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COMPOUNDS & ADVANCED SILICON

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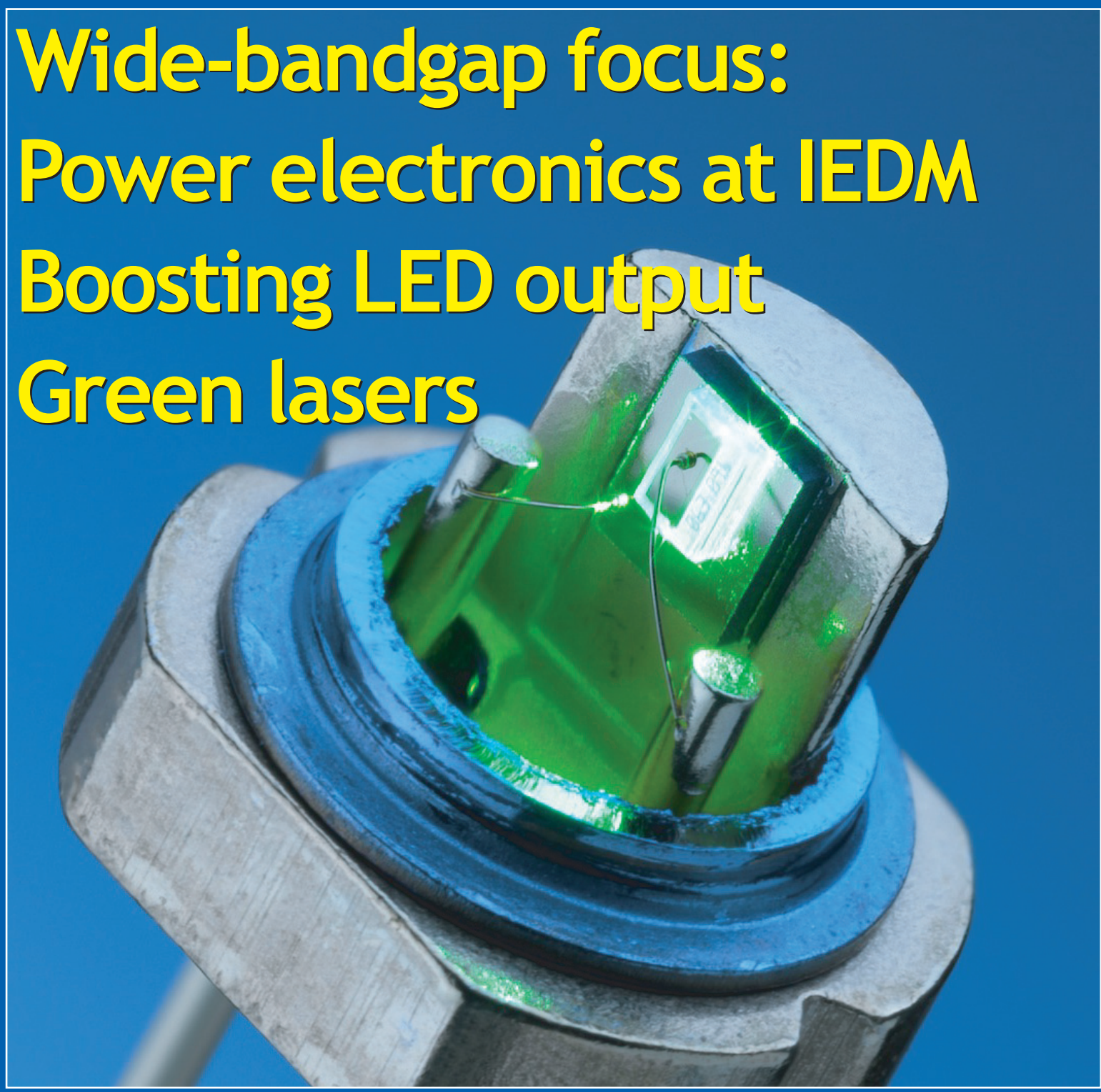
Wide-bandgap focus: Power electronics at IEDM

Boosting LED output

Green lasers



LEDs produced on 6" wafers • Emcore's China JV to Huainan
Backlighting rebounds • States lure Silicon Valley CIGS start-ups

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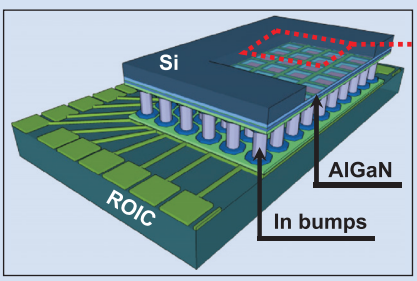
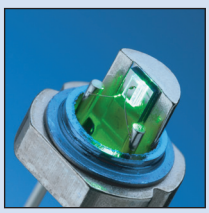
p46 Optogan's new LED component & module factory in St Petersburg, the largest LED plant in Eastern Europe.

p57 Scattering-assisted injection has allowed emission from a quantum cascade laser at a teraherz frequency of 1.8THz at a temperature up to 163K.



p100 AlGaN imager after flip-chip integration and Si substrate removal, reported at IEDM by IMEC/CRHEA-CNRS/Royal Observatory of Belgium.



Cover: Osram Opto Semiconductors has won the annual Beckurts Prize of Germany's Karl Heinz Beckurts Foundation for "pioneering work in researching direct green semiconductor lasers", which promise to open up new markets such as ultra-compact mobile RGB laser projectors. **p52**

editorial

Nitrides power boom

As well as a plethora of news reports on developments in silicon carbide targeted at power electronic devices (including Japan's Showa Denko making SiC a focus of its new five-year business plan — see pages 20–23), December saw the IEEE's annual International Electron Devices Meeting focus on power electronics, particularly gallium nitride (see page 98).

We also report recent research on GaN high-electron-mobility transistors, including raising their breakdown voltage. The UK's QinetiQ/University of Sheffield used SiN bi-layer passivation to avoid current collape (page 94), while the University of Fukui, Sharp and Sumitomo Electric Industries (SEI) produced AlGaN channels with Al content exceeding 50% for the first time, achieving record breakdown of 1800V for AlGaN-channel HEMTs (page 96).

Also, in optoelectronics, SEI has used its semi-polar free-standing GaN substrates to fabricate green laser diodes with optimized quantum well structures, cutting threshold current density to nearly half that of conventional polar c-plane devices in the 520–530nm range (rather than the theoretical 65%) — see page 88. The variation in threshold current with temperature was also smaller than for c-plane green lasers.

Meanwhile, Osram Opto has won a prize in Germany for its work in developing direct-emitting green laser diodes (page 52), and UCSB spin-off Soraa has demonstrated green lasers emitting over 75mW of cw power at 520–525nm, suitable for >20 lumen pico projectors with much reduced speckle compared with conventional green lasers based on second-harmonic generation. Soraa exhibited its lasers in early January at the Consumer Electronics Show (CES) in Las Vegas, where MicroVision displayed a prototype RGB laser projector following December's deal with Pioneer to jointly commercialize laser display products (page 54).

Osram Opto also recently doubled the brightness of its green LEDs, and is seeking partners to develop office projectors (with the LED due for market launch this summer— see page 50). In addition, a team from UCSB, Sharp and substrate maker Mitsubishi Chemical has achieved record output of 9.9mW and external quantum efficiency of 20.4% for green LEDs on semi-polar GaN (page 86). Meanwhile, Taiwan's National Cheng-Kung University has boosted nitride LED output both by using a stepped series of quantum wells in an electron-emitting layer to improve electron capture in the active light-emitting region (page 82) and by using a selective high barrier region (SHBR) under the p-electrode to reduce current crowding and photon absorption in the hole injection layer (page 84).

Also, following the USA's Lumileds (now in mass production on 6" wafers), Taiwanese LED makers Lextar and Epistar may introduce 6" production in second-half 2011, while December's $91m IPO of US-based SemiLEDs (which manufactures in Taiwan) will fund 6" development (page 42–49).

Epistar is also investing more in China joint venture United LED Shan Dong, as well as forming the new JV KFES Lighting with Great Wall Kaifa (page 47). ULED joins China-based new entrants APOLLO Precision and Aqualite in ordering multiple MOCVD reactors from Aixtron (page 28–29).

Despite a rebound in TV backlighting demand from Q4/2010's slowdown, there are concerns about China's subsidies on MOCVD reactor puchases driving LED production overcapacity (page 7). So, much hinges on the expected take-off of the LED lighting market in 2012 to prevent oversupply.

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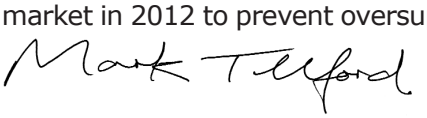

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***Semiconductor Today* covers the R&D and manufacturing of compound semiconductor and advanced silicon materials and devices** (e.g. GaAs, InP and SiGe wafers, chips and modules for microelectronic and optoelectronic devices such as RFICs, lasers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

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LED market grows from $6.1bn in 2009 to $10bn in 2010

Samsung jumps to second; to challenge Nichia in 2011

Although the TV backlighting boom temporarily fell back in fourth-quarter 2010 due to weaker demand and supply chain corrections, 2010 was still a year of tremendous growth in the LED industry, dramatically higher than the typical growth rates of recent years, according to IMS Research.

The analyst firm believes that the market for LEDs (including all types: standard, AlInGaP and InGaN) has grown from $6.1bn in 2009 to about $10bn in 2010, driven by economic recovery, lighting and above all backlights, especially in TVs. Suppliers are hence having to grow by 64% this year just to maintain their market share.

Nichia is still the number one in market share by total revenue in 2009 and 2010, with Seoul Semiconductor, Samsung LED and Cree among the suppliers with the strongest growth in 2010.

However, in 2011 Nichia will be challenged strongly by Samsung LED, which now has the capacity to take the number 1 position, and increasing demand for LED TVs from Q2/2011 onwards should enable them to do so. IMS ranks Samsung as third in 2009 and second in 2010, swapping places with Osram, which has previously ranked second for many years.

Lumileds (ranked third by IMS in 2006, 2007 and 2008) has fallen to fourth in 2009 and a provisional 6th in 2010. Its market share has actually been fairly steady as they are estimated to have grown in line with the market, but they look set to fall in rank due to tremendous growth from Seoul Semiconductor and Cree. Along with Samsung, these suppliers are among those who have grown even more than 64% in 2010.

Market shares vary by application segment. For lighting, IMS believes Cree is the market leader. For automotive, Osram is the market leader. Nichia is also strong in both these sectors as well as backlighting and signage/large displays. However, 2011 will be an interesting year for the LED industry in terms of market shares, reckons IMS, with Samsung and others continuing to challenge Nichia's long-standing position as market leader.

www.imsresearch.com

US enterprise LED lighting market to grow 30% in 2011, and reach $1bn by 2014

The US market for commercial and industrial LED lighting is forecasted to be $330m in 2010, as the transformation of lighting technology to LEDs is beginning in this sector first, according to the report 'Enterprise LED Lighting, Trends, Opportunities and Leading Market Players in Commercial and Industrial LED Lighting' from Groom Energy and Greentech Media Research. The market sector should grow by more than 30% next year and surpass $1bn in annual revenue by 2014.

The report provides a guide to the market, with profiles of the the top 50 LED fixture makers and ten LED component providers, analyzing the top four enterprise LED market leaders including Cree, Philips, Lighting Science Group and BetaLED.

The complex engineering challenges behind LED lighting (compared to incandescents) have created opportunities for startups, and venture capital funding has flowed into the sector in hundreds of millions of dollars, say the market research firms. However, the incumbent sales channel controlled by the likes of Sylvania, Osram and Philips presents a challenge to newcomers and requires a new channel approach or aggressive partnering with these existing vendors.

Venture investors such as Alan Salzman of VantagePoint Venture Partners see this transformation occurring in lighting, with everything switching to solid-state lighting and causing "a $100bn industry to flip". In Salzman's view, the mammoth lighting incumbents like Philips, GE and Osram "might catch up — or might not".

The study also recognizes that rapid market growth will come from three emerging trends:

1.Recent advances in LED chip performance that allow more cost-effective designs for replacing existing lighting systems;
2.Newly introduced utility energy-efficiency financial incentives for converting to these LED-based systems;
3.Increased interest from building owners in applying sustainably oriented lighting retrofits that save money for their operations.

"We're seeing a whole range of well engineered new products that produce high-quality light and provide strong financial return based on their energy savings," says report co-author Fritz Troller, Groom Energy's VP of marketing. "It's a perfect combination to produce accelerated LED market adoption."

www.groomenergy.com
www.greentechmedia.com

LED oversupply accelerating due to cut in usage per panel

Samsung and LG battle over leadership in LED consumption

LED supply growth is significantly outpacing demand growth, creating a widening surplus and increased pricing pressure on vendors, according to IMS Research's latest 'Quarterly GaN LED Supply and Demand Report', which features a new LED supply and demand model built by a new global team of authors.

"LED supply is rapidly expanding on China's MOCVD stimulus program, ramping of recently installed tools and improving yields on existing tools," says senior VP Ross Young. "On the other hand, a significant second-half 2010 reduction in LEDs per panel is causing demand to grow slower than expected, leading to reduced fab utilization and increased pricing pressure," he adds. "Because of China's MOCVD subsidies, MOCVD shipments and supply growth are not slowing down, resulting in an accelerating supply imbalance that is expected to widen through 2012 if MOCVD shipments remain on schedule."

The latest report (which reveals each panel suppliers' quarterly panel shipments, LED panel shipments, number of LEDs per panel and LED consumption at every size, resolution and refresh rate) shows that the weighted average number of edge-lit LEDs per panel fell by about 30% in both TVs and monitors from second-quarter 2010 to third-quarter 2010 as panel and backlight suppliers further optimize their designs to reduce costs. Improvements in light-guide and LED efficiencies and optimization of optical films caused the reduction, which is contributing to a growing LED oversupply.

The latest 'Quarterly GaN LED Supply and Demand Report' also tracks LED consumption by panel supplier in the notebook, monitor and TV markets, where Korea's LG Display consumed the most LEDs in notebooks in Q3/2010 and is expected to lead in Q4/2010. In monitors, LG also led in Q3, but Samsung is expected to lead in Q4. In TVs, Samsung led in Q3 and is expected to lead in Q4.

Regarding total LED consumption, Samsung led in Q3 and is expected to lead in Q4, at more than 2bn LEDs. However, LG Display is expected to lead for full-year 2010, at nearly 6bn LEDs consumed.

www.ledmarketresearch.com

LED lighting $15.4bn in 2011 as market share tops 10%

The high-brightness LED market will grow 53% from US$8.25bn in 2010 to US$12.6bn in 2011, according to the latest data from Digitimes Research. In particular, significant growth in the LED industry will be generated by lighting applications. The overall use of LEDs in lighting will rise from 4.8bn units in 2010 to 12.4bn units in 2011, as the effects of LED light bulbs replacing incandescent bulbs will start to show in 2011.

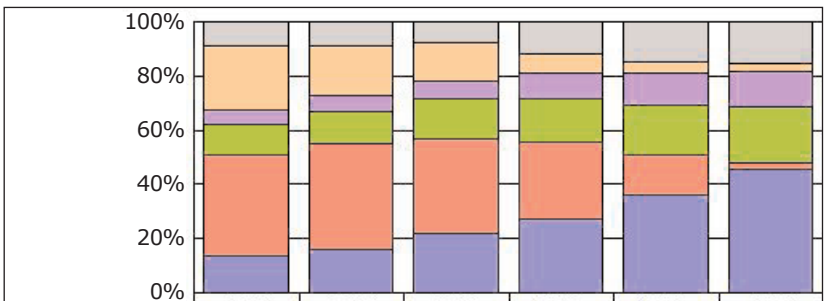
Although lighting will not represent a high share of the overall LED market (accounting for just 3.2% of the overall LED industry value in 2010), major countries worldwide have laid down LED lighting policies and been actively promoting the development of the LED lighting industry due to growing environmental concerns.

Global demand for LED light bulbs will more than quadruple from 596 million units in 2011 to 2.5bn units in 2013, notes Digitimes Research analyst Jessie Lin. In particular, due to trial projects in many major cities in China, USA and Europe, demand for LED streetlamps will rise from 2.2 million units in 2011 to 9.8 million in 2013.

With major countries promoting LED lighting, LED lumen efficiency has been improving significantly, and the prices for LED lighting are dropping 20–30% every year, says Digitimes Research. Lin estimated that LED lighting demand will increase at a compound annual growth rate (CAGR) of 97.4% from 2009 to 2013, which is more than the expected CAGR of 62.6% for LEDs used in large-size LCD backlighting.

The overall LED lighting market will reach US$15.4bn in 2011, when LED lighting devices should account for 10.6% of the overall lighting market, Lin adds.

www.digitimes.com



	2013	2012	2011	2010	2009	2008
Others	9.1%	9.0%	7.8%	12%	14.8%	15.1%
Lighting	23.5%	18.3%	13.8%	7.0%	4.2%	3.3%
Car	5.5%	5.8%	6.9%	9.4%	11.8%	13.2%
Billboard	10.9%	12.0%	14.4%	16.2%	18.4%	20.7%
Large-size LCD	37.3%	39.0%	35.2%	28.0%	14.6%	2.1%
Handheld devices	13.7%	15.9%	21.9%	27.4%	36.1%	45.5%

HB-LED usage as a proportion of application, 2008–2013.

CdTe to maintain lead over silicon in cost

CIGS to overtake crystalline silicon in profitability by 2013

Advances in crystalline silicon technology, and the falling cost of the polysilicon raw material, have only increased the pressure on manufacturers of emerging thin-film technologies, including thin-film silicon (TF-Si), cadmium telluride (CdTe), and copper indium gallium diselenide (CIGS), according to a new report 'Module Cost Structure Breakdown: Can Thin Film Survive the Crystalline Silicon Onslaught?' from Lux Research.

In the face of renewed pricing pressures, solar device makers have had to refocus on minimizing costs and maximizing performance as many need to improve profit margins or face extinction, says the market research firm. In particular, with a clear edge in both efficiency and profit margin, crystalline silicon solar modules threaten to steal market share from thin-film solar technologies, the report adds.

The report compares incumbent multicrystalline silicon (mc-Si) technology (representing about 80% of the crystalline silicon market) on a $/Watt basis against three challengers: TF-Si, CdTe and CIGS. It also surveys process changes and cost-reduction efforts that module developers have undertaken, and forecasts which technology will gain a long-term cost advantage at the module level.

