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Ann Arbor becomes third LED City Banff trials LED street lighting Workable low-cost silicon carbide GaN power electronics

Skyworks converting to 6" • Cree launches 100mm ZMP SiC
RFMD's multi-market product focus • Dilute nitrides boost LEDs

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contents

Editorial	2
News	
Markets	4
LEDs back to double-digit growth in 2007 • Blue-laser drives in 10% of PCs in 2008 • Cell-phone shipments hit 286m in Q3/2007	
Micro	8
RFMD launches non-cellular Multi-Market Products Group • Skyworks converting fab to 6" • Anadigics' margins dip during accelerated capacity ramp • SI GaAs epi market to grow at 8% through 2011 • SiGe:C BiCMOS process challenging GaAs	
Wide-bandgap electronics	20
Nitronex qualifies fab for volume production • SiC electronics market \$800m by 2015 • Cree launches 100mm ZMP SiC • First TO-220 SiC switching power transistor • SiCED expands • Microsemi wins \$1.6m AFRL contract • GeneSiC wins SBIR & STTR grants	
Materials and processing equipment	26
AXT's 6" GaAs sales dip due to BiFET transition • Aixtron raises 2007 forecast and buys Nanoinstruments • Veeco's MOCVD sales boom • Kyma ships AlN template substrates • Rubicon IPO raises \$100m	
LEDs	36
Ann Arbor becomes third LED City • Street lighting project in Banff • Honeywell vs Lumileds & Cree; Nichia vs Seoul; Osram vs Kingbright • Osram & Toyoda exchange patents • Dilute nitrides boost stability	
Optoelectronics	42
First transistor-based single-photon detector • QPC raises full-year 2007 guidance • NEC C&C prize awarded to VCSEL inventor	
Optical communications	46
JDSU partners with Mintera on 40Gb/s; agile products boost profit • Alcatel-Lucent extends Avanex agreement; sells stake to Pirelli • Bookham grows revenue 20% and raises \$41m	
Market focus: GaN power electronics	52
Towards low-cost high-power-density devices	
GaN power electronics are now ready to address a \$3.5bn market, reckons Philippe Roussel of market research firm Yole Développement.	
Technology focus: SiC	54
Seeking workable low-cost silicon carbide	
SiC deposited on a silicon substrate has many attractions from a volume production perspective. Dr Mike Cooke reports on Japanese and US efforts to make this a viable option.	
Suppliers' Directory	58
Event Calendar	64
Advertisers' Index	64

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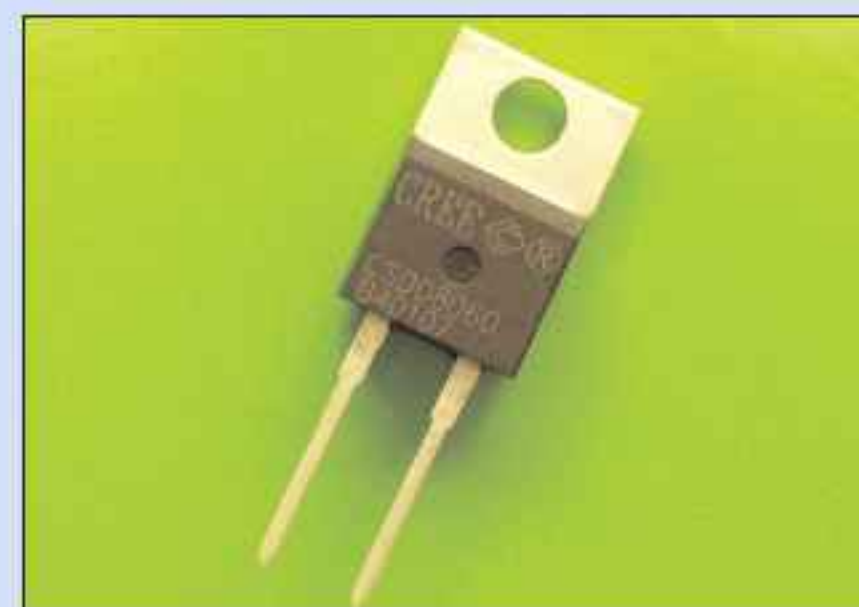
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Vol. 2 • Issue 9 • November 2007



p20 Nitronex's fab in Durham, NC, USA, now qualified for volume production of its GaN-on-Si RF power transistors.



p23 Cree's new CSD08060 8 Amp silicon carbide Zero Recovery Schottky diode, targeted at computer servers.



p37 LED street lighting installed in Ann Arbor, MI, USA, which is the third city to join the LED City initiative, after Raleigh, NC, USA and Toronto, Canada.



Cover: Street lights in Banff, Alberta, Canada, which have been converted from the previous 100W metal halide fixtures by retrofitting with custom-made LED prototype fixtures as part of a joint pilot project with Osram Opto Semiconductors. Each streetlight contains 54 Golden Dragon Argus LEDs. **p38**

GaAs RFIC makers switching strategies

Financial results for third-quarter 2007 cell-phone handset shipments show healthy quarterly growth of 10%, driven by entry-level GSM markets in emerging regions. In addition to the overall continued consolidation of the market on the top five vendors, this trend has benefitted top vendor Nokia the most, at the expense of profit-driven Motorola. However, Motorola has also been losing market share in high-margin 3G products to Samsung (which took second place from it in Q2/2007) and fourth-place Sony Ericsson (to which the market-share gap has narrowed from 13.4% a year ago to just 4% in Q3/2007, according to Strategy Analytics — see page 6).

Fortunately for main RFIC supplier RF Micro Devices, Motorola's decline appears to be bottoming out. But RFMD's 21% sequential growth has been boosted mainly by the start of high-volume shipments of its Polaris 3 quad-band EDGE RF front-end for Nokia's 3G phones (see page 10).

As well as increasing the GaAs dollar content per module, use of multiple RFICs in multimode 3G handsets and the strong growth in demand has led to handset makers suffering front-end component shortages, says Strategy Analytics. Both RFMD and Anadigics have consequently been expanding fab capacity. However, in the case of Anadigics, Q3 profits were lower than expected due to short-term manufacturing inefficiencies associated with accelerating its capacity ramp-up (see page 12).

As previewed last issue, Skyworks is expanding not by building new fab capacity but through a 'hybrid' strategy of converting its GaAs HBT fab from 4" to 6" wafers while expanding partnerships with foundries in Taiwan (see page 15). Apart from making capacity expansion more flexible and less disruptive, the specialty process technology offered by foundries matches with Skyworks' balanced portfolio of both handset- and non-handset-related products (e.g. higher-margin linear products).

The lack of such diversity is what led to vulnerability in RFMD when the vast majority of its revenues were handset-related. However, that was before its acquisition of Sirenza Microdevices in November and the consequent creation of its new Multi-Market Products Group, with five business units: aerospace and defense; broadband and consumer; wireless connectivity; wireless infrastructure; and standard RF components (see page 11). RFMD's strategy is to apply to these additional new market areas both its existing handset technologies and its latest technologies, including its gallium nitride process (in power amplifiers for CATV and PA modules for cellular and WiMAX infrastructure) and GaAs enhancement/depletion-mode (E/D) pHEMT switch and GaAs BiFET processes. RFMD's new technologies were highlighted at the firm's recent annual Analysts' Day, as will be detailed in the next issue.

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- conference reports;
- event calendar and event previews;
- suppliers' directory.

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Fiber laser market to grow 39% to \$240m in 2007, then at 26% to 2011

The fiber laser market is on track to grow 39% this year to more than \$240m, and is forecast to grow at 26% annually through to 2011 (more than doubling from 2007), reports Strategies Unlimited in 'Fiber and Industrial Lasers Market Review and Forecast—2007' (which this year has been expanded to provide more insight and precision into applications). The industrial laser market (in which fiber lasers play) will grow at nearly 10% annually. This should be good news to the nearly 40 suppliers of fiber lasers, as well as to the many suppliers of gain blocks and laser components, says the firm.

While much growth in fiber lasers comes at the expense of suppliers of solid-state lasers, suppliers of other laser types will see steady growth as well (about 7% annually through to 2011). The strongest gains for fiber lasers will be in high-power metals processing and in micro-materials processing, a diverse set of mid-power and pulsed applications.

This year several prominent suppliers announced fiber laser products at Laser 2007 in Munich,

Germany, including GSI, Newport, Rofin-Sinar, and Trumpf, adding credibility to the technology (which is currently dominated by IPG Photonics). The industry is not one to make rapid changes, but many application trends are becoming clearer in this period of transition, says Strategies Unlimited.

"Over the last year we had the opportunity to examine more closely the many applications where fiber lasers may play, and we have been able to fine-tune our estimates," says Tom Hausken, Strategies Unlimited's director of components research. "There are many applications where a fiber laser is not a good solution, and many where fiber lasers are already doing well," he adds. "What remains are the many applications where the questions are still unresolved."

However, many key questions remain, such as how fast and how much market share can kilowatt fiber lasers gain from CO₂ lasers in sheet metal cutting, and how much vertical integration is necessary to succeed in the fiber laser market?

www.strategies-u.com

Blue-laser drives in 10% of PCs in '08

The adoption of Blu-ray Disc (BD) and/or HD DVD blue-laser optical disc drives (ODDs) in desktop and notebook PCs will increase from less than 1% of all PCs in 2007 to 10% in 2008, reckons Masayuki Kozuka, general manager for the Storage Device Business Strategy Office of Japan's Matsushita Electric Industrial (Panasonic), reports Digitimes.com.

In the case of BD burners, OEM price levels have dropped from \$1000 in 2006 to \$800 in 2007 and may fall further to \$500 in 2008, mainly due to increasing yields and

production capacity of BD pick-up heads and chipsets, Kozuka says. This has increased the willingness of international PC vendors, including Hewlett-Packard (HP), Dell, Acer and Asustek Computer, to adopt blue-laser burners or drives.

Japan is the market promoting blue-laser consumer electronics the most, Kozuka notes. BD or HD DVD players as a percentage of all disc players/recorders sold in Japan has risen from 14.8% in 2006 to 20% in 2007 and is expected to grow to 50% in 2008.

www.digitimes.com

ITU approves WiMAX as IMT-2000 standard

In October, the Radiocommunication Sector of the International Telecommunication Union (ITU-R) approved the WiMAX Forum's version of IEEE Standard 802.16 for inclusion in the IMT-2000 set of standards. The decision significantly escalates opportunities for global deployment, especially within the 2.5–2.69GHz band, to deliver mobile Internet for both rural and urban market demand, says the WiMAX Forum.

"This is the first time that a new air interface has been added to the IMT-2000 set of standards since the original technologies were selected nearly a decade ago," says forum president Ron Resnick. WiMAX technology currently has the potential to reach 2.7bn people, and the announcement expands the reach to many more, he adds.

Administrations, industry and ITU have worked to achieve the decision between the initial application being made at January's ITU-R WP8F meeting and October's Radiocommunications Assembly in Geneva.

With approval of WiMAX as a new IMT-2000 specification, it will benefit from greater economies of scale, cutting the cost of providing broadband wireless services to include VOIP and multiple services expected from wireless broadband Internet access, the forum says.

Originally created to harmonize 3G mobile systems and to increase opportunities for global interoperability, the IMT-2000 family of standards will now support four access technologies: OFDMA (including WiMAX), FDMA, TDMA and CDMA.

"3G solutions based upon technologies such as W-CDMA, CDMA-2000 and TD-SCDMA were already included in the IMT-2000 set of standards," says Resnick. "With WiMAX technology now included, it places us on equal footing with the legacy-based technologies." Operators worldwide can now select the best technology to meet their business and regional needs."

www.wimaxforum.org

LEDs back to double-digit growth in 2007

The LED market should grow by 13.7% in 2007, and at a compound annual growth rate (CAGR) of 14.6% between 2006 and 2012 to more than \$12.3bn, according to the market report 'Solid State Lighting: LEDs Poised to Drive a New Lighting Revolution' from iSuppli Corp. The return to double-digit growth rates in 2007 follows two years of moderate single-digit growth, by only 2.1% in 2005 and by 8.7% in 2006.

Figures include all surface-mount device (SMD) and through-hole packaged lamp and alpha-numeric display LEDs, including standard brightness, high-brightness (HB) and ultra-high-brightness (UHB) LEDs. A significant portion of the growth will be driven by UHB and HB LEDs, says iSuppli. In 2012, UHB LEDs will account for about 31% of total LED revenue, up from 4% in 2005.

"The new phase of LED growth will be driven by the continued strong demand for solid-state lighting for the backlighting of keypads and displays in mobile devices," says principal analyst Jagdish Rebello. "It also will be propelled by new emerging markets for LEDs in the interior lighting of automobiles and in the backlighting of large-screen LCDs for TVs and notebook computers. Furthermore, continuous advances in solid-state lighting technology will allow LEDs to target new applications in the decorative-illumination and architectural-lighting markets."

For the immediate future, the backlighting of small-screen LCD displays and of keypads in mobile devices remains the single largest application market for LEDs, reckons iSuppli. In 2007, this application will account for more than 25% of total LED market revenue.

But, starting in 2007, backlighting of larger-screen notebooks and direct-view LCD TVs is emerging as the next big application for LCDs.

Back-light units (BLUs) are still much more expensive than conventional cold cathode fluorescent lamp (CCFL) BLUs, but the cost differential is narrowing quickly. Also, performance advantages offered by LED BLUs in terms of higher contrast ratios, faster turn-on times, wider color gamuts and the absence of mercury are driving their adoption.

Several BLU makers, LCD panel makers and TV/monitor OEMs are now starting to use LEDs for back-lighting large-screen LCDs. Commercial shipments of such screens are now commencing.

Also, the development of high-flux LEDs with luminous efficacies of over 100 lumens/Watt and the advent of innovative designs that allow LEDs to run on alternating current without the need for an inverter are pushing LEDs closer to adoption for mainstream general illumination. LEDs are already being used in different indoor and outdoor decorative illumination applications, and are just starting to target applications such as flashlights, garden lighting and street lighting. These uses are opening the market for LED illumination in the home and in enterprise illumination applications.

Furthermore, legislation worldwide is increasingly seeking to ban the use of incandescent bulbs in favor of more energy-efficient light sources. In the near term, compact fluorescent lamps (CFLs) will benefit from legislative efforts. However, in the longer term, the advantages of solid-state lighting will outweigh the cost differential between LEDs and CFLs, says iSuppli. Also, as progress continues in LED performance, the cost differential will narrow. iSuppli projects that LED light bulbs will begin to address the residential and enterprise general illumination market in 2010.

www.isuppli.com

WiMAX to hold \$36.4bn market in US enterprises telecommunications services by 2013

Given its low-cost adaptability for a wide range of telecoms applications, WiMAX will hold a \$36.4bn market in US enterprises telecom services by 2013, as the technology changes the way that enterprises view telecoms, according to the new report 'WiMAX in the Enterprise: Access, Applications and Affordability' from the firm Research and Markets.

In particular, Cisco's recent acquisition of WiMAX vendor Navini points to the powerful logic for WiMAX as an enterprise application as well as a carrier application.

Given the decline in landline telephone service in favor of mobile voice, mobile data is expected to follow a similar trend. For enterprises replacing their telecom provider's expensive legacy T1 overhead, WiMAX is a much more cost-effective means of service delivery than 3G cellular, with very competitive cost per megabit per employee, says the report's author, WiMAX pioneer Frank Ohrtman.

Wireless broadband access and mobile computing can come together via WiMAX to offer the enterprise a range of new applications, says Ohrtman. The technology therefore gives businesses the ability to virtually manage their workforce and add and remove new services and applications quickly.

So, in this new environment, telecom companies must respond to demands for lower prices, or customers could turn to new WiMAX operators or set up their own private network using WiMAX equipment.

www.researchandmarkets.com

Q3 cell-phone shipments of 286m led by Nokia in emerging entry-level GSM markets and Samsung in 3G

In 'Q3/2007 Global Handset Market Share Update', Strategy Analytics says that cell-phone shipments were 286m units (up just 13% on 253.8m year-on-year but up as much as 10% sequentially on Q2's 258m).

This was also up slightly on its forecast in August of 283m units, after strong demand in emerging markets (especially Asia and Africa) boosted sales for all major handset vendors. However, four of the top five brands saw average selling prices (ASP) fall.

Nokia sold a record 111.7m handsets, up 11% sequentially and 26% year-on-year, driving market share from 34.9% to 39.2% (more than the next three biggest brands combined). Growth is due to its entry-tier products and a strong lead in emerging markets including China and India (as it continues to outsell Motorola in the entry-tier GSM segment).

With about 8m new clients signing up for mobile telephony each month in India alone, handset makers are competing for first-time buyers with low-priced handsets. Nokia has made this a key driver for unit, revenue, and profit maximization, says Strategy Analytics, whereas rivals have been shying away from the cost-intensive entry-tier segment. As a clear leader in low-price phones, Nokia reported its highest profit margin (22.2%) since Q4/2003. This compares with 12.3% for Samsung, 12.6% for Sony Ericsson and 8.3% for LG, while Motorola made another loss on handset operations.

Samsung continued its strong unit growth for the second consecutive quarter (up 47% year-on-year from 28.9m to 42.6m; the highest growth among the top-five vendors). The firm therefore retained the second place that it gained from Motorola in Q2, with market share up from 11.4% a year ago to 14.9%, particularly in 3G feature phones (where Sony Ericsson has also had much recent success). Drivers were reduced marketing expenses and a focus on mature markets, built on a

strong product mix in mid- and high-tier 3G product segments (in which Motorola is struggling). But, without significant product lines in broader entry-tier segments, Samsung's quarterly revenue growth will continue to be volatile, and the pressure to realize a larger proportion of revenues from new (higher-tier products) will intensify in the short term, says Strategy Analytics.

Motorola's shipments have fallen 31% year-on-year from 53.7m to just 37.2m, with market share falling from 22.4% to just 13%. Due partly to a ramp-up in RAZR2 volumes, shipments are stabilizing. However, shipments, revenues and operating income are all far below a year ago. Continuing its aim to protect profits by refusing to compete on price, Motorola is losing market share in emerging regions, specifically China. New 3G products are a small step forward, but more is needed in early 2008 in design and feature appeal if Motorola is to seriously compete with Samsung and Sony Ericsson in higher product tiers, says Strategy Analytics. Motorola is now under threat by fourth-place Sony Ericsson.

In Q3, SonyEricsson continued its strong shipment growth, up 31% from 19.8m a year ago to 25.9m (from 7.8% to 9.1% market share). The firm's distribution of sales was balanced across low- and higher-tier average selling prices (ASPs). But rapidly declining ASPs are a sign that 3G shipments are not growing fast enough to offset declines due to rising volumes of entry-tier products.

LG maintained its growth, shipping 21.9m units (up 15% quarterly and 33% year-on-year). Market share rose from 6.5% to 7.7%. Efforts to improve its cost structure via a streamlined platform offering drove improving profits and enabled strong performance in emerging markets, where demand for entry-tier CDMA and GSM phones helped it grow at its fastest rate for 18 months. However, demonstrating the difficulties facing global rivals, LG failed to balance this success in 3G product segments, as its WCDMA volumes fell 32% sequentially in Q3.

Market share for other vendors shrank further, from 18.3% a year ago to 16%, evidencing continued consolidation on the big five vendors.

For the holiday-sales-fuelled fourth quarter, the top vendors expect the market to grow more than 10% sequentially. Strategy Analytics forecasts 330m units. However, due to the strong demand, at least four of the top five have been suffering component shortages (mostly in LCDs and front-ends), which may persist in Q4 if growth continues at current rates, according to Strategy Analytics analyst Neil Mawston. Such component shortages could cut sales by about 5m units in Q4. Nevertheless, the market research firm does not expect much 'bleed-over' into Q1/2008. "Our latest channel-checks indicate an easing of supply constraints toward the December-January timeframe," Mawston adds.

www.strategyanalytics.net

Handset shipments (millions), market shares, and change in share.

Vendor	Q3/06	Share	Q3/07	Share	Change
Nokia	88.5	34.9%	111.7	39.2%	10.97%
Samsung	28.9	11.4%	42.6	14.9%	23.49%
Motorola	53.7	21.2%	37.2	13.1%	-61.83%
Sony Ericsson	19.8	7.8%	25.9	9.1%	14.29%
LG Electronics	16.5	6.5%	21.9	7.7%	15.58%
Others	46.4	18.3%	45.7	16.0%	-14.38%
Total	253.8	100%	285.0	100%	

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Hittite's revenues near \$40m in Q3 as growth continues

For Q3/2007, Hittite Microwave Corp of Chelmsford, MA, USA, which designs and supplies ICs, modules and subsystems for RF, microwave and millimeter-wave applications, reported revenue of \$39.9m (up on the firm's forecast of \$38.5–39.5m). This is also up 6.1% on \$37.6m last quarter and up 15.3% on \$34.6m a year ago. Of total revenue, 43% came from the USA and 57% from non-US customers (slightly down from last quarter's 59%).

Gross margin was 71.0%, level with last quarter but, unsurprisingly, down slightly on 73.5% a year ago. Net income was \$13.7m (again, up on its forecast of \$12.3–12.6m). This is also up from \$12.2m last quarter and \$11.6m a year ago.

Total cash and investments continued to rise, by \$17.7m during the quarter to \$161.5m.

"The continued acceptance of our products allowed us to deliver strong quarterly results," says chairman & CEO Stephen Daly. During the quarter, the firm introduced its 15th product line (its third this year): microwave passive ICs (initially including nine passive fixed attenuator paths, operating at up to 50GHz). "These building blocks will help our market penetration strategy," says Daly. Hittite also introduced 17 new active GaAs MMIC products (eight frequency converters, seven amplifiers, and two vector modulators), adding depth to its product line, says Daly. It is critical to continu-

ously extend frequency coverage and functionality and to improve performance attributes of the existing product line to maintain a competitive edge, he adds.

In October, Hittite also entered into a strategic agreement with Northrop Grumman Space Technology to license the Velocium line of MMIC products and related technology (see October issue, page 7). "These additions and the continued growth of our product portfolio will enhance our ability to penetrate our target markets," reckons Daly.

For Q4/2007, Hittite expects revenue up slightly to \$41.5–42.5m and net income of \$13.7–14.0m (level or slightly up on Q3).

www.hittite.com

WJ's 23% revenue drop widens losses, despite cost cuts

WJ Communications Inc of San Jose, CA, USA, which designs and supplies RF products for wireless communications, RFID readers and WiMAX, reported Q3/2007 revenue of \$9.8m. This is down 23% on \$12.7m in both the prior quarter and a year ago, due to several operational challenges, says president and CEO Bruce Diamond. "We experienced a shortage of lead frames late in the quarter due to several deliveries being rejected upon inspection by our assembly vendor. This issue has since been resolved, and we have resumed our shipment schedules."

Operating expenses have been cut to \$6.3m from \$7.3m last quarter and \$8.7m a year ago. "We remain pleased with the positive impact of our cost savings initiatives during the last several quarters," says Diamond. Following the closure at the end of March of its 4" GaAs wafer fab in Milpitas, CA (acquired in WJ's mid-2004 purchase of EiC Corp's wireless infrastructure business), which should save \$7m annually in costs, and the pending completion of the transition of final test and support operations to the Philippines (currently 90% com-

pleted and well ahead of its schedule of Q2/2008), WJ is now operating under a business model that has a much lower cost structure, Diamond adds. "We believe the cost savings associated with these initiatives [\$9m annually in total] will provide substantial leverage on future revenue improvements."

However, cost-saving initiatives were offset by higher-than-expected charges for inventory reserves of about \$200,000. This, together with the lower revenue, led to gross margin of 49%, down from 52% last quarter and 56% a year ago.

Net loss was \$1.3m, up from \$416,000 last quarter but almost level with \$1.2m a year ago. EBITDA was \$366,000, compared to \$1.3m last quarter (the first positive result in five years) and a loss of \$32,000 a year ago. "We were able to deliver positive EBITDA results for the second consecutive quarter despite lower-than-expected revenue," says Diamond.

WJ remains on track to introduce at least 15 new products in second-half 2007 (making a total of 32 in full-year 2007, compared to 21 in 2006 and just four in 2005).

Diamond believes this will add to the firm's robust design-win pipeline.

Also, WJ continues to expect that the TD-SCDMA build out in China will make a meaningful contribution to its business in 2008. China Mobile rolled out 10,000 base-stations to 10 Olympic cities in early 2007. Phase 2 will involve roll out to 110 more cities (in which WJ will have more involvement), including 40 cities in 2008. This comprises 40–50,000 base-stations in 2008 and 110,000–140,000 in total. Diamond says that WJ has design wins with two of the base-station suppliers (involving \$100 worth of MCMs, 28V power products and small-signal products per base-station, making a potential market of \$5m). However, the exact timing of the associated orders remains uncertain, although China Mobile is expected to make decisions in February.

For Q4/2007, WJ expects revenue of \$9.3–10.3m (flat on Q3, due to some weakness in the overall market) and gross margin of 49%±2% (flat on Q3). However, Diamond believes that WJ can ultimately drive towards a 60% gross margin.

www.wj.com



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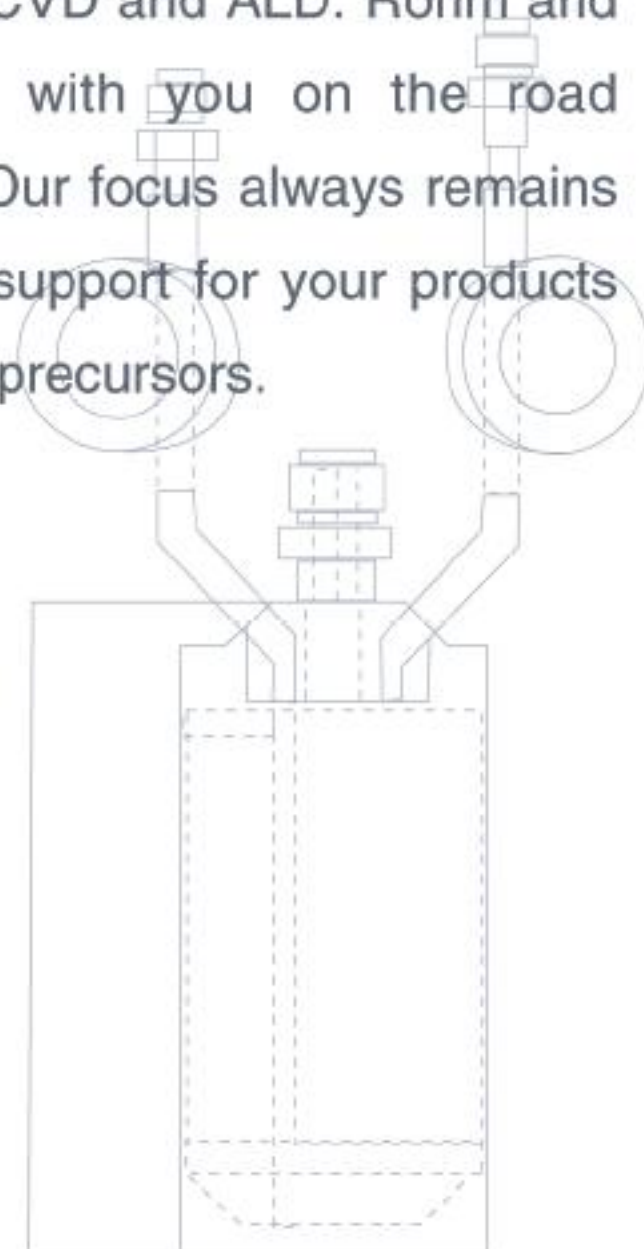
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RFMD's 21% sequential growth driven by Polaris 3 shipments to Nokia plus Motorola recovery

For its fiscal Q2/2008 (to end-September 2007), RF Micro Devices Inc of Greensboro, NC, USA has reported revenue of \$255.8m. This is up 3.6% from \$246.9m a year ago and a huge 21% sequentially from last quarter's \$211.6m, as it recovers from the drop in orders from Motorola that hit the first-half of calendar 2007.

"RFMD's record September quarterly revenue performance was driven by share gains, new product cycles, a strong customer base and a robust overall handset market," says president & CEO Bob Bruggeworth.

Compared to a net loss of \$20m a year ago, net income was \$14.5m (though down on \$23.6m last quarter). However, on a non-GAAP basis (excluding \$0.5m in start-up costs from expanding the Beijing assembly plant, \$1.1m in restructuring charges from the sale of Bluetooth assets, etc), net income has risen from \$6.6m last quarter to \$23.4m (nearly equal to \$23.7m a year ago).

In the Cellular sector, RFMD says it experienced sequential growth at leading handset makers, with strength at top customers and across all major tiers of the handset market. The firm started high-volume shipments of Polaris 3 (a fully integrated quad-band EDGE RF front-end) to Nokia and anticipates an aggressive product ramp in the December quarter. Also, 3G front-end revenue grew sequentially faster than 3G unit growth, as RFMD extended its number-one position in the high-growth 3G multimode device market (becoming the first company to ship 100 million WCDMA cellular front-ends for 3G handsets).

In the Wireless Connectivity sector, RFMD grew sales of wireless LAN front-ends, driven by its leading position in WLAN-enabled handsets and participation in leading 802.11n reference designs. The firm also achieved interoperability of its GPS architecture with a leading handset customer's system

platform. It also began commercial shipments into the WiMAX market and experienced favorable design activity on a leading WiMAX/WLAN reference design.

In the Infrastructure sector, RFMD shipped production volumes of all five products in its RF386x family of GaAs pHEMT multi-market low-noise amplifiers (LNAs). The firm also completed customer design review for GaN-based S-band military radar and started prototype testing and evaluation. In addition, RFMD started GaN design activity for new markets, including CATV line amplifiers and high-lumen lighting sources.

"RFMD is benefiting from higher-than-anticipated demand for Polaris 3 and record demand for our transmit modules," says Dean Priddy, CFO and corporate VP of administration. "The aggressive demand is temporarily impacting gross margin as Polaris 3 start-up yields are low, and the increase in demand for our transmit modules is causing higher-than-planned outsourcing of pHEMT switches," he adds.

"As a remedy, we are driving steady improvements in Polaris yields — even as we meet upside customer demand — and we anticipate yields will continue to improve throughout the quarter." Also, RFMD is continuing to add GaAs manufacturing capacity (announcing a \$100m expansion with a second GaAs fab in Greensboro). "We plan to reduce our reliance on outsourced pHEMT as that capacity comes online," says Priddy (having already terminated outsourcing of GaAs pHEMT switch manufacturing at Filtronic's Compound Semiconductor division, which has a 6" GaAs pHEMT fab in Newton Aycliffe, UK, from September onwards). "Accordingly, we view both issues as temporary in nature and expect both to be margin levers in calendar year 2008."

