john.buss@pira-international.com

www.intertechpira.com

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LED EXPO 2008

KINTEX, Seoul, South Korea

E-mail: led@exponu.com

www.ledexpo.com

27–29 June 2008

2008 China (Beijing) International LED Exposition (CILED)

Beijing, China

E-mail: ciled@ciled.cn

www.ciled.cn

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Moscone Center, San Francisco, CA, USA

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Shenzhen Convention and Exhibition Center, China

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Vancouver, Canada

E-mail: erin.gendron@ubc.ca**www.mbe2008.ca****31 August - 5 September 2008****NUSOD '08:****8th International Conference on Numerical Simulation of Optoelectronic Devices**

University of Nottingham, UK

E-mail: eric.larkins@nottingham.ac.uk**www.nusod.org/conf08****6-9 September 2008****10th China International Optoelectronic Exposition (CIOE)**

Shenzhen Convention & Exhibition Center, China

E-mail: nancy@cioe.cn**www.cioe.cn****7-11 September 2007****9th International Conference on Mid-Infrared Optoelectronics: Materials and Devices (MIOMD-IX)**

Freiburg, Germany

E-mail: info@miomd-9.de**www.miomd-9.de****14-18 September 2008****21st IEEE International Semiconductor Laser Conference**

Hilton Sorrento Palace, Sorrento, Italy

E-mail: m.hendrickx@ieee.org**www.ieee.org/organizations/society/leos/LEOSCONF/ISLC2008****15-19 September 2008****Solid-State Device Research - 38th European Conference (ESSDERC-2008) and****Solid-State Circuits Research - 34th European Conference (ESSCIRC-2008)**

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