"Crystalline silicon is dominant by volume and remains the cost/price benchmark for solar modules. Cadmium telluride is limited in efficiencies, but is the absolute leader in cost," says Ted Sullivan, senior analyst and lead author of the report. "These two technologies will continue to be highly profitable," he projects. "The profitability of thin-film silicon is much dicier, but CIGS is positioned to outplace crystalline silicon in profitability by 2013 as leading developers improve process stability."

To forecast how module developers would reduce the key components of cost (capital, materials, utilities and labor), Lux Research built detailed cost-of-goods-sold (COGS) models for the four key technologies (mc-Si, TF-Si, CdTe and CIGS) through 2015, including both glass and flexible substrates for CIGS. The key observations include:

CIGS sputtered on glass (Lux Research's benchmark, given its critical mass of developers) will see COGS plummet from $1.69/W to $0.76/W as efficiency improves from 10% to 14.2% and factory nameplate capacity and yields grow, allowing gross margins over 30%

- Multicrystalline silicon remains highly profitable as COGS decline. The dominant technology will continue to be profitable throughout the value chain as vertically integrated players drive cost from $1.45/W in 2009 to $0.93/W in 2015, assuming poly pricing at $70/kg. Efficiency will be a key driver of cost reduction, rising from 14% in 2009 to 16.1% in 2015.
- Improvements enabled by Oerlikon's new ThinFab line will push thin-film silicon efficiencies from 9% to above 11%. Significant improvements in output will cut depreciated CapEx per watt, and help to reduce TF-Si costs from $1.32/W in 2009 to $0.80/W in 2015.
- CdTe technology remains the long-term leader in terms of COGS. Led by First Solar, CdTe has a significantly lower cost structure than mc-Si, and its cost reductions will march onward, keeping it the most profitable solar technology, as COGS falls from $0.80/W in 2009 to $0.54/W in 2015.
- Costs for select CIGS technologies drop dramatically. CIGS sputtered on glass (Lux Research's benchmark, given its critical mass of developers) will see COGS plummet from $1.69/W to $0.76/W as efficiency improves from 10% to 14.2% and factory nameplate capacity and yields grow, allowing gross margins over 30% for top developers.

www.luxresearchinc.com

CIS/CIGS PV market to grow at CAGR of 43.9% to 2015

Total thin-film photovoltaic market forecast to grow at 32.2% from $3.4bn in 2009 to $19.4bn in 2015

Low cost and optimum efficiency is driving the growth of thin-film PV cells in the overall photovoltaic market, according to the market research report 'Thin Film PV-Advanced Technologies and Global Market (2008–2015)' from MarketsandMarkets. The global thin-film photovoltaic market is expected to grow at an estimated compound annual growth rate (CAGR) of 32.2% from $3,406m in 2009 to $19,422m in 2015.

Although amorphous silicon contributes the most to the total thin-film PV market, copper indium selenide/copper indium gallium diselenide (CIS/CIGS) is expected to grow at a CAGR of up to 43.9% from 2010 to 2015. Meanwhile, grid-connected power supply applications are expected to have the highest CAGR of 39.1%.

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Skyworks overtakes RFMD as biggest GaAs vendor after global market exceeded $4bn

Driven by smartphones and consumer adoption of data-intensive applications, the total market value for gallium arsenide revenues has grown strongly since the low of early 2009, according to the Strategy Analytics GaAs and Compound Semiconductors (GaAs) report 'GaAs Device Vendor Market Share 2009: North America'.

The dramatic slowdown of production that hit the industry at the end of 2008 continued into the first part of 2009 and challenged the entire supply chain, says market research firm Strategy Analytics. Despite this, global GaAs revenue rose 1% from 2008 to $4.03bn for full-year 2009.

In particular, Skyworks Solutions Inc of Woburn, MA edged past RF Micro Devices Inc of Greensboro, NC to become the biggest North American GaAs vendor by revenue. However, less than 1% market share separates the two firms. TriQuint Semiconductor Inc of Hillsboro, OR and Avago Technologies both recorded strong revenue growth, gaining substantially on industry leaders.

"Even though revenue from the GaAs market in 2009 was only slightly higher than 2008, the story that emerges is the strong industry recovery during the last three-quarters of the year," notes Eric Higham, director of the Strategy Analytics GaAs and Compound Semiconductor Service. "This growth is driven by consumer demand for new data-intensive applications, smartphones and the infrastructure that supports these capabilities," Higham adds. "We expect these drivers to continue fueling growth through 2010."

Growth is driven by consumer demand for new data-intensive applications, smartphones and the infrastructure that supports these capabilities. We expect these drivers to continue fueling growth through 2010

The report provides strategic comments, representative products and selected news items for a comprehensive set of North American GaAs vendors. It also identifies the top ten global vendors in terms of GaAs device market share. Strategy Analytics estimates that six of the top ten GaAs vendors — including all four top contenders — are located in North America.

www.strategyanalytics.com

WIN surpasses Eudyna as largest Asia-Pac GaAs vendor

Four Asia-Pac vendors in global top-ten, led by WIN in 5th

Due to the continuing growth in the gallium arsenide industry, Taiwan's WIN Semiconductors is expected to become the largest GaAs foundry in the world by the end of 2010, according to the Strategy Analytics GaAs and Compound Semiconductors (GaAs) report 'GaAs Device Vendor Market Share 2009: Asia–Pacific and Europe'. The report also estimates that four of the top ten GaAs vendors globally are located in the Asia-Pacific region, led by WIN in the fifth place.

Driven by smartphones and consumer adoption of data-intensive applications, the total market value for GaAs revenues globally has grown strongly from the lows of early 2009, reaching $4.03bn for full-year 2009 (a slight increase on 2008).

In particular, WIN vaulted into the fifth place in the Strategy Analytics GaAs vendor revenue rankings due to an accelerating global trend toward outsourced and hybrid manufacturing. "A notable development in this region is the growth of pure-play foundry WIN Semiconductors," notes Eric Higham, director of the Strategy Analytics GaAs and Compound Semiconductor Service. "Growth in GaAs demand and a trend to more foundry outsourcing by suppliers has enabled them to double their GaAs revenues in the past two years," he adds.

The Japanese electronics industry is working through consolidation of large GaAs suppliers like Eudyna, NEC, OKI, Renesas, Sony, Toshiba, Sanyo and Panasonic

WIN's growth also makes it the largest GaAs vendor overall in the Asia-Pacific region, surpassing Sumitomo Electric's Eudyna Devices group. The report also highlights the effect of many large Japanese electronics firms either merging or re-structuring during 2009.

The Japanese electronics industry is working through consolidation of large GaAs suppliers like Eudyna, NEC, OKI, Renesas, Sony, Toshiba, Sanyo and Panasonic.

Strategy Analytics reckons that RFMD's European fab may challenge Europe's main GaAs foundries UMS and OMMIC as they begin supplying European defense applications.

With strong demand and a settling global economy, the GaAs industry is poised for strong growth in 2010, concludes Strategy Analytics .

GaAs IC market grows 36%

Growth of 18% expected in 2011

In 2010, strong demand in wireless (both cell phones and WiFi) has driven 36% growth in the GaAs IC market (the highest since 2003's 52%), according to a report from The Information Network. By comparison, the silicon IC market grew 33% in 2010. In 2011, strong momentum will drive the GaAs IC market to grow 18%, it is reckoned.

Every cell phone contains power amplifiers (PA), which enable the handset to transmit voice and data back to the base-station tower, which routes a call to another phone number or Internet address. PAs, the most critical radio frequency component in the phone, are currently dominated by circuits made with GaAs.

In particular, third-generation (3G) handsets often contain up to five PAs, and GaAs makes up 100% of the market, which is close to $5bn. In addition, the number of PAs per handset is growing due to complex 3G systems, global roaming support, and data roaming support.

Pricing for PAs has increased from $0.80 per handset to $2.90 currently, and is projected to increase to more than $3.50 after LTE (long-term evolution) and AWS (advanced wireless services) spectrum emerge on the market in advanced handsets.

While industrialized countries are using 3G networks, today's world is a mixture of 2/2.5G and 3G networks. The heavy majority of subscribers are actually on 2G-based networks and are predicted to remain so for a number of years, says The Information Network. Of new handsets sold in 2010, about 50% will still be 2G.

2G handsets contain one PA, so it represents a sizable market. But because they are not as technologically advanced as 3G cell phones, particularly smartphones, silicon is making inroads into the GaAs domain. For 2009, 90% of PAs were made in GaAs, 5% in silicon CMOS, and 5% in silicon LDMOS.

Leading GaAs RF IC makers in the USA include RF Micro Devices, Anadigics, TriQuint, Skyworks and Hittite. For both Skyworks and RFMD, 70–80% of GaAs business is in PAs.

Besides the technical dynamics, Skyworks has positioned itself in the market with the mid-2009 acquisition of CMOS PA supplier Axiom Microdevices Inc. Also, in September 2009, privately held Black Sand Technologies Inc of Austin, TX announced the world's first 3G CMOS RF PA. Black Sand's proprietary CMOS PA architecture offers a breakthrough in combined performance, cost, battery life and reliability for mobile devices, says The Information Network. Other CMOS PA companies of note include Javelin and Amalfi. Another rumored to be working on CMOS PA is ACCO Semiconductor Inc of Sunnyvale, CA.

Replacing GaAs with CMOS can improve manufacturing yield, performance, cost, battery life and call quality, says The Information Network. The cost for GaAs is about $0.10/mm^2. By comparison, CMOS cost depends on process node, but mature CMOS technology pricing is often $0.05/mm^2 or lower, or even as low as $0.02/mm^2.

www.theinformationnet.com

HTC selects Skyworks power amplifier modules and switches for 4G smart phones

Skyworks Solutions Inc of Woburn, MA, USA, which manufactures linear products, power amplifiers, front-end modules and radio solutions for handset and infrastructure equipment, says that its highly integrated power amplifier modules (PAMs) and switch technology are powering multiple smart phones from Taiwan-based HTC (one of the fastest-growing companies in the mobile sector), including the EVO, Desire HD and Desire Z.

The EVO 4G features Wi-Fi with instant access for up to five computers, a true high definition (HD) camcorder with HD multimedia interface cable that allows flat-screen connections, large 4.3"-wide video graphics array resolution, a multi-touch screen, Web connectivity that is up to 10 times faster, access to live-streaming video applications, and an 8 megapixel camera with auto focus. The Android-based Desire HD houses a bright LCD display, Dolby Mobile and SRS virtual sound, and is the first to be powered by the new 1GHz Qualcomm 8255 Snapdragon processor. The Desire Z features a unique 'pop hinge' that opens to reveal a QWERTY keyboard with a variety of shortcuts and two customizable keys for instant access to common functions without the need to open menus.

"By leveraging our technology leadership, integration capabilities and scale advantages, Skyworks is capitalizing on the rising tide of increasing RF content associated with these band-intensive 3G and 4G architectures," Liam K. Griffin, Skyworks' senior VP of sales & marketing.

Of the power amplifier modules selected by HTC, the SKY77701, SKY77702, SKY77703, SKY77704 and SKY77705 are fully matched 10-pad surface-mount modules developed for wideband code division multiple access (WCDMA) applications. The modules pack full 1920–1980MHz (SKY77701), 1850–1910MHz (SKY77702), 1710–1785MHz (SKY77703), 824–849MHz (SKY77704), and 880–915MHz (SKY77705) bandwidth coverage into a single, compact package. Because of high efficiencies attained throughout the entire power range, the PAMs deliver unsurpassed talk-time advantages. The devices also meet the stringent spectral linearity requirements of high-speed downlink packet access (HSDPA), high-speed uplink packet access (HSUPA), and long-term evolution (LTE) data transmission with high power-added efficiency (PAE). A directional coupler is integrated into the modules, eliminating the need for any external coupler.

Of the Skyworks switches selected by HTC, the SKY13309-370LF is a GaAs pHEMT IC single-pole, three-throw (SP3T) antenna switch operating in the LF–3GHz frequency range. Switching between the antenna and transmit/receive (Tx/Rx) ports is accomplished with three control voltages. The low loss, high isolation, high linearity, small size and low-cost features suit wireless local-area network (WLAN) and Bluetooth systems operating in the 2.4–2.5GHz frequency band.

The SKY13362-389LF is a GaAs pHEMT single-pole, ten-throw (SP10T) antenna switch with an integrated CMOS decoder and dual low-pass harmonic filters. It has five Tx/Rx ports that suit any combination of 2G/3G multimode cellular applications, Skyworks says.

The SKY13364-389LF is a GaAs pHEMT SP10T antenna switch with an integrated CMOS decoder and dual low-pass harmonic filters. It has four WCDMA Tx/Rx ports, four GSM Rx ports, and two GSM Tx ports that suit cellular handsets and data-card applications.

www.skyworksinc.com

Kopin announces $15m stock repurchase program

Kopin Corp of Taunton, MA, USA, which makes III-V heterojunction bipolar transistor (HBT) epiwafers and CyberDisplay LCDs, says that its board of directors has authorized the repurchase of up to $15m of the firm's common stock, financed with available cash.

Kopin plans to buy shares in the open market or through privately negotiated transactions from time to time over the next 24 months, subject to market conditions and other factors and in compliance with applicable legal requirements. The plan does not obligate Kopin to acquire any particular amount of common stock, and can be suspended at any time at the firm's sole discretion. Kopin has about 64.9 million shares of common stock outstanding. On 7 December, its common stock closed at $4.18 per share.

"This repurchase program represents an efficient use of capital and an additional opportunity to build long-term value for our shareholders," believes president & CEO Dr John C.C. Fan. "With $110m in cash and equivalents as of 25 September and no long-term debt, we have ample resources to fund this program while maintaining the financial flexibility to invest in our growth initiatives," he adds. "At the same time, we remain committed to maintaining a strong balance sheet, and want to assure shareholders that we will implement this repurchase program judiciously."

www.kopin.com

Smartphone demand to buoy Taiwanese foundries in 2011

After seeing quarterly growth of 4.4% to almost NT$2bn in third-quarter 2010, Taiwan-based GaAs foundry WIN Semiconductors Corp saw a flat Q4 following month-on-month drops in sales in both October and November due to inventory adjustments at some customers.

Likewise, after seeing its revenue grow 17.2% quarter-on-quarter to a record NT$543m (US$18.6m) in Q3/2010, revenue for fellow Taiwan-based GaAs foundry Advanced Wireless Semiconductor Company (AWSC) drop 3.7% sequentially to NT$523m in Q4 after December revenue fell 15.5% month-on-month due to seasonality. For Q1/2011, AWSC is also likely to see a 10% sequential drop in orders.

However, benefiting from the continued growth expected for the smartphone industry, both firms are expected to enjoy rising shipments in 2011 overall, reckon market sources in a report in Digitimes.

GaAs ICs are used in handset power amplifiers (PAs), and one smartphone (e.g. an iPhone 4) contains as many as five PAs. AWSC's largest client, Skyworks Solutions Inc of Woburn, MA, USA, is expected to increase its outsourcing to the foundry partner in 2011 due to soaring demand for Apple devices.

The foundry is also reported to have secured orders from Avago Technologies. Sales generated from shipments to the new client will start contributing to revenue in second-quarter 2011.

www.awsc.com.tw
www.digitimes.com

Smartphone demand drives GaAs foundry WIN to boost capacity

Monthly output to rise from 12,000–14,000 to 20,000 wafers by end 2011

Taiwan-based GaAs wafer foundry WIN Semiconductors Corp has revealed plans to ramp up capacity in 2011 in anticipation of brisk demand for power amplifier (PA) from the smartphone sector, reports Digitimes.

WIN will start moving in new equipment in January, paving the way for the upcoming expansion of its 6-inch GaAs wafer fabrication plant, the firm says. Monthly capacity is currently 12,000–14,000 wafers, but WIN expects to boost this to 16,000 by mid-2011 and then to 20,000 by the end of 2011.

WIN's total shipments for 2010 are likely to be up by more than 80% year-on-year, reckons Brian Lee, VP of sales & marketing. Continued strong demand for smartphones as well as outsourcing from the overseas integrated device manufacturer (IDM) sector will continue driving shipment growth, he adds.

In addition, WIN Semiconductors intends to build capacity for gallium nitride (GaN) power amplifier products used in base-station and satellite applications, Lee notes. Capacity for this new product segment, which would yield higher gross margins, is scheduled to come online by the end of 2011.

WIN Semiconductors' revenue for January through November 2010 was NT$6.42bn, up 49% year-on-year.

Market watchers have forecast that the firm will see sales rise 30% in 2011, according to the Digitimes report.

www.winfoundry.com

IN BRIEF

AWSC wins Japan GaAs switch orders

AWSC has won orders from Japan for GaAs switch products, as well as receiving verification from IDMs, reports Digitimes. Volume shipments to new customers will start in Q2/2011.

Skyworks remains the largest client (60–70% of revenue), but this should drop to 50–55% in 2011 as the client base expands.

AWSC is likely to see sales hit by seasonality in Q1 but rebounding in Q2. Monthly revenue should top NT$200m sometime in 2011, yielding NT$3bn for the year.

Buoyed by strong demand for power amplifiers for smartphones, AWSC saw revenue double year-on-year to NT$1.78bn in the first 11 months of 2010.

www.awsc.com.tw

GaAs epi foundry VPEC sees rebound

After four months of declines, revenue for Taiwanese GaAs epi foundry Visual Photonics Epitaxy Co (VPEC) rebounded to NT$176m (US$5.8m) in October, up 5.2% year-on-year and up 21.4% on September (which was hit by clients' inventory adjustments).

Sales for November were similarly high, with shipments driven by sustained demand for power amplifiers for smartphones.

HBT wafers for PAs still contribute most to revenue. But the firm has also begun supplying wafers made using a BiHEMT process (combining the advantages of both HBT and pHEMT technologies for products with complex circuit designs) to a GaAs device vendor since mid-2010.

Q4/2010 revenue was expected to grow 20% sequentially, with gross margin rebounding to 38% (comparable with Q2's 38.2%). Q1/2011 sales should rise further.

www.vpec.com.tw

Samsung selects TriQuint's complete 3G RF front-end for Galaxy Tab and Galaxy S

Korea's Samsung (the world's second largest handset maker) has selected the complete 3G RF front-end of TriQuint Semiconductor Inc of Hillsboro, OR, USA for its new Samsung Galaxy Tab. This is in addition to Samsung choosing TriQuint's total 3G RF front-end solution for its flagship smartphone series, Galaxy S.