In the December quarter, RFMD expects sequential revenue growth of 4–9% to \$265–280m, driven by

its newly formed Cellular Handset and Multi-Market Products Groups. In the cellular handset market, RFMD is expanding its dollar content on a per-handset basis through strong sales of cellular front-ends and other high-performance RF solutions (including Polaris). The firm is also experiencing favorable design activity in its Multi-Market Products Group, and expects growth driven by multiple applications, including WLAN front-ends, multi-market LNAs and GaN devices.

"Our December guidance reflects strong market dynamics as well as continued share gains in RF semiconductors and an expanding leadership position in the industry's highest-growth segments and customers," concludes Bruggeworth.

● Sirenza extends run of record positive cash flow, despite drop in sales

RF component maker Sirenza Microdevices Inc of Broomfield, CO, USA (which RFMD acquired in mid-November) reported Q3/2007 revenue of \$45.9m, down slightly on \$46.7m last quarter but up 16% on \$39.7m a year ago.

"Our gross margin remained robust [at 45%, compared to 46% last quarter] and our pro forma operating expenses were lower than expected, resulting in strong pro forma profitability," says president and CEO Robert Van Buskirk.

"We again achieved a record level of pro forma income before taxes [\$10.1m, matched last quarter], particularly in light of our slight sequential revenue decline," says Van Buskirk. Excluding the effects of charges, pro forma net income was \$9.7m, up from \$9.1m a year ago and \$8.7m last quarter. Net income was \$2.7m, down slightly on \$2.8m last quarter and \$3.3m a year ago.

Cash flow from operations was \$7.2m, extending the record number of consecutive quarters of positive cash flow to four years.

www.rfmd.com

RFMD launches non-cellular Multi-Market Products Group

RF Micro Devices Inc of Greensboro, NC, USA has completed its acquisition of RF component supplier Sirenza Microdevices Inc of Broomfield, CO, USA.

For each Sirenza share, stockholders have received a combination of \$5.56 in cash and 1.7848 shares of RFMD common stock. Outstanding options to purchase Sirenza common stock were assumed by RFMD and converted into options to purchase RFMD common stock. Based on RFMD's closing stock price on 13 November, the Sirenza stock is valued at \$16.80 per share and represents an aggregate value of about \$900m (about \$300m in cash and the balance in RFMD stock). Sirenza common stock has ceased to be publicly traded and is no longer listed on Nasdaq.

The board of directors of the combined company consists of the current nine members of RFMD's board and two new members from Sirenza's board. Also, to capitalize on the expanded opportunities created by the merger, the management teams of RFMD and Sirenza are being combined.

"The acquisition of Sirenza Microdevices brings RFMD a broad set of customers and a diversified product portfolio of high performance RF components for multiple markets," says RFMD's president and CEO Bob Bruggeworth. "We are thrilled to add Sirenza's employees, stockholders and customers to our organization, and we look forward to executing on the many opportunities created by the combination of RFMD and Sirenza Microdevices, which we believe creates the world's largest, most diversified and best positioned RF company."

As a result of the acquisition, RFMD has announced the establishment of the Multi-Market Products Group (MPG), with Bob Van Buskirk

(former Sirenza president & CEO) relocating to North Carolina as the group's president. MPG joins the Cellular Handset Products Group (CPG), led by Eric Creviston, reporting to Bruggeworth.

"We believe this transaction clearly serves the best interests of the shareholders of Sirenza and RFMD as well as the best interests of the customers, suppliers and employees of both companies," says Van Buskirk.

MPG will drive its business through five market-oriented business units: aerospace and defense; broadband and consumer; wireless connectivity; wireless infrastructure; and standard RF components.

"We expect the formation of the Multi-Market Products Group will enable RFMD to significantly diversify its business and drive new, profitable growth opportunities beyond the cellular handset market," says Van Buskirk. "RFMD has a tremendous range of technologies, products and supply chain capabilities that MPG can leverage and deploy to better serve our broad base of multi-market end markets and global customers."

The firm cites examples of technology, products and supply chain benefits including:

- The deployment of RFMD's high-performance gallium nitride process technology into power

amplifiers (PAs) for CATV applications, power modules for new light-generation applications, and PA modules for cellular infrastructure and emerging WiMAX infrastructure applications;

- the re-deployment of existing cellular handset intellectual property (IP) into a wide range of broadband, consumer and wireless connectivity products;

- the addition of existing CPG products, currently incorporated into highly integrated cellular handset RF solutions, to MPG's current standard products portfolio, such as mixers, RF switches, variable gain attenuators, control devices and PA ICs;

- access to advanced technologies currently in development by RFMD, including micro-electro-mechanical systems (MEMS), integrated RF shielding, multi-chip module (MCM) packaging and gallium arsenide technologies, including next-generation GaAs HBT and GaAs pHEMT;

- the realization of significant supply chain efficiencies, including enhanced component and semiconductor wafer sourcing, cost-efficient IC packaging from common suppliers and greatly improved R&D development cycle times through RFMD's vertically integrated wafer fabs, IC/module assembly facilities and test facilities.

"As the president of RFMD's newly formed Multi-Market Products Group, I am extremely excited about our ability to grow our combined multi-market businesses," says Van Buskirk. "We intend to expand margins by leveraging our technology base and robust global supply chain, and we believe we have a tremendous opportunity to achieve profitable growth as the acknowledged leader in RF solutions," he concludes.

www.rfmd.com

The Multi-Market Products Group will enable RFMD to significantly diversify its business and drive new, profitable growth opportunities beyond the cellular handset market

Anadigics' margins dip during accelerated capacity ramp

For Q3/007, Anadigics Inc of Warren, NJ, USA, which makes GaAs-based wireless and broadband communications components and modules, reported its 10th consecutive quarter of revenue growth, to a record \$59.5m. This is up 10.5% on \$53.9m last quarter and up 35.5% on \$43.9m a year ago. Top customers were Cisco, Intel, LG Electronics, Huawei, Samsung, and World Peace Group.

Wireless revenues were \$34m (up 22% on last quarter and 45% year-on-year), spurred by continued strong momentum in 3G (\$30.3m, up 14% and 50%). Broadband revenues were \$25.5m (down 2% on last quarter but up 25% year-on-year), including \$14m in wireless LAN and \$11.5m in CATV. In particular, WiFi revenues were up strongly, by 21.6% sequentially and 42.7% year-on-year.

Net income was \$2.4m, an improvement on \$1.9m last quarter and net loss of \$1.3m a year ago. Excluding costs from September's acquisition of Fairchild Semiconductor's RF Group, pro forma income was \$6.5m (up from \$5.7m last quarter and \$1.1m a year ago). However, this was down slightly on guidance, as was gross margin at 35.1%. This is due mainly to manufacturing inefficiencies associated with the rapid build up of production capacity at its Warren fab.

"Anadigics has significantly increased its market share with several top tier customers, resulting in an unprecedented demand for its 3G, broadband CATV, and

WiFi 802.11n products," says Dr Bami Bastani, president & CEO. WiFi markets, in particular, continue to grow rapidly, driven by Intel's launch in May of its Santa Rosa fourth-generation Centrino platform (leading to Anadigics' content per motherboard doubling).

"These dynamics have required acceleration in our plans to add production capacity, which have caused short-term productivity issues," Bastani adds. These included equipment downtimes, as some tools did not ramp-up as quickly as anticipated (which impacted cycle time), and the inevitable higher incidence of mistakes by operators still in training mode (which impacted yield). "We anticipate some continuing manufacturing inefficiencies associated with the production capacity ramp throughout the fourth quarter," says Tom Shields, executive VP and chief financial officer.

However, Bastani highlights September's recruitment of John Coleman as senior VP of operations (formerly of STMicroelectronics, Atmel and Maxim Integrated Products) as timely. "Anadigics is getting to run rates where we thought we needed to bring someone in

from the silicon industry," he says. With Coleman already making a contribution, Anadigics will continue to address manufacturing inefficiencies in Q4/2007, Bastani adds.

Most new equipment should be in place by the end of Q1/2008, putting Anadigics' capacity ahead of demand and enabling an annual run-rate capability of \$400m by Q3/2008 (67% up on the run rate achieved in Q3/2007). In addition, the new fab under construction in Kunshan, China is on track to come on-line in early 2009, says Bastani.

"We remain confident in the company's ability to expand our financial leverage as we solve our manufacturing inefficiencies and achieve a more favorable product mix [of higher-value products in 3G WEDGE, WiFi 802.11n, and CATV]," Shields says. Also, Anadigics is engaging the merging market for WiMAX mobility products with complete reference designs, adds Bastani, claiming 70% share of the combined WiMAX point-to-point and mobility market.

For Q4/2007, Anadigics is already 100% booked to the low-end of its guidance of \$65.5m. The firm expects revenues to rise 10-14% sequentially and 35-40% year-on-year to a new record, reflecting continued strong demand. Gross margin should remain at about 35%, but in Q1/2008 should return to historic levels and exceed 40% by the end of 2009, reckons Bastani. In addition, visibility for Q1/2008 is "the healthiest we've ever seen", adds Shields.

www.anadigics.com

These dynamics have required acceleration in our plans to add production capacity, which have caused short-term productivity issues

Anadigics wins New Jersey Electronics Company of the Year award

In November at the Liberty Science Center, Jersey City, Bami Bastani received the New Jersey Technology Council's annual Electronics Company of the Year award for Anadigics' "exemplary best practices in technology, business strategy and market growth as benchmarked against other electronics



CEO Bastani (left) receiving the award.

companies throughout New Jersey".

Anadigics was also cited for its "leadership role in the semiconductor electronics market and its dedication to promoting the growth of third- and fourth-generation technology, specifically within the broadband wireless and wireline communication markets".

TriQuint makes gains, despite cost of Peak acquisition

For Q3/2007, RF front-end IC maker TriQuint Semiconductor Inc of Hillsboro, OR, USA has reported revenues of \$122.9m (up 19% on a year ago and 8% sequentially). Revenues comprised 54% for handsets, 35% networks, and 11% military; with 65% from Asia (up dramatically from 48% last quarter), 24% from the Americas (down from 38%), and 11% from Europe. For the sixth quarter in a row, Motorola and Samsung each contributed more than 10% of revenues.

Handset revenues grew 35% year-on-year (consisting of GSM/GPRS 43%, CDMA 39%, wideband CDMA, EDGE etc 18%). Transmit module revenues grew 185% year-on-year (CDMA up 440%; GSM up 110%). In particular, wideband CDMA/EDGE revenue doubled. After a slightly later-than-expected launch, TriQuint is now shipping millions of units per quarter of its EDGE transmit module.

Revenue for point-to-point radio products rose 46% on a year ago (due to increases in backhaul demand for remote locations). Ground-station product revenue rose 52%. TriQuint also achieved five design wins in the cable market. Military revenue grew a faster-than-expected 10%.

Because revenue gains were supported by inventory reductions, factory utilization was flat on last quarter. In particular, GaAs equipment utilization was about 70% (below the targeted 85-95%), leaving capacity for continued growth, says president and CEO Ralph Quinsey.

Operating expenses were \$39.5m (32.2% of revenue), up on \$30.7m (26.9% of revenue) last quarter. Net income was \$1.9m: though up from \$1.4m last quarter, this is down from \$8.1m a year ago.

However, this is due mainly to increased R&D spending of \$1.5m and in-process R&D charges of \$7.6m from the acquisition of Peak Devices. Excluding these, net income was a higher-than-expected \$11.8m, up on \$3.5m last quarter.

Gross margin was 32.2% (up from 26.5% last quarter).

Despite capital expenditure of \$5.6m and a net cash payment of \$14.7m to acquire Peak Devices, cash reserves rose from \$154.8m at the end of June to \$174.7m at the end of September.

"This was a strong quarter for TriQuint with solid revenue growth from each of our major markets," says Quinsey. This is due to strong growth in the firm's markets combined with improved execution, he adds.

"Integral to TriQuint's strategy is our broad technology portfolio, the broadest in the industry," Quinsey claims. "This includes multiple compound semiconductor technologies, SAW filters, BAW filters and high-volume module capability," he adds.

Furthering this strategy, the acquisition of Peak Devices brings

new products and technology for wideband applications.

TriQuint is currently expanding its product offering with new multi-function devices and application-specific filters for the radio and base station markets. "These integrated RF solutions are reducing system design complexity and improving performance for our customers," Quinsey says, who expects revenue to ramp in Q4/2007 and Q1/2008.

TriQuint has also raised its expectations for the military market, with interest in upgrades for existing airborne radar systems, technology migration to non-airborne radar systems, and opportunities in communications and electronic counter-measures (boosted by the addition of wideband capability from Peak).

Quinsey says that TriQuint is also continuing to attract funding for its gallium nitride development program and to complete key milestones. With stable, reliable process technology now in place, the firm is moving into the product design phase.

In Q3, bookings were a record \$144m. For Q4/2007, TriQuint is currently 87% booked and expects revenue of \$125-130m (up 21-27% on a year ago).

Quinsey outlines prospects as: growing handset revenue driven by multiple standards; and expanding growth drivers into non-handset markets. While making additional investment in R&D, continued efficiency improvements and improved product mix should also yield improved margins.

Quinsey targets that, when TriQuint achieves \$160-170m in quarterly revenue, gross margin should be 40% (dependent on a good product mix, keeping handsets in the 54-58% range).

www.triquint.com

Because revenue gains were supported by inventory reductions, factory utilization was flat on last quarter.

Quinsey outlines prospects as: growing handset revenue driven by multiple standards; and expanding growth drivers into non-handset markets.

Skyworks doubles earnings, driven by multi-mode front-end modules and linear products

RFIC maker Skyworks Solutions Inc of Woburn, MA, USA has reported fiscal Q4/2007 (to end September) revenue of \$190.5m, up 9% on last quarter's \$175.1m (though down slightly from \$193 a year ago).

Non-GAAP gross margin has risen to 39.4%. Chief financial officer Donald W. Palette attributes this to delivering on yield improvement initiatives, higher equipment efficiency and factory utilization, and enhanced product mix from multi-mode front-end modules (FEMs) and linear products becoming an increasing part of business.

Net income was \$22.0m, up from \$11.4m last quarter and compared to a net loss of \$96.4m a year ago (associated with exiting the base-band business in October 2006). Diluted earnings per share were a record \$0.14, compared to a loss of \$0.60 per share a year ago.

Skyworks also generated a record \$30m in cash flow from operations, despite investing \$12m in capital expenditure (mainly for wafer fab and assembly & test capacity).

"As we outlined a year ago when we exited the baseband product area, we set out to intensify our focus on areas of competitive differentiation [in the analog and RF domain], diversify into [non-handset] linear products markets with higher gross margins and longer product life-cycles, capitalize on content growth in 3G multimode applications, and generate superior financial returns," says president & CEO David J. Aldrich. "Today's results reflect progress along each of these strategic fronts, with strong top line and gross margin performance driving both record earnings per share and quarterly cash flow generation."

Aldrich adds that Skyworks is now partnering with leading chipset providers, which it was unable to do while competing with them in the baseband arena. The firm has captured several reference designs with top base-band providers.

Also, in the last year, Skyworks has launched over 100 new analog products as it rounds out its catalog. Linear products are now nearly 25% of the firm's total revenues. The addressable market is nearly four times that of the wireless handset industry, reckons Aldrich.

During the quarter, Skyworks ramped first-generation solutions enabling cost-effective remote metering/monitoring for utility and industrial applications (with a potential market of 2.5bn premises worldwide currently still using manual meter reading).

The firm also reached volume production levels with multiple, high-performance receivers in support of several top-tier base-station suppliers (resulting in higher RF dollar content for Skyworks, lower bill-of-materials cost for the customer, and smaller base-station size).

Aldrich says that Skyworks also enhanced its multimode FEM market share by growing EDGE and WCDMA shipments across all industry-leading handset OEMs, as well as securing important new customers, including starting shipments to a further tier-1 handset OEM. "We now have business with all five leading handset OEMs with multi-mode designs," he adds. Compared to \$1–2 per phone for 2G (CDMA, GSM), the average selling prices (ASPs) for front-end content in multi-mode handsets is three times more (nearly \$6). "This presents an incremental market opportunity of billions of dollars."

Also, Research In Motion (RIM) of Waterloo, Canada (which has shown strong growth in enterprise users) and MediaTek Inc of Hsinchu, Taiwan (which focuses on low-cost platforms for emerging markets) are now two of Skyworks fastest-growing customers. During the quarter, the firm launched power amplifier modules for RIM's 8830 world phone and extended the partnership with MediaTek beyond EDGE to encompass low-cost GPRS solutions.

"Further, with our implementation of a hybrid internal manufacturing and outsourcing strategy [for both foundry and assembly services], we are well positioned to profitably capture the increasing demand for highly integrated linear products and front-end solutions," reckons Aldrich, who believes Skyworks can outpace growth in its addressable market.

"Our operating model enables us to maintain high operating capacity utilization by creating second sources for high fixed-cost services like foundry and assembly." This gives supply chain flexibility, lowers capital investment and provides the ability to meet upside demand, which should improve gross margin and lower capital expenditure, he adds.

"Given strong order visibility and the ramp of our newest analog and front-end module designs, we once again anticipate revenue growth approaching 10% on a sequential basis [to \$207m for fiscal first-quarter 2008, to end-December]," says Palette. "Operationally, we plan to continue to leverage our diversified business model, further expand our gross margin to between 39.5% and 40% and, in turn, deliver earnings per share of \$0.15–0.17, on a non-GAAP basis."

● Skyworks acquires Rockwell HBT and RF MEMS patents and Freescale's GaAs PA/FEM IP

Also during the quarter, Skyworks acquired 16 fundamental HBT and RF MEMS patents developed by Rockwell Science Center, as well as the proprietary GaAs power amplifier/front-end module intellectual property, patents and rights to designs and reference designs of Freescale Semiconductor Inc of Austin, TX (which is exiting the PA sector to focus on core strengths). Freescale is now a reference design partner for Skyworks, giving it the vast majority of Motorola's PA business through 2008, reckons Aldrich.

www.skyworksinc.com

Skyworks converting fab to 6" and partnering with foundries

Skyworks Solutions Inc, which makes linear products, power amplifiers, front-end modules and radio solutions, says that it is expanding its manufacturing capacity, given the heightened demand for its products from tier-one handset original equipment manufacturers (OEMs) and a diverse set of analog customers.

The firm has already started the conversion of its internal GaAs HBT power amplifier wafer fabrication plant in Newbury Park, CA, from 4-inch to 6-inch wafers.

Also, to complement its internal manufacturing capabilities at both its GaAs HBT power amplifier fab in Newbury Park and its GaAs pHEMT switch fab in Woburn, MA, Skyworks is expanding partnerships with several foundries in Taiwan. In addition to leveraging their capabilities for specialty processes, chief financial officer Donald W. Palette says that, over the last few years, the firm has done a lot of work to provide 'copy exact' capability for critical processes of mature GaAs technology (e.g. pHEMTs and HBTs) to foundry partners.

Skyworks has also already acquired much of the required 6" equipment for its internal manufacturing transition. The firm is still buying some new equipment and qualifying new processes. However, this fits comfortably into the capital expenditure profile that Skyworks has had for the last several quarters, Palette adds.

Skyworks says that the hybrid expansion model requires no extra 'bricks and mortar', will cost much less than building a new standalone facility, and allows it to meet the surge in demand with a high degree of flexibility. The steps are designed to expand gross margins while maximizing return on invested capital.

The firm says that demand is being fueled by new customers and the growing need for 3G multimode front-end architectures in handsets.

The hybrid expansion model requires no additional 'bricks and mortar'... and allows it to meet the surge in demand with a high degree of flexibility

These contain increasingly complex transmit modules and provide an incremental market opportunity measured in the billions of dollars annually, and are forecasted to represent the majority of the more than 1.2 billion cell phones that will ship in 2009 as consumers move to more feature-rich, multi-band devices.

"With continued strong mobile phone growth forecasted for the foreseeable future, increasing GaAs content per handset, and traction within our Linear Products portfolio, we are implementing a hybrid capacity expansion model to maximize our internal capabilities while at the same time leveraging external partnerships," says Bruce Freyman, VP of worldwide operations.

"While we will continue to invest internally, our balanced approach is less capital intensive and more flexible, allowing us to meet customer demand without compromising gross margin or other key operating metrics," he adds. "These initiatives position Skyworks to support well over \$1bn in annual compound semiconductor revenue."

● Skyworks ships transceivers, PAs & LNAs for FEMTO cells

Samsung is using multiple solutions from Skyworks' Linear Products portfolio, including transceivers, PAs and low-noise amplifiers (LNAs) for use in FEMTO cells (small cellular base-stations for residential and small business environments that provide enhanced coverage in wireless networks and solve near-term signal coverage and capacity issues).

In-Stat forecasts that FEMTO cell subscriptions (installed devices) will grow to 40m by 2011 and surpass 100m end-users over the next five years, representing a market for FEMTO cell devices of over \$4bn.

www.skyworksinc.com

Skyworks orders second Tegal 6500 tool

Skyworks has ordered a second 6500 Advanced Etch cluster tool from plasma etch and deposition systems maker Tegal Corp of Petaluma, CA, USA.

The system will be installed in Skyworks' fab in Newbury Park, CA, joining its existing 6500 (ordered in December 2006, and already in use for etching SiN and other thin films on GaAs substrates), and will support Skyworks' business expansion in the multimode and multimedia handset market.

The 6500 is a high-vacuum cluster tool used in production fabs to etch a variety of thin films, and has an easy-to-use GUI, SECS/GEM communication, and flexible wafer shape and size handling capabilities, says Tegal. Optional integrated plasma strip and rinse chambers, electro-static chucks with a wide temperature range, plasma emission diode array end-point detection, and active wafer temperature monitoring and control are also available.

www.tegal.com

Kopin given to 17 December to regain Nasdaq compliance

Kopin Corp of Taunton, MA, USA, which makes heterojunction bipolar transistors (HBTs) and liquid-crystal CyberDisplays, has 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 third-quarter 2007 Form 10-Q financial report in time.

Kopin has previously received Nasdaq notifications for failing to file its Q3/2006 Form 10-Q, 2006 Form 10-K, and Q1/2007 and Q2/2007 Form 10-Q financial reports. The delays are due to an investigation into the firm's past stock option granting practices by a special investigative committee (appointed by Kopin's board). In May, the committee issued preliminary findings and recommendations that financial statements for 1995 through 2006 (and the related interim periods) should not be relied upon and should be

restated. Kopin says that it is working to complete any necessary restatements.

Nasdaq's staff have asked Kopin to provide an update as to whether the inability to file Q3/2007's Form 10-Q in time is a result of new circumstances or reflects any significant events concerning the investigation, the restatement or the firm's compliance with Nasdaq's listing requirements.

Previously, on 27 July, the Nasdaq Listing and Hearing Review Council decided that Kopin had until 25 September to file its overdue reports and any necessary restatements with the US Securities and Exchange Commission and Nasdaq, otherwise it could be suspended from the Nasdaq Global Market. But, after a review of the council's decision, on 17 September Nasdaq's board of directors stayed Kopin's delisting and, in late October, extended the deadline to 17 December.

"The board considered the actions of the company to identify and address the underlying problems that caused its failure to file, including its reliance on outside advisors, and its progress towards regaining compliance," says Joan C. Conley, Nasdaq senior VP and corporate secretary. "The board also considered the extraordinary circumstances faced by numerous public companies that have been required to restate historical financial statements due to accounting issues, including the delays associated with conducting independent investigations, seeking guidance from the SEC and obtaining review by outside auditors."

However, if Kopin has not regained compliance by 10 December, the Nasdaq board will instruct its staff to discuss the reason with the firm and to update it on whether they believe its stock should remain listed.

www.kopin.com

IEEE's Ebers Award for Pearton

The Institute of Electrical and Electronics Engineers Electron Devices Society's J.J. Ebers Award has gone to Steve Pearton, a distinguished professor of materials science and engineering at the University of Florida, in recognition of "developing advanced compound semiconductor processing techniques, and clarifying the roles of defects and impurities in compound-semiconductor devices".

Pearton earned his doctorate from Australia's University of Tasmania in 1983, then spent a decade at AT&T Bell Labs in New Jersey, where he developed both the scientific understanding and the application of a robust method of ion implantation isolation for III-V transistors now widely used in cell phone chips, including GaAs FETs, AlGaAs/GaAs HEMTs and AlGaAs/GaAs and InGaP/GaAs HBTs, enabling larger scales of integration and improved manufacturability.

Pearton joined the University of Florida in 1994. He has published 1280 papers, given 1000 talks and secured 12 pending or current patents. His work has been cited 23,000 times in academic papers by other scientists and engineers.

"Over the years, my collaborators and I have developed methods that helped realize new types of semiconductor chips and lasers ... that are now used extensively in cell phones, DVD players, the infrastructure of the Internet and military systems like advanced radar," Pearton said.

<http://insideuf.ufl.edu>



Steve Pearton.

First 4.5–10.5GHz fully molded 4mm x 4mm QFN receiver

Mimix Broadband Inc of Houston, TX, USA has launched what it claims is the industry's first fully molded 4mm x 4mm QFN-packaged receiver covering the 4.5–10.5GHz frequency range.

The XR1011-QH GaAs MMIC integrates an image reject mixer, an LO buffer amplifier, and a low-noise amplifier. The image reject mixer eliminates the need for an image bandpass filter after the amplifier to remove thermal noise at the image frequency. The receiver has a noise figure of 1.8dB and 13dB conversion gain across the band.

The XR1011-QH is suited to wireless communications applications such as millimeter-wave point-to-point radio, local multi-point distribution services (LMDS), satcom and VSAT.

www.mimixbroadband.com

SI GaAs epi market to grow at 8% through 2011 to \$467m

Driven by demand for HBT and pHEMT devices, the semi-insulating GaAs epitaxial substrate market will grow steadily at a compound annual average growth rate of (CAAGR) 8% through 2011 to \$467m, forecasts Strategy Analytics in its report 'SI GaAs Epitaxial Substrates Markets 2006-2011'.

In terms of surface area, the SI GaAs epi substrate market (merchant and captive) grew by 30% from 12,525ksi in 2005 to 16278ksi in 2006, and will grow at a CAAGR of 10% through 2011, reckons the market research firm.

In terms of revenue, North America will remain the largest market. However, the Asia-Pacific epitaxial

market, specifically Taiwan, will become second largest, benefiting from consolidation in GaAs manufacturing and integrated device manufacturer (IDM) facility upgrades, forecasts Strategy Analytics. Also, there will be a boost in 6-inch wafer demand, while the market for 4-inch material will fall sharply, by 24% over the next two years.

"As predicted last year, we have seen some significant supply chain changes," notes Asif Anwar, director of Strategy Analytics' GaAs service. "Our analysis shows that the acquisition of Emcore's epitaxial substrate business, in conjunction with strong growth for its own MBE substrates, placed IQE within 1 percentage

point of Kopin in 2006, while the MBE Technology acquisition should push the company into the number-one spot in 2007."

"GaAs will remain the mainstream solution for cellular handsets, which will be reflected in the continued demand for epitaxial substrates," predicts Stephen Entwistle, VP Strategic Technologies. "However, we have tempered our demand forecast to reflect die size reductions and the increasing integration capabilities of GaAs processes," he adds. "Nevertheless revenue growth will remain strong, as increasing raw material costs keep wafer price erosion at a minimum."

www.strategyanalytics.net

Strategy Analytics urges Filtronic sale rather than closure

Filtronic Compound Semiconductor in Newton Aycliffe, Durham, UK faces some significant challenges, given its scale of operation in a volatile and capital intensive environment, set against the small size of parent company Filtronic, reckons market research firm Strategy Analytics.

In 2006, Filtronic was the largest European GaAs device supplier, and was ranked 12th worldwide in the Strategy Analytics GaAs device vendor share rankings. However, exasperated by the loss of number-1 GaAs RFIC maker RF Micro Devices of Greensboro, NC, USA as a primary customer, Filtronic's management has been considering options that could include closure of its compound semiconductor operation.

However, in its report 'Filtronic — Life after RFMD', the Strategy Analytics GaAs service notes that, despite the official termination of its contract with RFMD, in 2007 Filtronic has continued to secure mul-

tiple orders for its pHEMT switch wafers (driving volume throughput) and is seeing strong demand from higher-value infrastructure and defense markets.

Filtronic continues to develop a sustainable position in both high-volume and high-value

markets, placing the firm in mutually exclusive sectors. This gives Filtronic a balance that is still being sought (or acquired) by leaders such as RFMD and Skyworks

and completely missing from other companies including Hittite and WJ, making the operations a sound investment for a potential buyer.

Filtronic continues to develop a sustainable position in both high-volume and high-value markets... a balance that is still being sought by leaders such as RFMD

"Filtronic still faces some significant challenges if this multi-pronged strategy is to be successful," observes Asif Anwar, director of the Strategy Analytics GaAs service. "Specifically, the company needs to concentrate on expanding its design and process capabilities, further develop its product lines and target high-margin sectors."

Strategy Analytics strongly recommends that Filtronic management strikes closure of its compound semiconductor operation off the list of options being considered. "We believe that the optimum solution for customers, employees and shareholders alike would be to sell to a company in similar or adjacent markets, creating opportunities to capitalize on Filtronic's existing capabilities, and growing strength and strategic position as a UK-European supplier of compound semiconductor technology," notes Stephen Entwistle, VP Strategic Technologies.

www.strategyanalytics.net

IN BRIEF

SiGe expands Asian design & application abilities in Hong Kong

SiGe Semiconductor of Ottawa, Canada plans to expand in Asia by relocating its Hong Kong operations to the Hong Kong Science and Technology Park (HKSTP), a US\$1.5bn project covering 22 hectares. The move is in line with SiGe's strategy to deliver its technology in conjunction with consolidated application design support.

SiGe's HKSTP facility will occupy 7522ft², an area three times that of its previous location. It will encompass design, applications, sales operations and customer support functions, including expanded engineering and applications lab facilities to keep pace with the increased demand for the firm's portfolio of products.

The move is expected to enhance SiGe's local R&D capabilities and support its local sales and operations functions. "HKSTP provides an ideal location for our design team to meet our customers' needs," says CEO Sohail Khan. "The high-quality infrastructure and support facilities provided by HKSTP will improve our working environment, and in turn we hope that this will result directly in efficiency gains." The strong link with local universities and applied research institutes should provide recruitment opportunities for local engineers to join SiGe, he adds.

HKSTP places participating tenants in focused technology sector clusters encompassing electronics, biotechnology, precision engineering and the information technology and telecoms industries. "This relocation to HKSTP is an important step for SiGe and our staff and clients in Greater China and Asia," says Khan.

www.sige.com

Radar ICs targeted at mid-range cars

Infineon Technologies AG of Neubiberg, Germany has announced the new RASIC family of radar system ICs, aiming to bring long- and medium-range automotive radar to mid-range cars as soon as mid-2010.