TriQuint claims that, compared with other 3G WEDGE architectural solutions, its 3G RF front-end offers the lowest current consumption and highest degree of design flexibility, scalability and miniaturization. The solution includes TriQuint's family of WCDMA TRITIUM PA Duplexer Modules in combination with its linear WEDGE QUANTUM Tx Module.

"We are committed to utilizing our unique in-house technology portfolio to provide customers with integrated innovation and quality," says Tim Dunn, TriQuint's VP of Mobile Devices. "In recognition of TriQuint's commitment to quality, Samsung awarded TriQuint with its Samsung Quality Award for our development efforts related to the Galaxy Tab and Galaxy S series," he adds.

TriQuint's TRITIUM PA Duplexer Module family integrates a duplexer, power amplifier, and an inter-stage filter that supports the major WCDMA bands 1 (TQM676021), 2 (TQM676022), 4 (TQM676024), 5 (TQM676025) and 8 (TQM676028L). The linear QUANTUM Tx Module (TQM6M9014) integrates an EDGE power amplifier, low-pass filtering, and a SP8T antenna switch. The solution is tested and certified with a leading chipset provider/system integrator to optimize the overall system performance. TriQuint says that, together, the TRITIUM family and QUANTUM Tx module demonstrate its breadth of technologies and capabilities in delivering an entire 3G RF solution, from the transceiver to the antenna.

TriQuint Semiconductor claims that its 3G RF solution is one of the most prevalent architectures chosen by leading manufacturers of increasingly complex mobile devices such as smartphones and tablet PCs.

www.triquint.com

TriQuint recognized for excellence by Raytheon for third year

At its 2010 SAS Supplier Excellence Award (SEA) recognition event, Raytheon Company has honored RF component maker and foundry services provider TriQuint Semiconductor Inc of Hillsboro, OR, USA for the third consecutive year for exceptional performance in supporting Raytheon's Space and Airborne Systems (SAS) business.

Winning suppliers represent under 1% of SAS' supply base. Only 34 firms that supply Raytheon SAS received awards.

Winning firms were chosen by Raytheon for meeting demanding quality and delivery performance, customer satisfaction as well as total business and financial health standards during 2009. Evaluations from Raytheon buyers and material program managers who work with TriQuint every day were part of the selection process.

"This award honors TriQuint professionals' commitment to service, quality and highly reliable solutions for phased array radar chipsets and other critical programs," says TriQuint VP Tom Cordner. "TriQuint expertise supports service members across the globe," he adds.

TriQuint says that its expertise in gallium nitride, gallium arsenide, surface acoustic wave and bulk acoustic wave (SAW/BAW) technologies has made it a leading supplier of RF system components to Raytheon and other major defense/aerospace contractors. TriQuint says that its module capabilities, packaging technology and monolithic microwave integrated circuits (MMICs) continue to expand its global market reach. TriQuint is a Department of Defense (DoD)-accredited 'Trusted Foundry' (Category 1A) and is a supplier of GaAs and GaN foundry services. It also supplies RF components for consumer retail products including mobile devices, wireless LAN, triple-play CATV systems, optical network and wireless infrastructure applications.

www.triquint.com/defense

Anadigics' LTE PAs used for LG's 4G USB wireless modem

Broadband wireless and wireline communications component maker Anadigics Inc of Warren, NJ, USA says that its power amplifiers are being used by LG Electronics for its new VL600 USB wireless modem. To be offered by Verizon Wireless, the VL600 adapts Anadigics' ALT6713 and AWT6321 power amplifiers (PAs) to boost performance and reliability.

With the ever increasing worldwide commitment to LTE (long-term evolution), the VL600 is LG's first product for Verizon's 4G network, enabling significantly higher mobile data speeds with increased network throughputs. Verizon recently said that it will be rolling out LTE network connections in 38 cities across the USA in the coming months. The VL600 will support the 700MHz LTE band (as well as 1900MHz/800MHz EVDO bands for areas without LTE coverage) and is backward compatible with existing 3G networks.

The single-band ALT6713 is the leading product in Anadigics' portfolio of HELP4 (High-Efficiency-at-Low-Power) PAs for LTE devices. Supplied in a 10-pin 3mm x 3mm x 1mm package, it supports bands 13/14, encompassing operating

Anadigics' ALT6713 and AWT6321 power amplifiers.

frequencies in the UMTS 700MHz frequency range (specifically 777–798MHz).

Three mode states maximize power-added efficiency at several power levels during operation of an LTE device. The ALT6713 hence delivers exceptional efficiency at low power levels (18% @ 16dBm P_{out}) and offers what is claimed to be the industry's lowest quiescent current (3mA) without the need for external voltage regulators. It exceeds the stringent linearity needs for LTE modulations and averages about 30% less current consumption compared to the previous generation of HELP products. Leakage current in shutdown mode is <5μA. The ALT6713 also has integrated 'daisy chainable' directional coupler with 19dB directivity, and matching networks optimized for output power, efficiency and linearity in a 50Ω system.

Anadigics' AWT6321 dual-band CDMA HELP2 PA supports both the Cell (824–849MHz) and the PCS (1850–1910MHz) bands. Supplied in a 14-pin 3mm x 5mm x 1mm package, it delivers low quiescent current (15mA) and greater efficiency without SMPS or DC–DC converters. Through selectable bias modes, the AWT6321 achieves optimal efficiency across different output power levels, specifically at low- and mid-range power levels (19% @ 16dBm P_{out}) where the PA typically operates, increasing handset talk-time and standby time.

Both PAs are in mass production and are manufactured using Anadigics' proprietary InGaP-Plus heterojunction bipolar transistor technology for reliability, temperature stability and ruggedness.

www.anadigics.com

Anadigics joins NASDAQ Global Select Market

Anadigics Inc of Warren, NJ, USA has been chosen by the NASDAQ Stock Market to join its Global Select Market for companies s atisfying the highest financial and liquidity qualifications.

Established in 2006, the NASDAQ Global Select Market was created as a separate market classification to drive greater recognition for world-class NASDAQ-listed firms that demonstrate a commitment to high standards and good governance.

According to NASDAQ, qualifying for the Global Select Market is a mark of achievement, leadership and stature for the companies that are included, while also demonstrating a message of high standards to investors.

Anadigics has been a publicly traded company on the NASDAQ Stock Market since 1995. "We have enjoyed a long-term, highly successful affiliation with the NASDAQ Stock Market," says chief financial officer Thomas Shields.

Qualifying for the Global Select Market is a mark of achievement, leadership and stature for the companies that are included, while also demonstrating a message of high standards to investors

For the nine months of 2010 (ended 2 October), Anadigics' net sales totaled $156.5m, up 58.6% year-on-year. Looking ahead into 2011, the firm says that it looks forward to building on its success with its new product design portfolio for 3G, 4G/LTE and multi-mode multi-band technologies, along with new design engagements with chipset providers and tier-1 OEMs.

www.nasdaq.com

IN BRIEF

Mitsubishi unveils WCDMA PAs for PC datacom terminals

Tokyo-based Mitsubishi Electric Corp is launching five new GaAs power amplifiers to be used in personal computer (PC) data communication terminals for WCDMA cellular networks.

Due to the faster data transfer speeds of cellular networks, development of PC data communication terminals (such as data cards or USB terminals) has become extremely active, says Mitsubishi Electric. However, market demand for smaller terminals, requiring more power output due to greater data traffic, has created the issue of needing to limit heat accumulation as much as possible.

Incorporating GaAs bipolar field-effect transistor (BiFET), Mitsubishi Electric's new GaAs power amplifiers (PAs) achieve a high level of integration (in a small 3mm x 3mm x 1mm mold package) and what is claimed to be an industry-leading power-added efficiency (PAE) of 45% at maximum output power of 670mW (28.25dBm), contributing to lower power consumption and heat emission in data communication terminals. The amplifiers also include a built-in coupler monitoring the output power and an attenuator that switches the power gain (G_p is 27~27.5dB, but can be set at 13–13.5dB with the built-in attenuator). The supply voltage is V_{cc} is 3.4V.

The series line-up covers the five major frequency bands in North America, Europe and Asia: BA012F1, -2, -3, -5 and -8 for 1920–1980MHz, 1850–1910MHz, 1710–1785MHz, 824–849MHz and 880–915MHz (bands 1, 2, 3, 5 and 8), respectively. The BA012F3 is available from June and the others from March.

www.MitsubishiElectric.com

M/A-COM launches 3000 & 4000MHz highly linear RF driver amplifier

M/A-COM Technology Solutions Inc of Lowell, MA, USA (which makes semiconductors, components, and subassemblies for RF, microwave and millimeter-wave applications) has launched the MAAM-009560, an HBT driver amplifier for cellular and WiMAX infrastructure applications.

The driver amplifier covers a broad frequency range of 250–4000MHz with linearity of 42dBm output IP3 over a greater than 20dB input power range. Typical gain is 15dB.

"This versatile MAAM-009560 HBT driver amplifier delivers high-linearity performance while consuming low power, providing a highly efficient driver amplifier solution for cellular and WiMAX base stations," says product manager Jack Redus.

Just in December, M/A-COM Tech launched the MAAM-009563 two-stage HBT driver amplifier, covering frequencies of 250–3000MHz with linearity of 47dBm OIP3 and typical gain of 19.5dB. "This highly efficient amplifier delivers high linearity and gain, and lower power consumption to cover a broad frequency range for infrastructure applications," says Redus.

The lead-free surface-mount plastic packages (SOT-89 for the MAAM-009560 and SOIC-8EP for the MAAM-009563) are RoHS compliant and compatible with solder reflow temperatures up to 260ºC. The ESD susceptibility achieves a class 2 ESD rating.

Engineering samples, sample boards and production devices for the MAAM-009560 and -009563 are available from stock.

www.macomtech.com

Mitsubishi launches InGaP HBTs for satellite digital radio amplifiers

Japan's Mitsubishi Electric Corp is launching two new models of indium gallium phosphide (InGaP) heterojunction bipolar transistor (HBT) for receiver systems in satellite digital radios.

The devices have an industry-standard 4-pin full-mold package, and are best used in the second or third stages of low-noise amplifiers for L- to C-band (0.5–6GHz) applications.

Satellite digital audio radio service (SDARS), common in North America since 2001, does not require tuning to adapt to regional broadcasting like analog radio services, says Mitsubishi Electric. Car audio systems therefore use SDARS to access traffic information, entertainment programs and other information services. Low-noise amplifiers used in the reception systems of these satellite digital radios are composed of two or three stages. The first stage requires efficient low-noise and high-gain characteristics, and the second and third stages require high-gain and high-power characteristics.

On 7 February 2011, Mitsubishi Electric will begin shipping a new series of InGaP HBTs including the MGF3021AM, which features high-gain characteristics, and the MGF3022AM, which has high-power characteristics. Collector efficiency is 32% for the MGF3021AM and 44% for the MGF3022AM at P1dB. Single power supply operation suits application for the second or third stages of low-noise amplifiers.

The amplifiers operate best in combination with the MGF4921AM, Mitsubishi Electric's low-noise gallium arsenide high-electron-mobility transistor (HEMT), which is already available for first-stage amplification (and which has the same footprint as the MGF3021AM and the MGF3022AM).

www.MitsubishiElectric.com

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Amalfi recruits RF Magic co-founder as CEO

Amalfi Semiconductor of Los Gatos, CA, USA, a fabless firm developing CMOS-based RF and mixed-signal ICs for cellular mobile handsets, has recruited Mark Foley as CEO.

Foley has "proven management experience, knowledge and vision" in the RF semiconductor industry targeted at high-volume consumer electronics. "We were looking for a combination of management qualities and industry experience that would help grow Amalfi into a multi-million dollar company," says board member Ken Lawler, a general partner at Battery Ventures. Foley has a proven track record of growing a company from inception to a multimillion-dollar high-gross-margin business, he adds.

Foley has over 28 years experience as an entrepreneur and executive in RF semiconductors and components. Most recently, he was CEO of NuTune Singapore Pte Ltd, a joint venture between NXP Semiconductor and Technicolor for developing CAN tuners for TVs and set-top boxes.

Previously, Foley was co-founder of fabless firm RF Magic. As CEO, he built a viable, diversified semiconductor firm with multiple product lines and eight consecutive profitable quarters. The firm eventually merged with Entropic, where Foley took the role of president & chief operating officer and led an initial public offering that raised $50m.

Prior to RF Magic, Foley had management and engineering roles in several RF semiconductor- and component-related firms, including Conexant Systems Inc, ComStream Corp, Adams-Russell Electronics Inc and Ford Aerospace.

"Amalfi has shown great success in revolutionizing and improving the performance curve of power amplifier technology in cellular handsets," comments Foley.

In 2009, Amalfi launched the first CMOS transmit module for cellular handsets. The form claims that, compared with traditional GaAs transmit modules for cellular handsets, its product offers better performance and big cost savings. Specifically, it says that its proprietary AdaptiveRF silicon architecture has proven to increase the battery life or talk time of cellular handsets while decreasing the footprint and cost of front-end cellular handset designs. Products are currently shipping to cellular handset manufacturers in millions of units per month.

www.amalfi.com

Tektronix Component Solutions validated as 'Ready for IBM Technology' for SiGe 100 & 200GHz processes

Tektronix Component Solutions of Beaverton, OR, USA (a microelectronics services provider formerly known as Maxtek, offering custom design, prototyping, manufacturing and test services to equipment makers) says that its ASIC design and custom IC packaging services are now validated by IBM Corp as 'Ready for IBM Technology' on silicon germanium (SiGe) 5HP, 7HP, 7WL and 8HP process technologies.

"We've worked with IBM's process for 15 years, designing and packaging over 30 SiGe ASICs across multiple technology nodes," notes president Tom Buzak.

'Ready for IBM Technology' is a collaborative ecosystem of firms that enables IBM to complement its semiconductor capabilities and provide complete foundry solutions to clients. It helps foundry customers to speed time-to-market, reduce development risk, lower development costs, and improve return on investment by identifying IP, design and manufacturing solutions and services that have been tested and validated for compatibility with IBM Foundry technologies. IBM business partners support a comprehensive set of solutions, including RF design services, digital design services, libraries, mixed-signal IP cores, non-volatile memory, reference flows, simulation tools, test and packaging services. The 'Ready for IBM Technology' foundry program was launched in 2002, and more than 30 firms have since been validated.

Tektronix Component Solutions has more than 40 in-house ASIC designers developing high-complexity ASICs for both customers and Tektronix instruments. It says that its depth of experience in SiGe enables customers to reduce the risk inherent in complex IC development projects while achieving next-generation performance levels. From circuit and physical design to product engineering and foundry relationship management, the firm says that its capabilities provide a turnkey option for ASIC development and a seamless connection to IC packaging services. Tektronix Component Solutions designs performance ASICs for the measurement, military, aerospace, and high-speed communications markets, with a focus on signal acquisition, generation, conversion, and conditioning.

Complementing these ASIC design capabilities, Tektronix Component Solutions has over 60 engineers and 32,000ft^2 of Class 10,000 manufacturing devoted to the development, assembly and test of high-performance custom IC packages and modules, including devices for classified defense programs. With an emphasis on low-volume, high-complexity applications, the organization leverages experience across a broad base of material, process and interconnect technologies to meet the performance, reliability and quality requirements of the instrumentation, military, aerospace, medical and high-speed communications markets.

http://component-solutions.tektronix.com

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Cree's 650V SiC Schottkys to boost data-center efficiency

Targeting the latest data-center power supply requirements, Cree Inc of Durham, NC, USA, which manufactures silicon carbide (SiC) power devices, has launched its new line of Z-Rec 650V junction barrier Schottky (JBS) diodes.

The diodes provide blocking voltage to 650V to accommodate recent changes in data-center power architecture that industry consultants estimate will result in energy-efficiency gains of up to 5%. Since data centers account for nearly 10% of the world's annual consumption of electrical power, any efficiency gain represents a significant opportunity to reduce overall power consumption, says Cree.

Conventional switch-mode power supplies typically have an input voltage range of 90–264V, supporting various AC input sources worldwide. In existing data-center power architectures, 3-phase/480V power is supplied from the local utility. This is converted to 3-phase/208V by a power transformer and then further conditioned to provide input power to the server power supply. This conversion step reduces overall efficiency due to transformer losses.

Recent trends in data-center power architecture call for the elimination of the 480V-to-208V conversion to boost overall data-center efficiency. Instead of providing 120V AC from the 3-phase/208V line to neutral, server power supplies will now be expected to accept a broader universal line voltage range of 90–305V (277V plus a 10% guard band) directly from the 3-phase/480V line to neutral. This architecture eliminates the need for the step-down power transformer, along with the related energy losses and expense.

Optimal operation of server power supplies with a higher input voltage range of 90–305V requires power components such as Schottky diodes that have an extended maximum blocking voltage of 650V. Cree says that its new 650V-rated devices provide a suitable solution for designers of state-of-the-art power supplies for data-center servers and communications equipment. The Z-Rec SiC diodes not only feature the 650V blocking voltage needed for these power supplies but they also further reduce energy losses (compared with silicon devices) by eliminating reverse recovery losses.

"SiC technology is critical to developing the next generation of advanced, energy-efficient data-center power system designs because it virtually eliminates diode switching losses," says Cengiz Balkas, Cree's VP & general manager, Power and RF. "Conventional silicon devices' switching losses are known to be big contributors to energy inefficiency, so replacing them with SiC devices can boost the efficiency of the power factor correction stage of the power supply by up to 2%, resulting in even greater overall efficiency improvement than with architectural changes alone," he adds.

The initial products in the C3DXX065A Series 650V Z-Rec Schottky diode family include 4, 6, 8 and 10A versions in TO-220-2 packages. All devices are rated for operation from –55°C to +175°C. The devices are fully qualified and released for production use.

www.cree.com/power

NASA SBIR award for GeneSiC's power management project for Venus explorers

GeneSiC Semiconductor Inc of Dulles, VA, USA, which develops silicon carbide (SiC) devices for high-temperature, high-power, and ultra-high-voltage applications, says that its project 'Integrated SiC Super Junction Transistor-Diode Devices for high-power motor control modules operating at 500ºC' has been selected by the US National Aeronautics and Space Administration (NASA) for a Phase I SBIR award.