With the European Union planning to continue its safety campaign aimed at further improving road safety and decreasing the number of traffic accidents by 50% by 2010, there is a need for the large-scale introduction of integrated safety systems that can help reduce accident risk in critical situations, says Infineon. Long- and medium-range radar systems (covering distances of 20–200m to the front of a vehicle) can play a valuable role by identifying obstacles and automobiles ahead, despite visibility. If a collision is anticipated, headrests and seatbelts are in position to help alleviate the impact in advance of the accident. A similar signal is also sent to the braking or airbag systems. "Radar technology is the key to building innovative driver assistance systems to help avoid automobile accidents," says Hans Adlkofer, VP and general manager of Infineon Technologies' Sense and Control business unit.

However, with a price of more than €1000, existing automotive radar systems are very expensive and are an option in higher-end, luxury vehicles only. The systems also typically measure 10cm x 20cm, taking up a large amount of space in a car's fender area.

For this very reason, Infineon has used silicon germanium (SiGe) process technology, developed with the aid of Germany's Federal Ministry of Education and Research (BMBF) as part of the KOKON project and designed and qualified specifically for automotive use, to fabricate a highly integrated radar

chip. Unlike gallium arsenide components, SiGe manufacturing technology makes it possible to build simpler, smaller and more cost-effective radar sensors, claims Adlkofer.

Infineon's first radar chip, the RXN7740, is a front-end chip operating in the 76–77GHz frequency range (thanks to the SiGe transistor's transit frequency, f_T , of 200GHz) that includes function blocks for the oscillator, the power amplifier and four mixers for multiple antennas. Compared to existing radar systems, which implement these functions discretely, the RXN7740 enables radar systems to be shrunk to a quarter of the current size, while reducing system costs for the RF module by more than 20%, Infineon claims.

Infineon has also introduced new integrated test methods to ensure that its radar sensors meet the automotive industry's demanding quality requirements.

Initial samples of the RXN7740 radar chips are available, with production expected to ramp-up in mid-2009.

Adlkofer reckons that, thanks to the RXN7740 chip, long-range radar could become part of the standard equipment for automobiles in the mid-range automotive segment by mid 2010.

The market research firm Strategy Analytics predicts that, from 2006 to 2011, the use of long-range distance warning systems in cars could rise by more than 65% annually, with demand reaching 3m units in 2011, including 2.3m using radar sensors. By 2014, 7% of all new cars will include a distance warning system, primarily in Europe and in Japan, the firm reckons.

www.infineon.com/radar
www.kokon-project.com

NXP's SiGe:C BiCMOS process challenges GaAs for wireless

NXP Semiconductors of Eindhoven, The Netherlands (formerly Philips Semiconductors until September 2006) has launched the first of a series of silicon-based discrete solutions with the release of the BFU725F microwave NPN transistor.

The new device combines high switching frequency (70GHz), high maximum stable gain (27dB at 1.8GHz/10dB at 18GHz), and very low noise (0.43dB at 1.8GHz/0.7dB at 5.8GHz), suiting a variety of RF applications. Packaged in a plastic surface-mount package SOT343F, the BFU725F is available now for shipping in high volumes.

The ultralow noise figure improves the reception of sensitive RF receivers in various wireless devices (such as GPS systems,

DECT phones, satellite radio, WLAN/CDMA applications) and the high cutoff frequency is suited to meeting the needs of applications that operate in the 10–30GHz range (such as satellite low-noise blocks).

Developed to address both the performance needs of existing devices and the cost concerns of manufacturers, the BFU725F was developed using NXP's proven QUBiC4X silicon germanium carbon (SiGe:C) process technology for discrete components (the same process used to develop monolithic ICs and wideband transistors).

Other solutions already on the market include the TFF1004HN, a highly integrated IC for satellite low-noise block down-converters (LNBs), and the BFU725F

microwave transistor. NXP is also developing several more silicon-based wideband transistors and monolithic microwave integrated circuits (MMICs) that are due for launch later this year and in early 2008.

"QUBiC4X was designed specifically to meet the needs of real-life, high-frequency applications and delivers an unrivalled fusion of high power gain and excellent dynamic range", claims professor Bart Smolders, NXP's innovation manager. "The idea is to have a silicon-based process with the performance of gallium arsenide technologies, so we can provide cost-effective integrated high-frequency solutions".

www.nxp.com

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Nitronex qualifies new wafer fab for volume production

Nitronex Corp, which manufactures gallium nitride on silicon (GaN-on-Si) RF power transistors for the commercial wireless infrastructure, broadband and military markets, has completed qualification of its new manufacturing plant in Durham, NC, USA, verifying that it has replicated the process developed at its former headquarters and R&D facility in Raleigh, NC and that the new fab is prepared for volume production.

The move from Raleigh to Durham began in first-quarter 2007 and was finished in the second quarter, with qualification testing being completed in October. A summary of Nitronex's fabrication qualification report was due to be made available in late November.

"Completing rigorous qualification verifies that the material produced in the new Durham facility matches material produced in Raleigh," says VP of operations Bruce Cochran. "The data for parts generated in Durham show the same reliability and performance when compared to products from our Raleigh facilities," he adds. "This is a milestone for the company, and is further evidence that we have evolved from pilot-line production to volume manufacturing."



Nitronex's fab in Durham, NC, now qualified for volume production.

The qualification completes the firm's relocation into its new 85,000ft² R&D and manufacturing facility. Nitronex says the move enhances its manufacturing capacity and capabilities, while providing additional space for expanding R&D efforts.

This is evidence that we have evolved from pilot-line production to volume manufacturing

● ISO 9001 certification

Nitronex has received ISO 9001:2000 certification from Det Norske Veritas (DNV), verifying that its Quality Management System meets the global standard and expectations.

"ISO certification is a significant milestone in our journey to become a mainstream supplier to the wireless, broadband and military industries," reckons Cochran.

www.nitronex.com

Nitronex launches 5W pre-driver to complete amplifier line-up

Nitronex has developed a 28V, 5W-class GaN-on-silicon high-electron-mobility transistor (HEMT) designed for broadband applications from DC-6.0GHz.

Designed using Nitronex's patented SIGANTIC NRF1 process and packaged in a cost-effective plastic over-molded SOIC-8 package with an exposed thermal pad, the NPTB00004 achieves 250mW average output power at 1% error vector magnitude (EVM) in 3.5GHz WiMAX systems (single-carrier orthogonal frequency-division multiplexing access (OFDMA), 64-QAM 3/4, 8-burst, 20ms frame,



Nitronex's 5W NPTB00004 GaN HEMT.

15ms frame data, 3.5MHz channel bandwidth, and peak/average = 10.3dB).

"Having seen market demand for full transmitter line-ups based on

GaN technology, we developed the NPTB00004, an excellent pre-driver for our higher-power products such as the NPT25100," says director of marketing Ray Crampton. "Combined with other broadband Nitronex devices, this device allows designers to develop power amplifiers for multiple frequency bands using a common power device lineup," he adds.

The NPTB00004 is production ready, and the qualification report is available online.

Samples and application boards are available. Typical pricing is \$9 each in quantities of 1000.

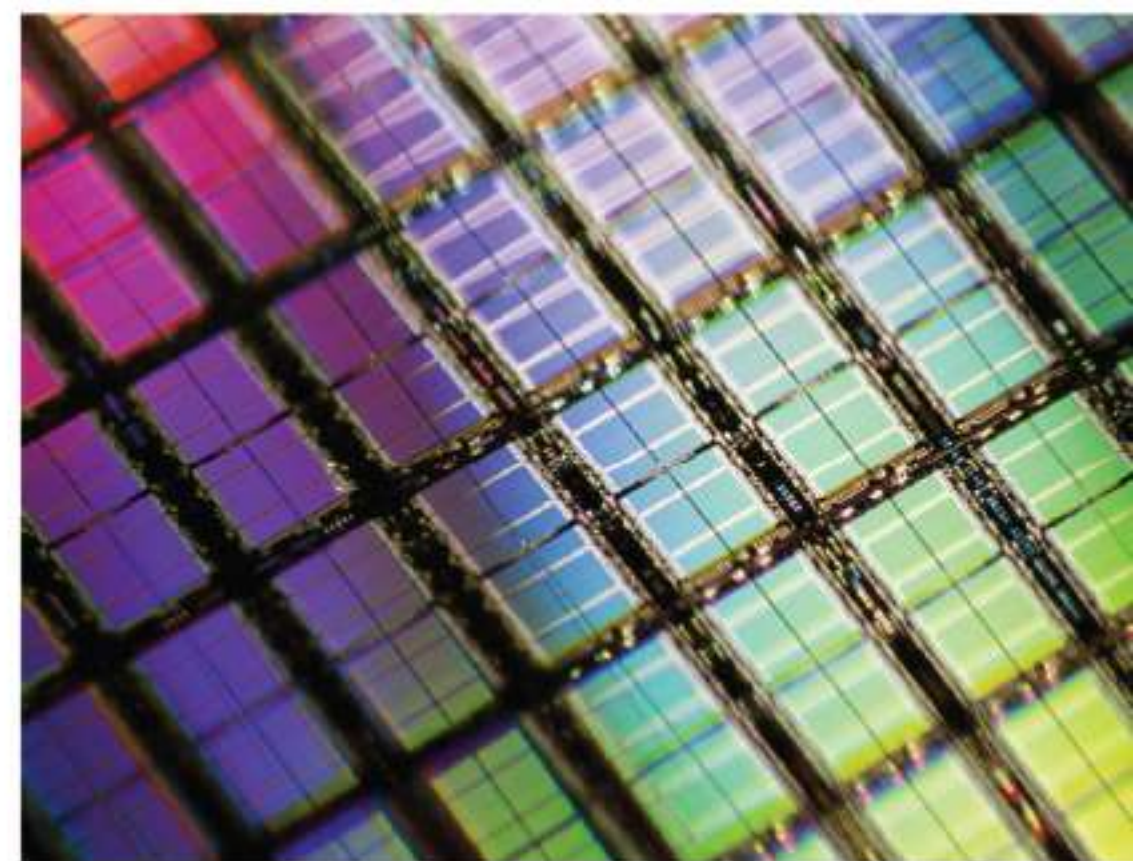


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SiC electronics \$800m by 2015

With the launch of a silicon carbide switch expected by 2010 expected to drive new developments in the automotive, industrial and IT fields, the annual SiC electronics device market should easily reach \$800m by 2015, according to the new report 'SiC'08 — Materials, Devices & Applications' by Yole Développement.

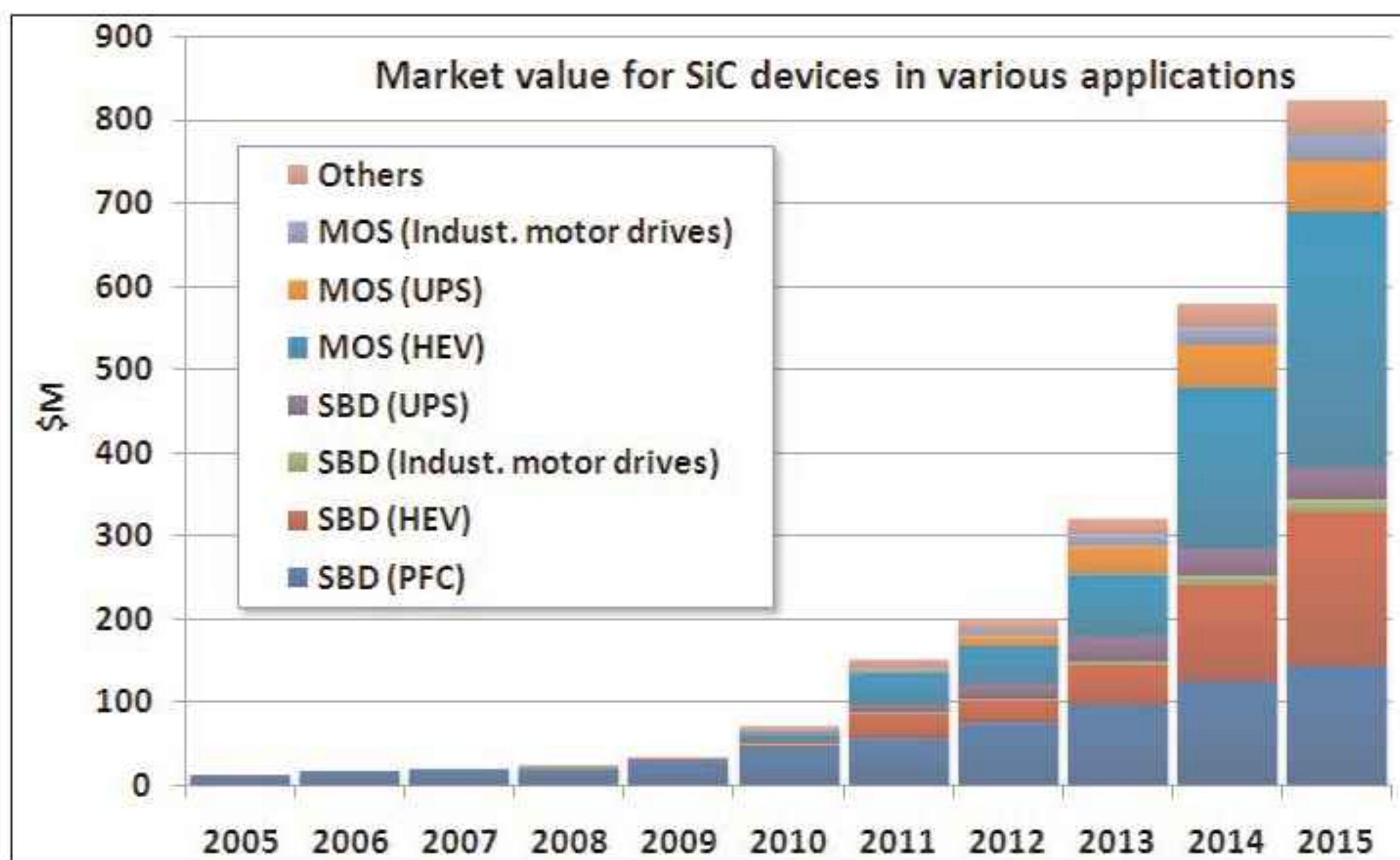
It is now clear that the relative stagnation of the SiC power device market is partly due to a lack of reliable transistor technology, says Yole. The power factor correction (PFC) sector is the only one driving SiC device sales, and prospects for higher market penetration are linked mainly to a drop in device cost.

Also, other applications require a complete SiC-based switching cell (i.e. a diode and a transistor).

SiC metal-oxide-semiconductor field-effect transistors (MOSFETs) have been investigated by major SiC R&D teams, but it seems increasingly certain that junction gate field-effect transistor (JFET) or bipolar junction transistor (BJT) technologies may be launched on the market first.

With the introduction last January of 4" diameter SiC substrates coupled with the ZMP (Zero MicroPipe) technology acquired with substrate maker IntrinSiC Semiconductor Corp of Dulles, VI, USA in July 2006, Cree Inc of Durham, NC, USA is now marketing a product able to match the main requirements of power device makers. However, few have yet entered into the production phase and, with the exception of Cree, Infineon and newcomer STMicroelectronics, no other player is commercially active in this segment.

The material cost and small diameter of SiC substrates have always been cited as a constraint to explain the low interest from the big players in the power device sector. So, now that these two issues are being resolved, the prospect of developing a SiC switch is not so far off.



Silicon carbide electronic device market, segmented by device type.

The SiC device business is not yet the most exciting money-making activity, acknowledges Yole. The market research firm estimates that sales of SiC-based power electronic devices generated revenues of about \$15m in 2006. The only product that is commercially available is the Schottky barrier diode (SBD), which is now reaching the 1200V and 20A range. This component targets many possible applications, but it is mostly used in high-end PFC systems, where it brings some impressive added value, such as improved power conversion efficiency and the elimination of many passive discrete components. However, the introduction of a SiC switch should definitely boost the market, says Yole.

Diodes and switches are coexisting quite well together but, even if the hybrid SiC-silicon approach is an option, full SiC electronics are highly desired for many applications.

To highlight this, hybrid electrical vehicles (HEVs) currently use silicon-based insulating-gate bipolar transistors (IGBTs) and diodes in their inverter module to power the (30–150kW) electric motors. This silicon chipset has to be cooled by a water-based system to maintain a device junction temperature of about 85°C. However, this requires

a dedicated water-cooling system (separate to the cooling system for the engine, which can handle higher temperatures). One of the objectives of HEV manufacturers is to simplify this setup by implementing SiC-based electronics that can easily withstand 150°C and more. This would then allow the use of a single water-cooling system rather than two. This way, a money saving of about 15% on the power module could be achieved. However, this approach only applies for a full SiC electronics chipset, and would not be realistic with a hybrid SiC-silicon solution. In terms of the requirements for this particular application, 1200V/100A SiC single chips would be ideal.

Up to now, the main R&D effort has been oriented towards the launch of SiC MOSFETs. Many announcements have been made (e.g. by Rohm, Cree, Acreo, Toshiba etc). However, oxide reliability and poor electronic mobility issues remain partially unsolved. So, even if the MOSFET remains the most studied device type, alternatives such as the JFET and BJT exist and are coming within the scope of some of the most prestigious R&D groups, concludes Yole.

www.yole.fr/pagesAn/products/sic.asp

Cree introduces 100mm Zero Micropipe SiC substrates

Cree Inc of Durham, NC, USA has announced the commercial release of its 100mm (4") Zero Micropipe (ZMP) n-type silicon carbide substrates.

Micropipe crystalline defects in SiC substrates can not only decrease the number of usable SiC and GaN devices (yield) produced per wafer but also negatively affect the performance parameters of each device produced (e.g. power-switching devices, LEDs and RF power transistors for wireless communications). The firm says that micropipes have been present in nearly all SiC wafers manufactured and sold by commercial substrate vendors until recently.

The first commercially available, zero-micropipe SiC substrates (with diameters of 2- and 3-inches) were developed by IntrinSiC Semiconductor Corp of Dulles, VA, USA. IntrinSiC was subsequently acquired in June 2006 by Cree, which integrated the ZMP technol-

ogy into its product line. The firm has since sold 76.2mm (3-inch) ZMP n-type 4H-SiC substrates (specified as having zero micropipes per cm^2) as well as (since September 2005) 100mm n-type 4H-SiC substrates specified as ultra-low micropipe (less than 5 per cm^2), low micropipe (less than 15 per cm^2) and select micropipe (16–30 per cm^2).

Together with previous R&D efforts at Cree — partially funded by the US Army Research Laboratory and the US Defense Advanced Research Projects Agency (DARPA) — the micropipe density in 100mm SiC substrates has been dramatically reduced.

Integration of this [ZMP] technology across other Cree product lines is expected to accelerate the adoption of silicon carbide

This led, in May, to Cree demonstrating the first 100mm ZMP, n-type SiC substrates.

"We expect that ZMP technology can significantly improve device yields, expand the range of products that can be designed and produced, and enable manufacturing at higher-volume levels than had been possible before," said Dr Cengiz Balkas, Cree's VP and general manager for materials (and former president and CEO of IntrinSiC), in May.

"The transition to production of Cree's 100mm ZMP substrate technology is an important step to the wide-scale industry adoption of SiC as the material of choice for high-power switching components," claims Balkas now. "The integration of this technology across other Cree product lines is expected to accelerate the adoption of SiC as a high-volume, production-ready material platform," he adds.

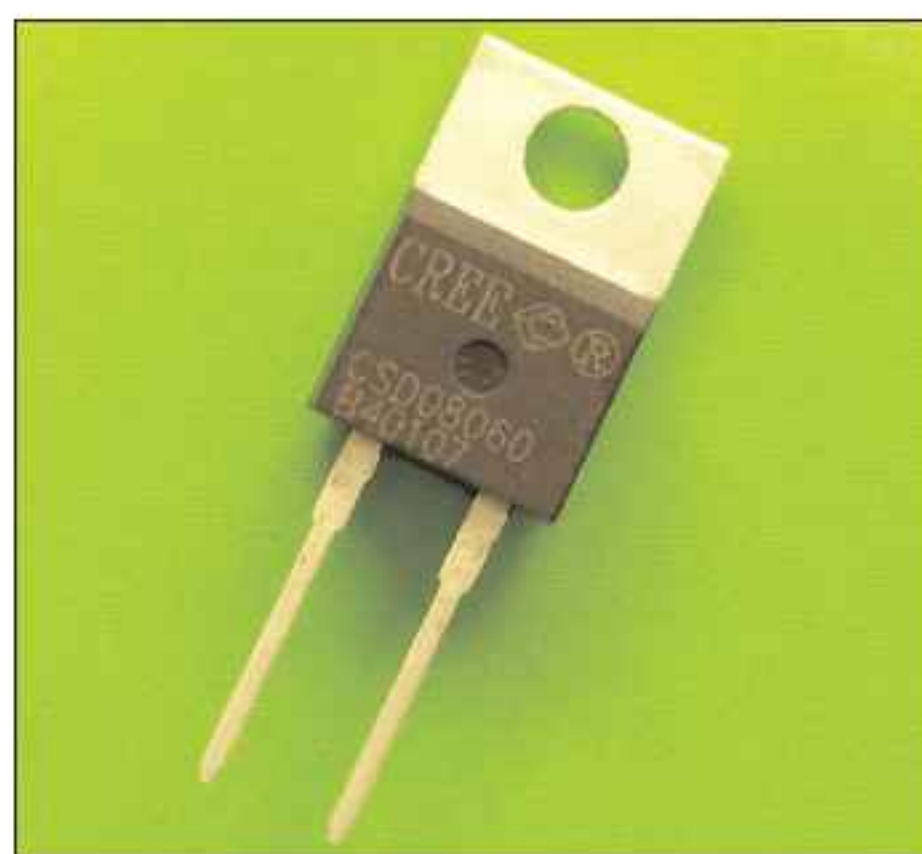
www.cree.com

Cree launches 8A rectifier to boost server farm efficiency

Cree Inc of Durham, NC, USA has launched a new 8 Amp silicon carbide Zero Recovery Schottky diode rectifier that can significantly increase power-supply efficiency in computer servers, the firm claims.

The CSD08060 expands Cree's SiC Zero Recovery product line, which includes 600V diodes with 1A, 2A, 4A, 6A, 10A and 20A ratings.

Compared with traditional silicon-based diodes, Cree claims that its SiC-based rectifiers can: simplify power factor correction (PFC) boost design; eliminate the need for snubbers; reduce power losses, leading to cooler operating temperatures; produce significantly less electromagnetic interference (EMI); offer faster switching speeds with-



Cree's new CSD08060 8Amp SiC Zero Recovery Schottky diode.

out reverse recovery currents; enable streamlined circuit design, resulting in smaller board size and component counts; and allow

higher-power-density designs for compact power supplies for high-performance applications.

Cree reckons that such devices can help to solve a significant global energy problem — the increasing power demands from large server farms. "Our new Schottky diode can significantly improve the efficiency of the power factor correction circuits used in switch-mode power supplies," says John Palmour, executive VP of advanced devices. "By replacing silicon-based rectifiers with the new 8 Amp SiC Zero Recovery rectifier, power supply manufacturers can cut power losses by at least 10% in a typical 1kW server power supply," he adds.

www.cree.com

SiCED expands

The Siemens/Infineon joint venture SiCED Electronics Development GmbH of Erlangen, Germany is extending its SiC epitaxy capabilities after choosing Aixtron's latest-generation Planetary Reactor platform, an AIX 2800G4 HT system, for 10 x 100mm and future 6 x 150mm SiC wafers.

"SiC material production technology for electronic power devices has reached a maturity level over the past decade that we are now in the position to prepare for the future," says SiCED's managing director Dr Peter Friedrichs. "We will benefit from a significant increase in wafer capacity for the available 100mm technology, and we will be prepared for future diameter enlargements," he adds.

"In the past six years of employing Aixtron Hot-Wall Planetary Reactor technology at SiCED we have been impressed by the reproducibility of production results from more than 1000 processed 3" SiC wafers per year with a wafer yield reaching 99% for commercial high-power Schottky diode products," says Friedrichs. "The new production platform will further drive down the costs of epitaxy required for SiC power devices."

"Planetary Reactor technology has been proven to deliver state-of-the-art SiC epitaxial layer quality with exceptional high wafer yield of 99% for today's Schottky diode volume production at SiCED," says Dr Frank Wischmeyer, managing director of Aixtron subsidiary Epigress AB. Implementing the newest-generation reactor technology will enable the next step in volume production of SiC power devices at SiCED in 2008. The system represents a 100% increase in processed wafer area per run compared to today's 6 x 100mm VP2400HW platform. "It is the largest and highest-throughput SiC epitaxy system in the market place," he claims.

www.siced.de

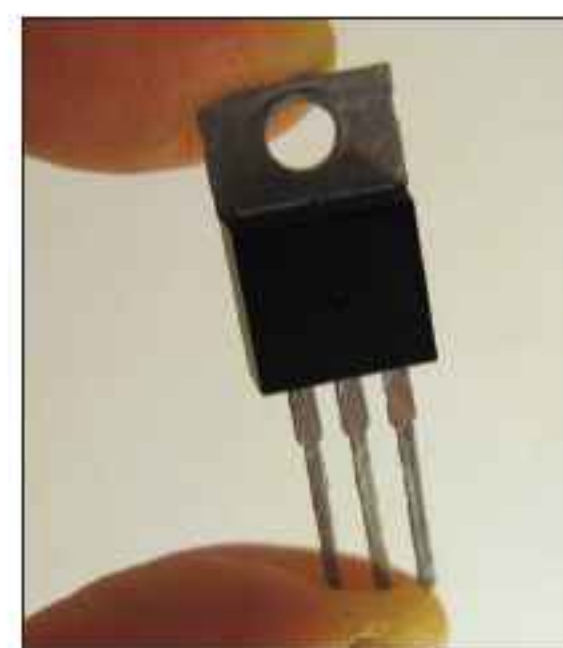
TranSiC launches first SiC switching power transistor in TO-220 package

TranSiC AB of Kista, Sweden, which was spun off from the Royal Institute of Technology in 2005 and develops SiC power transistors, has launched the world's first SiC switching power bipolar junction transistor (BJT) in a TO-220 package. This follows the introduction of engineering samples of its BitSiC1206 chip earlier this fall.

The new BitSiC1206 (1200 Volt, 6 Amp) device is a 'normally off' transistor (much desired for power electronics) and can handle very high junction temperatures. Currently, there is nothing else available that is 'normally off' for such high breakdown voltages and high junction temperatures (above 225°C), claims CEO Bo Hammarlund.

SiC Schottky diodes have been available for a few years, but designers have been in need of a switching transistor. "Our first release of the chip was successful, and we have plans now to follow up this release with high-temperature (250°C) metal can packaging for our BitSiC as well," says Hammarlund.

The BitSiC also has a negative temperature coefficient, so it is



TO-220 packaged BitSiC 1206.

suitable for parallel coupling for higher currents.

TranSiC says that a few applications are arising where designers want to

migrate from silicon power components, e.g. controlling high-power (1kW+) motors in hybrid electric vehicles (HEVs), trains and avionics, as well as next-generation wind turbines and distributed electrical power grids. For all these applications, SiC can solve the problems of a high-temperature environment, electro-magnetic interference (EMI) and switching losses, the firm says.

Engineering samples of the packaged BitSiC1206 are available.

Hammarlund adds that TranSiC is accelerating its development and is now moving to 20A devices.

www.transic.se

Microsemi wins \$1.6m AFRL contract to develop SiC RF power devices

Microsemi Corp of Irvine, CA, USA has been awarded \$1.6m by the US Air Force Research Laboratory (AFRL) for its Power Products Group (formerly Advanced Power Technology of Bend, OR, USA) to develop silicon carbide RF power semiconductor components for future designs of lighter and more efficient jet-fighter avionics, communications and radar systems.

SiC offers advantages in avionics applications including increased reliability, extended battlespace coverage, point-of-use power conversion, and reduced size and cooling requirements, says the firm.

Microsemi reckons that the AFRL

contract will enable substantial growth of its operations in Bend, and establish the firm as an independent supplier of products to the commercial market.

The AFRL program complements the initial license agreement with US defense contractor Northrop Grumman Corp announced in February 2006, in which Microsemi provides it with SiC products.

"Microsemi is committed to being a technology innovator in the development of next-generation SiC products for defense and commercial applications," said president and CEO James J. Peterson.

www.microsemi.com

SMI wins SBIR Phase II funds for SiC MOSFET dielectrics

Structured Materials Industries Inc (SMI) of Piscataway, NJ, USA says that it has received funding for Phase II of a project to develop electronic devices based on silicon carbide with significantly improved performance and reliability.

Specifically, the project is developing gate dielectric materials for SiC devices based on high dielectric constant (high-k) materials.

Such materials allow increased transistor gate thickness without sacrificing device speed or performance, allowing lower electric fields

in the vicinity of the transistor gate and reducing leakage currents. Similar technology has been applied to silicon device manufacturing to allow the continued shrinking of transistor dimensions. SMI is applying high-k materials to SiC device manufacturing to produce transistor devices that are more reliable and have better high-temperature performance. Energy-efficient, high-temperature, radiation-hard transistor devices are needed in high-energy physics applications, as well as other com-

mercial, military and scientific applications.

In Phase II, SMI is integrating its high-k film structures into SiC device manufacturing, and refining production-worthy tools and process technologies for both high-k film deposition and SiC MOSFET fabrication. At the end of Phase II, the firm says that it will have developed and demonstrated optimized SiC MOSFET devices, with significantly improved performance and reliability over existing devices.

www.structuredmaterials.com

GeneSiC wins SBIR & STTR grants for SiC power devices

GeneSiC Semiconductor Inc of Dulles, VA, USA says that it has recently won three Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) grants from the US Department of Energy (DoE).

Founded by Dr Ranbir Singh as president in 2004, privately held firm GeneSiC develops high-temperature, high-power, and ultra-high-voltage silicon carbide devices for rad-hard and sensor applications, including high-temperature rectifiers, field-effect transistors (FETs), bipolar devices as well as particle and photonic detectors. The firm's initial focus is on government-centered customers but, as commercial applications are identified, it will focus on commercial markets.

The DoE grants allow GeneSiC to demonstrate high-voltage SiC devices for energy-storage, power grid, high-temperature and high-energy physics applications.

The projects are as follows:

- A Phase II SBIR grant from the DoE's Office of Science for the development of multi-kV SiC power devices for high-voltage power sup-

GeneSiC's new lab and office space in Dulles.



plies used in high-power RF system applications (following on from a Phase I SBIR grant in fiscal 2006).

- A Phase I SBIR award focused on high-current, multi-kV thyristor-based devices oriented towards energy-storage applications.

- A Phase I STTR award addressing optically gated high-voltage, high-frequency SiC power devices for environments rich in electromagnetic interference, such as high-power RF energy systems or directed-energy weapon systems.

"These projects will enable GeneSiC to develop industry-leading SiC devices through its unique device solutions," says Singh.

Collectively, the devices developed in these projects promise to provide critical enabling technology to support a more-efficient power grid, and will open the door to new commercial

and military hardware technologies that have remained unrealized largely due to the limitations of contemporary silicon-based technologies, the firm says.

GeneSiC says it is capitalizing on its core competencies in device and process design to develop SiC devices, backed up by access to a suite of fabrication, characterization and testing facilities. In support, the firm recently relocated to expanded laboratory and office space in Dulles, with significantly upgraded equipment and personnel infrastructure. GeneSiC is also hiring additional key personnel experienced in device fabrication, power device design and semiconductor detector designs.

"Being awarded this significant Phase II follow-on, along with the new grants in high-visibility applications such as energy-storage and management, is an important validation of GeneSiC's core competencies," concludes Singh.

www.genesicsemi.com

AXT's 6" GaAs sales dip due to BiFET transition

For Q3/2007, substrate and raw material supplier AXT Inc of Fremont, CA, USA reported revenue of \$14.5m, up 7% on Q2's \$13.6m and 16% on \$12.5m a year ago.

Gallium arsenide substrate revenue was \$9.9m, up 6% on Q2's \$9.3m but down 7% on \$10.6m a year ago.

In particular, revenue for 2-3" semiconducting (SC) GaAs substrates rose from Q2's \$4.6m to \$6.3m, driven by demand from LED makers (both existing customers fearing GaAs shortages and therefore placing large orders, as well as new customers seeking an alternate source). The latter includes a US customer returning after many years (qualified for production release in Q4).

However, 6" semi-insulating (SI) GaAs wafer sales of \$2.2m were down from \$2.8m in Q2 (with the split of SI to SC GaAs correspondingly shifting from 67:33 to 42:58). This was due to "two unexpected events with two 6" customers", says chief financial officer Wilson Cheung.

CEO Phil Yin says this included one customer making an inventory correction due to AXT only being qualified for BiFET technology in Q4/2007. The other customer transitioned to a new device with different specifications. A consequent gain issue led to inconsistent failure rates, so production shipments were put on hold while new sample substrates were sent. These now conform to the new requirements, says AXT, so large-scale shipments have resumed.

Indium phosphide revenue was back to a more 'normal' \$408,000, down 38% on Q2's \$660,000 (which included \$250,000 from a one-time sale of InP scrap). Nevertheless, this was up 20% on \$340,000 a year ago.

Germanium substrate revenue was \$536,000, up 33% on Q2's \$402,000 and 39% on \$387,000 a year ago. AXT says it is one of few substrate suppliers for concentrator photovoltaic (CPV) cells, with two customers in production, a large US customer taking initial production orders (ramping slowly to mid-2008) and four in Europe in qualification.

Raw materials sales were \$3.6m, up 9% on Q2's \$3.3m and almost tripling from \$1.3m a year ago due to demand from a US customer and price rises. Four-nines (99.99%) pure gallium has risen from \$350-400/kg in January to \$650-700/kg now, while six- and seven-nines gallium has risen to \$750-900/kg. Likewise, germanium has risen from \$630/kg a year ago to \$1200-1300/kg now.

Gross margin was 31.3%, down on Q2's 36.9% but up from 27.7% a year ago. Likewise, net income was \$858,000, down from Q2's \$1.2m but up from \$639,000 a year ago.

Several trends are driving rising demand, such as rapid cell-phone replacement cycles, the emerging market for low-cost handsets, the proliferation of applications for LED lighting and the increasing focus on solar energy, says Yin.

The qualification of BiFET devices led to an industry-wide slowing of 6" SI GaAs substrate sales in 2007, adds Yin, but the emergence from the lull after the transition to BiFETs is a positive step for suppliers. The technology's higher level of integration suits low-cost phones for emerging markets, which are on course to comprise 481m unit sales in 2007 (43% of the market). Also, BiFET's contribution to longer battery life and lower RF losses should drive use in high-end handsets too.

For Q4/2007, AXT reckons revenue will grow again sequentially, by 6-9% to \$15.3-15.8m, mostly due to the two 6" SI GaAs customers ramping back up to expected run rates (and big 6" order influxes from AXT's four largest customers), as well as SC GaAs for LEDs gaining momentum. However, 6" SI GaAs substrates should be a larger proportion of sales in 2008 (targeting a return more to the 67% proportion of Q2/2007), so profit margin should recover to Yin's target of mid-30% in Q4.

Longer term, October's announcement by Skyworks of its transition from 4" to 6" GaAs represents an opportunity for AXT, says Yin.

Raw materials revenues should fall to a 'more normal' \$3.2m as gallium pricing has peaked, reckons Yin. Nevertheless, AXT is investigating opportunities for more joint ventures for raw materials, he adds.

InP revenue should remain at the \$400-500,000 level near term. However, AXT is qualifying a new InP customer that should contribute to revenues in 2008. Since InP is one of AXT's most profitable products, this should boost margins.

"Our own internal competencies are expanding into complementary technologies, such as standard Czocharski and liquid encapsulated Czocharski (LEC) crystal growth, allowing us to offer a comprehensive product portfolio spanning a wide variety of applications," says Yin. Small-diameter (2-3") SC GaAs substrate sales are high-volume and low-margin, below 20% (especially for the majority of customers — LED makers in Taiwan — where pricing pressure is 'horrendous'). However, the less critical etch-pit density for LEDs (compared to microelectronic devices) allows the use of LEC growth (which is faster and yields longer ingots than VGF). Also, the trend among some manufacturers to transition to 4" substrates should help, although ramps are currently small, and AXT has so far only shipped mechanical wafers. In contrast, single-element Ge (with no segregation coefficient) can be grown faster using standard Czocharski, offering greater flexibility in pricing and performance.

"We believe we are coming to another inflection point in our business as the convergence of these increasing market opportunities, coupled with the completion of the industry BiFET transition and leverages within our business model, create opportunities for growth in the coming years," Yin concludes.

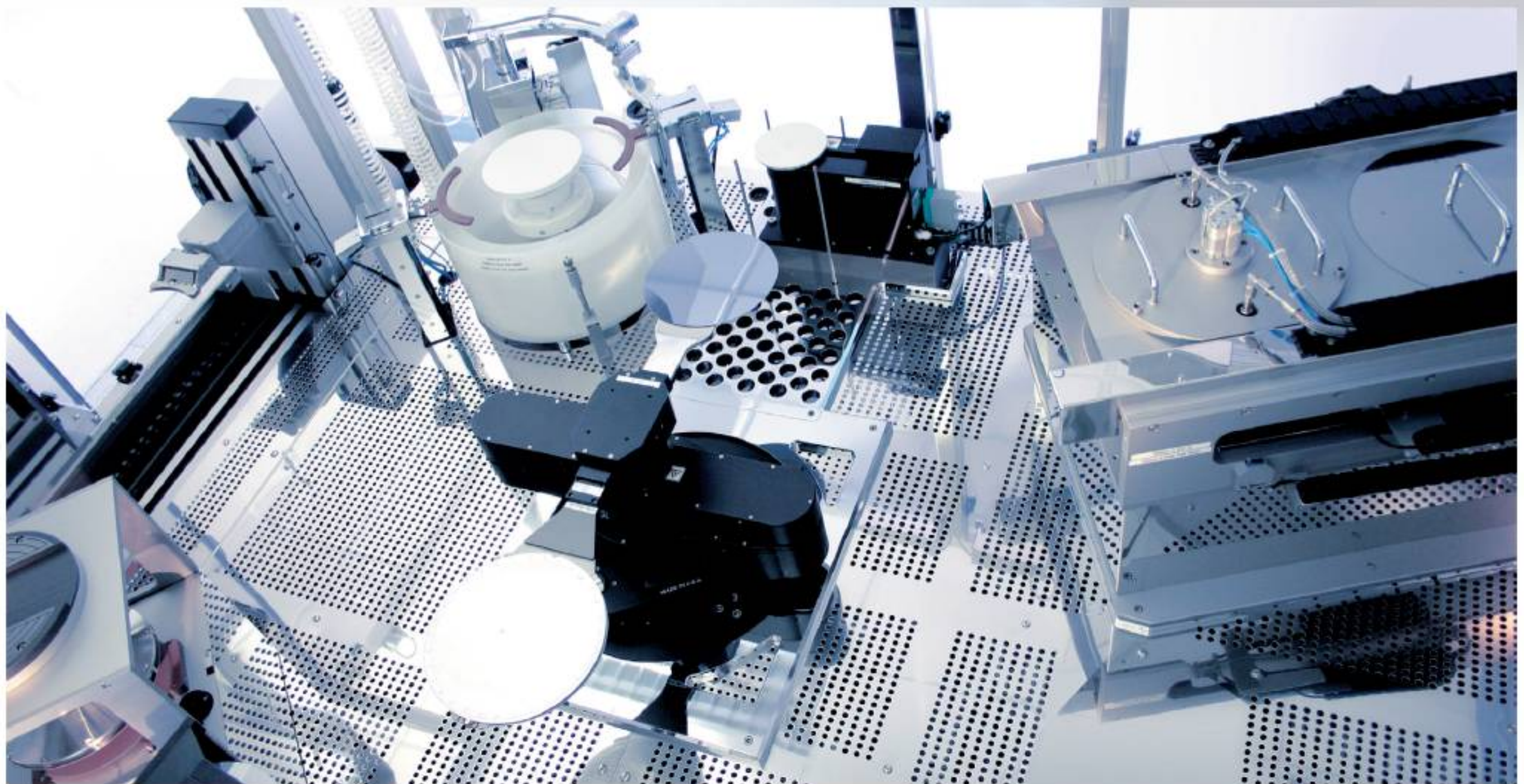
www.axt.com

Emergence from the lull after the transition to BiFETs is a positive step

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Lam receives further Nasdaq notice

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

This follows a similar letter received on 27 August due to delayed filing of Lam's annual report on Form 10-K for the year ended 24 June. Subsequently, in a hearing before the Nasdaq Listing Qualification Panel on 11 October, Lam's management presented its plan to regain compliance with respect to the annual report. Pending a decision of the panel, Lam's shares will continue to be listed on the Nasdaq Global Select Market. Lam is now presenting its views with respect to this additional deficiency to the panel, requesting an extension.

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

The independent committee is working with independent outside legal counsel to complete the review as soon as possible. Lam will not be able to file the delayed 2007 Form 10-K or September Form 10-Q until after completion of the review and until the firm can determine whether it needs to record any non-cash adjustments to compensation expense related to prior stock option grants.

www.lamresearch.com

Applied acquires Edwards' Kachina parts cleaning & refurbishment unit

Process equipment maker Applied Materials Inc of Santa Clara, CA, USA has completed its acquisition of certain assets of the Kachina semiconductor equipment parts cleaning and refurbishment business of Edwards Vacuum Inc of Wilmington, MA, USA.

The acquisition (announced in late August) expands Applied's existing Chamber Services network of facilities and enhances its position as a global service provider of critical parts cleaning, coating, refurbishment and analytical technologies.

Included in the deal are Kachina's operations at facilities in Austin, TX; Phoenix, AZ; and Hillsboro, OR, as well as Kachina's on-site service operations at customer sites in the state of Virginia, Israel and Ireland. The assets will be integrated within Applied Materials' Global Services organization, which operates parts cleaning facilities throughout North America as well as in Europe, Israel, Taiwan, Singapore and China as part of its Metron Chamber Performance Services product unit.

Kachina's former parent company Edwards (formerly BOC Edwards until this July) of the UK, which supplies vacuum and abatement equipment and services, retains the the division's operations in France and the UK.

"The sale of the Kachina parts-cleaning business to Applied Materials will enable Edwards to focus resources on providing world-leading products and services either side of the process tool and on the profitable growth of its core vacuum and abatement business," said Edwards' CEO Nigel Hunton.

Separately, in late August Edwards sold its 50% stake in BOC Edwards HTC Ltd (which was formed in early 2005 in Hsinchu to supply parts cleaning services in Taiwan) to its former joint venture partner Highlight Tech Corp of Tainan City, near the Tainan Scientific District.

www.appliedmaterials.com

www.edwardsvacuum.com

www.high-light.com.tw

SMI sells its largest GaN system

Structured Materials Industries Inc (SMI) of Piscataway, NJ, USA has sold its largest GaN MOCVD system, capable of depositing on several 2" wafers or a single 6" or 8" wafer.

The reactor is capable of operating well through 1200°C, using SMI's new patent-pending face-cooled showerhead, which offers two-line injection for uniform ammonia and precursor isolation, as well as zoned radial precursor isolation for depletion effect cancellation.

The system also offers a center heater design for full deposition-plane thermal uniformity, tunable at all temperatures. The showerhead also offers one of the largest optical access ports in the industry, SMI claims, suiting optically

monitored film deposition for researchers and single large wafer manufacturers.

The large-area deposition tool suits LED and electronic device film growth and provides an alternative and economical solution for GaN materials research compared to commercial production tools, SMI claims.

"This system will be our most advanced nitride tool yet — providing advanced heating and monitoring capabilities not previously available — and contributes to our growing line of research and pilot reactor systems," says Structured Materials Industries Inc's president and CEO, Dr Gary S. Tompa.

www.structuredmaterials.com

StratEdge expands to new HQ

StratEdge of San Diego, CA, USA has moved its headquarters to new facilities, still in San Diego, CA, USA, that enable it to increase capabilities and space for package design, manufacturing, assembly and test services, and to streamline these processes to maximize quality and efficiency.

The new 12,268 square foot facility includes a Class 100 manufacturing area for precision bare die assembly. Besides corporate offices, the plant will house design, manufacturing, assembly, and test for StratEdge's high-performance packages, which operate at frequencies from DC to over 50GHz. The main manufacturing lines are thick-film printing, furnace operations, plating, and microelectronics assembly (including component attachment, wire bonding, and electrical test).



StratEdge's Class 100 assembly cleanroom.

"We were able to design and build our new offices to our own specifications for optimal manufacturing and traffic flow, improved efficiency, and to increase space for our assembly and packaging services, which have grown considerably over the past year," says president and CEO Tim Going. "We are also putting many green practices into effect, such as our closed-loop water purification system."

www.stratedge.com

GPT expands European network

Johnson Matthey Gas Purification Technology (GPT) group of West Chester, PA, USA, which makes bulk and point-of-use gas purifiers, has expanded its European Distribution and Service network via:

- CMC Instruments in Germany;
- Innodys in France, Spain, Portugal and the UK;
- Sigma Technologies in Italy and Eastern Europe.

"Our new distributors support gas companies and customer facilities using high-purity gas for silicon, compound semiconductor, PV and analytical applications," says national sales manager Stuart Bestrom. "Our distributors' knowledge of their local markets will help us make sure that our products and services meet the needs of the growing European marketplace."

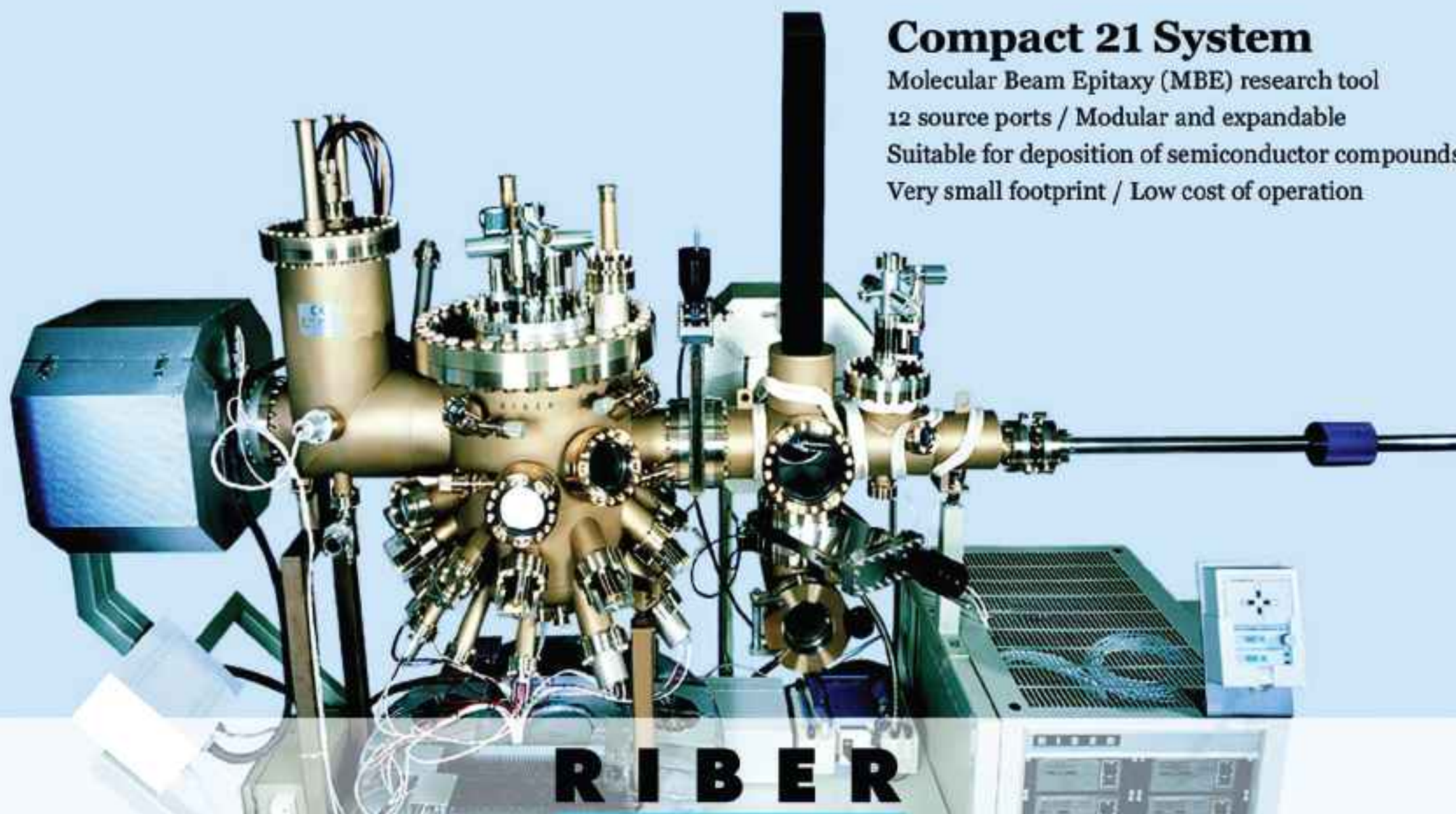
www.pureguard.net

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Aixtron's Q3 orders rise 39% on Q2, raising 2007 forecast

For the first nine months of 2007, deposition equipment maker Aixtron of Aachen, Germany has reported revenues of €160.7m (up 48% year-on-year from €108.6m). Equipment for silicon comprised 21% of revenue (down from 31% of revenue a year ago) and compound semiconductor equipment comprised 67% (up significantly from 49% a year ago, as Asian LED makers drove a doubling in compound semiconductor equipment revenue). Of total revenue, 86% came from Asia (up from 81% a year ago), 8% from the USA (down from 9%) and 6% from Europe (down from 10%).

Reflecting the increasing proportion of new common platform system revenues, paired with a favorable product mix, gross margin improved slightly from 38% to 39%.

Earnings before interest and taxes (EBIT) was €16.4m (compared to a €2.4m loss a year ago). This led to net profit of €14.8m (compared to a €2.4m loss a year ago).

In Q3/2007, revenue was €51.7m, up 14% on Q2's €45.2m and 26% on €40.9m a year ago.

Also, equipment order intake was a quarterly record of €70.0m (up 39% on Q2's €50.3m and the sixth consecutive quarter over €40m). This led to nine-months intake of €160.8m (up 20% year-on-year from €133.5m). Of this, silicon equipment comprised just 19% as compound semiconductors grew to 81% (compared to 24% and 76%, respectively, a year ago).

Order backlog rose 28% during Q3, from €80.3m to €102.8m (up 5% on €98.3m a year ago, and the

largest backlog since 2002). Of this, silicon equipment comprised just 7% and compound semiconductors 93% (versus 14% and 86% a year ago). This was due to silicon equipment order backlog falling 50% year-on-year, while compound semiconductor order backlog rose 14%.

"Coupled with the continuously improving profitability during the year, we are just beginning to reap the benefits of the very focused approach the business has taken over the last few years," says CEO Paul Hyland.

"The record level of deposition equipment demand we experienced in Q3 reflects the increasing appearance of the first-generation consumer LED backlighting products appearing in the market [replacing incumbent cold cathode fluorescent lamp (CCFL) technology]. At this early stage, these initial commercial products are predominantly small- and medium-sized backlighting units utilizing white LEDs, and we have not yet seen the impact of full RGB backlighting technology [beyond a few premium product offerings from Asian suppliers], which should become more evident in the next year," he adds.

In particular, in Q3/2007 Aixtron received an increased number of repeat and multiple orders, mainly for GaN-based LED production, for its latest high-capacity Crius and

Almost 70% of order intake consisted of 'Integrated Concept' common-platform systems

G4 systems (launched in December 2005). These are based on the firm's 'Integrated Concept' common platform approach, which uses a high degree of common components for Aixtron's Planetary and CCS (Close Coupled Showerhead) type reactors. In the first nine months of 2007, over 40% of compound system revenue and almost 70% of order intake consisted of such 'Integrated Concept' common-platform systems.

"Another interesting market development is the degree to which the 'premium-player' LED producers have recently increased the frequency of announcements on new efficiency records for their LEDs, suggesting that they believe they are ahead of the generally accepted roadmaps and that solid-state lighting may become commercially viable earlier than previously envisaged," adds Hyland.

In addition, Aixtron has seen a small rise in demand from Asia for systems used in producing blue and red lasers for optical storage.

"These factors, along with a greater level of activity in e.g. LED automotive applications [including the possible wider introduction of LED head-lights], leave us with a more promising short-to-medium term outlook than I can recall over the last five years", Hyland concludes.

Following the continued positive revenue and EBIT developments, Aixtron has raised its full-year 2007 guidance for revenue from €200m to €215m (up 25% on 2006's €171.7m and 2005's €139.4m) and for EBIT from €16m to €20m (up on 2006's €5.7m and 2005's loss of €52.7m).

www.aixtron.com

Aixtron lists short-term market opportunities as: a further increase in capacity for the production of high-performance lasers and LED backlighting for next-generation LCD screens; and greater adoption of LEDs in automotive applications.

Mid-term opportunities include: increased research leading to LED applications in general lighting;

increased qualification of high-volume SiC production applications and hybrid automotive applications; and increased research on specialized solar cell applications.

Long-term opportunities include: development of technologies for organic LED lighting and large-area deposition of organic materials; intensified activity in the develop-

ments of new, complex semiconductor material applications as substitute materials in silicon ICs; and the development of new applications using carbon nanotubes.

Correspondingly, Aixtron's total staffing has risen 7% year-on-year (from 561 to 601), due mainly to a rise in R&D staffing of 16% (by 28, from 179 to 207).

Aixtron acquires Nanoinstruments

Deposition equipment maker Aixtron entered a new market in mid-October by acquiring the UK-based firm Nanoinstruments Ltd.

Founded in 2005, the University of Cambridge spin-off manufactures chemical vapor deposition (CVD) and plasma-enhanced CVD research systems for carbon nanotubes (CNTs) and other nanomaterials. As Aixtron Nanoinstruments, and retaining key managers including founders Dr Ken Teo and Dr Nalin Rupesinghe, the unit will focus on both R&D and industrial-scale CNT equipment.

Aixtron says CNT is a promising material for applications including flat-panel displays, heat sinks, ICs, sensors and electron guns, and adding Nanoinstruments' products will create mid- and long-term opportunities in nanotechnology markets.

"We have been very impressed with what the Nanoinstruments team has achieved in the short time they have been operating. They have already supplied systems to key research and industrial institutions around the world," says Aixtron's president and CEO Paul Hyland.

"This emerging technology is highly complimentary to our core skill set."

"Aixtron is the right partner to take our technology to the next level," adds Teo. "Customers will strongly benefit from the acquisition not only in terms of increased R&D capabilities, but also from Aixtron's production capabilities and its worldwide sales, service and support network. We will be able to operate more closely with our customers through Aixtron's subsidiaries in Europe, USA, Japan, China, Korea and Taiwan."

Poland's ITE orders sputtering tool

Surrey NanoSystems of Newhaven, UK has won an order for its Gamma 1000 thin-film sputtering tool from the Institute of Electron Technology (ITE) in Warsaw, Poland, for delivery by the end of 2007. The system will be a key platform for the institute's microelectronics and optoelectronics fabrication R&D activities. ITE recently founded two Centres of Excellence: CEPHONA (Physics and Technology of Photonic Nanostructures) and MANTARC (Micro- and Nanotechnology Applied Research Centre).

Surrey NanoSystems was founded in December 2006 with funding from IP Group, and stems from a joint venture formed in 2005 by thin-film tool maker CEVP of Newhaven, UK and The University of Surrey's Advanced Technology Institute (ATI), which had developed a process for manufacturing carbon nanotubes at room temperature. ATI and CEVP contributed staff and intellectual property to Surrey NanoSystems.

Due to its highly modular, versatile architecture, ITE has specified a Gamma 1000 system configuration capable of depositing metal, dielectric



CEO Gerry Thurgood (left) with ITE's director, professor Cezary Ambroziak.

and semiconducting films by both sputter and sputter-etch processes, making it one of Surrey NanoSystems' largest, most sophisticated sputtering tools. The configuration demonstrates the modularity of the underlying architecture, says the firm's chief technology officer Ben Jensen.

The system will also feature a very-high-vacuum capability of 1×10^{-9} Torr (up to two orders of magnitude higher than some other commercially available sputtering systems), providing a high-purity environment for film deposition.

www.ite.waw.pl

www.surreynanosystems.com

IN BRIEF

Nanometrics sells VerteX PL mapping system to Aixtron

Metrology equipment manufacturer Nanometrics Inc of Milpitas, CA, USA says that deposition equipment maker Aixtron has bought one of its VerteX photoluminescence (PL) mapping systems, to be installed at its demonstration facility in Aachen, Germany during fourth-quarter 2007.

Aixtron will use the system to determine material composition, measure layer thickness and improve the wafer uniformity performance of its equipment.

"The VerteX system will be a tremendous asset to our demonstration facility," says professor Michael Heuken, VP corporate R&D at Aixtron. "Not only will we be able to monitor the performance and accuracy of our equipment, but our customers will get quantifiable data from our tool as well," he adds. "Our installation of the VerteX system will give our facility the most advanced production PL mapping capability on the market today, which is required to demonstrate the advantages of our recently introduced reactors with larger production capacity."

The VerteX will replace Aixtron's existing photoluminescence mapping tool, a Nanometrics' RPM2000, in order to obtain greater execution for its deposition systems and processes.

"This purchase of our VerteX system marks another milestone in our long-term relationship with Aixtron," says Tom Ryan, Nanometrics' business unit manager for Materials Characterization. The collaboration with Aixtron will give great insight into future technology, which will help Nanometrics to advance its PL mapping technology, he adds.

www.nanometrics.com

Veeco losses lead to job cuts, despite booming MOCVD sales

For Q3/2007, Veeco Instruments Inc of Woodbury, NY, USA has reported revenue of \$97.7m, flat sequentially but down 13% on \$112.4m a year ago. Compared to a year ago, sales were up 14% in LEDs/wireless and 8% in research, but down 26% in semiconductor and 35% in data storage (due to delayed sales of new products).

Bookings were \$118.3m, up 5% sequentially and 3% on a year ago, raising order backlog to \$182m. This was driven by strong activity for scientific research (up 17% and 26%) and high-brightness LEDs/wireless (with orders up 26% sequentially and 49% year-on-year, as new K-series MOCVD reactors for GaN blue-green LED epiwafers penetrate key accounts, including multi-unit orders from four key customers). Veeco also recently launched its next-generation E475 As/P reactor for red, orange and yellow LEDs, which has 15% greater capacity. Orders for the solar market were \$5m, including strong interest in Veeco's new copper indium gallium diselenide (CIGS) thermal deposition sources. However, the data storage and semiconductor markets remain challenging (down 15% and 22% sequentially, respectively).

North America represented 30% of sales but 41% of orders, Asia-Pacific 38% of sales and 30% of orders, Japan 13% of sales and 10% of orders, while Europe was steady at 19%, indicating a shift from Asia-Pacific to North America.

Net loss was \$5.7m, compared to net income of \$4.5m a year ago.

"We have initiated the first phase of a multi-quarter turnaround plan to improve Veeco's profitability through a combination of increased focus on our best growth opportunities, gross margin improvement and expense reduction and containment," says CEO John R. Peeler.

Short-term activities include a reduction in staff by about 100 employees, consultants and temporary workers, a reduction in discretionary expenses, the realignment of the sales organization to more closely match current market/regional opportunities, consolidation of certain engineering groups (specifically PVD and ion beam), and downsizing and consolidating the corporate headquarters.

"I am also taking specific steps to strengthen Veeco's leadership team, and we have begun to identify strategies to accelerate the company's growth," adds Peeler.

For Q4/2007, Veeco expects revenues of \$104-112m (bringing full-year 2007 to \$400-408m, down 10% on 2006 and down on the previous expectation of \$400-420m) as well as bookings down slightly to \$105-115m.

"We're providing this cautious order outlook based upon continued lack of visibility in data storage and the very strong Q3 we have recently completed in high-brightness LED/wireless, which may be hard to repeat on a sequential basis," says CFO Jack Rein. Additional restructuring charges of \$8-13m could impact Q4/2007 and Q1/2008 earnings.

"While the 2007 performance for Veeco is disappointing, primarily due to the challenging overall data storage and semiconductor markets, we believe these markets have stabilized," says Peeler. Veeco expects to exit this year with about \$180m in backlog, setting the stage for an improved 2008. "We are seeing favorable growth trends for Veeco's MOCVD and MBE technologies in the HB-LED/wireless market, as well as early penetration in specific solar applications, such as multi-junction solar cells and CIGS thermal deposition sources," says Peeler.

Given a strong end-of-year backlog

of \$180m, 2008 should be a growth year, says Rein, but will start off slowly due to the movement of data storage revenues, improving only modestly in first-half 2008 compared to second-half 2007. "We are currently planning for 2008 to be a recovery year for Veeco, where we will return to better revenue growth and profitability performance... It will, however, be a second-half 2008 recovery."

Peeler adds that Veeco is aligning its 2008 R&D spending onto HB-LEDs, where it sees a "significant long-term growth opportunity, with deep end-market applications". Veeco plans to increase investment to advance technology, improve customers' cost of ownership and gain market share. "Our goal is a multi-generational process in technology improvements to drive forward the solid-state lighting industry roadmap".

In solar, Veeco plans to begin with a greater focus on its existing product lines, the MOCVD, Fixed Deposition Sources and metrology tools. "We'll also complete a thorough business assessment of how to apply Veeco's unique deposition and measurement technology expertise to this exciting market opportunity," says Peeler.

● During Q3/2007, Veeco received orders for five MBE systems: an R&D GEN930 system, two pilot-production GEN20 systems, and two production GEN200 systems.