The SBIR project is focused on developing monolithic integrated SiC junction barrier Schottky (JBS) diode-Super Junction Transistor (MIDSJT) devices optimized for operation under Venus-like ambients (500ºC surface temperatures). The SiC MIDSJT devices will be used to construct motor control power modules for direct integration with Venus exploration rovers.

"This project will enable GeneSiC to develop industry-leading SiC-based power management technologies through its innovative device and packaging solutions," says the firm's director of technology Dr Siddarth Sundaresan. "The SiC MIDSJT devices targeted in this program will allow kiloWatt-level power to be handled with digital precision at temperatures as high as 500ºC," he adds.

"In addition to outer space applications, this novel technology has the potential to revolutionize critical aerospace and geothermal oil-drilling hardware requiring ambient temperatures in excess of 200ºC," Sundaresan notes. "These application areas are currently limited by the poor high-temperature performance of contemporary silicon and even SiC-based device technologies such as JFETs and MOSFETs," he adds.

GeneSiC says that it continues to rapidly enhance the equipment and personnel infrastructure at its facility. The firm is hiring personnel experienced in compound semiconductor device fabrication, semiconductor testing and detector designs.

www.genesicsemi.com

DOE grants $3.9m for SiC HEV charger development

Arkansas researchers partner with Cree and Toyota

A $3.9m award from the US Department of Energy (DOE) aims to allow electrical engineering researchers at the University of Arkansas to continue contributing to the development of a compact and highly efficient silicon carbide (SiC) battery charger for plug-in hybrid electric vehicles (HEVs). Benefits of the project extend beyond vehicles into other areas, such as wind and solar power, and could also lead to reduced energy consumption.

The grant is part of the DOE's Advanced Research Projects Agency-Energy (ARPA-E) program and will benefit a collaborative partnership that includes five private and public entities: project leader Arkansas Power Electronics International Inc (APEI) of Fayetteville, AK; its private partner the National Center for Reliable Electric Power Transmission (at the University of Arkansas); Oak Ridge National Laboratory (ORNL); Cree Inc; and Toyota Motor Engineering & Manufacturing North America Inc.

"This effort will lead to breakthroughs in efficiency, size and weight reduction, and overall improved vehicle performance," believes Department of Electrical Engineering professor Alan Mantooth, director of the National Center for Reliable Electric Power Transmission (who holds the 21st Century Endowed Chair in Mixed-Signal IC Design and CAD).

Under Mantooth's direction, the Arkansas researchers will develop basic semiconductor device models to enable other researchers to design integrated circuitry. The work will help engineers simulate circuits on computers to verify functionality before committing to fabrication. As part of the overall project, the researchers will also design key components of the charging circuitry.

Since 2009, the DOE has allocated nearly $350m to universities, small and large businesses, national labs and non-profit groups to support research that can change how the US generates, stores and uses energy. As part of the American Recovery and Reinvestment Act of 2009, the funding is intended to create jobs and foster economic growth. "These innovative ideas will play a critical role in our energy security and economic growth," says US Secretary of Energy Steven Chu. "It is now more important than ever to invest in a new, clean energy economy," he adds.

"The award was highly competitive, and we look forward to delivering on the challenges in this groundbreaking project," says Serdar Yonak, Toyota's US power electronics R&D manager.

"This technology will help reduce energy consumption in everyday applications, such as personal vehicles," says APEI's director of business development Ty McNutt. "In addition, it will reduce the strain on the nation's power grid as electric vehicles become prevalent, while helping to decrease the nation's carbon footprint. Equally as important, the engineering and manufacturing jobs created by this award will remain in America," he adds.

"Cree has been leading the development of the silicon carbide power components at the heart of this proposed system," says John Palmour, Cree's chief technology officer for power and radio frequency. "We are hopeful that this demonstration will lead to the use of silicon carbide power devices in the electric motor drives themselves, creating even more efficiency gains for hybrid vehicles."

The National Center for Reliable Electric Power Transmission is one of just a few university-based research centers chosen by the DOE to investigate electronic systems to make the USA's power grid more reliable and efficient. Five years ago, the DOE funded the center because of the university's research expertise in advanced power electronics and longtime investigation of silicon carbide. Electrical engineering researchers at the university have developed and packaged SiC systems for more than a decade and recently won an R&D 100 Award, in collaboration with APEI, for the first 250ºC-capable power module rated at 1200V and 150A.

www.engr.uark.edu

SDK's new 'PEGASUS' business plan targets SiC epi

Following its 'Passion Extension' program of structural reform in 2009–2010 in response to the downturn of second-half 2008, Japan's Showa Denko K.K. (SDK) has a new medium-term business plan 'PEGASUS' for 2011–2015 targeting demand for components, materials and solutions in 'Electronics' and 'Energy/Environment'.

As well as expanding business in high-purity gases for semiconductor processing and commercializing large-diameter GaN epiwafers based on its proprietary Hybrid PPD technology for LED manufacturing, new growth sectors targeted by SDK include silicon carbide epiwafers for power devices.

The aim is to rapidly realize a stable supply of high-quality SiC epiwafers, meeting the needs for medium- to high-voltage applications.

SDK says that, to accelerate the launch of such new businesses, it will use partnerships as well as mergers & acquisitions to advance its business strategies and R&D.

www.sdk.co.jp

IN BRIEF

Warwick receives 1800ºC furnace for SiC power devices

Professor Phil Mawby at the UK's University of Warwick has taken delivery of a furnace that can reach 1800ºC (500ºC higher than traditional silicon furnaces), for use in fabricating power devices based on silicon carbide .

"It will allow us to really push the boundaries of what we know about SiC and how it functions under such intense temperatures," says Mawby. "This will allow us as a university to make great strides in developing the material for use in energy management and hopefully find a means of using the material to run electrical energy in a much more efficient manner," he adds.

"SiC is the next-generation semiconducting material," Mawby continues. "It is very similar to silicon but a much smaller piece of the material can perform the same functionality, meaning space and weight are saved, and less heat is lost."

The new furnace has been funded by the Science City Research Alliance (SCRA) Energy Efficiency Project, which is part of a larger investment by Advantage West Midlands and the European Regional Development Fund (ERDF) in the research infrastructure of the UK's West Midlands region. SCRA unites the University of Birmingham and the University of Warwick in a strategic research partnership formed under the Birmingham Science City initiative (a region-wide partnership of public sector, businesses and the research base).

The £10.5m Energy Efficiency project has already invested £1.8m in a cleanroom at the University of Warwick that has the capability to manufacture the complete SiC device.

www2.warwick.ac.uk

Micross to develop hermetic packaging for SemiSouth's SiC JFETs and Schottkys up to 260ºC

Collaboration targets hi-rel military, aerospace and down-hole drilling markets

Micross Components Inc, which provides specialized products & services and distributed components for the electronics industry, and SemiSouth Laboratories Inc of Starkville, MS, USA have announced a collaborative effort to expand SemiSouth's line of silicon carbide (SiC) power JFETs and Schottky diodes.

Founded in 2000 as a spin-out from Mississippi State University, SemiSouth is a privately held firm that designs and manufactures high-voltage SiC power devices and electronics for high-efficiency, harsh-environment power management and conversion in applications ranging from 3kW to 100kW (with products in development to serve applications up to 1MW). With a 10,000ft^2 cleanroom and more than 70 staff at its Starkville headquarters, products include 1200V and 1700V transistors as well as high-voltage diodes and power modules.

Micross represents a single source for specialty electronics that can provide the design, manufacture, logistics and die distribution processes needed to realize and support an application from start to finish. Micross has been serving military & aerospace customers for more than 30 years and has been a certified QML supplier for more than 14 years with over 1600 DSCC-listed products.

SemiSouth will provide select JFET and diode die to Micross for packaging and test in metal hermetic packages. Micross will then offer these value-added hermetically packaged versions, targeted at the military, aerospace and down-hole drilling markets. The firms aim to draw on each other's respective strengths in order to promote SiC product sales synergy in the worldwide market.

Micross plans to offer screening of the JFETs and Schottky diodes to military and space specifications such as MIL-PRF-19500 equivalent initially and eventually offering standard certified MIL-PRF-19500 products in the future. The initial Micross SiC product offering will include: four 1200V and one 1700V JFETs with 1250ºC continuous max drain current capability of 4–50A and low RDSon; and four 1200V Schottky diodes capable of 5–30A continuous forward current. The range for operating junction temperature (T_J) is –55ºC to +200ºC, with special screening up to 260ºC upon request.

"This is a significant product addition to our military & aerospace products family that will better serve the satellite customer with state-of-the-art SiC technology for high-power FETs and diodes," says Jeff Kendziorski, Micross Components' director of marketing & new product development.

SemiSouth will provide select JFET and diode die to Micross for packaging

"With our Hermetic packaging offering, this also expands the product use for extreme temperatures seen in deep down-hole drilling of up to 260ºC," he adds.

"We are continuing to search for ways to sell our SiC power electronics products in to hi-rel and mil-aero customers, and are pleased to be working with a well-known hi-reliability products vendor such as Micross," says SemiSouth's chief technology officer & VP of business development Jeff Casady.

www.semisouth.com

www.microssaustin.com/siliconcarbide

NEULAND project aims to halve energy loss for renewables, telecoms and lighting

€4.7m from Germany's BMBF funds 3-year SiC and GaN-on-Si project

Six partners from the semiconductor and solar industries (Aixtron, Azzurro Semiconductors, MicroGaN, Infineon Technologies, SiCrystal, SMA Solar Technology) are partnering in the research project 'NEULAND' to explore new avenues for the efficient use of electricity from renewable sources.

Headed by Infineon, NEULAND will run until mid-2013. Of the project's €4.7m total budget, 52.6% (€2.47m) will come from Germany's Federal Ministry of Education and Research (BMBF) under the government's High-Tech Strategy ('Information and Communications Technology 2020', ICT 2020 program) as part of the call for proposals on 'Power Electronics for Energy Efficiency Enhancement'.

Focusing on innovative power devices with high energy efficiency and cost effectiveness based on wide-bandgap compound semiconductors, NEULAND aims to reduce the losses in feeding electricity into the grid (e.g. in photovoltaic inverters) by as much as 50% — without significantly increasing system cost — by using devices based on silicon carbide (SiC) and gallium nitride on silicon (GaN-on-Si).

The new devices are also to be used in future in switched-mode power supplies for desktop and laptop PCs, for flat-screen TVs, servers and telecom systems, with a view to likewise halving energy loss in these applications.

On the market for about ten years now, SiC Schottky diodes enable significantly reduced losses in current and voltage conversion in switched-mode power supplies. They are used primarily in switched-mode power supplies for PCs or TVs, in solar inverters and motor drives. At present, GaN material is used mainly in white light-emitting diodes. Studies into the suitability of the material for power applications began in 2006. NEULAND aims to reveal the applications for which GaN devices live up to or outperform existing SiC devices in terms of reliability, ease of use, and cost. This will pave the way for introducing the energy-efficiency benefits of reduced losses throughout the consumer electronics spectrum, the project partners believe.

The project consortium brings together expertise in SiC and GaN across a wide area of the value chain. Aixtron is represented as a provider of semiconductor manufacturing equipment, and SiCrystal and Azzurro as wafer manufacturers. Device know-how is being supplied by MicroGaN and Infineon, and experience in systems engineering for photovoltaic applications comes from SMA Solar Technology.

www.infineon.com

TriQuint wins $17.5m TITLE III GaN manufacturing development contract for high-power, high-frequency

The US Air Force Research Laboratory (AFRL) has awarded RF component maker and foundry services provider TriQuint Semiconductor Inc of Hillsboro, OR, USA a Defense Production Act Title III gallium nitride (GaN) manufacturing development contract worth $17.5m.

The overall goal of the contract is to increase yield, lower costs and improve time-to-market cycles for defense and commercial GaN integrated circuits on 100mm wafers in high-power, high-frequency device manufacturing. TriQuint says that the contract was awarded on the basis of its previous success developing new GaN technologies and products for US Defense Advanced Research Projects Agency (DARPA) technology development programs.

The new GaN program is divided into three phases, with goals and assessment criteria at each milestone.

The primary first-phase goal is to make a baseline assessment of manufacturing readiness.

In the second phase, TriQuint will work to improve and refine the production process to reach a manufacturing readiness level (MRL) of 8 in developing its monolithic microwave integrated circuits (MMICs).

In the final phase (expected to conclude in 2013), the program aims to demonstrate MMIC fabrication that meets full performance, cost and capacity goals. TriQuint is the program's prime contractor and all the work is to be performed at its facility in Richardson, TX.

TriQuint has conducted GaN research and product development for both defense and civilian applications since 1999. In addition to its military design and manufacturing work, it has launched GaN amplifiers for wireless communications and a range of other applications over the last three years. TriQuint was the first to offer high-frequency, high-power commercial GaN foundry services (0.25μm GaN on SiC) in 2008.

"This program will take the technology from the early stages of production to a mature manufacturing process enabling next-generation systems," comments TriQuint vice president Tom Cordner.

www.triquint.com

Powdec unveils 600V GaN Schottky diode

Power losses halved on low-cost sapphire substrates

Powdec K.K. of Oyama City, Japan, which produces gallium nitride (GaN) wafers and devices, has used GaN to develop a Schottky diode with a high breakdown voltage of more than 600V.

In addition to the vertical Schottky diodes being fabricated on a low-cost, large-diameter sapphire wafer, a proprietary method was developed where the sapphire substate is removed, improving the device's thermal conductance. The GaN diode's on-resistance is more than 100 times smaller than existing silicon power diodes, reducing power losses by more than 50%, it is reckoned. Powdec plans volume shipments by 2012.

The new GaN Schottky diode can be used in the power conditioning of solar power systems and motor drive circuits, as well as in inverter and power factor correction (PFC) circuits, which are key in the power supply unit of servers and other equipment. Use of the GaN diodes can dramatically lower DC/AC conversion power losses, claims Powdec.

The replacement of existing silicon power diodes by these GaN power diodes can also result in a 15–30% cut in emitted CO_2, says the firm. Powdec reckons that its products will enable accelerated adoption of smart grids throughout society (where power and information networks are tied together, and where individually generated electricity from solar power etc can be smoothly connected to the main power grid).

Features of the Schottky diodes include:

1. Large-diameter sapphire substrates allow devices to be made at very low cost (as for LEDs).
2. At 620V, a leakage current of less than 1mA/cm^2 has been achieved. So, for a 10A diode, leakage current will be on the order of 20μA (one-tenth that of other GaN devices).

Figure 1. GaN vertical Schottky diode after separation from substrate.

3. The vertical structure does not suffer current collapse, as in lateral devices.
4. On-resistance is more than 100 times smaller than that in silicon diodes, providing very low power losses.
5. The diode's thickness is extremely thin at about 20μm (see Figure 2), giving very low conduction resistance and thermal resistance. This enables low power losses and higher operating temperatures as well as reduced system size (since fewer thermal components are needed).
6. The GaN Schottky diode provides high-speed performance, so high-frequency operation is possible, allowing a reduction in capacitors and inductors and hence leading to smaller and lower-cost systems.

It has been said in the past that creating a GaN diode with a vertical structure (like a silicon diode) would not be possible unless costly GaN substrates are used, comments Powdec.

Sapphire and silicon wafers are lower cost than GaN wafers but, up until now, their use has yielded lower-quality GaN crystal growth on top, reducing the voltage limits of the diode.

However, Powdec says that it has developed an innovative epitaxial lateral overgrowth (ELO) technology and realized very high-quality GaN crystal growth on sapphire wafers with dislocation numbers that are several hundred times less than those produced by conventional growth technologies, it is claimed.

While Powdec's new Schottky diode has achieved a breakdown voltage of 620V, the firm says that its proprietary technology also allows the possibility of creating 1200V diodes. Powdec says that it has been granted patents for the technology. The firm adds that, to accelerate market adoption of the low-power GaN devices, it is actively expanding its partnerships worldwide.

www.powdec.co.jp/e

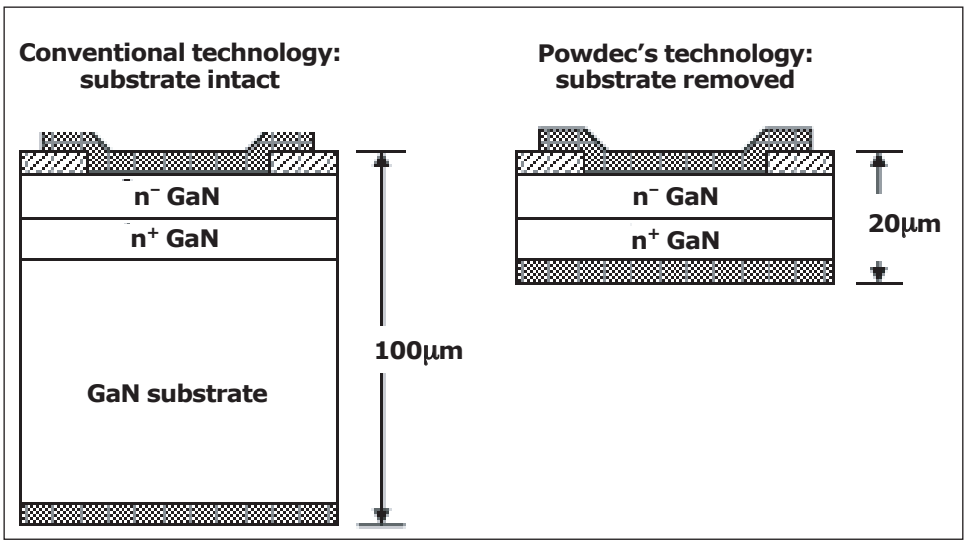


Figure 2. Comparison of device structure using conventional technology and Powdec's technology.

Test & Production

TECDIA

High Power Broadband

Bias Solution for GaN FET

Transmitting Your Power, Clean & Simple.

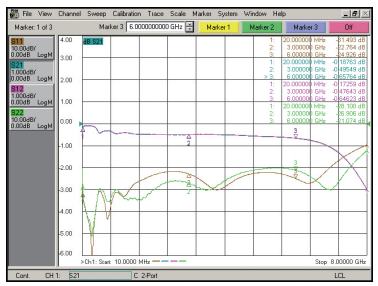
TBT-H06M20-F TBT-H06M20-F **25W / 20MHz～6GHz**

SPECIFICATION

Series		TBT			
Model		TBT-H06M20-F			
Impedance		50Ω			
Frequency Range		20MHz～6GHz			
		20～50MHz	50MHz～2GHz	2～3GHz	3～6GHz
VSWR (Return loss)		1.4 max.	1.22 max.	1.28 max.	1.4 max.
Insertion Loss		0.5dB typ.			0.7dB typ.
		0.8dB max.			1.0dB max.
Connector	RF	SMA (Female)			
	DC	Feedthru			
RF Power		25W max.			
Bias Current		3A max.			
Bias Voltage		50V max.			
Dimensions *		50 x 38 x 18 ㎜			
Weight		70g			
Temparature		0℃～ +40℃			

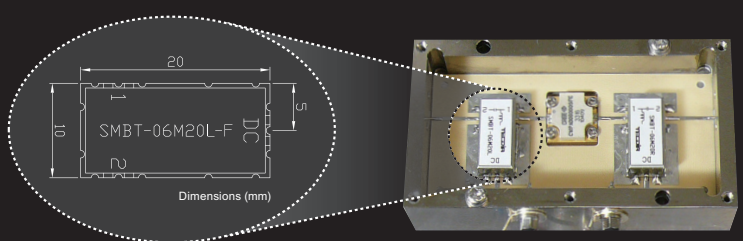
* Excluding Connectors

Typical VSWR & Insertion Loss



Surface Mount Design

20MHz～6GHz Typical Installation

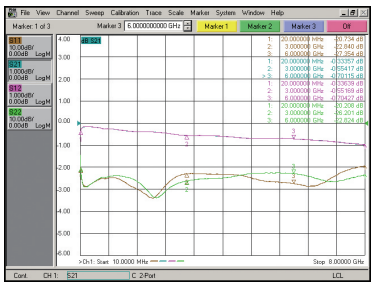


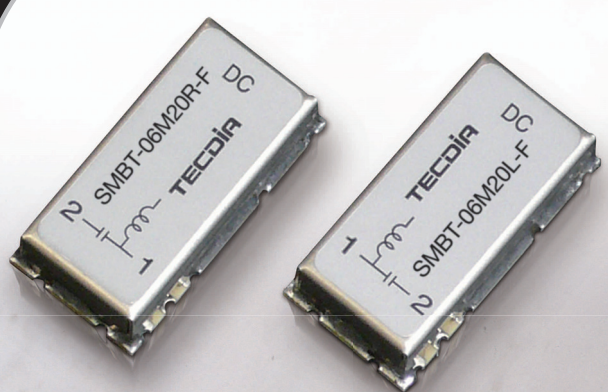
SPECIFICATION

Series	SMBT			
Model	SMBT-06M20□*-F			
Impedance	50Ω			
Frequency Range	20MHz～6GHz			
	20～50MHz	50MHz～2GHz	2～3GHz	3～6GHz
VSWR (Return loss)	1.5 max.	1.22 max.	1.28 max.	1.4 max.
Insertion Loss	0.8dB max.			1.0dB max.
RF Power	5W max.			
Bias Current	2A max.			
Bias Voltage	50V max.			
Dimensions	20 x 10 x 5 ㎜			
Weight	2g			
Temparature	-40℃～ +90℃			

*□=L or R for connection orientation

Typical VSWR & Insertion Loss





Ready-made Bias Network for GaN FET

* Left/Right Connection Available

Riber sells three production reactors to Asia for RFICs

Riber S.A. of Bezons, France, which manufactures MBE systems as well as evaporation sources and effusion cells, has sold three production systems to two Asian organizations working in compound semiconductor fields.

The orders consist of two MBE6000 systems, with a processing capacity of more than 1500 wafers per month, and one MBE49 system, with a processing capacity of 1200 wafers per month. The reactors will be used primarily to make radio-frequency communication microelectronic devices, enabling the users to significantly increase their production capabilities.

Riber says the orders illustrate the strong upturn in the compound semiconductor industry, as well as the strong level of interest in the firm's production systems. Since the beginning of 2010, Riber has booked a total of five orders for production reactors for delivery in Europe and Asia.

The firm says that the latest commercial orders confirm the growth in its sales in emerging countries, as well as highlighting its key position in the Asian market.

www.riber.com

AXT upgraded to NASDAQ Global Select Market

AXT Inc of Fremont, CA, USA, which manufactures gallium arsenide, indium phosphide and germanium substrates and raw materials, says that the NASDAQ Stock Market has upgraded the listing of its securities from the NASDAQ Global Market to the NASDAQ Global Select Market, effective 3 January. The firm's securities continue to trade under the symbol 'AXTI'.

As one of three market tiers at NASDAQ, the Global Select Market recognizes the highest financial listing standards in the world, with measures including market value, liquidity and earnings, according to NASDAQ, and qualifying for it is a mark of achievement, leadership, credibility and high ethical standards for companies.

"Having qualified for the NASDAQ Global Select Market is significant validation of the company and our board's dedication to corporate governance practices of the highest standard and integrity," reckons CEO Dr Morris S. Young. "Inclusion in this market should increase our visibility in the capital markets and further broaden our shareholder base," he adds.

www.axt.com

INL orders MBE reactor research

Riber S.A. of Bezons, France has sold a Compact 21 research MBE system to the Lyon Institute of Nanotechnology (Institut des Nanotechnologies de Lyon, INL).

The new system will supplement existing Riber MBE systems at INL and contribute to expanding the its research capabilities for developing micro- and optoelectronic components, specifically the use of silicon as a 'universal' substrate. The project is being financed with funds from a State-Region planning contract.

INL is a mixed research unit, overseen by the French national center for scientific research (CNRS), Ecole Centrale de Lyon, INSA de Lyon and Université Lyon 1. Its mission is to develop research, from materials to systems, paving the way for the emergence of groundbreaking technical fields. Applications cover the main economic sectors, from the semiconductor, microelectronic and photonic industries to telecoms, energy, health, biology, industrial control, defense and the environment.

Riber says that the Compact 21 system sold to INL offers high modularity and flexibility, making it possible to deposit materials with both low and high evaporation temperatures simultaneously (which is particularly suited to growing crystalline oxides on silicon). Drawing on Riber's technical experience and INL's oxide growth expertise, the reactor is being integrated into the other Riber systems at INL, which are devoted to growing III-V semiconductor-based nanostructures.

Riber says that, in addition to confirming the commercial success of the Compact 21 range (the world's best-selling MBE research system), the new order from a leading semiconductor research laboratory highlights Riber's expertise in nanotechnologies.

http://inl.ec-lyon.fr
www.riber.com

IN BRIEF

Riber sells reactor for Indian research

Riber has sold a Compact21 reactor to a "leading research institute based in India", enabling the lab to ramp up its research capacities for the growth of new ultra-thin-film electronic structures.

The system was selected for its flexibility and adaptability, allowing it to be tailored for research on the most complex structures. Riber's portfolio of components also contributed to the institute's decision to acquire all of the firm's technology.

Riber says that, in addition to confirming the commercial success of the Compact 21 range (the world's best-selling MBE research system), the order confirms the strong development of Riber's sales in India, where the semiconductor industry is growing rapidly.

IN BRIEF

Aixtron completes conversion into European company

Aixtron AG of Herzogenrath, Germany has completed its conversion from a German company (Aktiengesellschaft) into a European company (Societas Europaea, SE) with entry into the commercial register of the Aachen municipal court as Aixtron SE, under which name it will operate and report.

An SE is a public limited-liability company under European law. Aixtron says the supranational legal form reflects its European and international orientation and is a natural step with respect to its global operations and business development. Nearly half of the firm's employees work abroad and more than 90% of revenue is generated outside Germany.

The conversion was approved by a large majority of shareholders at the 2010 Annual General Meeting in May. Over 94% of the represented share capital approved the Executive and Supervisory Board's proposal for conversion.

Negotiations with the staff representatives concerning future staff participation in Aixtron SE were concluded within the statutory period of six months.

The firm's headquarters will remain in Herzogenrath in the Aachen region. The two-tier system consisting of a Supervisory Board and an Executive Board also remains. All members of the boards retain their original functions in the corresponding boards in the SE. No further changes are planned within Aixtron Group in conjunction with the conversion. Shareholders of Aixtron AG automatically become shareholders of Aixtron SE, and their shareholders' rights will not be affected by the conversion. There are also no changes to the manner or content of financial reporting as a result of the conversion.

Chinese thin-film PV equipment firm APOLLO enters LED epi

In third-quarter 2010 Aixtron received an order for a CRIUS 31x2"-wafer MOCVD reactor from new customer APOLLO Precision Ltd of QuanZhou, FuJian Province, China.

Delivered in December, the system will be used for production of LED back-light units (BLUs). The local Aixtron support team is commissioning it in a dedicated facility at the firm's China production plant.

As an investment holding company incorporated in 2008 and operating as a subsidiary of RBI Holdings Ltd, APOLLO Precision Ltd is, through its subsidiaries, a manufacturer and seller of specialized equipment and turnkey solutions for the production of amorphous silicon thin-film photovoltaic modules. The new LED-related development should allow the group to enhance its earning capacity and diversify market risk.

"We are making a new investment to enter the LED epitaxy business, and the CRIUS reactor will form the basis of our growth plans," says APOLLO's chief operating officer professor ShuLin Wang. "We feel confident with the CCS CRIUS system — one of the world's most productive MOCVD systems for production of GaN-based LEDs."

www.apollosolar.com.hk/en

HUGA orders multiple Aixtron G5 MOCVD reactors for blue HB-LED production

Aixtron has received a repeat order from existing customer HUGA Optotech Inc for a double-digit number of AIX G5 HT 14x4" configuration MOCVD systems.

After delivery between Q4/2010 and Q1/2011, the systems will be used for producing GaN-based materials for ultra-high-brightness (UHB) blue LEDs. The local Aixtron support team in Taiwan is commissioning the reactors in HUGA's newly expanded facility in Taichung Science Park, Taiwan.

"HUGA Optotech has been particularly impressed with the overall performance of our first Aixtron G5 HT MOCVD system," says president C.N. Huang. "Factors that have influenced our decision centre on the excellent performance we have seen from the G5 Planetary system, plus its capability to perform continuous runs without baking or cleaning. This has been achieved as smoothly and efficiently as we could wish," he adds. "These and other positive factors have reassured HUGA Optotech management and engineers alike that they can have the highest confidence with the AIX G5 HT platforms on order. We plan to base our complete current expansion around the G5."

Founded in 1998, HUGA first achieved mass-production of its own blue LED chip product in 2001. It now also manufactures and develops other GaN components such as laser diodes and UV emitters as well as GaAs-based devices for communications.

The G5 HT is Aixtron's flagship MOCVD system and is used for the most demanding of compound semiconductor material production tasks. The latest and most capable evolution of the Aixtron Planetary Reactor series, the G5 has been optimized to meet all requirements for advanced production with respect to performance, cost of ownership and yield. The designation HT (high temperature) refers to the particular application to the manufacture of wide-bandgap materials including but not restricted to UHB LEDs.

www.hugaopto.com.tw
www.aixtron.com

Veeco ships 200th TurboDisc K465i MOCVD system

Veeco Instruments says it has shipped its 200th TurboDisc K465i MOCVD system to a "leading LED manufacturer located in Asia".

"Since its introduction to the market in January 2010, the K465i has become the market-leading MOCVD system for high-volume manufacturing of LEDs," reckons Bill Miller, executive VP, Compound Semiconductor and head of Veeco's MOCVD operations. "We are proud of Veeco's ability to ramp production of the K465i and support our global customers to meet the strong demand for tools as LED adoption accelerates for backlighting and lighting applications," he adds. "This is a significant milestone for our business."

Veeco says that the production-proven K465i extends its lead in capital efficiency (the number of good wafers per day for each capital dollar) for high-volume LED makers. The K465i provides ease-of-tuning for fast process optimization on wafer sizes up to 8 inches and fast tool recovery time after maintenance, the firm adds.

www.veeco.com

Veeco appoints GT Solar's CEO to board of directors

Epitaxial deposition and process equipment maker Veeco Instruments Inc of Plainview, NY, USA says that Thomas Gutierrez has been appointed to its board of directors.

Gutierrez is currently president, CEO & director of GT Solar International Inc of Merrimack, NH, USA, which provides polysilicon production technology as well as sapphire and silicon crystalline growth systems and materials for the solar, LED and other specialty markets.

"Tom brings a broad, global technology background to Veeco's board that includes experience in multi-national organizations and clean technology," says CEO John R. Peeler. "He will quickly become a valued advisor and partner in Veeco's future growth," he believes.

Prior to joining GT Solar in 2009, from 2001 to 2008 Gutierrez was CEO and a member of the board of directors of Xerium Technologies Inc, a multinational company that develops and manufactures technically advanced synthetic textiles. From 1995 to 2001, he was CEO of Invensys Power Systems, a $3bn firm in power control and energy storage systems and services for industrial applications. Gutierrez also has extensive international experience in product development, manufacturing, marketing and sales. He received his BSc. degree in Electrical Engineering from Florida Institute of Technology.

China's ULED receives six Aixtron CRIUS systems for GaN LEDs

Deposition equipment maker Aixtron SE of Aachen-Herzogenrath, Germany has announced an order for six 31x2"-wafer configuration CRIUS deposition systems from new customer United LED Shan Dong Corp (ULED) of Shandong, China. Following installation and commissioning of the systems in ULED's dedicated new production plant in third-quarter 2010, they will be used for the production of GaN LEDs for back-lighting units (BLU) and general lighting applications.

ULED is a joint venture between UMC, the world's second largest silicon wafer foundry, and high-brightness LED chip maker Epistar, both of Taiwan. "Our strategy is to integrate LED-based technology and IC industry resources to produce LED chips for lighting applications," says ULED's Epi Division director Dr Tzu-Chi Wen. "Aixtron CRIUS reactors have been selected due to their high performance and excellent productivity. It will provide us with a very rapid start-up so that we can be producing our own LED products at lowest risk," he adds.

Our strategy is to integrate LED-based technology and IC industry resources to produce LED chips for lighting

"This is the first set of MOCVD equipment in this new facility and we have been with ULED every step of the way to ensure smooth installation and commissioning," says Dr Christian Geng, Aixtron VP of Greater China & general manager of Aixtron Taiwan Co Ltd.

www.aixtron.com

IN BRIEF

Aqualite orders six CRIUS systems

Aixtron says that in Q4/2010 its local support team in China installed six CRIUS 31x2"-wafer configuration MOCVD systems at existing customer Aqualite Co Ltd for the production of high-power LEDs.

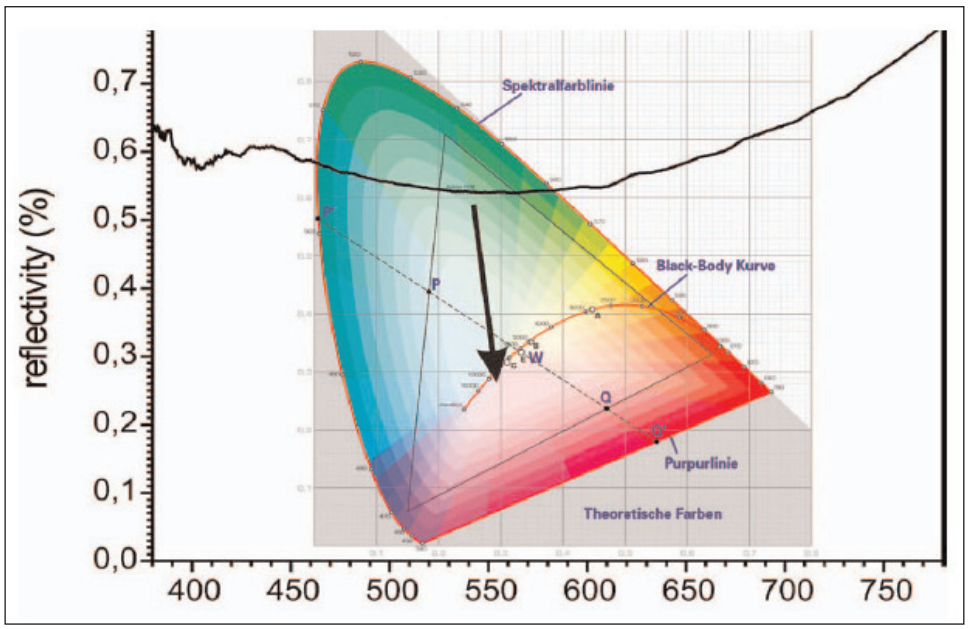
"We have been very satisfied with our three existing reactors as they are perfectly matching our requirements. However, we now have to increase our production capacity for high-power LEDs," says Aqualite's CEO Dr James Dong. "Our systems have delivered on their performance promise — Aixtron engineering means they have superior specification on all counts but particularly in uniformity and yield."

www.aqualite-led.com

LayTec adds color measurement capability to SolR thin-film photovoltaic monitoring tool

LayTec GmbH of Berlin, Germany (which provides in-situ optical metrology systems for thin-film processes) says that, in addition to measuring the precise film thickness of all layers throughout the solar cell manufacturing process, its SolR system can now monitor the following photovoltaic (PV) cell features in-line: texture and surface roughness and — in the case of transparent conducting oxide (TCO) — conductivity. The new feature now allows determination of the precise color value of the layer surface.

LayTec says that, after a deposition step, it is often possible to anticipate by visual inspection if the coating was performed successfully and if the solar module will meet the color spaces. But this process can now be objectified using the SolR. The real-time analysis software transforms the reflection spectra into a color space model. Available models are RGB, CIEXYZ or CIELAB color spaces. In either model the color is represented by a data triple. Slight variations in surface color can indicate deviations in stoichiometry or other detrimental effects. The Figure shows the reflectance spectrum of a $CuInSe_2$ absorber layer in a copper indium diselenide (CIGS) thin-film PV cell and the representation of the typical grey-bluish color in the CIEXYZ color space.



CIGS reflectance spectrum and CIEXYZ color space.

In contrast to human visual inspection, color measurement can be performed in narrow spaces and in a variety of atmospheres and vacuum, says LayTec. The new feature can hence lead to a new level of quality control in solar cell production, the firm claims.

www.laytec.de

● LayTec says that (since October) Hyun Lee is a new team member in its R&D department, responsible for pre-production series and replenishment planning for the firm's PV section. He graduated as an engineer in physical techniques at the Rhein-Main University of Applied Sciences, from which he already has experience in optics and sensor systems.

In addition, a position is currently open in the firm's PV section for an experimental physicist.