The systems will be used for applications ranging from III-V research to novel devices used in alternative energy and lighting.

"We are excited to see MBE technology being adopted for novel material and device requirements such as alternative energy and lighting applications," says Jeffrey Hohn, VP and general manager of MBE Operations.

www.veeco.com

Sanan expands ROY HB-LED capacity with Veeco MOCVD tools

Veeco Instruments Inc of Woodbury, NY, USA says that Xiamen Sanan Optoelectronics Co Ltd, China's largest maker of ultra-high-brightness (UHB) LED epiwafers and chips, is using two recently purchased Veeco TurboDisc E450 As/P MOCVD systems to expand its manufacturing capacity for red, yellow and orange (ROY) HB-LEDs. "We are seeing increased demand for these LEDs in such applications as signs and displays," says general manager Kechuang Lin.

Sanan's products include full color LED epiwafers and chips, as well as optical communications devices.

Veeco's TurboDisc As/P tools (with integrated RealTemp 200 technology for direct closed loop in-situ wafer temperature control, and fast gas switching for strict control of interface abruptness) are designed for high-volume production for applications such as HBTs, pHEMTs, ROY HB-LEDs, solar cells and laser diodes.

www.veeco.com

Epistar orders reactors for GaN LEDs

Epistar of Hsinchu, Taiwan, which is one of the world's largest manufacturers of ultra-high-brightness (UHB) LEDs, has placed an order with Aixtron for multiple MOCVD reactors.

The order comprises CRIUS Close Coupled Showerhead (CCS) reactors as well as AIX 2800G4 HT Planetary Reactors, which are the firm's flagship products for large-scale GaN-based LED production. Aixtron is Epistar's principal supplier of MOCVD tools. The latest order is one of Aixtron's largest this year.

"We are now implementing our plans for expanding our production capacity in response to increased customer demand in the emerging UHB LED market," explains Dr Ming-Jiunn Jou, executive VP at Epistar. Installation of the large-capacity systems is due to take place in 2008.

Epistar has been a major user of Aixtron MOCVD tools for over ten years and was the launch customer for the AIX 2800G4 HT, which is the firm's highest-capacity system.

www.epistar.com.tw

Huga qualifies AIX 2800G4 HT reactor

Huga Optotech Inc, which is a top-two manufacturer of InGaN-based LED chips in Taiwan, has qualified its recently acquired Aixtron AIX 2800G4 HT MOCVD reactor, shortly after installation of the system at its facility in Taichung Industrial Park.

Founded in 1998, Huga uses several Aixtron reactors to produce blue and green high-brightness LED epiwafers. In 2006, the firm nearly doubled its annual revenue.

The new system is now fully operational, producing high volumes of LEDs with excellent yield and uniformity according to



Aixtron's high-volume AIX 2800G4 MOCVD system.

Huga's president Sybil Yang, and has helped the firm to meet a large rise in orders from its customer base.

www.hugaopto.com.tw

IN BRIEF

University of Virginia orders CCS MOCVD reactor

Aixtron says that in Q2/2007 it received an order for a Thomas Swan 3x2-inch wafer Close Coupled Showerhead (CCS) MOCVD reactor from the University of Virginia (UVa) in Charlottesville, VA, USA.

The system will be installed in the recently completed, \$43.4m Wilsdorf Hall facility (which is designed to foster collaborative research in materials science and engineering, chemical engineering, and nanotechnology). The reactor will be used to explore novel materials and structures for devices and circuits used in various applications such as communications, imaging, spintronics (spin electronics), and medical diagnostics.

"The design that the CCS reactor employs will help us reproducibly create these materials while keeping our operating costs low," said Archie Holmes, professor in the Charles L. Brown Department of Electrical and Computer Engineering, who is heading UVa's MOCVD lab.

"While the creation of novel materials and devices is important for the research efforts at UVa, CCS also provides a pathway to having these ideas commercialized," he adds.

"Another important advantage of the CCS system is that the technology used in our research reactors is the same being used in production systems. This enables us to train future scientists and engineers on equipment that they will use in the field," says Holmes. "It also provides an easier path for important research breakthroughs to be transferred to the corporate world."

www.virginia.edu

www.aixtron.com

Kyma ships record AlN template substrate order

Nitride substrate maker Kyma Technologies Inc of Raleigh, NC, USA has announced its recent volume shipment of 2" diameter c-plane aluminum nitride template substrates.

Kyma's AlN templates are available with a 0.5µm thick layer of highly oriented AlN deposited on sapphire, or other substrates, and up to 100mm in diameter, for use as a substrate for the production of several different types of nitride semiconductor devices.

The manufacturing processes used by the firm to make AlN templates benefit from intellectual property (IP) exclusively licensed from North Carolina State University (from which Kyma was spun out in 1998), as well as additional patent-pending IP developed at the firm.

"Kyma's nitride-based templates offer a low cost substrate approach to achieving a dislocation density of 10^7cm^{-2} while eliminating the need

for expensive buffer layer processes that are difficult to control," says Dr Ed Preble, chief operating officer. Use of the AlN templates offers an alternative to traditional two-temperature or direct nucleation schemes on sapphire, silicon carbide or silicon substrates, he adds.

"Our AlN templates have been shown to present excellent starting surfaces for subsequent growth of gallium nitride layers by metal-organic chemical vapor deposition and also by hydride vapor phase epitaxy," says Dr Drew Hanser, chief technology officer and VP business development. "We also have customers testing our AlN templates in molecular beam epitaxy-based processes and we are confident about the results."

Many of Kyma's AlN templates are produced on c-plane sapphire, which leaves the AlN with a c-axis

preferred orientation that possesses ideal properties for nucleating GaN thin films. Other combinations of AlN orientation and substrate orientation are also available. Recent shipments include a-plane oriented AlN grown on r-plane sapphire, c-plane AlN grown on conductive SiC, as well as c-plane AlN grown on 100mm silicon.

Kyma offers flexible business models that can be tailored to customers, the firm says. "Speed and flexibility are of key importance," says Dr Keith Evans, president and CEO. "While we are happy to simply supply the substrates, we are also happy to establish AlN template manufacturing capacity at the customer's site and to subsequently maintain either a close or a distant relationship, depending on exactly what the customer desires," he adds.

www.kymatech.com

Rubicon raises \$94m in IPO on Nasdaq

Rubicon Technology Inc of Franklin Park, IL, USA, which makes monocrystalline sapphire material, wafers, and components for substrates and optical windows, has raised \$93.8m in its initial public offering of 6,700,000 shares of common stock (announced in September) at a price of \$14 per share.

Rubicon sold 5,500,000 shares and stockholders sold 1,200,000 shares. After deducting underwriting costs and other expenses, the firm expects proceeds of about \$80.3m. After repaying a loan and security agreement with Hercules Technology Growth Capital Inc of about \$6.1m, Rubicon will use remaining proceeds for working capital, capital expenditures and other general corporate purposes.

Rubicon has also granted underwriters an option to purchase up to 1,005,000 shares to cover over-allotments (to raise a further \$14m).

www.rubicon-es2.com

BluGlass announces reactor sale, uniform large-area plasma generation and Technical Advisory Committee

BluGlass Ltd of Sydney, Australia (which was spun off from Macquarie University, New South Wales in mid-2005) says it has taken three critical steps in the commercialization of its GaN-on-glass blue LED technology, setting it on track to demonstrate commercial production in 2008.

- A specialist team from BluGlass and the Space Plasma, Power and Propulsion Group (SP3) of The Australian National University in Canberra (ANU) has successfully tested a key component of the firm's next-generation, prototype production-scale remote-plasma CVD (RPCVD) equipment, involving use of a new plasma source design that demonstrated uniform large-area (300mm susceptor) plasma generation.

- Lakehead University in Ontario, Canada has entered a provisional agreement to purchase BluGlass'

first research-scale reactor (with a 150mm susceptor) for delivery in mid-2008. The deal will involve ongoing collaboration for R&D of new LED and related technologies.

- A Technical Advisory Committee has been formed to provide independent advice to the board and to help advance commercialization of its LED production process and access complementary technologies. The committee comprises professor Chennupati Jagadish of ANU; associate professor Matthew Phillips of the University of Technology, Sydney; Dr Gia Parish of the University of Western Australia, Perth; and Macquarie professor Trevor Tansley.

These developments follow September's award of a second Federal Government grant, for AUS\$5m (\$4.3m), to progress the technology.

www.bluglass.com.au

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Cree launches solutions providers

Cree has launched a value-added Cree Solutions Providers network to offer LED lighting systems and design assistance, aiming to help accelerate time-to-market and cut product development cost.

To ensure alignment of technologies, Cree will work with network members with a history of collaborating with customers. These include: BAFA/Zerolight; CRS; Entity; Heatron; I2 Systems; Innovative Electronic Solutions; Illumination Optics; Infinilux; LED Lighting Supply; LED Specialists; Marktech; Optoelectronix; Relume; and Forge Europa Visible Solutions.

Services provided include: design consulting; customized design; LED engines; turn-key solutions; sub-assembly; and complete assembly.

XLamp plant ISO/TS certified to automotive standards

Cree has completed an advancement assessment audit for its ISO/TS 16949 certification. This year's audit includes its XLamp LED plant in Durham, NC as well as its LED chip, power and materials manufacturing operations.

TS 16949 encompasses all requirements of ISO 9001:2000 plus further requirements from the automotive industry, superseding the QS-9000 quality standard.

The Automotive Industry Action Group was selected in 1994 by the Chrysler, Ford and General Motors Supplier Quality Requirements Task Force to oversee publication and distribution of QS-9000 and administer sanctioned training. It has since expanded to TS 16949.

"Compliance to TS signifies that Cree's quality management system is capable of meeting one of the highest-quality standards worldwide," says Norbert Hiller, Cree's VP of Lighting.

www.aiag.org

Rising expenses lead to operating loss as Cree expands LED capacity

For fiscal Q1/2008 (to 23 September 2007), Cree reported revenue of \$113.4m, up 2% on last quarter and 9% on \$103.9m a year ago.

However, operating expenses have risen 35% on a year ago, from \$26.4m to \$35.7m (mainly through a 52% rise in sales, general & administrative expenses to \$18.2m, plus \$4m in amortization expense from acquisitions). Gross margin has fallen from 41% to 31% of revenue.

Compared to an operating income of \$16.5m a year ago, Cree made an operating loss of almost \$1m, partly due to continuing costs from integrating LED maker Cotco (acquired in March). However, a one-off gain of \$14.1m from August's sale of its stake in lighting system maker Color Kinetics Inc of Burlington, MA, USA to Philips limited the drop in net income, from \$13.3m a year ago to \$12.7m.

On a non-GAAP basis, net income was \$8.8m, down on \$15.6m a year ago. Cash reserves rose by \$38.2m during the quarter to \$332.5m.

"The LED business expanded both quarter-over-quarter and year-over-year, led by our XLamp LED product line, and we made good strides increasing our capacity for these products," says chairman and CEO Chuck Swoboda. In August, Cree announced plans to triple white XLamp LED manufacturing capacity within a year by expanding production at Cotco in China. "We believe our strategy to increase sales by growing our LED component product lines while maintaining the current level of LED chip sales is on track," Swoboda added.

For its fiscal Q2/2008 (to end-December 2007), Cree is targeting revenue of \$115-119m.

www.cree.com

LEDs to light up Beijing Olympics

Cree is to provide the effects lighting for the new Beijing National Aquatics Centre (the 'Water Cube', home for most of the 2008 Summer Olympics aquatic events).

Covered with a water bubble design, the rectangular, plastic building will be illuminated by Cree's XLamp LEDs from inside the structure's translucent walls.

"The Water Cube is designed to provide spectacular lighting effects to be seen by millions of people around the world during the Olympics and for years to come," says Dr XiGuang Fu, chief engineer for primary contractor Grandar Landscape Lighting and Technology Group.

"This unusual venue spans some 80,000m², and will have approximately 440,000 Cree XLamp LEDs embedded throughout the structure.



The LED-illuminated Beijing National Aquatics Centre

The scale of the project, combined with unique lighting controls provided by Grandar, will result in a truly memorable display of changing images and colors," said Scott Schwab, Cree Asia Pacific managing director. "It's an extraordinary design that relies on LEDs to create dramatic effects."

The Water Cube integrates the geometry of water bubbles into a rectangular, plastic structure, allowing the entire building to glow with color-changing LED light. Cree also provided technical support.

www.grandar.com

Ann Arbor to be third LED City

The City of Ann Arbor, MI, USA has joined the LED City initiative.

Launched by LED maker Cree Inc of Durham, NC, USA with the City of Raleigh, NC last February and joined by Toronto, Canada in July, the initiative aims to create a community of cities committed to the evaluation, deployment and promotion of LED lighting in city infrastructure applications. Member cities share their experiences with LED lighting trials and deployment to foster the creation and adoption of best practices for LED lighting.

As part of the initiative, Ann Arbor aims to be the first US city to convert 100% of its downtown streetlights to LED technology, and in early November began by installing 1400 LED streetlights. Full implementation of the initiative should halve the city's public lighting energy usage. Ann Arbor expects a 3.8-year pay-back on its initial investment.



LED lighting installed in Ann Arbor.

Each street lights uses just 56W and is projected to last for 10 years, compared with 120W and about two years for current fixtures.

Following three years of research on the energy and maintenance savings of using LED lighting, the city received a \$630,000 grant from the Ann Arbor Downtown Development Authority to fund retrofits for the downtown lights.

The initial installation should save the city more than \$100,000 per year and reduce annual greenhouse gas

emissions by about 294 tons of CO₂. "Our plan is to retrofit all downtown lights with LED alternatives over the next two years," says mayor John Hieftje.

"We applaud the tremendous efforts by Ann Arbor's civic leaders to make energy efficiency a priority for the city," says Cree's chairman and CEO Chuck Swoboda. "We are especially pleased that Ann Arbor is joining the LED City program to share the results of their product testing and surveys with other municipalities to help accelerate the adoption of LED lighting worldwide."

The LED street lights currently installed in Ann Arbor are based on the New Westminster Series made by Lumec Inc, which contain LED light engines from Relume Technologies Inc, based on Cree's XLamp LED.

www.cree.com/xlamp

www.lumec.com

Duke Energy demos 48% lighting saving at Cree HQ

LED maker Cree is collaborating with electricity supplier Duke Energy of Charlotte, NC, USA to evaluate the use of LEDs in widespread commercial applications.

With the aim of demonstrating the technology's energy efficiency and longevity, the parking lots, entryways, lobby and conference rooms at Cree's headquarters and manufacturing facility in Durham, NC are now 100% lit by its XLamp LEDs. Cree says that its 'LED Workplace' conversion validates the energy savings, quality of light and reality that LED lighting is now a viable option for business and residential consumers.

"We believe LED technology holds tremendous potential for reducing both energy consumption and equipment maintenance without compromising safety," says Ted Schultz, Duke's VP of energy efficiency. "We believe this collaboration with Cree will further

demonstrate LEDs as a viable alternative to existing commercial lighting technology," he adds.

"Working with Duke Energy to evaluate advanced LED lighting technology in outdoor and office lighting is a valuable step in demonstrating the LED's quality, reliability and energy efficiency," says Cree's chairman, president and CEO Charles M. Swoboda.

To provide a third-party perspective, also collaborating on the project are the nonprofit organizations Advanced Energy of Raleigh, NC and the Electric Power Research Institute (EPRI), which has sites in Palo Alto, CA and Knoxville, TN as well as Charlotte, NC. Their main role is to collect data, assure research protocols are observed and report results.

A study of energy usage before and after the conversion indicate that the new LED lights use 48% less energy than the incandescent, fluorescent and high-pressure

sodium lights that they replaced. The combination of the energy savings, reduced maintenance and disposal costs and the environmental savings demonstrate that LED lighting is now a real alternative to traditional lighting solutions, Cree claims.

Cree now plans to convert all lighting to LEDs. "Conventional wisdom is that LED lighting is years away from widespread adoption," says Cree's chairman & CEO Chuck Swoboda. "The conversion of Cree's site demonstrates that the LED lighting revolution is well underway."

"We expect our energy efficiency plans to be approved next year and are committed to having a complete line of lighting solutions available for customers," Schultz adds. "At that point, we expect to have programs developed that will take advantage of LED technology."

www.ledworkplace.org

www.duke-energy.com

LLF raises \$16.5m to expand product line and speed R&D

LED Lighting Fixtures Inc (LLF) of Morrisville, NC, USA, which makes LED-based light fixtures for general illumination, has raised \$16.5m in a financing round led by Digital Power Capital LLC. LLF plans to use the proceeds to significantly expand its product line and accelerate R&D efforts.

LLF's LR6 six-inch downlight has a high color rendering index — warm (2700K) or neutral (3500K) white — and is designed for a 50,000 hour lifetime.

The firm expects to launch new products early next year, including a four-inch downlight as well as a recessed architectural lay-in fixture suitable for commercial and office environments.

www.LLFinc.com

Honeywell sues Lumileds and Cree over LED patent

Honeywell International Inc has filed a lawsuit in the US District Court for the Eastern District of Texas against LED makers Cree Inc of Durham, NC and Philips Lumileds Lighting Co of San Jose, CA, alleging infringement of its US Patent No. 6,373,188 B1 (issued in April 2002).

Honeywell, the world's largest maker of airplane cockpit controls, is seeking an order barring Philips Lumileds and Cree from using its technology without permission as well as cash compensation for past infringement.

Honeywell says that Lumileds is infringing the patent by selling LEDs in products such as automobiles, emergency lighting systems and flashlights, and Cree is infringing the patent in products such as cell phones, automobiles, digital cameras, outdoor displays, lighting, TVs and monitors.

<http://patft.uspto.gov/netahtml/PTO>

Osram launches joint pilot LED street lighting project in Banff

Osram Opto Semiconductors GmbH of Regensburg, Germany has launched a joint pilot project with the Canadian town of Banff, Alberta to convert its street lighting to LEDs.

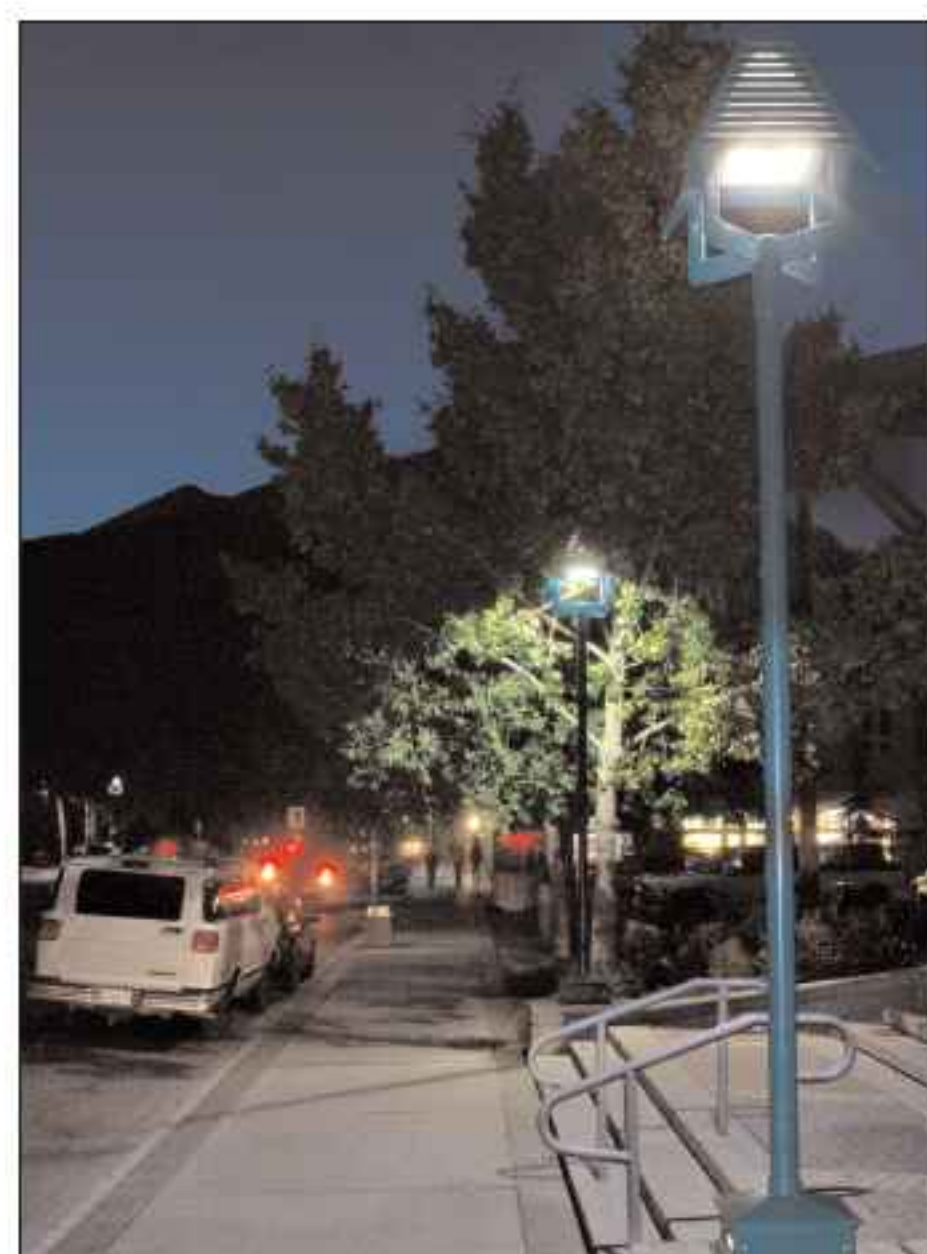
Established in 1885 in the heart of the Rocky Mountains, the main town in the Banff National Park (a UNESCO World Heritage Center) has traditionally been at the forefront of environmental protection, and says that its aims are to use more energy-efficient, environmentally friendly light sources, as well as lowering power consumption.

There is no need to purchase new fixtures, says Osram, because the use of retrofit systems means that only the lamp and control gear have to be replaced. The firm provided the engineering support to retrofit custom-made LED prototype fixtures into the existing 100W metal halide streetlights. Thanks to the small size of the LEDs, each streetlight contains 54 Golden Dragon Argus LEDs.

In one of the major challenges facing Osram's engineers, a specially designed lens directs the light pattern from the LEDs away from the surroundings or the Banff night sky (dramatically reducing light pollution and stray light) and instead down onto the paths and streets, providing more homogeneous illumination. This, coupled with high LED efficiency, leads to high luminaire efficiency.

The lower energy consumption and the possibility of adapting the brightness to the surrounding ambient light level using sensors can lead to reductions in electricity costs.

"Collaborations such as these are essential, especially given rising energy costs and environmental concerns," says Banff's mayor John Stutz. Also, the long and predictable life-time of LEDs of up to 50,000 hours (compared with 15,000 hours for the previous lamps) should cut maintenance costs considerably due to longer service intervals.



New LED street light in Banff.

The changeover started with the lights in the square in front of the Town Hall, before the beginning of the lighting season. Eight streetlights have already been upgraded, reducing energy consumption by 36%. Progressively more streetlights will be upgraded to LEDs.

"For the first time we are able to observe the use of LEDs in a day-to-day situation virtually under the laboratory conditions of a small town, giving us an immediate insight into the ecological and economic effects of our LEDs on the community," says Dr Rüdiger Müller, CEO of Osram Opto Semiconductors. The goals of the pilot project are to gather performance data and track energy consumption during variable weather and lighting conditions.

Banff residents will also be asked to provide their opinion of the new lamps. "This important new knowledge will speed up the spread of LED lighting," Müller adds. "We expect LEDs to become more and more popular in the medium term for street lighting."

On the basis of the project results, an extension of the pilot project is under consideration, says Osram.

www.osram-os.com

Osram agrees laser and LED patent exchange with Toyoda Gosei

Osram GmbH of Munich, Germany and Toyoda Gosei Ltd of Aichi, Japan have signed an agreement for the mutual use of patents for certain LED and laser technologies.

Cooperation relates to InGaN technologies concerning white, blue and green LEDs and lasers.

From Osram's side, this mainly involves basic technologies for industrial production of LEDs and lasers, and patents for white LEDs. Toyoda Gosei, which claims development of the world's first blue LED in 1991, possesses patents relating to blue LEDs.

The agreement aims to make it easier for both firms to develop, manufacture and market new products — and in particular to speed improvements in the luminous intensity of LEDs — without fear of unintentional patent violations.

"The agreement with Toyoda Gosei is a prime example of respectful and responsible dealings with the intellectual property of other companies — with benefits for both the market and customers," says Dr Rüdiger Müller, CEO of Osram's LED-making subsidiary Osram Opto Semiconductors GmbH of Regensburg, Germany. The cooperation with Toyoda Gosei will help to make LED technology more available and enable the infant market for LED products to develop in a spirit of fair competition, he adds.

Osram has previously entered into many license agreements with other firms for the use of its patents and for the exchange of patents, but adds that it will pursue any infringements of its patent rights.

www.osram-os.com

www.toyoda-gosei.com

German court find infringement of Osram LED patents by Kingbright

At the end of October, the District Court of Düsseldorf in Germany upheld almost all the claims of Osram Opto Semiconductors in a patent dispute against Taiwanese LED maker Kingbright Electronic Co (Taipei) Ltd and its German subsidiary Kingbright Europe GmbH that was filed in May 2006.

The court confirmed three infringements by Kingbright of Osram Opto's basic patent and utility model rights relating to the production of white LEDs using a blue-light-emitting InGaN chip with a phosphor converter. Kingbright can therefore no longer sell the corresponding LED products in Germany and must also destroy the stock in the country. However, the court reserved its decision on a patent for surface-mount LED packaging technology.

Nevertheless, Osram Opto's CEO, Dr Rüdiger Müller, says that the

judgment supports the firm in its efforts to protect its intellectual property worldwide. Osram also recently filed a lawsuit against Kingbright for infringement of a white LED patent made in China.

In response, on 8 November, Kingbright filed an appeal with the Düsseldorf Higher Regional Court against the initial judgment (with the hearing scheduled for late 2008). Kingbright is also contesting the validity of the Osram patents.

Kingbright says that the German Patent And Trademark Office issued opinions against two Osram utility models, noting that they lack inventiveness in comparison to the prior art. Another related European patent is under examination by the European Patent Office (EPO).

www.osram-os.com

www.kingbright.com

Toyoda's LED sales may double, driven by more energy-efficient laptops

Annual LED sales for Toyoda Gosei Co Ltd of Aichi, Japan (the world's second-largest maker of LEDs for screen backlighting) may almost double in two years, from 16bn yen last fiscal year to about 30bn yen (\$270m) in the year ending March 2009, forecasts the firm's president, Takashi Matsuura, in an interview with Bloomberg.

Toyoda Gosei is betting that demand will surge with Apple Inc and Sony Corp beginning to sell LED-equipped notebook computers. Toyoda is seeking a bigger share of a market that research firm iSuppli Corp estimates will double to \$12.3bn and provide a light source for 24% of the world's laptop computers sold in 2012, compared to just 1% in 2007.

Last year, 72% of Toyoda Gosei's LED sales were for cell phones. However, the firm is now targeting LED products for laptops and TVs since they are more profitable, Matsuura says. He adds that the firm is winning customers with brighter LEDs geared for laptop screens and plans to introduce backlights for flat-panel televisions.

Toyoda Gosei may also offer products for car navigation displays. The firm, which is 43%-owned by Toyota Motor Corp and generates more than 90% of its revenue from automotive parts, is also benefiting from its parent company's growth in China, helping sales in the Asia-Pacific region rise 60% in the first half of the year. Increased production of Toyota Camry sedans in Guangzhou province and Corolla sedans in Tianjin raised sales of air bags, glove compartments and cup holders, according to the firm.

www.bloomberg.com

Dilute nitrides boost stability & efficiency versus AlInGaP LEDs

Quanlight Inc of San Diego, CA, USA, which is developing high-power, high-brightness red LEDs based on InGaNP dilute nitrides, has reported prototype devices fabricated in production-scale Veeco MOCVD reactors with improved color and brightness stability with changing temperature compared to traditional LEDs.

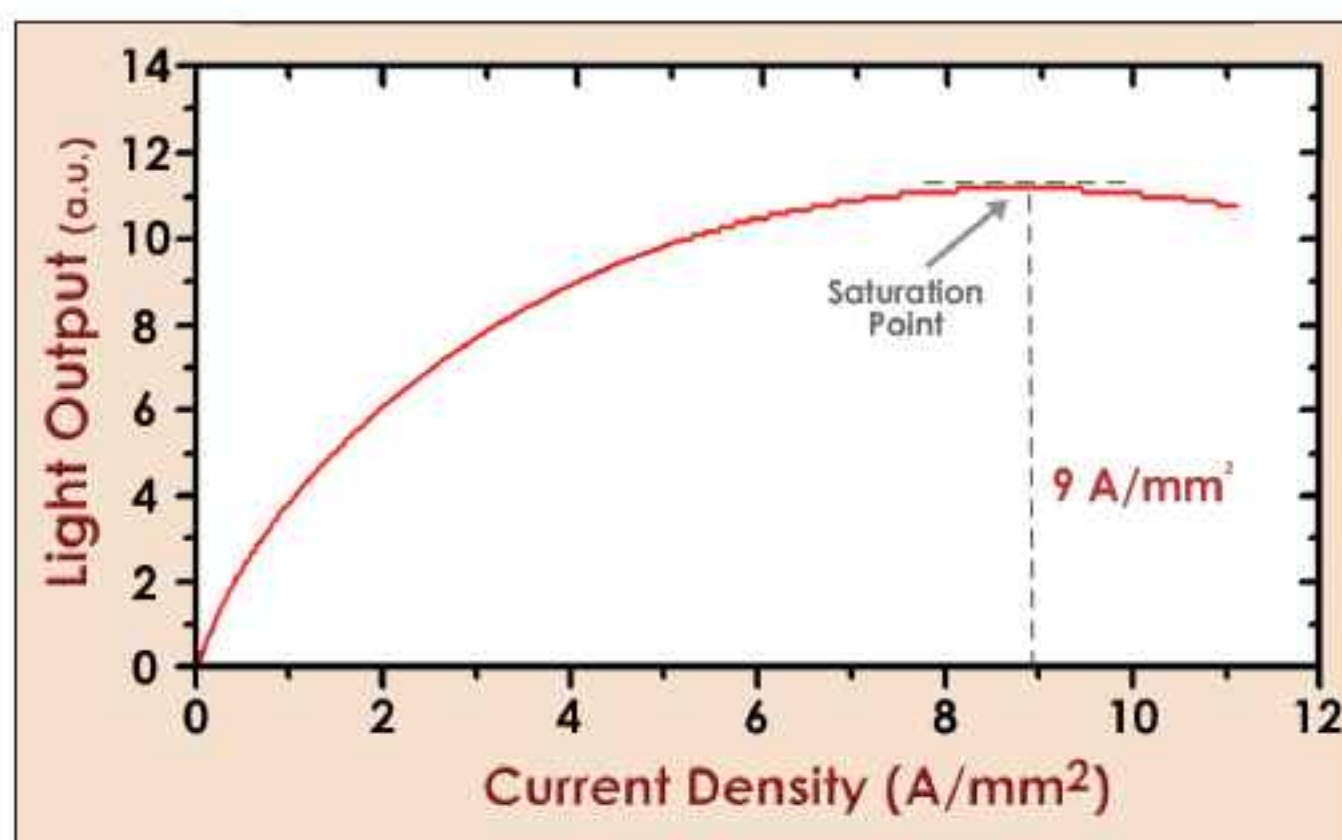
While InGaN materials are used for blue and green LEDs, most commercial yellow, amber and red (YAR) LEDs are fabricated using AlInGaP, which has temperature stability issues that are inherent to the material, says Quanlight. While the efficiency of all LEDs drops as the drive current is increased, InGaNP-based LEDs remain very efficient at higher current loads.