DGKK Workshop discusses opto, photonics, solar

In conjunction with its 25th anniversary, the Epitaxy Work Group of the German Society for Crystal Growth (Deutsche Gesellschaft für Kristallwachstum und Kristallzüchtung e.V., or DGKK) held a workshop 'Epitaxy of III/V Semiconductors' on 9–10 December in the SuperC building at RWTH Aachen University. The event was co-organized by RWTH Aachen (Rheinisch-Westfälische Technische Hochschule Aachen) and deposition equipment maker Aixtron AG of Aachen-Herzogenrath, Germany (spun off from RWTH in 1983).

The annual two-day symposium for 'epi specialists' focused on the latest developments and results in optoelectronics, e.g. LEDs for the lighting industry, nano-technology, photonics and solar technology.

On both days, junior scientists presented their ideas to the scientific community for the first time. The workshop also serves as a national forum where doctoral candidates for the first time have the opportunity to demonstrate their knowledge to a group of renowned experts, notes Dr Holger Kalisch, senior engineer at the Chair of Electromagnetic Theory (Institut für Theoretische Elektrotechnik) at RWTH Aachen.

"Topics addressed in the workshop represent high added value for Germany," says professor Michael Heuken, VP of R&D at Aixtron and adjunct professor at RWTH Aachen University, who has headed the DGKK's Epitaxy Work Group for many years. "Companies such as Osram, Philips, Infineon and many Asian companies such as Samsung and Nichia use the technology."

www.gan.rwth-aachen.de/dgkk
www.aixtron.com

LayTec wins technology transfer award 'Science Creates Jobs 2010'

LayTec GmbH of Berlin, Germany (which provides in-situ optical metrology systems for thin-film processes) and its research partners Otto-von-Guericke University of Magdeburg and Ferdinand-Braun-Institute in Berlin have won Germany's 'Science Creates Jobs 2010' award, which honors the most successful technology transfer from academia to small- & medium-sized enterprises.

The €20,000 prize was awarded for the third time by the Technical University of Chemitz and Deutsche Postbank AG under the patronage of the German Federal Minister of Economics and Technology. Of the 35 German applicants, LayTec's EpiCurveTT development project was recognized by the jury as the most relevant technlogical breakthrough and as an economic success.

In 2005, in a prototype tool developed by professor Alois Krost and co-workers at the University of Magdeburg, LayTec recognized a method with the potential to revolutionize the production of LEDs. "Despite some scepticism in the LED industry at that time, we further developed the method of in-situ wafer curvature measurement to make it suitable for industrial applications," says president & founder Dr Thomas Zettler. "Just two years later, in cooperation with the Ferdinand-Braun-Institute, we successfully conducted field tests to adapt our new in-situ metrology system to industrial requirements."

Since its launch, EpiCurveTT has generated revenue of over €10m.

The number of staff at LayTec has risen from 20 in 2005 to more than 60 in 2010. The firm says that research partners also benefit from the development: due to the patent license agreement, the University of Magdeburg receives 2.5% of all EpiCurveTT revenue annually.

"The jury was convinced by the fact that the partners were not discouraged by the initial scepticism of the LED industry and continued intensive and goal-oriented development of the sensor that fulfills industrial demands and meets numerous challenges occuring during the growth of compound semiconductors," commented jury member professor Urs Fueglistaller (director of the Swiss Research Institute of Small Business and Entrepreneurship in St. Gallen) at the award ceremony.

In addition to enabling the brilliant picture quality of the newest LED-backlit flat-panel displays, LayTec reckons that in a few years, due to their energy efficiency, LEDs will completely replace the currently still modern low-energy light bulbs. The firm says that its EpiCurveTT helps to produce affordable, bright LEDs with a precise color spectrum.

www.wissenschafftarbeit.de

Professor Klaus-Jürgen Matthes (left) und Deutsche Postbank's Dr Mario Daberkow (right) congratulate Zettler.

Altatech launches system for inspecting wafer edges and controlling multi-layer overlap

At the SEMICON Japan 2010 trade show (1–3 December), Altatech Semiconductor S.A. of Montbonnot, near Grenoble, France is launching its high-throughput AltaSight EyeEdge inspection system, which can detect, identify and generate images of defects as small as 2μm along the edges of 300mm wafers, including compound semiconductor, silicon, silicon-on-insulator (SOI), quartz and transparent substrates. Applications include inspecting bare or patterned wafers, through-silicon vias (TSVs) used in 3D semiconductor integration, and thin-film layer overlap at the extreme edges (the crown or apex) of wafers.

Available as either a stand-alone tool or as a modular, fully retrofitable enhancement on Altatech's 300mm AltaSight platform, the EyeEdge system maximizes device yield and profitability by finding and accurately classifying defects that other inspection schemes (including laser-scanning systems) cannot, the firm claims. In addition, throughput of 100 300mm wafers per hour enables EyeEdge to achieve higher productivity than other inspection systems on the market, it adds.

"We developed EyeEdge based on close communications with our strategic partners in the semiconductor market, whose requirements for critical edge inspection and cost-of-ownership performance are incorporated into this new product," says president Jean-Luc Delcarri.

Altatech says that it has installed two beta-site systems at customers' R&D laboratories, where the equipment is being qualified for use in volume production.

Designed for a wide range of users — from wafer suppliers to integrated device manufacturers (IDMs) and foundries to product development laboratories — EyeEdge is a fully automated defect-classification system that comes standard with three high-speed optical sensors

Altatech's new EyeEdge inspection system.

for single-pass inspection. Using Altatech's proprietary DeepSight technology, these sensors collect sufficient data to define the size, shape and location of defects anywhere within 1.5mm of a wafer's edge. EyeEdge then generates a three-dimensional image of each surface anomaly for easy classification.

"The ability to detect minute shifts in optical signals is critically important at the edges of wafers, where thin-film overlapping and delamination issues complicate the inspection process," says Delcarri. "More expensive laser-scan inspection systems cannot discriminate between real defects and false, irrelevant signals. Faced with wafer-to-wafer variations, laser systems are not adaptive enough to continually changing noise/signal ratios," he adds. "Furthermore, relying on scattered light information limits the ability to accurately classify defects in today's production environments."

Ability to detect minute shifts in optical signals is critically important at the edges of wafers

EyeEdge is designed to accommodate an optional fourth optical sensor to analyze a programmable crown area on a wafer's front-side edge. While maintaining the system's processing accuracy and high throughput, the additional sensor enables EyeEdge to measure layer-overlapping control, providing what is claimed to be a unique high-speed, low-cost solution to control insulating, barrier and seed layers, copper electroplating and chemical mechanical planarization (CMP), photoresist edge-bead removal (EBR) and edge-cleaning effectiveness.

EyeEdge is a stand-alone system, but can be added as a module onto the AltaSight platform to create a holistic system that can inspect a wafer's front-side, back-side and edge simultaneously using a combination of reflectivity, topographical, dark-field and DeepSight technologies.

"We have fuelled our innovation with continued customer interaction and partnership and a large breadth of technologies in our IP portfolio," says Delcarri. "We have quickly converted them into productive products and brought them to the market," he adds. "The demand is out there. As everyone is striving for improved performance, our engineering team, sales and support services are being expanded worldwide to solve our customers' challenges."

www.altatech-sc.com/en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UHB LED Solid State Lighting
Strained Layer & Quantum Well
HBTs
pHEMTs
BiFET/BiHEMTs
Multi-junction CPV Cells

JPSA completes expansion; adds workstations to job shop

JP Sercel Associates Inc (JPSA) of Manchester, NH, USA, which makes UV laser-based materials processing workstations for wafer processing and micromachining, says that construction on expanding its laser manufacturing facility has been completed.

This adds an extra 24,000ft^2, giving JPSA a total of over 58,000ft^2 of work space and providing the ability to meet increasing demand for LED, solar, and excimer laser micromachining systems.

The expansion doubles the size of the existing laser production area used to manufacture high-throughput, high-precision laser micromachining systems. It will also provide cleanrooms, R&D laboratories to develop cutting-edge micromachining applications, and ergonomic office space to accommodate growing customer service and engineering teams.

"The laser equipment and R&D services we provide will carry our growth into the next decades as we continue to develop new technologies and increase our workforce," says chairman & chief technology officer Jeffrey P. Sercel. "We at JPSA feel fortunate to partner with Jewett Construction in our growth," he adds. "Their commitment to providing us an energy-efficient building while meeting deadlines ensures JPSA will have a smooth transition to our next phase of business."

JPSA has also announced an expansion to its job shop operations with the addition of new diode-pumped solid-state (DPSS), ultrafast and excimer laser workstations. This will extend the firm's capacity to accommodate its global micromachining customers with cutting edge applications in the LED, solar, semiconductor, specialist microelectronic, and biomedical industries.

JPSA's building expansion provides additional space, enabling the installation of several laser micromachining workstations, including the ultrafast laser tools. As well as providing cleanrooms and expanding production for manufacturing laser micromachining systems, the new facility houses an expanded full-featured job shop and applications laboratory.

"The ultrafast lasers will permit fabrication of traditionally difficult materials such as quartz, glass, and various metals, allowing us to deliver a wide spectrum of materials processing capabilities," says Sercel. "We also added key application scientists as part of our planned growth strategy to better serve a global laser technology market."

www.jpsalaser.com

Invenlux orders JVS' HRXRD tool for LED epi production

X-ray and vacuum ultraviolet (VUV) metrology tool maker Jordan Valley Semiconductors Ltd (JVS) of Migdal Haemek Israel has received an order from Invenlux Optoelectronics (China) Co Ltd of Haiyan, Zhejiang for its QC3 HRXRD high-resolution x-ray diffraction tool, a high-throughput, multiple-wafer-size diffractometer, used for the quality control of epitaxial layers in the LED production line.

"Jordan Valley's XRD system will have a key role at our new production line of GaN (blue, green and purple) epi-wafers, for which InvenLux has their own patent," says InvenLux Optoelectronics' CEO Dr Chris Yan. "We have selected JVS systems to meet our customers' significant extension in demand, which appears about to gather yet more momentum," he adds. "Having JVS as our supplier gives us confidence that we will increase our capacity and gain operational efficiency and consistency."

InvenLux Optoelectronics (China) was founded in May 2009 and is the LED product manufacturing facility for US-based InvenLux Corp of El Monte, CA, USA. The firm spans the complete LED manufacturing chain, including MOCVD growth, LED device design and processing, material and device characterization, and LED packaging & testing for volume LED production and advanced R&D.

"The QC3 diffractometer was designed for high throughput and low cost of operation, assuring outstanding cost/performance value," says JVS' director of sales & marketing Alon Kapel. "With RSM [reciprocal space mapping] scans performed in just a few minutes, a multiple wafer stage (2–6") and best analysis software (JV RADS), the QC3 system is optimized for LED mass production quality control," he adds. Since the QC3's launch in January 2010, many tools have already been installed and are running in production lines across China, Taiwan and other LED manufacturing sites worldwide, Kapel notes.

The QC3 production metrology tool was designed for the characterization of all common semiconductor materials, including GaAs, InP, Si and GaN (thick buffers) for high-brightness (HB) LED manufacturing. The system also suits the analysis of multilayer structures such as HEMTs and HBT, due to its capability to determine the thickness and composition of all layers within a stack, especially graded composition layers within HBT structures (determined from first principles using the firm's RADS HRXRD simulation software). The tool suits the measurement of MQW (multi-quantum well) thickness, indium composition, tilt and twist, and its high intensity gives higher precision for better throughput, it is claimed.

www.jvsemi.com
www.invenlux.com

Oxford Instruments appoints training officer

As part of its ongoing commitment to its customers, UK-based equipment maker Oxford Instruments Plasma Technology (OIPT) has expanded its system maintenance and process training offering, with a new program and by employing a dedicated training officer.

Nick Curtis' remit is to ensure that customers gain an insight into the full range of Oxford Instrument's etch, deposition and growth systems in order to maximize their performance and process capabilities. Curtis joins Oxford Instruments with many years experience in customer and in-house training for a large technical company, and is hence suited to developing the training programs at OIPT, the firm reckons.

"We build long-term relationships with our customers based on trust and respect, and want to ensure that they capitalize on the capabilities of their 'Oxford' systems," says OIPT's sales & customer support director Mark Vosloo. "Working with Oxford Instruments' trained system technicians and engineers, customers learn how to optimize the performance of their system," he adds.

"In addition our applications team and development scientists conduct process training courses in our extensive UK applications laboratories, tailored to individual customer requirements," notes Vosloo. "All our questions were answered and I have to say that I was very content with the course," comments University of Leoben's Matthias Edler of a recent course. "You supplied good, solid, thought-provoking information," says Hilary Tanner, L-3 Communications EOS. "I learned a lot about ion sources," adds Michael Hume of University of Alberta, Canada. "The knowledge gained about sources should prove extremely valuable."

The aim of the courses is to ensure optimized system operation, increased productivity, and consequently to reduce down-time to a minimum

Oxford Instruments offers a program of System User and Maintenance Training courses to help train customers' staff at its factory near Bristol, UK, in addition to on-site customer training. Courses are available for the FlexAL and OpAL ALD (atomic layer deposition) systems, the full range of Plasmalab plasma etch and deposition systems, and Ionfab ion beam systems.

The aim of the courses is to ensure optimized system operation, increased productivity, and consequently to reduce down-time to a minimum and reduce service costs, while reinforcing long-term relationships with customers based on trust and respect, concludes OIPT.

www.oxford-instruments.com

IN BRIEF

Brewer Science opens offices in Tokyo and Seoul

Brewer Science Inc of Rolla, MO, USA says that, to better serve its Asian customers with process and material solutions for the semiconductor, MEMS, and LED industries, it has recently opened new offices in Tokyo, Japan and Seoul, Korea, joining its existing offices in Taipei, Shanghai, and Hong Kong.

"Local customer support is a commitment of Brewer Science," says president Terry Brewer. "Working side by side with customers provides us with an opportunity to address their issues and provides them with the most effective manufacturing solution for the long term."

Brewer Science has delivered technology solutions to the microelectronics industry for 30 years, beginning with the invention of anti-reflective coatings for microlithography processes, the firm says. The firm's products include ARC anti-reflective coatings, ProTEK protective coatings, WaferBOND bonding materials, the ZoneBOND thin-wafer processing systems, OptiNDEX high-refractive-index materials, OptiStack multilayer lithography systems, and Cee benchtop processing equipment.

The new offices are located at:

- Brewer Science Japan G.K., Level 28, Shinagawa Intercity A, 2-15-1, Konan, Minato-ku, Tokyo, Japan 108-6028, Tel: +81 (0)3 6717-4378;
- Brewer Science Asia Ltd, Korea Representative Office, 30th Floor ASEM Tower, 159-1, Samsung-dong, Gangnam-Gu, Seoul, Korea 135-798, Tel: +82 2 6001 3498.

Brewer Science exhibited in the Next Generation Technology Pavilion at the SEMICON Japan 2010 trade show (1–3 December).

www.brewerscience.com

Obducat secures equity financing

Obducat AB of Malmö, Sweden, which supplies systems based on nano-imprint lithography (NIL) and electron-beam lithography, has entered a financing agreement with YA Global Master SPV Ltd (Yorkville) under which it, on several occasions during a 48-month period, may issue new class B shares to Yorkville up to an aggregate of SEK30m (about €3.3m, or $4.46m).

"Our ability to choose if, and when, to access funds under this facility provides us with important flexibility going forward," says CEO Patrik Lundström. "The facility gives us a valuable additional financial resource to accomplish the commercialization of our product portfolio," he adds.

The subscription price for new shares will be 95% of the lowest daily volume weighted average price for Obducat's class B share during five trading days after Obducat notifying Yorkville that a new issue under the facility will be made. Further, in connection with each new issue, Obducat has a right to determine a floor price below which it will not issue any shares. No single new issue under the facility may exceed SEK400,000 of proceeds. Also, Yorkville is only obliged to subscribe for such a number of shares that Yorkville's holding in the firm does not exceed 4.99% of Obducat's total number of shares. The facility entails certain customary representations and warranties and covenants by Obducat to Yorkville.

In consideration for its undertakings under the agreement, Yorkville is entitled to a fee of 1.5% of the SEK30m committed amount. Obducat will also reimburse Yorkville for certain legal costs.

The agreement was conditional upon approval by a general meeting of Obducat on 3 January, including an initial authorization to issue new shares under the facility.

As announced on 30 November, Obducat is also carrying out a rights issue of convertibles with preferential rights for its shareholders and warrant holders.

www.obducat.com
www.yorkvilleadvisors.com

Ultratech opens Singapore International Operations facility

Lithography and laser-processing system maker Ultratech Inc of San Jose, CA, USA has officially opened its new manufacturing facility in Singapore, attended by about 200 guests (including Singapore Economic Development Board chairman Leo Yip) and followed by a plant tour. The firm plans to spend more than $125m over the next several years in support of its Singapore International Operations.

"After an extensive study in the Asia Pacific region, we selected Singapore for several business reasons including being conveniently located to Ultratech's served markets," says chairman & CEO Arthur W Zafiropoulo. "We expect 75% of our business to be located in the Pacific region and, with this new facility in Singapore, Ultratech can better serve customers from Thailand to Taiwan."

The manufacturing facility will be capable of producing more than 100 lithography steppers annually for the advanced packaging and the high-brightness LED (HB-LED) markets. Along with providing engineering support in Singapore, the facility will also serve as headquarters for Ultratech's global service operations and Asia Pacific sales organization. The firm plans to start manufacturing lithography systems at its Singapore facility in late 2010, with the first tool shipments to customers scheduled for first-quarter 2011.

www.ultratech.com

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Soitec and SEI to co-develop engineered GaN substrates

Smart Cut targets lower cost for high-brightness LEDs and power devices for hybrid and full electric vehicle

Soitec of Bernin, France, which manufactures silicon-on-insulator (SOI) wafers and other engineered substrates, and Japan's Sumitomo Electric Industries Ltd (SEI), a provider of compound semiconductor materials, say that they are working together to develop engineered gallium nitride (GaN) substrates.

The alliance will draw on Sumitomo Electric's GaN wafer manufacturing technology and Soitec's unique Smart Cut layer transfer technology by which ultra-thin GaN layers are transferred from a single GaN wafer to produce multiple, engineered GaN substrates retaining the original, high crystalline quality of Sumitomo Electric's GaN wafer but at a lower cost. The technology is therefore expected to facilitate widespread use of GaN substrates in applications such as high-brightness LEDs as well as electric power devices designed for hybrid and full electric vehicles.

"Our collaboration with Soitec will open the door to high-quality, lower-cost GaN substrates," believes Masamichi Yokogawa, Sumitomo Electric's executive officer and general manager of its Compound Semiconductor Material division. "We have demonstrated that the transfer of a thin layer of our high-quality GaN crystal to a carrier wafer is the right approach to make our GaN material accessible for various applications such as power devices and white LEDs," he adds. "We are expecting the collaboration with Soitec will enable wider use of our high-quality GaN wafer... device manufacturers focused on low unit area costs will find value in the greater functionality of these engineered substrates," Yokogawa believes.

"We are partnering with the leader in GaN wafer manufacturing to offer engineered substrates that have the best crystal quality available today," claims Soitec's CEO Andre-Jacques Auberton-Herve. "This collaboration represents the first step of an important move in our strategy to address the need for dramatically improved efficiency in power conversion and lighting with innovative materials engineering solutions."

www.soitec.com
http://global-sei.com

GT Solar wins first orders for sapphire furnace since acquiring Crystal Systems

$84m in orders from new sapphire makers in China

GT Solar International Inc of Merrimack, NH, USA (a provider of polysilicon production technology as well as sapphire and silicon crystalline growth systems and materials for the solar, LED and other specialty markets) has received its first orders for sapphire crystallization furnaces since July's $57.8m acquisition of privately held large-area sapphire substrate growth firm Crystal Systems Inc of Salem, MA.

Totaling more than $84m, the two orders come from Jiangsu Jixing New Material Co Ltd and Jiujiang Sapphire Tech Co Ltd (affiliates of two "highly valued long-term photovoltaic customers") for their new production facilities. The total annual production capacity of the two orders is about 8 million two-inch equivalents (TIE) of sapphire substrates.

"The response to our sapphire equipment strategy from customers has been very positive," says president & CEO Tom Gutierrez. "We continue to talk with other potential customers in the Asia region for our sapphire crystallization systems, and believe we are on track to meet our projected $100m in revenue in our fiscal year 2012 from sapphire crystallization equipment sales," he adds.

The two orders represent GT Solar's entry into the LED equipment market, which it stated it would pursue on acquiring Crystal Systems. Both Jiangsu Jixing New Material and Jiujiang Sapphire Tech are positioning themselves to capitalize on the expected growth of the LED market over the coming years by building the capacity to produce high-quality, large-area sapphire substrates. These initial customers will be targeting the high-brightness LED market segment, says GT Solar.

"Our advanced sapphire crystallization systems are built on a highly scalable and reliable architecture that lets customers quickly ramp to volume production with a lower capital investment compared with other competing crystallization technologies," claims Gutierrez. "The combination of our technology and the depth of our regional service and installation expertise deliver compelling value to our customers by reducing the risks of equipping and commissioning a new manufacturing facility," he adds.

The two orders, in combination with other DSS (Directional Solidification System) and polysilicon orders, bring GT Solar's bookings for the current quarter (fiscal Q3/2011 to date) to more than $245m, strengthen the firm's view for a strong fiscal 2012 (based on the pipeline of orders still under discussion with customers).

www.gtsolar.com

Peregrine and Soitec announce bonded SOS substrate

Peregrine Semiconductor Corp of San Diego, CA, USA, a provider of radio-frequency (RF) integrated circuits (ICs), and Soitec of Bernin, France— which manufactures engineered substrates including silicon-on-insulator (SOI) wafers and (through its Picogiga International division) III-V epiwafers — have announced the joint development and ramp in production of a new, bonded silicon-on-sapphire (SOS) substrate that has been qualified for use in manufacturing Peregrine's next-generation STeP5 UltraCMOS SOS-based RF ICs.

Soitec says that its core direct wafer-bonding technologies and industrial know-how, combined with Peregrine's legacy SOS process development and IC design expertise, enabled the rapid development of a tuned substrate that delivers the RF performance required by ever-advancing mobile wireless and industrial markets.

The new substrate is a bonded monocrystalline SOS substrate jointly engineered by the two firms. Soitec's process expertise was used to transfer and bond a high-quality, monocrystalline thin silicon layer onto a sapphire substrate. It is claimed that the resulting bonded silicon layer offers improvements in transistor mobility and silicon quality beyond conventional SOS wafers, which use an epitaxially grown silicon layer. The new substrate provides Peregrine a design landscape for enhancements in RFIC performance, functionality, and form factor, enabling IC size reduction and performance increase by as much as 30%, says Soitec. It also enables Peregrine to continue its long-term strategy toward highly integrated RF front-end (RFFE) IC solutions in a substrate technology that matches the yield and scalability qualities of bulk silicon.

"Soitec's impressive substrate expertise and industrial capabilities enabled us to meet our vision for next-generation UltraCMOS processing," says Mark Miscione, Peregrine's VP, RF Technology Solutions. "This achievement has provided the opportunity to exploit even greater RF performance in our products. We look forward to continuing our collaboration and exploring new opportunities together with Soitec," he adds.

"In just two years we were able to move from the feasibility phase to a mature product ready for industrialization and production ramp," says Bernard Aspar, general manager of Soitec's Tracit business unit (which provides thin-film layer transfer technologies used to manufacture substrates for power ICs and microsystems, as well as generic circuit transfer technology, Smart Stacking for applications such as image sensors and 3D integration). "This is an excellent example of how our core technologies can extend to new applications and markets, where there is always a need for more functionality at the substrate level."

www.psemi.com

Monocrystal launches 10-inch sapphire substrate

Monocrystal Inc of Stavropol, Russia, which provides sapphire products and metallization pastes to the semiconductor, optical, and photovoltaic industries, has announced the availability of its ultra-large 10-inch c-plane epi-ready sapphire substrate.

The LED industry continues to shift to larger-diameter substrates as it strives to achieve greater cost savings and to increase LED chip production throughput in order to bring LED lighting closer to widespread use, says Monocrystal. The firm says that it hence continues to develop next generation large-diameter sapphire wafer technology.

"The introduction of innovative 10-inch LED sapphire substrates clearly demonstrates that Monocrystal is well positioned to support the growing market demands and expand LED industry prospects," claims CEO Oleg Kachalov. "This further strengthens Monocrystal position," he adds.

Monocrystal's 10" c-plane epi-ready sapphire substrate.

Sapphire substrates are currently used for more than 90% of gallium nitride (GaN) LED chips produced, including high-brightness devices used for LED lighting products (as well as increasingly being adopted in applications such as mobile devices, displays, traffic lights, car lighting and interiors). Compared with conventional incandescent lamps, LEDs consume up to 90% less energy and have a life-span 50 times longer, says Monocrystal.

www.monocrystal.com

San Chih's revenue for sapphire ingots to overtake silicon wafers in second-half 2011

December's sapphire sales 10–15% of revenue after November start up

Analysts forecast that the revenues of Taiwan's San Chih Semiconductor Co Ltd from sapphire ingot production will exceed those from semiconductor wafers (silicon) in first-half 2011, reports Digitimes.

San Chih's sapphire ingot facility and equipment went online in fourth-quarter 2010 and began contributing to revenue in November. December's sales should rise to NT$7m (US$234,000), about 10–15% of overall monthly revenue.

San Chih will have installed 10 furnaces by the end of 2010 and plans to increase this to 15–20 in first-half 2011, bringing monthly capacity to 100,000mm, the firm indicates, adding that the facility could house maximum monthly capacity of 400,000mm when all production lines are online in first-quarter 2012.

San Chih mainly manufactures 2-, 4- and 5-inch semiconductor wafers, but it has also entered volume production of 6-inch wafers and is currently evaluating opportunities for producing 8-inch wafers. The firm forecasts revenue growth higher than the industry average for 2011 since fabs in Europe and the USA are outsourcing small- to medium-size wafer business as they place more emphasis on the large-diameter segment.

However, due to the higher margin of sapphire ingot business, San Chih's earnings per share (EPS) is expected to rise from NT$7–8 in 2010 to NT$12 in 2011, analysts note.

www.sanchih.com.tw/en
www.digitimes.com

Rubicon opens sapphire polishing facility in Malaysia

First plant outside US supports large-diameter demand

Rubicon Technology Inc of Bensenville, IL, USA, which makes monocrystalline sapphire substrates and products for the LED, RFIC, semiconductor and optical industries, has opened its first facility outside the USA. The plant in Penang, Malaysia will be responsible for labor-intensive crystal polishing processes, significantly expanding the firm's production capacity for large-diameter (6", 8" and 12") polished wafers.

As the only vertically integrated manufacturer of large-diameter sapphire wafers in large volumes, Rubicon supplies to LED makers worldwide. The Malaysia facility, combined with Rubicon's new 135,000ft^2 crystal growth facility in Batavia, IL which produced its first boule in early November (both leveraging large-diameter sapphire), have been established to deliver the sapphire capacity necessary to support the growing demand for LEDs in the consumer electronics and general lighting industries.

"Rubicon's recent build-out of infrastructure optimizes our ability to deliver large-diameter sapphire wafers in large volumes to our customers worldwide," says president & CEO Raja Parvez. "While the Batavia facility leverages the stability and lower cost of valuable resources such as power, the facility in Malaysia leverages the location to further lower costs and bring our extensive experience in polishing large-diameter wafers close to the LED, consumer electronics and general lighting manufacturers in Asia," he adds.

The facility in Malaysia leverages the location to further lower costs and bring our extensive experience in polishing large-diameter wafers close to the LED, consumer electronics and general lighting manufacturers in Asia

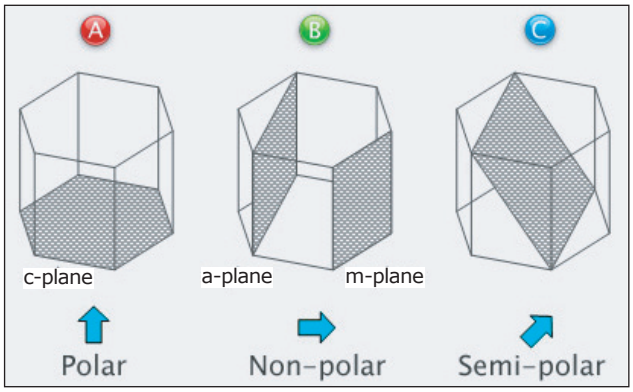
Market research firm iSuppli expects the global LED market to nearly double to almost $14.3bn by 2013, driven by the penetration of LEDs into the general illumination market (including light bulbs). LEDs are a popular option for backlighting screens from HDTVs, traffic lights and large displays as well as in a broad range of common consumer devices including tablets, notebooks, laptops, mobile phones, navigation devices, digital music players, digital photo frames, digital cameras and keypads, says Rubicon. LED usage in general lighting applications is also increasing significantly, particularly in applications like street lighting, industrial lighting and architectural lighting.

Rubicon claims that its expansion into Asia demonstrates its leadership in the production of high-quality, large-diameter sapphire wafers. The firm currently has the capability to produce polished sapphire wafers up to 12" in diameter. The transition to large-diameter wafers in LED production has started, it asserts. Earlier in 2010, Rubicon announced that it had entered into a $71m agreement with a major LED chip maker for which Rubicon will provide six-inch polished substrates.

www.rubicon-es2.com

LEDs on Ostendo/TDI's semi-polar GaN 2.5x brighter than c-plane LEDs

Ostendo Technologies Inc of Carlsbad, CA, USA (which develops solid-state lighting based display technologies and products for commercial and consumer markets) and Technologies and Devices International Inc (TDI, part of the UK's Oxford Instruments Group) say that LED structures grown on their semi-polar (11$\bar{2}$2) gallium nitride wafers have resulted in more than 2.5x the emission intensity of c-plane GaN-based LED structures (Strittmatter et al, 'Semi-polar nitride surfaces and heterostructures', Physica Status Solidi (b), October issue).



Schematic illustration of crystal orientations for (A) polar (c-plane), (B) non-polar (a-plane and m-plane) and (C) semi-polar nitride material for high-brightness LEDs.

In 2008, Ostendo and TDI entered into an Information Exchange Agreement with Xerox Corp subsidiary Palo Alto Research Center (PARC) to make semi-polar GaN wafers available on which PARC could grow LED and laser diode structures, and to independently validate and report the results achieved.

As part of their validation, PARC has grown a multi-quantum-well (MQW) LED structure on the semi-polar GaN side-by-side with a reference c-plane LED structure in the same MOCVD run. Some of the key results verify that: the LED structure grown on the semi-polar GaN achieved more than 2.5x more emission intensity than the reference LED structure grown on c-plane GaN; and the semi-polar GaN allowed higher indium (In) incorporation, resulting in a longer peak wavelength of ~25nm for the structure grown.

"This is an excellent validation of our work in the semi-polar GaN area for the last two and a half years as it verified the main advantage of our semi-polar GaN and should help encourage LED makers to start considering it for future LED brightness improvements," says Ostendo's Dr Hussein S. El Ghoroury.

"We are delighted that the production-grade, semi-polar GaN wafers produced at TDI, which are as a result of research funded by Ostendo, has generated such encouraging results," comments Frazer Anderson, business development director at Oxford Instruments. "This joint initiative with Ostendo and PARC meets our customers' needs through the advanced technology our companies have available," he adds.

In June, Ostendo and TDI announced the availability of a semi-polar (11$\bar{2}$2) GaN layer on sapphire substrate wafers using Ostendo's proprietary design together with TDI's proprietary hydride vapor phase epitaxy (HVPE) technology.

The firms says that this joint development now provides the opportunity to high-brightness light-emitting diode (HB-LED) and laser diode developers to increase optical efficiency significantly compared with structures grown on c-plane GaN substrates.

www.ostendo.com/gan
www.oxford-instruments.com
http://onlinelibrary.wiley.com/doi/10.1002/pssb.201046422/abstract

IN BRIEF

SETI 'highly commended' by IET's Innovation Awards for UVClean DUV LED lamp

Deep ultraviolet (UV) LED maker Sensor Electronic Technology Inc (SETI) of Columbia, SC, USA has been selected as a 'highly commended' innovative company by the Institution of Engineering and Technology (IET, Europe's largest professional engineering society) during its 2010 Innovation Awards.

This year, the IET received a record number of almost 400 nominations for the Innovation Awards, from which SETI was shortlisted to five entries in the category of 'Emerging Technologies' for the development of its UVClean deep UV LED lamps.

Based on the same technology as the firm's UVTOP products, SETI says that its UVClean lamps have been developed to provide a reliable, compact and environmentally friendly solid-state light source for healthy lifestyle products. Markets including water, air and surface disinfection have been identified, as well as phototherapy for treating conditions such as psoriasis, vitiligo and eczema. All of these markets require high-power lamps. SETI has standard UVClean products commercially available at powers of 1–3mW, 3-5mW, 10–15mW and 30–50mW.

UVClean lamps have already been designed into customer's disinfection products and SETI believes that, with the benefits delivered from LEDs, UVClean will become the industry standard for UV lamps in the healthy lifestyles market.

www.s-et.com

http://conferences.theiet.org/innovation-awards/category-emerging.htm

Lumileds enters mass production of GaN LEDs on 150mm wafers

3" production continuing during ramp-up

Philips Lumileds of San Jose, CA, USA claims to be the first power LED maker in mass production on 150mm wafers, producing millions of GaN-based LEDs weekly on them.

"Addition of 150mm manufacturing capacity to our existing capability leverages our epitaxy and wafer fabrication technology excellence and gives Lumileds the capacity to produce billions of LUXEON LEDs annually," says Matthijs Glastra, executive VP of worldwide operations. "The pace of LED adoption will require all other manufacturers to follow our lead and adopt similar strategies... Their challenge will be to achieve the high yields and quality levels that we have already demonstrated."

Each 150mm wafer produces four times the number of LEDs as the current 3" wafers. The transition to a larger size is critical to providing the increasing number of LEDs required by the lighting industry and ensuring a supportable and secure supply chain, says Lumileds.

Lumileds will continue its existing 3" wafer production while ramping up its 150mm capacity to meet increasing demand for high-quality, high-performance LEDs from the lighting, automotive, and consumer electronics segments.

Capacity expansion is a key driver in the adoption of LED technology, says the firm. The ability to add high-capacity epitaxial reactors with enhanced productivity and yield means it has a lower need for capital expenditure and can drive cost down as volume increases. "Some of the newer entrants to LED manufacturing require many more reactors to match our volume capacity," says Glastra.

Lumileds says that its engineers, scientists and system operators in San Jose and Singapore have installed, customized and optimized equipment to meet its production standards and ensure its processes deliver the light output, efficacy, reliability and quality expected.

www.philipslumileds.com

Crystal IS wins $5m DARPA award to develop efficient germicidal LEDs

Crystal IS Inc of Green Island, NY, USA, which makes UVC ultraviolet LEDs on aluminum nitride (AlN) substrates, has been awarded $5m by the US Defense Advanced Research Projects Agency (DARPA) to develop efficient LEDs operating at wavelengths below 275nm for use in water sterilization and other applications of interest to the Department of Defense.

"DARPA selected us for this award based upon the performance of our existing 265nm LEDs that leverage our proprietary AlN substrate technology," says CEO Dr Steven Berger. "With the tremendous help provided by DARPA, we believe we will accelerate the development cycle and bring bright, efficient, and long lifetime UVC LEDs to market sooner."

The program will run in parallel with a joint development with Japan's Asahi Kasei Corp announced in August to create a manufacturing process for large-diameter AlN substrates.

"To make the project as successful as possible we have assembled a group of expert collaborators," says Crystal IS' chief technology officer & founder Dr Leo Schowalter. "These include industrial and university partners and a cooperative research agreement with the Army Research Laboratory, administered by Dr Wraback."

www.crystal-is.com

Epistar expects 25–30% growth in 2011; plans $280m bond issue

$19.5m investment raises stake in China JV to 55%

After experiencing weakening demand and falling prices in fourth-quarter 2010, Taiwan's largest LED chipmaker Epistar Corp will resume its growth momentum in first-quarter 2011 in view of rising component re-stocking in China and South Korea, reckons analyst firm Primasia Securities Co according to a report in the Taipei Times. "We forecast the company's sales to grow by 25–30% year-on-year in 2011," the firm says in a client note.

After the increasing installation of new MOCVD reactors by companies in 2011 as well as a parity between supply and demand in the LED sector, Primasia forecasts that average selling prices (ASPs) for LEDs may drop by 10–15% in 2011. To offset this trend, Epistar aims to grow its sales of high-margin LEDs for TV and lighting application by 55–60% in 2011 (compared with growth of 40–45% in 2010), Primasia says. Previously, on 3 December, Epistar's VP of finance & accounting Rider Chang said that LED lighting accounts for about 20% of the firm's sales and backlighting about 50%.