Also, the simplified manufacturing process uses direct growth pseudo-morphically on a transparent GaP substrate, eliminating the usual AlInGaP wafer-bonding step of removing the epilayer from an opaque substrate and bonding it onto a second, transparent substrate to aid light extraction. This reduces material, process and labor costs, while increasing yield.

Color stability was tested by measuring the peak wavelength emitted while externally heating the InGaNP LED from 25°C to 125°C. The resulting shift of 3nm is only 20% of the 15nm shift of a conventional AlInGaP red LED.

In a test of brightness stability, light output was measured as the external temperature was raised from 25°C to 150°C. At the high end, the LED emitted 48% of its original light output compared to just 25% for a conventional LED.

"For applications requiring high power or stable color output, such as traffic signals, signage, theatrical lighting and backlighting units for LCD TVs, these differences are dramatic," says CEO Neil Senturia.



Light output saturates at high current density.

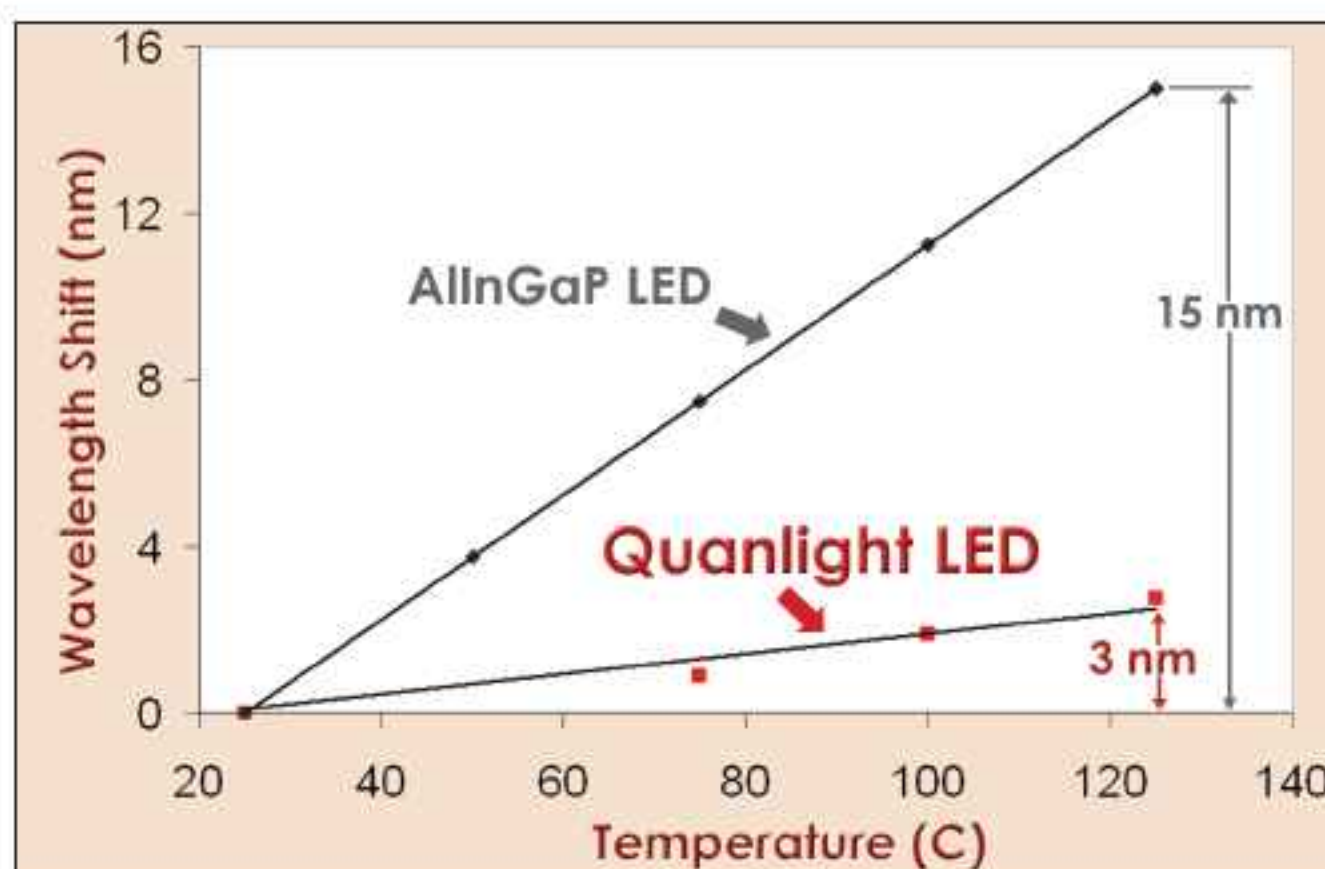
"Benefits from the reduced wavelength shifts and improved high-temperature efficiency will translate into simpler color control mechanisms and enhanced lighting intensity."

In December 2006, Quanlight received \$1m in Series A funding from San Diego-based Blackbird Ventures (whose principal Senturia joined as CEO). This May, to take the company from R&D to wafer

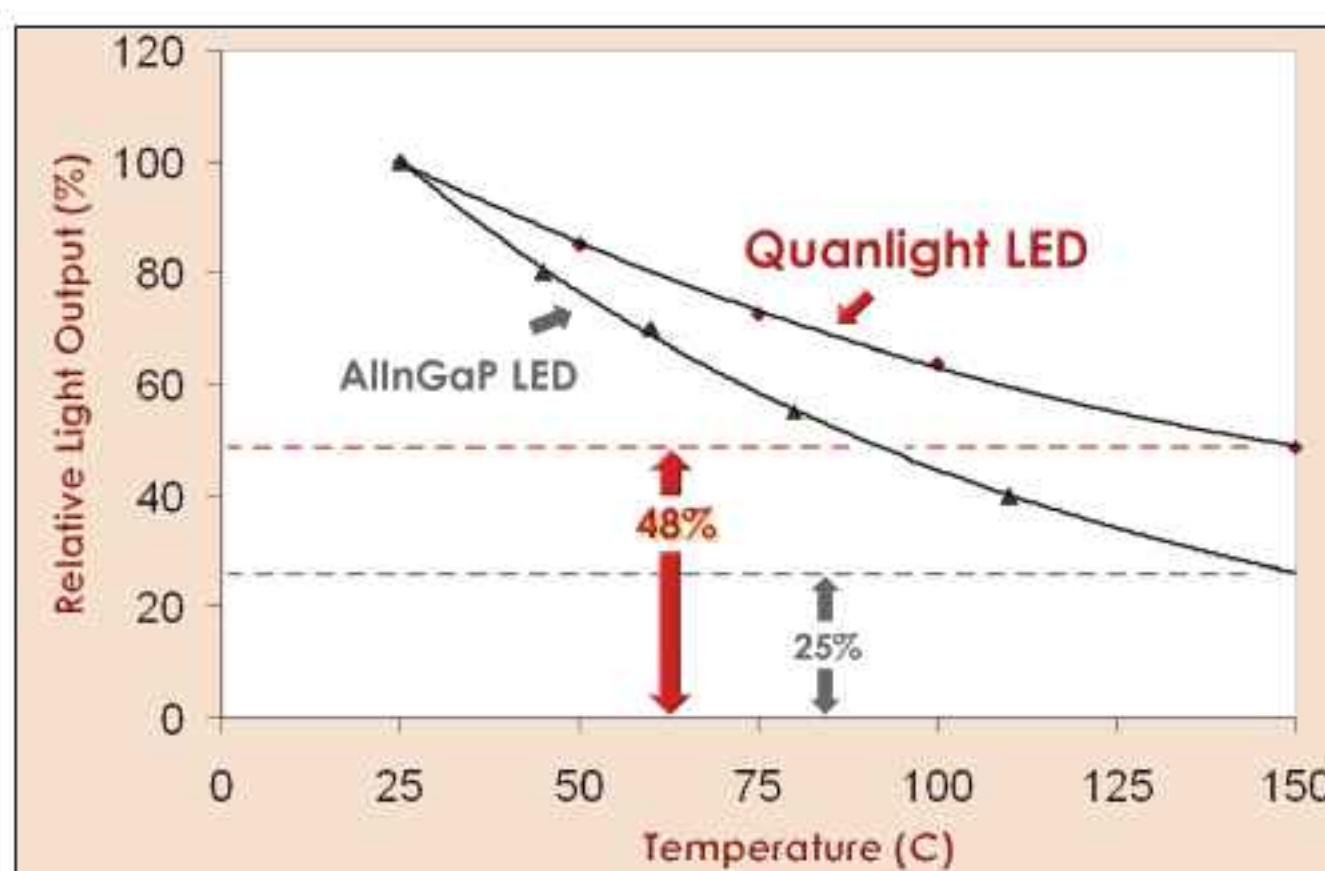
production, Quanlight raised \$3m in a Series B round of funding led by Blackbird Ventures and (SHW)² Enterprises, together with a small group of private investors. (SHW)² Enterprises chairman Harvey White (a co-founder and former president and COO of Qualcomm, and founder and former chairman and CEO of Leap Wireless) joined the firm as chairman. Quanlight is targeting a further fundraising round in mid-2008.

Quanlight also aims to extend the range of the LEDs to include orange and yellow wavelengths of 585–660nm.

www.quanlight.com



Color shift as temperature rises from 25°C to 125°C.



Light output as temperature rises from 25°C to 150°C.

Nichia patents infringed, says jury, but Seoul counter-sues

In a lawsuit in the US District Court for the Northern District of California, a jury verdict has unanimously found that the 902 series side-view LEDs of Korean LED maker Seoul Semiconductor Co Ltd and its US subsidiary Seoul Semiconductor Inc infringe US design patents D491,538, D490,784, D499,385 and D503,388 owned by Nichia Corp of Anan, Tokushima, Japan, and that Seoul's infringement was willful.

Nichia filed the action in January 2006, seeking damages for past infringement and an injunction against future infringing activity. Also originally named as defendants were Creative Technology Ltd and its US subsidiaries Creative Labs Inc and Creative Holdings Inc, which use Seoul Semiconductor's LEDs to backlight the liquid-crystal display (LCD) screens in their MP3 player but settled with Nichia in November 2006.

Seoul's 902 series LEDs are mostly used for LCD backlight units in consumer products such as cell phones. Nichia says that the verdict means that any consumer product distributed in the US that incorporates Seoul's 902 LED will be containing a patent-infringing product.

Nichia adds that it is confident that other courts in Korea, the USA and

Japan that are currently dealing with disputes between Nichia and Seoul Semiconductor will also uphold its intellectual property rights and recognize Seoul's infringement.

However, Seoul claims that it has 'substantially prevailed' in the verdict, as it was found to be not liable for damages on three out of four of the patents. Also, the jury's award for damages on patent D491,538 is limited to \$62.

Seoul Semiconductor says it continues to believe that Nichia's US design patents are invalid, and has asked the US Patent and Trademark Office to re-examine all four patents asserted against it. Nichia's design patents were previously invalidated by the Korean Intellectual Property Office in December 2006.

Seoul Semiconductor has since filed a lawsuit in the US District Court for the Eastern District of Texas alleging that Nichia's white, blue, green and UV LEDs infringe Seoul's US patent 5,075,742 (granted in late 1991), covering a method for reducing dislocations in a semiconductor layer by growing a sequence of three-dimensional inclusions.

Seoul claims that it has 'substantially prevailed'

Citing Nichia's 2006 revenue of about \$1.3bn (nearly ¥150bn) from LED and laser diodes, Seoul is seeking an injunction, and damages adequate to compensate for past and future infringement. The firm says that it will also continue to exercise the patent right against companies using Nichia's products.

To prosecute its claims against Nichia, Seoul has retained Weil, Gotshal & Manges LLP, whose Patent Litigation Group is led by David C. Radulescu. Radulescu earned a Ph.D. in compound semiconductor devices (including LEDs and lasers) and was a leading counselor representing LED maker Cree against a lawsuit from Nichia in 2002 (achieving a cross-license agreement between Nichia and Cree that succeeded in ending the patent disputes between them).

● Nichia also already has a lawsuit in the Seoul Central District Court alleging infringement of its Korean patent no. 491482 by Seoul Semiconductor's Z-Power LED P9 Series top-view white LED products (see October issue, p33). Nichia is seeking damages for past infringement as well as an injunction against any further infringing activity.

www.nichia.co.jp/specification/ip/verdict_form.pdf

Seoul wins damages and injunction against Itswell

The Seoul High Court has ruled in favor of Seoul Semiconductor's appeal against the Seoul Central District Court's rejection of its lawsuit against rival LED maker Itswell of Cheongwon Chungbuk, Korea.

The lawsuit sought damages for infringement of its utility patent for making white LED plus an injunction against any further infringement. The High Court ruled that Itswell should pay \$1.2m in compensation.

This follows the Patent Court of Korea's decision in October to turn down appeals by both Itswell and Advanced Optoelectronic Technology Inc (AOT) of Hsinchu, Taiwan to overturn the Korean Intellectual Property Tribunal's rejection of actions to invalidate the patent.

In 2005, Seoul won preliminary injunctions for patent infringement against both firms. AOT and Itswell responded by filing the invalidation

actions against Seoul in the Korean Intellectual Property Tribunal, the Taiwanese Intellectual Property Tribunal and the Patent Court of Korea. These have now all been rejected. AOT has since given up appealing the case, says Seoul Semiconductor.

Seoul Semiconductor claims that the decisions illustrate the novelty and validity of its white LED patent.

www.seoulsemicon.com

www.itswell.com

IN BRIEF

Spire receives STTR contract to develop room-temperature THz light source

Spire Corp of Bedford, MA, USA has received a \$99,724 Small Business Technology Transfer (STTR) program award 'Resonant Tunneling Diode for High-Power Room-Temperature Terahertz Emission' from the US Army Research Development and Engineering Command (RDECOM).

The new, miniature solid-state device has the potential to provide more than 10mW of continuous terahertz (sub-millimeter wave) light at room temperature, which is currently only obtainable from much more complex, larger and expensive vacuum devices.

Terahertz light is useful for defense, biomedical, and scientific applications, and has been shown to be capable of detecting hidden weapons and explosives. Spire will team with the University of Virginia, and will specify and analyze various candidate semiconductor material structures and specify required experimental methods. A subsequent phase of the program will produce a prototype terahertz oscillator.

"This program is of great interest and importance to Spire because such miniature terahertz sources are critically needed for defense, medical and industrial applications," says chairman and CEO Roger G. Little. "They can be readily manufactured in our Bandwidth Semiconductor foundry [in Hudson, NH], and their applications in biotechnology are in line with our Biomedical division's interest in offering this new modality for non-invasive cancer detection and other medical imaging concepts," he adds.

www.spirecorp.com

www.armysbir.com/awards/sttr_fy07_phasei_topic.htm

QPC raises full-year 2007 guidance to 2.5 times 2006 revenue

QPC Lasers Inc of Los Angeles suburb Sylmar, CA, USA, a vertically integrated manufacturer of high-power lasers for the industrial, defense and medical markets founded in 2000, has reported third-quarter 2007 revenue of \$2.2m. This is up 132% on \$930,000 a year ago and up 18% on \$1.8m last quarter due to both increased product and government revenues.

Gross margin has doubled, from 26% to 52%, due mainly to growth in product revenue. Operating expense was just \$2.9m (compared to \$8.2m a year ago, although that included a license termination fee of \$6m). Correspondingly, net loss has shrunk from \$8.3m a year ago to \$5.1m (partially offset by rises in sales & marketing and legal & accounting expenses). Cash and cash equivalents at the end of September were \$8.6m.

"Our solid revenue performance reflects the continued strong product sales momentum we are generating," says Dr Jeffrey Ungar, chairman and CEO. "During the third quarter, we achieved the very significant milestone of shipping our first Gen III 100 Watt Laser to a US surgical customer. We believe our Gen III technology has the potential to transform the existing multibillion dollar solid-state and gas laser market, offering up to a ten fold improvement in efficiency, cost, size, weight and ruggedness compared to today's conventional laser technology," he adds.

"We are seeing strong interest in our Gen III technology across all the markets we currently serve, most notably from military and defense," Ungar continues.

In late October, QPC was awarded a \$750,000 contract by a US defense customer to deliver high-power fiber laser pump engines for airborne directed-energy weapons applications. The latest award brings the total value of contracts

with this customer to \$1.75m since April. The new contract allows QPC to increase the power from levels targeted in previous contracts and accelerates the development and delivery of high-power laser prototypes for potential deployment on the customer's platforms.

The contract enables further refinement of Gen III laser technology for both military and commercial applications, says co-founder and executive vice chairman George Lintz. "As we continue our development and commercialization of these cost-effective high-power laser prototypes, we continue to expand the potential markets for our technologies and to identify potential new customers," he adds.

"We also continue to build momentum in demand for our core Gen I and Gen II product families. We see continued strength in our medical laser products and are pursuing expansions of our technology to include visible wavelengths, which would open up multiple new markets for us," Ungar adds. "Looking ahead, we expect solid growth from our core products and, as we continue the roll out of higher-powered additions to the Gen III product line for a variety of applications, we anticipate these products will contribute to a ramp in revenue in 2008," he concludes.

QPC also demonstrated its first visible laser: a green laser for displays (targeting growth markets including cell-phone projectors, laser TV, and cockpit displays).

In the meantime, QPC has revised its full-year 2007 revenue forecast upwards from \$6-7.5m to \$7-8m (about 2.5 times 2006's revenue of \$3.1m). "We have ramped our sales and marketing efforts around the world, continued introduction of additional products in our generation III line, and anticipate seeing them contribute to revenues in 2008 and beyond," says Lintz.

www.QPClasers.com

Intense adds senior sales & business development execs

Intense Ltd of Glasgow, Scotland, UK has hired three new executives for sales and business development of its line of high-power laser diodes:

- Electronics industry veteran Michael Fichtner is business development director, HPL Europe;
- Matthew Philpott (previously with Coherent Inc) is business development director, HPL North America;
- Scott Grayman (formerly with Laser Diode Inc, a division of Tyco Electronics) is account manager to oversee all key account sales of Intense-HPD laser diodes.

All three report to Kevin Laughlin, VP HPL global business development.

Intense makes both single-mode and multi-mode monolithic laser array products and high-power laser diodes based on its patented quantum well intermixing (QWI) and asymmetric waveguide (AW) technology.

"As the laser diode market heats up, we are seeing tremendous demand for high-brightness, high-reliability, QWI-enabled products," says Chris Baker, VP sales & marketing.

"Adding Michael Fichtner, Matthew Philpott and Scott Grayman to our team allows us to take full advantage of our geographic reach and builds on our momentum as

we roll out new products in 2008," he adds. "All are experienced veterans in the laser diode industry."

Fichtner has more than 15 years experience in international sales, marketing and product management in optoelectronics, semiconductors and telecoms, including at NEC, Lucent, Nortel, Zenastra, and Lightwave. He will be responsible for managing Intense's European distribution channel and for sales of its family of high-power laser diodes.

Philpott has experience in sales, marketing and product management in the laser industry. After starting his career in research, he held sen-



Michael Fichtner.

ior positions at Coherent Inc, most recently as market development manager for North America. His ability to blend sales management with marketing and customer satisfaction programs will help Intense expand its reach across North America, reckons the firm. Philpott will be responsible for managing North American sales of Intense's high-power laser diode products.

Scott Grayman has worked in the laser industry for more than 17 years, including in senior positions in business development, marketing, sales, and general management for development companies serving the fiber-optics, laser diode and optical receiver markets. His sales experience with optical component manufacturers (including Tyco Electronics and Thomas and Betts), coupled with knowledge of defense and telecoms applications, will drive Intense's expanding market share in laser diodes, reckons the firm. Grayman will be based in the firm's New Jersey office.

www.intenseco.com

Advanced Photonix achieves positive EBITDA

For fiscal Q2/2008 (ended 28 September 2007), Advanced Photonix Inc of Ann Arbor, MI, USA reported revenue of \$6.5m, up 6% on last quarter and 11% on \$5.9m a year ago.

Net loss was \$1.9m, up on \$1.1m a year ago. However, earnings before interest, taxes, depreciation, and amortization (EBITDA) was \$15,000 compared to a net loss of \$5,000.

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

Telecom revenues were \$1.6m, up 26% on last quarter but down 10% on a year ago. Medical revenues were \$1.4m, up 183% on \$481,000 a year ago, due to accelerated end-of-life purchases by a customer

(expected to be completed by the end of fiscal 2008). Industrial Sensing/NDT (non-destructive testing) revenues were \$2.6m, up 9%, due mainly to greater THz product platform sales for NDT. Military/aerospace revenues were \$950,000, up 9% on last quarter but down 17% on a year ago.

September's private placement of \$4.4m provides extra funds to help grow revenues and earnings, says chairman and CEO Richard Kurtz. "We continue to experience high-level design activity in our HSOR product platform, particularly in the more rapidly developing 40G deployment in the telecom industry, and we remain very bullish about the growth prospects of our HSOR products," he adds. "Finally, we are successfully dealing with the challenges of the wafer fabrication and assembly

consolidation, which should be resolved by the year end, which will result in significant cost savings and position us solidly for the future."

The firm completed its new 5000ft² optoelectronics R&D and manufacturing facility in June. The facility upgrades and consolidates the two microfabrication operations in Camarillo, CA and Dodgeville, WI, which produced silicon photodiodes in PIN, large-area APD (LAAPD) and Filtrode configurations, into one centralized facility at its subsidiary Picometrix LLC in Ann Arbor (acquired in 2005) which, since 1992, has used MBE to produce InGaAs and InP HSORs in APD and PIN configurations (currently with bandwidths of 2–60GHz and wavelengths of 700–1650nm for 10–40Gbps applications).

www.advancedphotonix.com

PLI and id Quantique to develop single-photon counting module for 1064nm

Princeton Lightwave Inc (PLI) of Cranbury, NJ, USA and id Quantique of Geneva, Switzerland have announced that they are collaborating to develop a single-photon counting module optimized for 1064nm by combining an avalanche photodiode (APD) with integrated biasing and quenching electronics.

It is difficult to detect single photons at wavelengths close to 1064nm with high efficiency, low noise, and low jitter, since this region of the spectrum lies at the limit of sensitivity of silicon and InGaAs avalanche photodiodes. The best approach currently is to use a silicon APD-based single-photon detector, but the efficiency is no more than a few percent.

To close this detection gap, Princeton Lightwave aims to use its expertise in III-V single-photon detector design and fabrication to develop an InGaAsP/InP APD optimized for high-efficiency Geiger-mode operation (i.e. at voltage biases above the breakdown voltage) at 1064nm. id Quantique will combine the photodiode with its integrated active quenching circuit, which has high performance due to fast quenching and low capacitance, as well as high reliability.

The resultant single-photon avalanche photodiode (SPAD) module, for detection in the wavelength range 950–1100nm, is due to be launched at the end of this year and to be demonstrated at the Photonics West show in San Jose, CA in January. Targeted applications include free-space quantum key distribution, remote sensing, and spectroscopy.

www.princetonlightwave.com
www.idquantique.com

First transistor-based single-photon detector

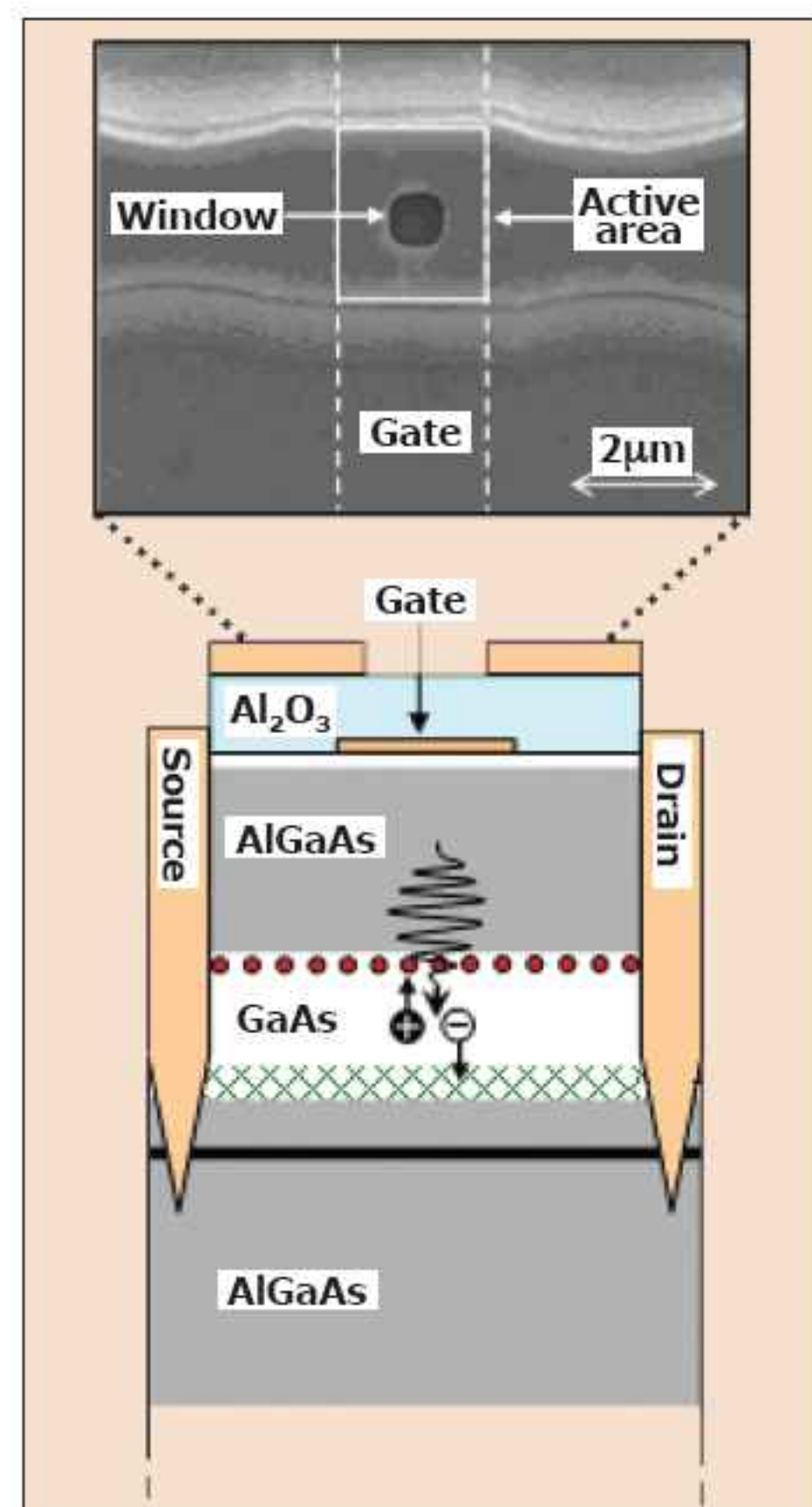
The first transistor-based detector that can count the number of individual photons absorbed has been demonstrated by researchers at the US National Institute of Standards and Technology (NIST), Los Alamos National Laboratory and Heriot-Watt University, UK (E.J. Gansen et al, *Nature Photonics* 1, 585 (2007), 1 October).

Most single-photon detectors simply 'click' in response to any small number of photons. The new 'QDOGFET' detector (quantum dot optically gated field-effect transistor) is a modified FET consisting of AlGaAs and a GaAs absorbing layer containing about 1000 quantum dots and can count one, two or three photons at least 83% of the time.

The transistor could be integrated easily into electronics and may be able to operate at higher temperatures than other single-photon detectors — practical advantages for applications such as quantum key distribution (QKD) for 'unbreakable' encryption using single photons.

Counting requires a linear, stepwise response and low-noise operation. This is essential for advanced forms of precision optical metrology and could be used to both detect photons and evaluate single-photon sources for QKD. The new device could also be cooled electronically, at much higher temperatures than typical cryogenic photon detectors.

In QDOGFET detectors, as a photon is absorbed, a positively charged hole is trapped by a quantum dot, while the corresponding electron is swept by the applied voltage into the channel. The current flow in the channel depends on the number of holes trapped. By measuring the channel response, the detected photons can be counted. NIST measurements show that, on average, each trapped hole boosts the channel current by about 0.2nA. The detector has an internal



QDOGFET structure and operation.

quantum efficiency (percentage of absorbed photons that result in trapped holes) of $68 \pm 18\%$, which is a record high for this type of photon detector, NIST claims.

The QDOGFET currently detects single photons at wavelengths of about 800nm. By using different semiconductor materials, NIST hopes to make detectors that respond to the longer near-infrared wavelengths used in telecoms. Also, researchers hope to boost the external quantum efficiency (the percentage of photons hitting the detector that are actually detected) — currently below 10% — and operate the device at faster speeds.

The NIST research is supported in part by the US government's Disruptive Technology Office, formerly the Advanced Research and Development Activity (ARDA).

www.nist.gov

NEC C&C prize awarded to VCSEL inventor Kenichi Iga

Tokyo-based non-profit organization NEC C&C Foundation says that its 2007 C&C Prize is to be awarded to two groups (receiving ¥10m each):

- Dr Kenichi Iga, president of Tokyo Institute of Technology (and former executive director of the Japan Society for the Promotion of Science), for the invention of the vertical-cavity surface-emitting laser (VCSEL) and resultant contributions to the progress of optoelectronics; and

- Dr Robert D. Maurer (retired research fellow at Corning Inc), Dr John B. MacChesney (retired fellow at Bell Laboratories) and Dr Tatsuo Izawa, executive VP for research at Tokyo Institute of Technology (former president and CEO of NTT Electronics Corp) for pioneering contributions to R&D resulting in low-loss optical fiber.

Established in 1985 and funded by NEC Corp, the C&C Prize is awarded in recognition of outstanding

contributions to R&D activities and pioneering works related to the integration of computers and communications (C&C) technologies and the social impact of developments in these fields.

Iga invented the VCSEL at the Tokyo Institute of Technology in 1977. He demonstrated surface emission under pulsed conditions in 1979, but continuous surface emission at room temperature only came in 1988. Iga and his team overcame the difficulties arising from the fundamentally short



Dr Kenichi Iga of Tokyo Institute of Technology.

active region length in the laser resonator structure by improving aspects such as the reflection layer structure and active layer configuration, e.g. by introducing a short-distance optical resonator structure, a reflector formed from dielectric multi-layer reflection layers, a circular buried hetero-structure (CBH), and current confinement in an active region for both GaAs and InP base configurations. Subsequently, several research organizations, starting with Bell Labs, reported continuous surface emission.

Further developments (such as lowering the threshold of emission) have since led to practical use, resulting in the commercialization of VCSEL products.

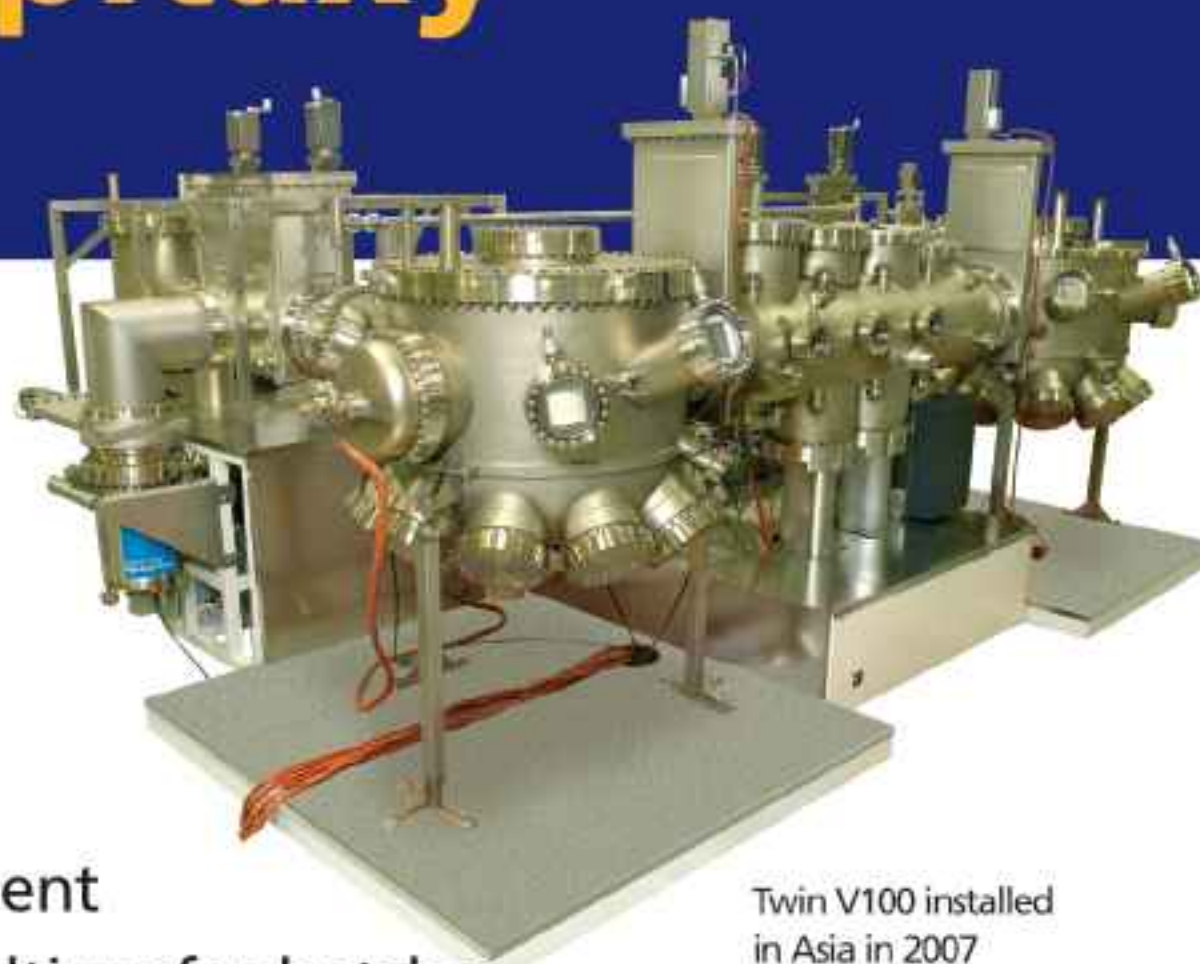
The award ceremony for the 2007 C&C Prize took place on 28 November at the ANA Intercontinental Hotel, Tokyo, Japan.

www.nec.com

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Oplink profits fall despite revenue growth

For its fiscal Q1/2008 (to end-September 2007), photonic component, module and subsystem maker Oplink Communications Inc of Fremont, CA, USA reported revenue of \$49.2m (\$32.8m in core business — up 7.3% on \$30.6m last quarter and up 66.6% on \$19.7m a year ago — plus \$15.4m from 58% ownership of Optical Communication Products Inc of Woodland Hills, CA, USA).

The consolidated revenue is up 149% on \$19.7m a year ago and up 32% on \$37.2m last quarter (which included \$30.6m from core business, plus about one month's revenue from OCP). Growth in core business came from strengths in the optical manufacturing solutions (OMS) and optical component business, says president and CEO Joe Liu.

Operating expenses have risen from \$5.5m a year ago and \$10m last quarter to \$15.8m, partly due to a rise in R&D expenses (the component R&D team in Wuhan, China). Hence, operating loss was \$3.9m, up from \$933,000 last quarter and compared to a profit of \$662,000 a year ago. Gross margin was 24.1% (32.7% for core business — up from 28% last quarter — offset by just 6.7% for OCP).

Net income was \$1.3m (\$5.5m from core business, minus a net loss of \$4.2m from OCP). This is down from \$3.0m last quarter (partly due to transitional costs for contract manufacturing rising from \$216,000 to \$755,000).

Cash, cash equivalents and investments are \$236.8m. About \$80m of this will be paid to former OCP stockholders for the remaining 42% stake acquired on 31 October. Also, in October, Oplink spent \$21.6m to repurchase common stock, as part of a share repurchase program announced in August.

For fiscal Q2/2008 (to end-December), Oplink expects revenue of \$46–50m (including core Oplink revenue up 5%, plus \$13–15m from consolidation of one month of 58% ownership of OCP and two months of 100% ownership).

"We look forward to integrating OCP with Oplink and being able to provide our combined customer base a broader portfolio of product offerings," says Liu. "We expect OCP to be fully integrated with Oplink in fiscal Q4/2008," adds CFO Shirley Yin. "We are already moving to quickly reduce or eliminate unnecessary costs, because we will finalize and implement plans to restructure the Woodland Hills business and the OCP Asia laser chip manufacturing subsidiary in Taiwan" (formerly GigaComm Corp, acquired by OCP in 2006).

OCP Woodland Hills revenue in recent quarters has been \$12–14m. "Gross margin averaged 15–20%, which could sustain the fabless transceiver business, provided that costs are controlled and pricing remains competitive," says Liu.

Oplink wants to take full advantage of its experience of moving

operations offshore. Proven OMS expertise with its existing setups in Zhuhai and Shanghai in China will ease integration of OCP's transceiver business at one of Oplink's core business units, reckons Liu.

At Woodland Hills, there is plenty of room for cost reductions in R&D. "We intend to continue to ramp up our Wuhan, China transceiver design capability to reduce R&D expenses," Liu says. He adds that Oplink had put the OCP Woodland Hills on the market for a selling price of \$28m, and has received an offer. Liu aims to close the deal on 20 December. Also, OCP will no longer be burdened with the substantial cost of independently complying with the SEC rules applicable to public companies, adds Liu, possibly leading to savings of \$2m per quarter.

Last quarter, OCP Asia's revenue of \$2.6m was exceeded by losses of \$2.8m (a gross margin of –105%). "We will consider options to better align its business model, preferably to the fabless transceiver business model," says Liu, e.g. by accelerating the transfer of manufacturing to China. Some of the business running there is sub-transceiver components [e.g. OSA and TO-10]. "That's not something that you can be profitable with stationed in Taiwan," he adds. By moving the operation to Zhuhai, it's highly likely to be very competitive again, he adds. The OCP Asia InP fab, in the worst case, could be shut, says Liu. Another option is a spin-off.

"The low-margin business that we will transition out to Zhuhai would be probably around 50% of the business.

For OCP, the next two quarters will be a transition period. Our internal goal is to achieve breakeven on a non-GAAP basis in June 2008. "With Oplink's leadership in the passive market and the addition of OCP's transceiver business, we believe OCP Oplink can create industry-leading solutions and access applications," says Liu.

www.oplink.com

Oplink completes acquisition of OCP

At the end of October, Oplink acquired the remaining 42% of the outstanding common stock of Optical Communication Products Inc of Woodland Hills, CA, USA, which designs and manufactures fiber-optic communication components and subsystems.

This followed approval of the corresponding merger (between OCP and a subsidiary of Oplink) by more than two-thirds of the hold-

ers of OCP common stock not held by Oplink. Oplink has paid the stockholders \$1.65 per share (about \$80m in total).

Oplink agreed on 19 June to acquire the outstanding OCP stock, after completing its purchase of the 57.9% stake of The Furukawa Electric Co Ltd on 5 June.

As a result of the merger's completion, OCP is now a wholly owned subsidiary of Oplink.

Opnext's 38% growth driven by 10Gb/s

For fiscal Q2/2008 (to end-September 2007), optical communications module and component maker Opnext Inc of Eatontown, NJ, USA reported a fifth consecutive quarter of increased sales and profitability.

Revenue was \$76.6m, up 38.4% on \$55.3m a year ago and 12.9% on \$67.8m last quarter, mainly due to increased sales of 40Gb/s, 10Gb/s and 1 Gigabit Ethernet products. Sales to Cisco and Alcatel-Lucent were 40.9% and 23.0% of total sales (compared to 35% and 23%, respectively, the prior quarter).

Sales of 10Gb/s and above products were \$63.5m, up 48.0% on \$42.9m a year ago and up 13.9% on \$55.8m last quarter, mainly due to strong demand for X2 and 300-pin fixed-wavelength and tunable products as well as 40Gb/s products.

Sales of less than 10Gb/s products were \$8.2m, up 25.9% on \$6.5m a year ago and up 11.7% on \$7.3m last quarter.

Sales of industrial and commercial products were \$4.8m, up 32.9% on \$3.6m a year ago and up 1.7% on last quarter's \$4.7m.

"The environment remains strong and we continue to be encouraged by the overall acceleration of broadband applications globally, which is driving the need for high-speed

optical networks," says president and CEO Harry Bosco. "This continues to translate into broad-based demand and high levels of interest from our core customer base."

Net income was \$5.8m, up from \$1.2m a year ago but down on \$6.7m last quarter. Cash and cash equivalents rose by \$2.8m to \$202.4m, as \$4.2m of cash from operations was partially offset by additional investments to expand manufacturing capacity.

"The 40Gb/s capacity expansion completed last quarter allowed us to clear out prior quarter backlog and meet current demand," says Bosco. "As certain of our key customers continued to implement their vendor-managed inventory programs, we successfully managed the transition with minimal impact to our business," he adds. "R&D investments were focused on the development and qualification of new products addressing the 40Gb/s, 10 Gigabit Ethernet, and DWDM markets, as well as on our continuous product cost-reduction programs."

For fiscal Q3/2008 (to end-December 2007), Opnext expects revenue to grow to \$77-80m (consistent with its aim to grow at least as fast as the market annually).

www.opnext.com

Opnext appoints former HP executive as COO

Opnext has appointed Gilles Bouchard as chief operating officer.

Bouchard has more than 17 years of experience with Hewlett Packard (HP), where he held senior management roles, most recently as executive VP of global operations (responsible for a \$50bn supply chain, procurement and customer-facing operations such as hp.com, sales support, and direct and indirect fulfillment). Previously, Bouchard acted in a dual role as chief information officer and executive VP of operations, and held senior management positions in HP's



Gilles Bouchard.

computing and printing businesses. Prior to joining HP, he worked for IBM.

"His broad business background and deep experience in supply chain management, manufacturing, and distribution will be invaluable in organizing our company to better serve our customers while improving our operational efficiency," says president and CEO Harry Bosco.

Emcore compliant with Nasdaq filing requirements

On 6 November, Emcore Corp of Albuquerque, NM, USA, which makes components and sub-systems for the broadband, fiber-optic and solar power markets, was notified that the Nasdaq Listing and Hearing Review Council, after consultation with the Nasdaq Listing Qualification staff, determined that the firm has demonstrated compliance with the filing requirements under Nasdaq's Marketplace Rules.

On 1 November, Emcore said that it had filed with the Securities and Exchange Commission its annual report on Form 10-K for the fiscal year to end-September 2006 and its quarterly reports on Form 10-Q for the quarters to end-December 2006, end-March 2007, and end-June 2007. This followed Emcore completing its voluntary investigation into past stock option granting practices, determining appropriate measurement dates for all grants that were incorrectly dated, and making corresponding accounting adjustments to its financial statements.

The filings supersede in their entirety the preliminary quarterly earnings releases issued on 8 January, 25 April, 10 July, and 10 October.

The notification adds that the firm's securities will continue to be listed on The Nasdaq Global Market. In mid-October, the Listing and Hearing Review Council had extended the deadline to 4 December for Emcore to demonstrate compliance with the requirements for continued listing.

Emcore says that it is now working to complete its proxy solicitation process and intends to hold its annual meeting in December.

www.emcore.com

Mintera partners with investor JDSU on 40Gb/s solution

JDSU of Milpitas, CA, USA has formed a strategic partnership with Mintera Corp of Acton, MA, USA, which makes high-bit-rate optical transport sub-systems, to provide a complete 40Gb/s solution set for optical network equipment manufacturers (NEMs) in the telecoms industry.

The partnership aims to provide products that combine Mintera's dense wavelength division multiplexing (DWDM) 40Gb/s transmission technology with JDSU's proven 40Gb/s-capable optical communications products and test and measurement solutions, while making use of JDSU's manufacturing expertise and supply chain.

Joint development will include a 40Gb/s DWDM transponder module (to be available in first-half 2008) that will be standardized according to 300-pin multi-source agreement (MSA) guidelines.

As the dramatic rise in voice, video and data traffic continues to strain network capacity, NEMs and service providers are turning to 40Gb/s solutions to bolster network back-bone requirements, the firms says. Compared to 10Gb/s solutions, 40Gb/s allows service providers to expand data transport over a single fiber four-fold, and to future-proof network capabilities with a more efficient and cost-effective approach.

"There is strong demand for 40Gb/s components, although the market is still in its early commercial phase," says Daryl Inniss, VP and

practice leader of Communications Components at telecom market research firm Ovum RHK.

"A mature supply chain is needed for mass commercialization of 40Gb/s solutions, and collaborations like these can help pave the way for widespread acceptance," he adds.

"Many suppliers offer pieces of a 40Gb/s solution. Through our alliance with Mintera, JDSU will be able to provide a complete 40Gb/s portfolio," comments David Gudmundson, JDSU's president of Optical Communications.

Through the Mintera collaboration, JDSU will be positioned to offer the widest range of optical solutions for 40Gb/s networks, the firm claims. JDSU optical components also include ROADMs (reconfigurable optical add/drop multiplexers) and optical amplifiers.

Mintera will also incorporate into the transponder its patent-pending adaptive-differential phase shift keying (ADPSK) technology, which enables optimal transmission of 40Gb/s signals over 50GHz channels in ROADM-enabled optical networks (a configuration commonly used in long-haul and metro networks). ADPSK reduces signal degradation from interference between channels and provides 'spectral efficiency' that allows wavelengths to be packed more closely together to carry more data over longer distances, allowing service providers to maximize their network capacities.

● Mintera has also raised a \$19m Series C round of venture capital, co-led by existing investors Polaris Venture Partners and RRE Ventures but joined by JDSU (plus existing investors including Court Square Ventures, Star Ventures and Portview Communications Partners). This financing brings the total amount raised to more than \$73m.

"Internet traffic growth is again accelerating, with the major new drivers being video, mobile, and embedded networking," says Bob Metcalfe, Ethernet inventor and Mintera director. "Upgrades of core DWDM plumbing are now moving to 40Gb/s in metro and back-bone ultra-long haul." Also, Mintera is already preparing for 100Gb/s a few years ahead of service provider network requirements, he claims.

Mintera will use the funds to complete the commercial launch of its 300-pin DWDM 40Gb/s Adaptive-DPSK Module, release new features on its MI 40000XS platform and develop new solutions at higher bit-rates (100Gb/s) based on its proprietary technology. "We are seeing increased demand now for cost-effective 40Gb/s solutions and are pleased with our investors' confidence," says CEO Terry Unter. Over the past year, the firm won significant new customers, and shipped its new patent-pending modulation format commercially.

www.mintera.com

www.jdsu.com

JDSU ships its 400,000th 980nm planar amplifier pump laser

JDSU has delivered its 400,000th 980nm amplifier pump laser based on its planar platform.

The recipient, China's Wuxi Zhongxing Optoelectronics Technology Co Ltd (WXZTE), has bought more than 30,000 980nm pump lasers from JDSU in the past three years. "Our partnership with JDSU has been a key element to WXZTE's success in expanding our international business to service

Tier 1 network equipment manufacturers around the globe," says VP of purchasing ZuQuan Qiu.

JDSU's 980nm planar pump lasers are used to power erbium-doped fiber amplifiers (EDFAs) for regenerating weakened network signals traveling long distances over agile optical networks (AONs).

JDSU says that its planar pump lasers have logged more than 7bn field hours since shipments began

in 2000. Network operators traced only 15 field failures, equating to industry-leading reliability of >3FIT (failure in time), the firm claims.

The planar approach requires fewer parts compared to older designs, yielding a more reliable product that can be flexibly manufactured in quick response to demand. The simplified approach also eased the transfer manufacturing to JDSU's plant in Shenzhen, China in 2005.

JDSU's profit margins boosted by agile products & cost cutting

For fiscal Q1/2008 (to end-September 2007), broadband and optical communications component maker JDSU of Milpitas, CA, USA reported revenue of \$357m (up 1.8% on last quarter and 12% on \$318.2m a year ago): 54% from the Americas, 28% from Europe, and 18% from the Asia-Pacific region.

Gross margin rose from 34.7% a year ago and 37.4% last quarter to 41.3%, due to slightly improved factory utilization as well as benefits from cost-reduction activity (providing quarterly savings of \$6m, rising to \$8m by the end of fiscal Q2). Non-GAAP net income was \$18.0m (up from \$15m last quarter and \$6.8m a year ago). Adjusted EBITDA (earnings before interest, taxes, depreciation and amortization) was \$23.7m, almost double last quarter's \$11.7m and up from \$9.6m a year ago.

JDSU was free cash flow positive for the third consecutive quarter, generating more than \$27m due to lower capital expenditures and reduced inventory.

"We saw improved margins in three out of four of our business segments due to product mix and the impact of our gross margin initiative," says chief financial officer Dave Vellequette.

Communications Test & Measurement comprised 47% of revenue: \$168.0m (down 1.9% on last quarter's \$171.3m but up 44% on \$116.8m a year ago). Profit was \$26.3m, up from \$6.8m a year ago.

Advanced Optical Technologies comprised 13% of revenue: \$48.0m (up 7% on last quarter's \$44.7m and up 22% on \$39.3m a year ago). Profit was \$18.3m, up from \$11.0m a year ago.

Commercial Lasers comprised 6% of revenue: \$19.9m (down 10% on last quarter and 17% on \$24.1m a year ago). Net loss was \$2.5m, compared to a profit of \$1.7m a year ago.

Optical Communications comprised 34% of revenues: \$121m. This is down 12% on \$138.0m a year ago but up 7.6% on last quarter's \$113m, mainly due to increased shipments of agile optical network (AON) products as well as a full quarter of revenue from pluggable optical transceiver maker Picolight (acquired in May). All three major market segments, including long haul (undersea, metro & datacom), saw sequential growth. Out of 12 product lines, nine experienced sequential increases (with eight having double-digit growth). Net loss was \$2.9m, compared to a profit of \$2.2m a year ago. However, operating loss of \$2.9m is improved from \$9.2m last quarter, due to greater gross margins (partly offset by higher operating expenses from the Picolight acquisition).

"There is a cautiously improving trend in the network equipment manufacturer market," says CEO Kevin Kennedy. By the end of the quarter, two of the three Optical Communications businesses rose to gross margins of 25% or more.

However, customers' lean initiative

and consolidation activities resulted in a delay of two to three quarters in achieving gross margins of 30-40% (which are

'healthy' levels for this industry, Kennedy adds).

To improve overall gross margin, JDSU is focusing on boosting factory utilization. Also, work is underway that can be operationally classified as a lean initiative, including cuts in manufacturing overhead, headcount (from 6688 to 6459 over the quarter, mainly through cuts in Optical Communications), inventory, and

procurement spending. Further improvements are expected due to contributions from VCSELs and other Picolight products. Relative to legacy products, AON products showed healthy bookings for reconfigurable optical add-drop multiplexer (ROADM) and tunables. "We are continuing to invest in pluggables, agile products such as ROADMs and tunables and products for the metro markets," says Kennedy.

"We are focused on functional integration as service providers strive for greater efficiencies in their networks and network equipment providers look for decreases in cost, power and equipment," he adds. "This quarter, we announced a new photonic integrated circuit that combines a tunable laser and an optical modulator. Tunable lasers are key elements, in part for the success of the deployment of agile optical networks." This new solution can be introduced into existing networks without architectural changes.

"We continue to see favorable end market indicators for broadband services and network ROADMs and we believe broadband capacity will continue to expand as higher data rates are being delivered through the access edge accompanied by video applications," says Kennedy.

The optical layer and components business, as well as test and measurement equipment, could therefore see increasing demand with the realization of deeper fiber penetration.

For fiscal Q2/2008 (to end-December) JDSU expects net revenue of \$372-394m. A near-term sustainable target is gross margin of 40%. "We believe we can achieve this model by the end of this calendar year," says Vellequette. "Longer-term, we believe we can achieve gross margins of 43-47%," he adds.

www.jdsu.com

There is a cautiously improving trend in the network equipment manufacturer market

3S heads into profit as it cuts costs and launches products

For its fiscal 2006/7 (to end-June), optical device maker 3S Photonics of Marcoussis, France reported net income of over \$1m, an improvement on a net loss of \$9.9m in fiscal 2005/6.

"This recovery [so quickly after divestiture by Avanex] is the first clear sign indicating the company is on the path towards profitability," says president, chairman and CEO Alexandre Krivine.

For Q1/2007/8 (to end September), revenue was over \$8m, up 25% on last quarter's \$6.4m.

3S was founded in 1994 as Alcatel subsidiary Alcatel Optronics S.A. and was acquired in 2003 by Avanex Corp of Fremont, CA, USA, becoming Avanex France S.A. This April it was bought by Krivine and Didier Sauvage and renamed.

3S plans to supplement the submarine market's return to growth by launching a new generation of fully qualified 980nm terrestrial pump laser modules using in-house chip technology, says VP marketing Yannick Bailly.

3S's executive committee has also announced a new global sales network to expand the customer base. Combined with the launch of the terrestrial pump laser modules, this should significantly boost sales in the coming months, the firm reckons.

For full-year 2007/8 (to end-June), 3S expects revenue of \$34-37m, up more than 38% on fiscal 2006/7 (considering only products retained post-divestiture).

"Given our good sales trends confirmed by our Q1 results and considering the global cost-reduction plan launched in June 2007, we are quite optimistic in achieving our ambitious but realistic goals for fiscal year 2007/8," says Krivine. "We expect to be break-even by Q3/2008."

www.3sphotronics.com

Alcatel-Lucent extends Avanex supply agreement as it sells stake to Pirelli

Optical communications component and module maker Avanex Corp of Fremont, CA, USA says that Alcatel-Lucent of Paris, France has extended its supply agreement by an extra three years and that Pirelli Group of Milan, Italy has purchased Alcatel-Lucent's 12.4% stake in it. Within the framework of the transaction, Pirelli has also signed a supply agreement with Alcatel-Lucent for related components.

"Pirelli has a demonstrated history of advanced technology development, with many capabilities that are complementary to Avanex, and we look forward to future collaborations with both Pirelli and Alcatel-Lucent for innovative photonic solutions," says Avanex's chairman, president and CEO Jo Major.

The investment in Avanex and the Alcatel-Lucent supply agreement give a stronger presence in the core business of second-generation photonics, says Claudio De Conto, Pirelli's general manager operations. This follows the start-up, in 2001, of the Pirelli Labs advanced research center and the founding in early 2005 of Pirelli Broadband Solutions, "built on a long history of experience in the field," adds De Conto.

"We view the long-standing partnership with Alcatel-Lucent as both a testament to our past efforts to support them and our team's demonstrated ability to bring new technologies and products to market," says Major.

www.alcatel-lucent.com

www.pirellibroadband.com

Avanex returns to profitability

For fiscal Q1/2008 (to end-September 2007), Avanex reported revenue of \$54.7m, up from \$51.1m last quarter and \$50.9m a year ago.

Operating expenses have been cut from \$18.1m last quarter to \$15.4m (in line with \$15.6m a year ago). Gross margin rose from 11% a year ago and 24% last quarter to 28%. Net profit was \$45,000, compared to a net loss of \$5.7m last quarter and \$9.7m a year ago.

"We achieved profitability, grew revenue by 7%, improved gross margins by 4 percentage points

and continued to keep our operational expenses in line," says chairman, president & CEO Jo Major.

"Continued financial improvements are reflective of the health of our solid operating structure and validate our strategy," he adds. "We are positioned well for profitable growth and to take advantage of growing bandwidth demand."

For fiscal Q2/2008 (to end-December), Avanex expects revenue to rise further to \$56-58m and gross margin to be flat to slightly up.

www.avanex.com

Former JDSU senior VP of sales recruited

Avanex has appointed Scott Parker as senior VP of sales, responsible for sales strategy, improving processes and increasing sales globally (focusing on new products in existing accounts and expanding into under-served regions).

Parker was VP of sales & marketing at Integration Associates and CEO at Chelsio Communications

(both funded by Sequoia Capital) after being senior VP of sales & marketing at JDSU, where he integrated the sales and customer service teams from many acquisitions. He has also held sales and general manager positions at VLSI, National Semiconductor and Intel.

● Yves Le Maitre has resigned as chief marketing officer.

Bookham grows revenue 20% & cuts losses, then raises \$41m

For its fiscal first-quarter 2008 (to end-September 2007), optical component, module and subsystem maker Bookham Inc of San Jose, CA, USA reported revenue of \$54.3m, up 20% on \$45.1m last quarter and above the guidance of \$50–54m. Nortel Networks and Cisco each comprised over 10% of revenue.

Compared to the prior quarter, gross margin rose from 16% to 23% and net loss has been cut from \$13.6m to \$11.0m.

On a non-GAAP basis (excluding restructuring and other non-recurring charges), gross margin was 24%, up on the guidance of 18–22%. Adjusted earnings before interest, taxes, depreciation and amortization (EBITDA) were –\$2.5m, an improvement on the guidance of –\$3–7m and on the prior quarter's –\$6.0m (which included a \$2.2m

gain from the sale of equipment and other assets). Net loss was cut from \$10.8m last quarter to \$8.0m. During the quarter, cash reserves fell from \$42.7m to \$34.4m.

"Our strong first-quarter financial performance reflects the continued improvement in sales to our top customers, success with our new product introductions, and the diversification of our customer base," says president and CEO Alain Couder. "Prospects are strong for further financial improvement in the December quarter," he adds. "We

We expect to see continued margin improvement with our new products and stable margins with existing products

expect to see continued margin improvement with our new products and stable margins with our existing products. From the cost side, we should hit our reduction objectives by the end of December."

For Q2/2008 (to end-December), Bookham forecasts revenue of \$55–58m, a non-GAAP gross margin of 23–26%, and adjusted EBITDA of –\$2m to +\$1m.

● Bookham closes \$41m public offering

On 13 November, Bookham closed a public offering of 16 million shares (announced on 29 October) at \$2.75 per share. Net proceeds are about \$41m.

Bookham has granted the underwriters a 30-day option to purchase up to an additional 2.4 million shares to cover over-allotments.

www.bookham.com

Finisar's revenues dip due to glitches in 10/40Gbps shipments, though gross margins are maintained

For its fiscal second-quarter 2008 (ended 28 October 2007), fiber-optic component and subsystem maker Finisar Corp of Sunnyvale, CA, USA says that, on the basis of preliminary financial results, it expects revenues of about \$101m (down from \$105.7m last quarter and \$108.2m a year ago). This is further below the low end of its earlier guidance of \$106m. However, revenue was negatively impacted by about \$6m due partly to the following factors:

- revenues for 10/40Gbps applications of \$18m being flat on last quarter due to: firmware changes requested for the recently qualified 10Gbps X2-SR transceiver reducing shipments (resolved by the end of the quarter); test setup changes needed for 40Gbps transponders

limiting shipment capacity (resolved shortly after the end of the quarter); supplier issues that limited production levels for 10Gbps 40/80km XFP transceivers; ● excess inventory of SAN (storage-area network) transceivers at a large customer limiting shipments.

Nevertheless, due to an improvement in yields associated with ramping production of several new products, Finisar expects non-GAAP gross margins of 35–36% (about the same as last quarter).

Finisar deferred its revenue guidance for fiscal second-half 2008 until its next quarterly conference call on 5 December. However, it reiterates that sequential revenue growth should resume in the fiscal third and fourth quarters as a result of:

- increased shipments of 10/40Gbps products due to resolution of the firmware and test setup issues;
- resolution of capacity constraints for 40/80km 10Gbps XFP transceivers;
- qualification of 40Gbps transponders at several customers;
- increased shipments of SFP+ transceivers for 8/10Gbps LAN local-area network) and SAN applications;
- qualification of an XFP-SR product for 10Gbps applications at several customers;
- design wins for GPON (Gigabit passive optical network) and 10/40Gbps products at a large telecom customer for shipment in calendar-year 2008.

www.Finisar.com

Towards low-cost high power density devices

Gallium nitride power electronics are now ready to address a \$3.5bn market, reckons Philippe Roussel of market research firm Yole Développement.

Gallium nitride is already widely used for blue/white LED manufacturing — consuming an equivalent of more than 5 million 2" wafers this year — and the related GaN industry is now maturing. In addition, since GaN's wide energy bandgap allows a high breakdown voltage, the material is suited to use in power electronics applications.

Silicon-based power electronics is forecasted to represent a \$13.5bn market for discrete devices in 2007. We estimate that GaN technology can address least \$3.5bn of this. The main applications that are feasible include power factor corrector (PFC) circuits, hybrid automotive, uninterruptible power supplies (UPS), and solar-panel and industrial motor control. To achieve this, nitride devices have to compete not only with silicon on cost but also with SiC on performance. This very challenging position is driving much activity in the nitride community to develop new GaN power devices.

GaN can cut device price by 30% versus SiC

Since 2001, possible GaN market segments have been partly covered by SiC technologies. SiC Schottky diodes are in full production at Cree and Infineon and the first commercial offerings in transistors are available from firms like SemiSouth, TranSiC and SiCed.

However, SiC devices remain very expensive compared to silicon, essentially due to the SiC single-crystal substrate price, which is generally more than 50% of the overall device cost. This can be dramatically improved in the GaN world, where substrate technology can benefit from long-term experience with LEDs and can lead to improved material at an affordable price (see Table).

The first initiative in GaN power devices came when Velox Semiconductor, a spin off from Emcore, unveiled 600V GaN Schottky diodes with zero recovery time for power supply applications. The firm claims to have achieved performances comparable to SiC diodes (see Figure 1) but at a fraction of their cost (30% less than the SiC-based Schottky selling price). GaN Schottky diodes are grown on 4" sapphire substrates. GaN dislocation density (which has plagued blue lasers) remains

Strengths	Weaknesses
<ul style="list-style-type: none"> • Breakdown voltage close to SiC's • Electron mobility twice SiC's • 4" epiwafers already available (Nitronex, Picogiga, IMEC, Azzurro): scalable technology • Micropipe-free material. • Only one polytype 	<ul style="list-style-type: none"> • Thermal conductivity 1/4 of SiC's • No bulk GaN substrate available at reasonable price • GaN epi substrates (sapphire, Si+AlN buffer) are insulators: no vertical device easily feasible • Lateral devices limited in breakdown voltage & current density for given device footprint
Opportunities	Threats
<ul style="list-style-type: none"> • Many possible suppliers: no monopoly situation • GaN industry is mature, thanks to opto markets • GaN HEMT can be transferred from RF to power applications • GaN Schottky diodes already proven and adopted (Velox, ST) • 30% device price reduction expected compared to SiC 	<ul style="list-style-type: none"> • No GaN switch on market yet • GaN power device development started 10 years after SiC

in the 10^8cm^{-2} range but seems to have a relatively low impact on the device performance. Velox has developed GaN diodes operating at 600V and currents of 2, 4, 6 and 8 Amperes and has teamed with STMicroelectronics for devices production and distribution.

GaN power electronics to boost epi market

The SiC-based power electronics industry has emerged due to the availability of bulk single-crystal SiC, enabling the growth of SiC epilayers in a homo-epitaxial process. This approach allows perfect lattice matching between the active layer and the substrate.

For GaN, the situation is more complicated: bulk GaN substrates remain very expensive (\$3-7000) and are only available at 2" diameter (although recent announcements from Hitachi Cable makes 3" GaN close to commercialization). Optoelectronics applications like blue laser diodes are helping to cut pricing by increasing demand for bulk crystal, but even the most optimistic roadmap shows bulk GaN remaining uncompetitive in price compared to SiC for quite a long time.

The first solution came from sapphire, which up to now has been the cheapest substrate available for growing GaN. This also means that GaN growth is based on a hetero-epitaxial process. However, sapphire

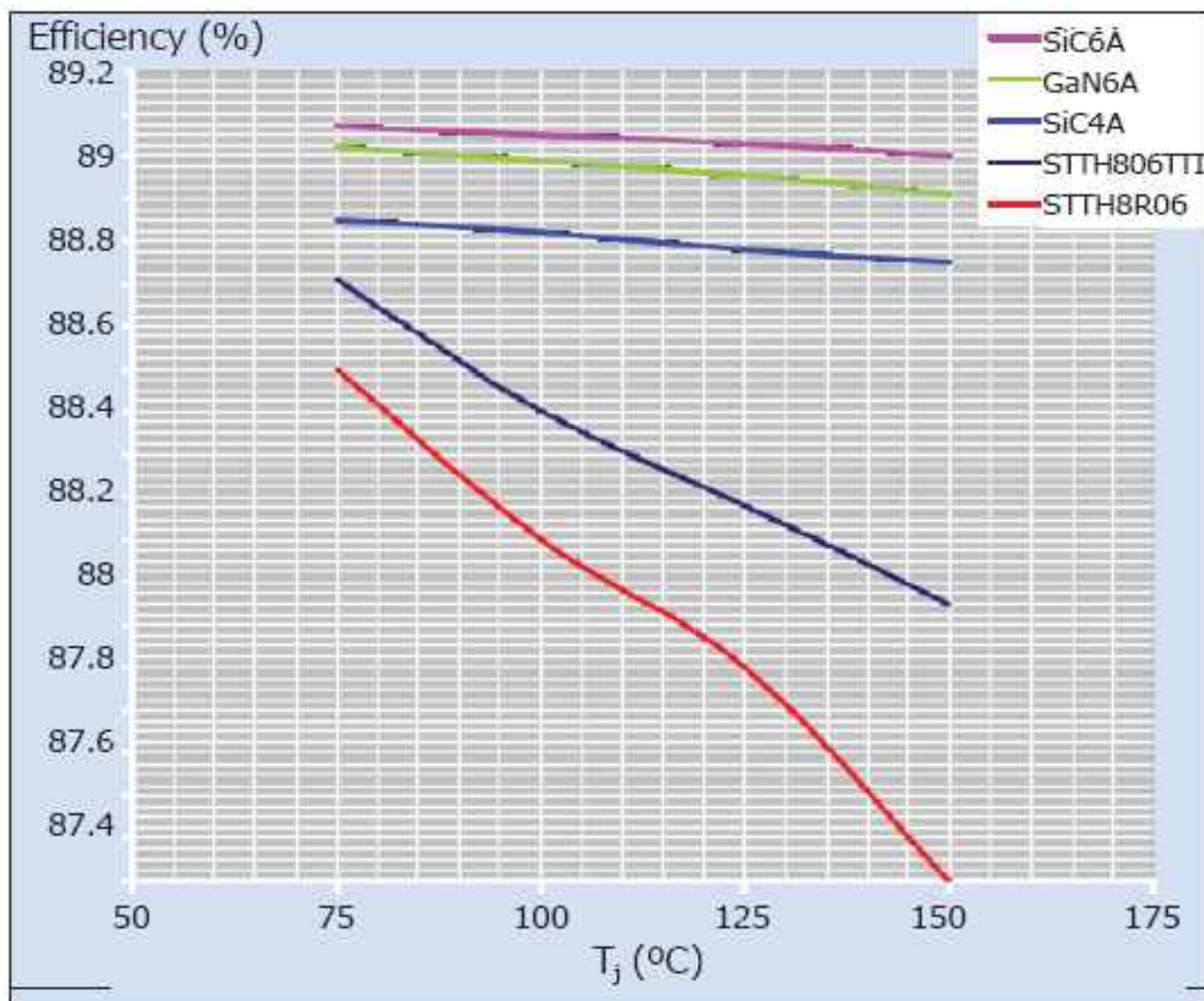


Figure 1. PFC efficiency comparison as a function of junction temperature and Schottky diode type (Si, SiC and GaN). Courtesy of STMicroelectronics.

is an insulator (thermally and electrically) so devices need lateral designs. Lateral devices are limited in term of breakdown voltage compared to vertical devices and rapidly become bulky for high power densities.

New developments are now focusing on decreasing the epiwafer cost by using silicon as a substrate for GaN growth. GaN/silicon substrates for power electronics has been proposed by companies like Picogiga, IMEC, Nitronex, IQE, Azzurro, NTT and Covalent Materials, and is commercially available in 4" and even 6" diameters.

Another promising material for GaN growth comes from Soitec subsidiary Picogiga, which proposes its SopSiC substrates, made of a thin silicon layer bonded onto a poly-silicon carbide wafer. This approach offers a thermally enhanced substrate compared to GaN/silicon and can be used as a template to grow GaN the same way as on bulk silicon. The product is now commercially available at a diameter of 4" (with 6" expected soon).

However, even grown on a Si substrate, GaN epiwafers won't allow vertical design, because of the AlN insulating buffer layer generally used to match Si and GaN crystals.

In summary, the challenge facing GaN power electronics is a subtle balance between substrate diameter, power density, chip size and device cost. In other terms, GaN power devices on sapphire or silicon can compete with SiC from a cost point of view by using larger 4" and 6" substrates to compensate for the bigger chip size at a given power density. We forecast a strong market ramp-up by 2010 and expect demand of more than 150,000 x 4" GaN epiwafers in 2012 (Figure 2).

So, with the introduction of affordable large-diameter epiwafers (4" or more), GaN power electronics is perfectly matched to target the 0–600V market in the short term, aided by the development of dedicated device technology. GaN power transistors can benefit

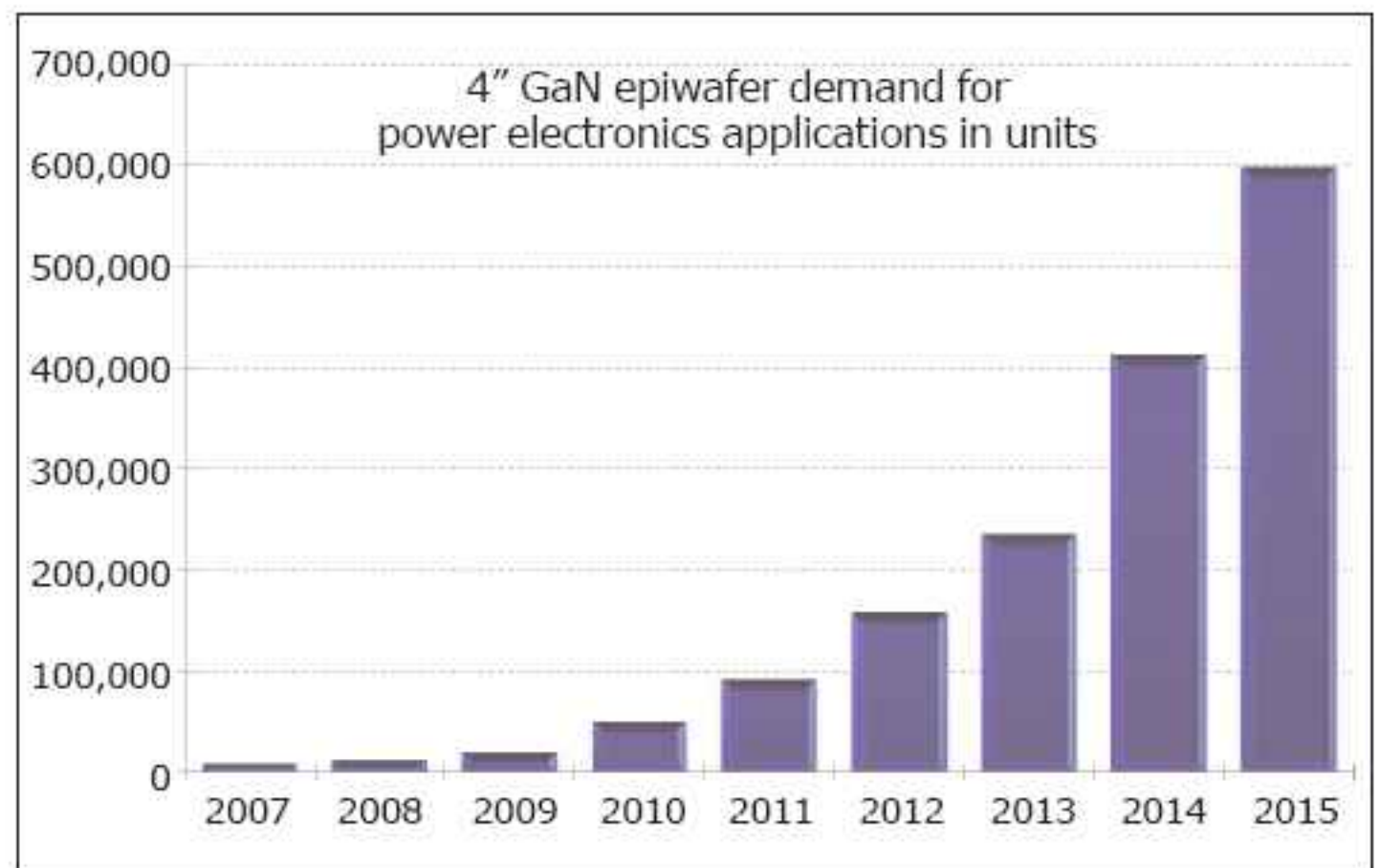


Figure 2: Unit forecasts for 4" GaN epiwafers.

from the long experience of developing GaN RF HEMTs. This can speed the emergence of a GaN low-frequency transistor, to be coupled with existing Schottky diodes.

GaN has now entered the power electronics battlefield. The first challenge is facing SiC technology but, with price reduction, silicon will become the main target.

Dr Philippe Roussel of Yole Développement of Lyon, France (www.yole.fr) is now editing the latest market report 'GaN'07' dealing with new GaN developments and markets from a material and device points of view.

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Seeking workable low-cost silicon carbide

Material properties suggest high temperature and power electronics could be well served by silicon carbide (SiC), but many production difficulties have blocked the easy paths to adoption. However, SiC deposited on a silicon substrate has many attractions from a volume production perspective. **Dr Mike Cooke** reports on Japanese and US efforts to make this a viable option.

Silicon carbide has many promising properties from an electronics perspective: high thermal conductivity, high breakdown field, and high mobility given the high breakdown field (see Table). High thermal conductivity is particularly attractive for components operating at higher temperatures or needing to dissipate power.

The various branches of the US military have been some of the long-term supporters of SiC research. Much of the equipment used in warfare, such as rockets and jet engines, run extremely hot. It is estimated that more than 50% of the air-conditioning effort on fighter planes is designed to cool the avionics, not the pilot. Other military fields where high-temperature ICs could be of interest are armored vehicles and missile control.

There is also commercial interest for applications in hot environments such as diesel-electric locomotives and automobiles. Engine-control computers in automobiles are presently located in passenger areas rather than under the hood due mainly to the temperature constraints of silicon technology. The high breakdown voltage suggests application to inverter devices, as used in air-conditioners and refrigerators, along with power devices in personal computers and home electric appliances.

However, despite the US Army spending some \$2bn on SiC research, the results have not been particularly good, and a diminishing returns effect has been seen.

The research focus is still on the simpler power components, where the material offers theoretical advantages.

SiC's application sees problems arising in one of its most basic semiconductor structures — the pn junction. These problems arise, as with so many other semiconductor materials (e.g. gallium nitride), in various forms of defect. It is found that the performance of a device based on a SiC pn junction degrades when the bias moves from one direction to the other, and that the effect is cumulative. Schottky diodes (metal-semiconductor junctions) are less affected. One main difference between these structures is that pn junction operation depends on minority carriers, while Schottky junction currents are dominated by majority carriers. SiC has therefore seen some success in the Schottky diode arena, particularly for those used in power factor correction devices to improve cost efficiencies in office automation products. When MOSFETs are constructed in SiC, it's common to include Schottky diodes to protect the pn junctions from performance-degrading bias reversals.

Production nightmares

The main problem with producing SiC devices is the extreme difficulty in producing suitable, low-defect substrates. Silicon carbide does not have one simple crystal structure — rather, there is a whole zoo of 'polytypes' of hexagonal (6H, 4H, 2H), cubic (3C) and rhombohedral (15R) forms that can arise. In addition,

Table. Comparison of material properties. SiC properties depend on polytype: ranges include 3C, 4H, 6H. Polytype 3C is at lower end of energy gap (E_g), breakdown field (E_b) and thermal conductivity (λ), while its electron mobility (μ_e) is around $800\text{cm}^2/\text{V-s}$. Linear thermal expansion coefficient (LTEC) comes from [1], while other values are from [2].

Material	E_g (eV)	E_b (MV/cm)	λ (W/cm-K)	μ_e ($\text{cm}^2/\text{V-s}$)	LTEC ($\times 10^6 \text{K}^{-1}$)
SiC	2.4–3.2	1–5	3.6–4.9	400–900	4.5
Si	1.12	0.25	1.3	1350	3.6
GaN	3.4	~5	2.0	1000–1350	5.6 (3.2)
AlN	6.2	1–2	2.85	300	5.3

silicon carbide does not have a liquid state except at very high pressure (>30 bar). The sublimation temperature (gas-solid transition) of SiC is well above the melting point of silicon (1420°C). This all makes control of the crystal growth process near to impossible. Most defects are related to the very high temperatures (1600–2500°C) needed to produce SiC crystals. The higher the temperature, the more defects are formed. Further, SiC is second only to diamond in hardness, making machining (polishing, grinding) of wafers very difficult.

One major SiC defect has been micropipes, which can be seen as being analogous to the streams of bubbles that emanate from nucleation centers in a pan of boiling water. When, in addition, one attempts chemical vapor deposition (CVD) epitaxy on top of a surface with micropipes, the open spots affect the deposition and one ends up with a 'Swiss cheese'-like layer of SiC. Most attempts to deal with micropipes have centered on slowing down bubble nucleation on the growing SiC surface. However, Cree, the supplier of the majority of SiC substrates, recently announced the commercial release of 'Zero Micropipe (ZMP)' 100mm wafers.

Looking for lower costs, higher volume

Production difficulties naturally translate into high cost and low technology uptake. Looking for lower-cost SiC, some researchers are developing silicon carbide layers on low-cost silicon. A further advantage of silicon is the possibility of making devices in far higher volume, since silicon wafers extend up to 300mm in diameter rather than the 100mm maximum of Cree's products. For sure, one loses SiC's thermal conductivity advantage, but thinning of wafers before packaging is a standard technique used in silicon processing to both reduce the size of components and increase thermal conduction.

Two firms following the SiC/Si approach with a view to low cost and high volume are Covalent in Japan and C9 in the USA. Covalent, formerly Toshiba Ceramics, has this year become independent of its parent company in one of the many recent reorganization efforts in the Japanese business landscape. C9 is a company that largely works on US defense R&D contracts.

SiC has been put on silicon before, usually in the cubic '3C' polytype. This is often performed by a carbonization process to create a buffer layer to bridge the 20% lattice mismatch between Si and SiC that normally leads to a high level of defects and consequent reduction in electronic performance [3]. One of the main problems of carbonization is the formation of voids in the substrate when the carbon supply is insufficient to form an adequate buffer layer. Another problem is that the buffer layer forms in islands that are not correctly oriented with respect to each other — in 'twinning' and 'antiphase' configurations — for

forming a high-quality SiC film. Optimization of the C:Si ratio is needed to produce the best-quality 3C SiC. High temperatures increase the growth rate, but the resulting material is usually not good enough for producing electrical devices due to high defect rates, although micromechanical systems have been produced using the etch selectivity between the two materials.

MOVPE 3C SiC/Si

In 2004, Toshiba Ceramics announced development of wafers with a cubic silicon carbide single-crystal film grown on a silicon substrate, using metal-organic vapor phase epitaxy (MOVPE). The firm reported that it had put a compound semiconductor buffer layer film with the same crystal form as silicon and silicon carbide between the silicon carbide and the silicon substrate to significantly reduce the crystal defects caused by the 20% SiC/Si mismatch. The aim was production on 6-inch or more diameter wafers of a cubic silicon carbide film for a comparatively low price with reliable quality. Another aim would be to insert such wafers into standard silicon device manufacturing lines. Toshiba Ceramics also hoped that the high-quality SiC layers on SiC could be used in the development of nitride semiconductor devices.

Hideo Nakanishi of Covalent's Core Technology Center comments: "We made every effort to develop SiC-on-Si substrates for power devices. However, nitride semiconductor materials are now in strong demand from many device makers. Therefore, we started GaN-on-Si substrate development. We have recently demonstrated that SiC is a useful buffer material for GaN crystal growth on Si substrates. Now, we are developing GaN/SiC/Si substrates for power high-electron-mobility transistor (HEMT) devices alongside SiC-on-Si substrate development."

Based on research reported last year [1, 4], Covalent researchers believe that GaN grown on 3C SiC on silicon wafers is a 'promising' route to power HEMT

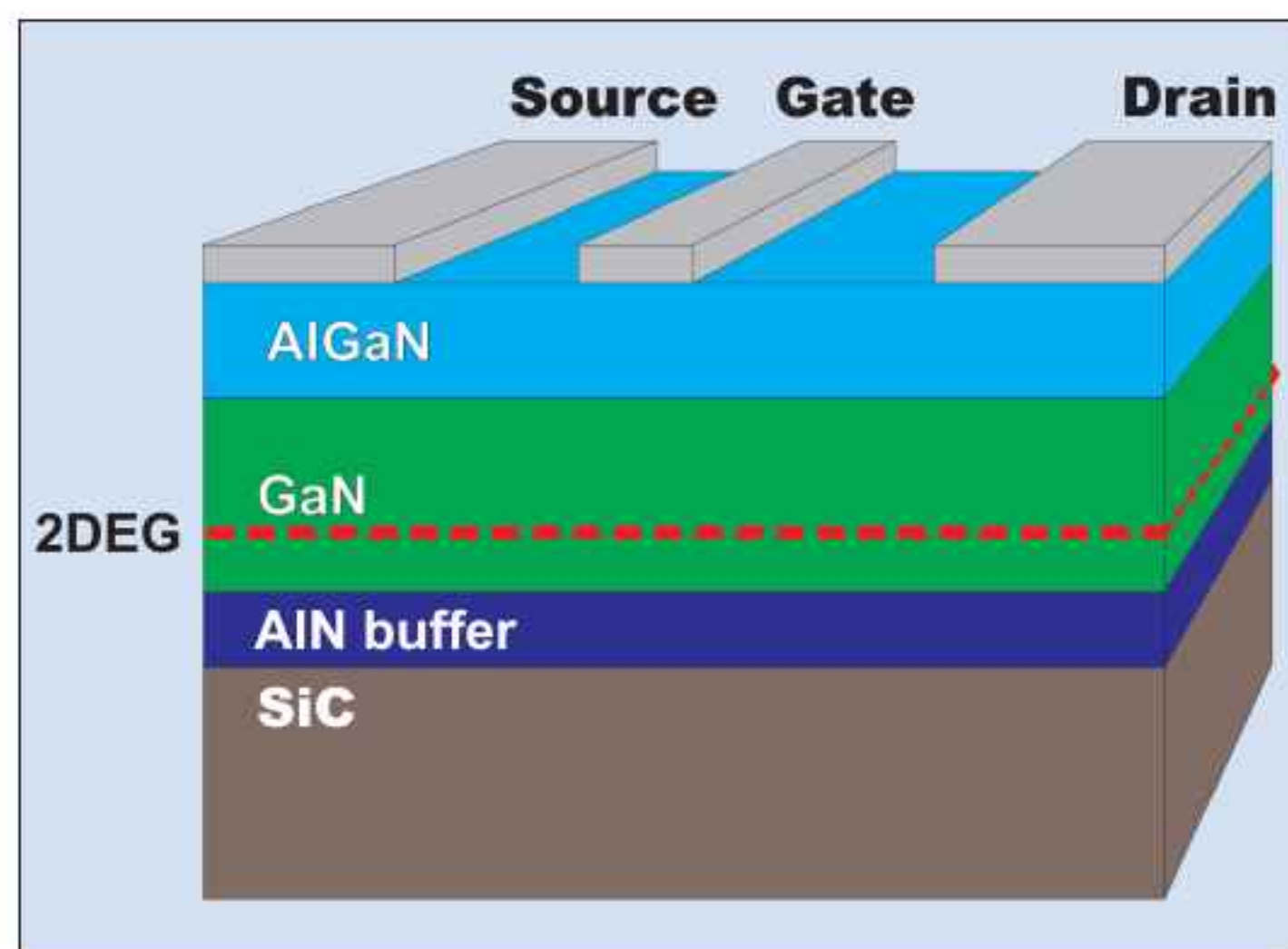


Figure 1. Schematic of GaN/SiC HEMT.



Figure 2. Covalent's GaN/SiC/Si layer structure with AlN buffer. The SiC crystal structure is oriented [111] and the xN [0001].

devices operating at high frequency at lower cost. In particular, Covalent has seen GaN layers up to 3 μm thick with reduced levels of cracking and has measured the respective polarities of the interfaces, finding that the GaN-SiC interface has the correct Ga and Si polarities for creating the two-dimensional electron gas (2DEG) needed for HEMT device operation (Figure 1).

The cracking of hexagonal GaN (wurtzite) on Si is a particular problem due to the large mismatches in both the lattice constant (17%) and the thermal expansion coefficient (33%). In contrast, the 3C SiC/GaN mismatch is 3%. The polarity characteristics of the GaN-SiC interface were determined using convergent beam electron diffraction (CBED). The MOVPE growth was on 3-inch (111) silicon substrates in a horizontal reactor. A thin AlN layer is interposed between the GaN and SiC to prevent unwanted Ga-Si interactions (Figure 2).

More recently, electrical characterizations have been performed on GaN and SiC Schottky contacts. The GaN contact was found to have a breakdown voltage of 250V, while on SiC it is 200V. The leakage currents are described as being 'low' in the case of GaN and 'high' for the SiC contact. The SiC leakage is provisionally blamed on 'antiphase' domains and stacking faults.

Superlattice SiC

C9 claims that its proprietary process is essentially micropipe free, being of the order of that in silicon (i.e. practically non-existent). The technology developed from work on silicon-on-insulator epitaxy over a period of about 10 years. Part of the advantage of C9's process comes from its use of atomic layer deposition on silicon substrates. This can form superlattices of SiC with varying levels of carbon (from 0% up to 40-50%). However, problems arise with going beyond a carbon content of 50%; C9's chief technology officer, CG Wang, has found during many years of research into growing diamond crystal that the process tends to deposit as graphite rather than diamond. C9 grows layers up to 100nm thick. One can also include doping elements as the growth progresses. Doping can vary majority carrier densities from intrinsic semiconductor up to a carrier density of $10^{22}/\text{cm}^3$ (p or n). Since the

doping is carried out at the atomic level, one can achieve very sharp junction profiles compared with diffusion. Since one is building superlattice structures, the energy band gap is tunable.

According to the company, the electron mobility is of the order of $1000\text{cm}^2/\text{Vs}$ and the breakdown voltage is the same or better than for traditional SiC. The company attributes this to reduced defect levels.

Since C9 is starting from a silicon substrate using standard processes and tools, the starting costs are much lower than for those using expensive SiC substrates. However, being based on atomic layer deposition, the process is very slow. To achieve productivity increases, one needs to expand laterally to larger wafers. C9 has had a 6" (150mm) machine working since June 2006 and is starting work on scaling up to 8" (200mm). Chief executive officer Kevin Donegan believes that C9 could have an 8" machine working by June 2008 and that C9's techniques are scalable to the largest-diameter silicon wafers of 300mm and beyond (e.g. the 18"/450mm presently being touted in the industry as the 'next step up'). Along with this, C9 will work to improve quality, reducing defects even further.

Being based on ALD, C9's epitaxial structures are 'nano-engineered'. Donegan comments: "C9's material

CEO Kevin Donegan believes that C9 could have an 8" machine working by June 2008 and that C9's techniques are scalable to the largest-diameter silicon wafers of 300mm and beyond

is a truly engineered material. The SiC resulting from other processes is God-made, because the temperature and other factors are almost impossible to control — one just has to pray that it doesn't go wrong."

C9 sees many possible applications for its materials, but has decided to focus on just a few. First are large-area Schottky diodes, since this is a well-established

SiC application. C9 plans to move from its present 1cm^2 Schottky diode products to 4cm^2 and eventually to whole wafer-area devices. Its Schottky diode structures can support current densities in the range $100\text{--}200\text{A}/\text{cm}^2$, so a 4cm^2 device could handle 800A. While great claims have been made for SiC elsewhere, the present reality is that single devices are generally rated at currents of 35-40A. Donegan believes that higher rated diodes ($\sim 75\text{A}$) are in fact multi-die products. Following on from Schottky diodes, pn junction diodes are planned, since C9's methodology should avoid the degradation seen in devices produced on standard SiC.

Another target is solar cells, particularly for hot environments (e.g. in Iraq) where amorphous silicon-based photovoltaics do not perform well. Logically, SiC solar cells could operate up to 600°C . C9 is looking to

produce multi-junction photovoltaic devices, with each junction centered on a different part of the available solar spectrum. Here, a tunable band gap comes in very handy. The standard SiC band energy comes in the large-energy photon ultraviolet range. Narrower gaps can scoop up the lower-energy photons into different 'buckets'.

At Boeing Spectrolab, compound semiconductor multi-junction solar cells have reached 40% efficiency. C9 believes that its single-crystal superlattice is at an advantage over multi-junction devices constructed out of conflicting materials. C9's structure consists of numbers of superlattice SiC layers with different band gaps connected in series with conducting tunnel diode junctions. The firm will be working with The Solar Energy Consortium (TSEC) in New York state, which has recently been allotted \$4m in US federal funds from the 2008 Defense Appropriations bill. It is hoped that the consortium will start by creating between 300 and 500 jobs after C9 has researched the technology.

Compound semiconductor multi-junction solar cells have reached 40% efficiency. C9 believes that its single-crystal superlattice is at an advantage over multi-junction devices

Beyond this, C9 is researching producing radio frequency devices based on high-electron-mobility transistors (HEMT). Another area is switching circuits. The most common structure for SiC switch devices is the junction gate field-effect transistor (JFET) in combination with silicon MOSFETs. The SiC power JFET combines a simple robust structure with high breakdown voltage and high speed. The SiC JFET Si MOSFET combination allows operation up to 175°C. If the SiC JFET could be released from the silicon temperature range, one could have devices operating in the 150–350°C range using standard packaging. One of the difficulties of producing high-performance SiC devices is making contact pads. With C9's ALD process, this can be overcome by first depositing a silicon layer and then the contact pad.

Donegan comments that limiting applications to power devices limits the possibilities to less than 10% of the total semiconductor market. C9 believes it can produce robust, rad-hard integrated circuits in SiC that could operate at much higher temperatures. ■

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Index

- | | |
|---|--|
| 1 Bulk crystal source materials p58 | 14 Chip test equipment p62 |
| 2 Bulk crystal growth equipment p58 | 15 Assembly/packaging materials p62 |
| 3 Substrates p58 | 16 Assembly/packaging equipment p62 |
| 4 Epiwafer foundry p59 | 17 Assembly/packaging foundry p62 |
| 5 Deposition materials p59 | 18 Chip foundry p62 |
| 6 Deposition equipment p60 | 19 Facility equipment p62 |
| 7 Wafer processing materials p60 | 20 Facility consumables p62 |
| 8 Wafer processing equipment p60 | 21 Computer hardware & software p63 |
| 9 Materials and metals p61 | 22 Used equipment p63 |
| 10 Gas & liquid handling equipment p61 | 23 Services p63 |
| 11 Process monitoring and control p61 | 24 Consulting p63 |
| 12 Inspection equipment p62 | 25 Resources p63 |
| 13 Characterization equipment p62 | |

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IntelliEPI	65	Veeco Instruments — MBE	IFC
Logitech	53	Veeco Instruments — MOCVD	7
Oxford Instruments Plasma Technology	45		

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