Last month, JPMorgan said that Epistar is in the process of shifting its focus from TV backlights to lighting applications and is undertaking a rapid change in product mix in order to sustain growth in earnings.

Also, in a stock exchange filing on 23 December, Epistar announced that its board has approved a plan to issue (over the next two years) zero-interest five-year euro convertible bonds (ECBs) worth US$280m, mainly for paying back previous US dollar-based loans and for future equipment purchases.

In particular, Epistar is investing an extra US$19.5m in United LED Shan Dong Corp, the joint venture established in China's Shandong Province last March with Taiwan's second largest silicon wafer foundry United Microelectronics Corp (UMC, which has a 15% stake in Epistar). Epistar's investment in the joint venture will hence total US$27.5m (after the two partners initially invested US$8m each), boosting its stake from 50% to 55%.

Despite worries of over-supply in the LED industry in 2011, Epistar says that short-term changes in terms of seasonality and supply–demand issues are hard to avoid, and it remains optimistic about future potential LED market growth (particularly due to continued growing demand for LED lighting), according to a report in Digitimes. The firm believes it should start funding capacity expansion for future demand, so that it will have enough capacity to handle orders when they arise.

www.epistar.com.tw
www.unitedled.cn
www.taipeitimes.com/News/biz/archives/2010/12/25/2003491794/1
www.digitimes.com

Taiwan's Lextar produces 6-inch LED epiwafers

Epistar to start small-scale 6-inch production in mid-2011

Lextar Electronics Corp of Hsinchu Science Park, Taiwan, a subsidiary of display panel maker AU Optronics (AUO) that manufactures high-brightness LED epiwafers, chips and packages, has produced its first 6-inch LED epitaxial wafer, while LED epiwafer & chipmaker Epistar Corp is expected to adopt 6-inch wafers in its production process in mid-2011, reports Digitimes.

Some industry players note that costs for 6-inch wafer production remains high, and mass production may not yet be economical. However, Lextar says that, by using new-generation equipment with special focus exposure and grinding technologies, it has been able to overcome problems such as warping or cracking in the 6-inch production process. Nevertheless, the firm expects to start mass production on 6-inch wafers only in second-half 2011.

Chairman David Su noted previously that Lextar will set up a 6-inch production plant at the end of 2011, as most LED players in Europe and Japan have already started to adopt 6-inch production equipment, while Korea-based LED makers are also focusing on expanding 6-inch equipment, and only Taiwan still remains at 2-inch production.

The number of MOCVD reactors at Lextar reached 50 at the end of third-quarter 2010, and was expected to rise to 70–80 at the end of the year (mainly 4-inch models), as the firm aims to become the largest production base for 4-inch wafers in Taiwan.

Epistar says that currently 50% of its capacity is from 4-inch equipment, but it is scheduled to start small-volume production on 6-inch equipment in mid-2011. However, the time-frame for mass production on 6-inch wafers remains unclear due to issues such as yields and the high cost of 6-inch sapphire substrates, says Digitimes.

www.lextar.com
www.epistar.com.tw
www.digitimes.com

LED chip demand for TV backlighting to return to first-half 2010 levels in February

Forepi MOCVD reactors to rise to from 56 to 126 in 2011

Taiwan-based LED chipmaker Formosa Epitaxy (Forepi) expects LED chip demand to return to the levels of first-half 2010 in February and March 2011 (including volume shipments for applications in tablet PCs beginning in February), according to chairman Chien Fen-ren reported in Digitimes. He adds that the firm could post record sales in second-quarter 2011.

Forepi will register NT$4.5bn (US$150.56m) in revenue for 2010 (up 120% on 2009), while growth of 50% is projected for 2011, market analysts indicate. TV backlight, lighting and tablet PC applications should account for 60%, 15% and 15% of sales, respectively.

Chien notes that Japan's Nichia and Toyoda Gosei are the LED chip suppliers for Apple's tablet PC. However, other tablet vendors such as Samsung Electronics and LG Electronics could begin sourcing from LED chipmakers in Taiwan, which should be boost gross margin.

With LED TV market penetration expected to rise significantly in 2011 due to falling prices, Chien expects gross margin for the sector to take a hit, but to still be maintained at 30–35% in 2011 due to new applications such as the tablet PC.

In fourth-quarter 2010, Forepi should ship 10–20 million LEDs for pico projectors, amounting to 2–3% of its quarterly revenue although average selling price (ASP) is 6–7 times higher than conventional chips, Chien says.

Forepi's Taiwan facilities are equipped with 56 MOCVD reactors, capable of producing 12 million epitaxial wafers per month. By the end of 2011, capacity should rise to 15–20 million wafers per month.

In 2011, with projected capital expenditure totalling NT$4–5bn, Forepi's total number of MOCVD reactors in Taiwan and China combined should rise to 126.

Forepi has also inaugurated its Jiangsu Canyang Corp LED chip subsidiary in Jiangsu, China, in which LG Display, Amtran, Unity Opto and Wooree are major investors. Its revenue for 2011 is projected to be CNY300–500m (US$44.95–74.92m) and it could become China's largest epiwafer maker in 2012 when it completes the installation of 50 MOCVD reactors.

www.forepi.com.tw
www.digitimes.com

Tablet PCs to drive high-end chip shortage in February

Forepi to spend $150m in 2011, targeting 50% sales growth

Due to the rise of tablet PCs, the supply of high-end LED chips is likely to fall short of demand, starting February 2011 at the earliest, forecasts Frank Chien, chairman of Taiwanese LED maker Formosa Epitaxy Inc (Forepi), according to a report in Taiwan Economic News.

Tablet PCs have quickly emerged as one of the most stellar products in the global market. Like LCD TVs and monitors, they mainly use LEDs as the light source for backlights, and Chien confirms that Forepi started delivering LEDs for tablet PCs in October.

In addition to Apple's hot-selling iPad, which uses LEDs made by Japan's Nichia Corp and Toyoda Gosei, many tablets developed by other global PC vendors are scheduled for launch from early 2011, most of which use Taiwan-made LEDs in their backlights, says Chien. It hence makes sense that shortages of LED chips, especially higher-end models, are very likely to loom then and linger throughout the year, he adds.

Aware of the possible LED shortage, some display panel makers have moved to secure their sources of supply. For example, Korea's LG Display has joined with Forepi and Taiwanese TV maker Amtran Technology Co Ltd to form the LED-making joint venture Jiangsu Canyang Corp in China. The collaboration will not only help LG Display to secure a stable supply of LEDs, but should also provide additional momentum to Forepi's business growth, Chien says.

In the meantime, Amtran is concerned about LED shortages in 2011, and has stated that, with selling prices falling, LED-backlit LCD TVs will replace traditional CCFL (cold-cathode fluorescent lamp) TVs more quickly in the coming years and, consequently, use a large part of the limited supply of LEDs in the future. This implies that demand for LEDs will skyrocket, along with more LED-backlit devices being put on product shelves worldwide.

To capitalize on the market boom, Forepi plans to add 15–20 MOCVD reactors for its Taiwan factory, and 25 for the LG Display–Amtran– Forepi joint venture. Currently, 60% of Forepi's LED output goes to usage in TVs, 15% each to tablets and LED lighting, and 10% to projectors and other devices. The firm aims to increase its capital equipment budget to NT$4–5bn (about US$150m) in 2011, targeting annual revenue of NT$7bn, or US$234m (up more than 50% on 2010's NT$4.5bn, or US$150m).

http://news.cens.com/cens/html/en/news/news_inner_34683.html

Mitsui to become Forepi's largest shareholder, taking 15% stake

Japanese industrial conglomerate Mitsui & Co (which has businesses involving the monitor and automobile industries) is to become the largest shareholder in Taiwan's second-biggest LED epitaxy and chip maker Formosa Epitaxy Inc by taking a 15% stake through private placement, reports Digitimes.

At a price of NT$36.44 per share, Mitsui is investing NT$2.7bn to buy 74.693 million shares, while Taiwanese LED packaging house Unity Opto Technology Co Ltd is raising its stake by buying 15.307 million shares for NT$0.558bn. The Taiwan Economic News says that the investment will help Unity to secure a steady source of LED chips for its backlight packages used in applications including TVs, computer monitors and tablet PCs. The firm has also begun introducing LED packages for general lighting.

Forepi will raise about NT$3.2bn (about US$107m) of funding in total. This is different from fellow chipmaker Epistar, which is focusing mostly on expanding capacity, it is said. Forepi continues to expand its development vertically and increase export demand.

Based on the roadmaps of Forepi and Mitsui, the investment will focus in the short-term on LEDs for monitor and TV back-lighting, in the mid-term on the lighting market, and in the long-term on the automobile market. The cooperation with Mitsui will focus on the Chinese and Japanese markets.

Forepi also expects to attract more strategic partners thought its cooperation with Mitsui.

www.forepi.com.tw
http://news.cens.com/cens/html/en/news/news_inner_34736.html
www.digitimes.com

IN BRIEF

Tekcore signs syndicated loan

LED chipmaker Tekcore has signed a NT$3.8bn (US$124.53m) syndicated loan with a banking consortium. The funds will be used to build a new plant and to purchase equipment.

Buoyed by shipments of high-margin blue LED chips, Tekcore has seen revenue grow boom in 2010, with profit generated in the first three quarters more than doubling year-on-year.

Tekcore expects global shipments of LED TVs to exceed 100 million units in 2011. This penetration rate of 51% in the LCD TV market should reach 87% in 2014.

Tekcore expected its monthly revenues in fourth-quarter 2010 to average about NT$200m.

www.tekcore.com.tw
www.digitimes.com

Tyntek to add 10–15 MOCVD reactors in Q2–Q3/2011

Subsidiary Alpha Plus could reach capacity of 30 reactors this year

Taiwan-based LED packaging firm Tyntek Corp plans to raise its capacity for LED epitaxy and chip production, according to Digitimes.

The firm's epiwafer subsidiary Alpha Plus Epi Inc currently has seven metal-oxide chemical vapor deposition (MOCVD) reactors at its plant in Taichung Industrial Park and has begun test production. Full production is scheduled for first-quarter 2011, when monthly revenue should be about NT$50m (US$1.6m).

In addition, Tyntek now plans to invest US$30m for Alpha Plus to install 10–15 more MOCVD reactors in the second and third quarters of 2011. A second phase of expansion starting in second-half 2011 (depending on market conditions) could increase the total towards the plant's maximum capacity of 30 reactors.

Also previously, in October, Tyntek announced plans to invest RMB153m (US$23m) to establish an LED joint venture with the Fuzhou city government in mainland China. Total investment will be RMB353m (US$53m). First-phase development will focus on LED epitaxy and chip production, with plans to install 30 MOCVD reactors and to start epiwafer production by fourth-quarter 2011. The second phase will install LED chip packaging equipment, targeting the backlighting and general public lighting markets in China.

A second phase of expansion starting in second-half 2011 (depending on market conditions) could increase the total towards the plant's maximum capacity of 30 reactors

Tyntek only recently branched out into chip making. According to the Taiwan Economic News, the firm established Alpha Plus after failing to agree a merger with epiwafer maker Ubilux Optoelectronics Corp of Southern Taiwan Science Park, which was founded in September 2007 as a subsidiary of Taiwanese DRAM chip-maker PowerChip Semiconductor Corp (PSC). With plans to produce blue, red and green LED chips as well as sensor devices, Tyntek is competing against fellow Taiwanese LED makers Epistar Corp, Formosa Epitaxy Inc, Genesis Photonics Inc and Tekcore Co.

www.tyntek.com.tw
http://cens.com/cens/html/en/news/news_inner_34757.html
www.digitimes.com

Optogan opens largest LED plant in Eastern Europe

First production line has annual capacity of 360 million LEDs

Sergey Ivanov, deputy Prime Minister of the Russian Federation, has officially opened the new manufacturing plant in St Petersburg of LED maker Optogan Group.

The ceremony was also attended by St Petersburg's Governor Valentina Matvienko; Yegor Borisov, President of Russia's Sakha Republic (Yakutiya); Anatoliy Chubais, general director of Rusnanotech; Mikhail Prokhorov, president of ONEXIM Group, as well as representatives from politics, research and industry.

Optogan's unique chip production technology was created by Vladislav Bougrov and Maxim Odnoblyudov, who were PhD students of Nobel prize winner and Russian Academy of Science member Zhores Alferov at the Ioffe Physico-Technical Institute in St Petersburg in the 1990s before working at Finland's Helsinki University of Technology then, in late 2004 (together with Alexey Kovsh), founding OptoGAN in Helsinki to develop GaN-based LEDs.

Optogan is now a vertically integrated manufacturer of high-brightness LED chips, components, lamps and luminaires. In addition to Optogan Group having locations in Helsinki, since 2005 Optogan GmbH in Germany has been developing chip technologies in Dortmund and has a chip production facility in Landshut. In July 2009, Optogan began operations in Russia. This May, it acquired the industrial facility and infrastructure of Elcoteq in St Petersburg, where it has been setting up LED production lines.

At the St Petersburg plant's opening, Odnoblyudov, Bougrov and Kovsh introduced the production facilities, as well as demonstrating Optogan's LED lamps.

With an overall investment of 3.35bn rubles (€80m), the new facility is the largest LED component and module manufacturing plant in Eastern Europe and the Commonwealth of Independent States (CIS), covering 15,000m^2 of floor space (including 5000m^2 of cleanroom). The first production line has an annual capacity of 360 million LEDs (30 million per month), and further capacity extensions are scheduled for the end of 2011. Staffing will be up to 800.

Optogan's new LED component and module factory in St Petersburg.

"LEDs produced in St Petersburg will be sold in Russia and abroad," says Vladislav Bougrov, general director of the plant. "We've already signed our first major contracts," he adds.

"Part of the LED shipments will be sent to our partner companies all over Russia to produce luminaries," notes Optogan's executive VP Alexey Kovsh. Optogan says that it has established a unique business model to supply core LED technology for luminaires and to support to an extensive network of partners within Russia. In future the luminaire business partner approach will be extended to global level, Kovsh adds.

In contrast to the trend to establish new LED production plants solely in the Far East, Optogan reckons that it has found a suitable legislative and infrastructure environment to establish high-tech manufacturing in Russia, enabling high-volume LED output at competitive cost. RUSNANO (the Russian Corporation of Nanotechnologies) — a fund providing investment for technology projects in the Russian Federation — has provided support for the firm and is one of its major shareholders. "The key goal of RUSNANO is to develop modern production facilities based on leading international scientific knowledge, ensuring they can compete globally," says RUSNANO's general director Anatoly Chubais. "The opening of Optogan's factory is one of the major synergies of science and business. Technology based on the work of Nobel prize winner Zhores Alferov has been transformed into mass production, making this a first step in the development of a new energy-efficient economy and development of the lighting industry in Russia."

Optogan's new high-volume LED assembly lines.

In late 2008, OptoGAN was acquired by ONEXIM, a private investment fund founded by Mikhail Prokhorov in May 2007 that invests in metals & mining, power engineering, including hydrogen power engineering and nanotechnologies as well as in financial services, mass media and real-estate industries. "ONEXIM's strategy is to invest in these types of innovative companies, which can produce quality products and win a major market share in Russia, as well as the potential to grow globally," says Mikhail Prokorov, president of main shareholder ONEXIM Group. "We are sure that, thanks to this type of production, our country has all the opportunities to develop on the global market."

www.optogan.com

Great Wall Kaifa, Epistar, Evertop & Country Lighting form KFES Lighting

Xiamen-based JV to install 30 MOCVD tools

Agreement has been reached to form a joint venture named KFES Lighting Co Ltd in Xiamen, Fujian province, China, to be owned 44% by Great Wall Technology Co Ltd subsidiary Shenzhen Kaifa Technology Co Ltd (Great Wall Kaifa), 40% by Epistar JV Holding (BVI) Co Ltd, 9% by Evertop (Fujian) Optoelectronics Co Ltd and 7% by Country Lighting (BVI) Co Ltd.

Capital injections of $52.8m, $48m, $10.8m and $8.4m respectively (each in two stages in cash) amount to registered capital of $120m ($80m in the first stage; $40m in the second stage). Total investment will be $160m. The final name of the limited liability company is subject to approval by the relevant government authorities.

KFES Lighting's board will consist of seven directors: three appointed by Great Wall Kaifa, two by Epistar, and one each by Evertop and Country Lighting. The chairman and vice-chairman of the board will be appointed by Great Wall Kaifa and Epistar, respectively. The chairman will also be the legal representative of the JV.

All JV partners are based in China, except for Country Lighting (BVI) and Epistar JV Holding (BVI), which are investment holding companies incorporated in the British Virgin Islands. Taiwan-based parent firm Epistar Corp makes LED epiwafers and chips. Evertop designs and makes LED-related components and modules (as well as providing after-sales services). Great Wall Technology develops and provides personal computers and information terminal products, storage products, power supply products, monitoring terminal, LCD TV products and EMS business. Great Wall Kaifa (which is listed on the Shenzhen Stock Exchange) manufactures HDD magnetic heads, remote control meters, tax-control products, memory modules, video heads and automation equipment.

KFES Lighting's scope will include the research, manufacture and sale of LED wafers, chips, light sources, light source modules and LED lighting, as well as the provision of after-sales services.

The investors have also entered into an agreement with the management committee of Xiamen Torch Hi-Tech Industrial Development Zone to establish the JV there. Support to be provided by Xiamen Torch Hi-Tech Industrial Development Zone includes preferential tax treatment and subsidies for the purchase of MOCVD equipment for manufacturing LEDs.

The LED wafers and chips will be used mainly for products made by the JV as well as satisfying the internal demand of Great Wall Kaifa and Evertop (and their respective strategic partners), which will be given priority in purchasing the JV's products. In the case that the JV out-sources LED chip packaging, light sources or light source modules, it will first purchase them from the JV partners and their associates (provided that the terms are reasonable under the prevalent market conditions).

Great Wall Kaifa says that, in view of the great prospects for LED products, its board of directors intends to eventually increase the registered capital and total investment in the JV to $240m and $490m, respectively, after completion of the installation of the first 30 MOCVD reactors. Such an increase in capital contribution and its timing will depend on the market situation and will be carried out pursuant to the relevant authorization and approval procedures.

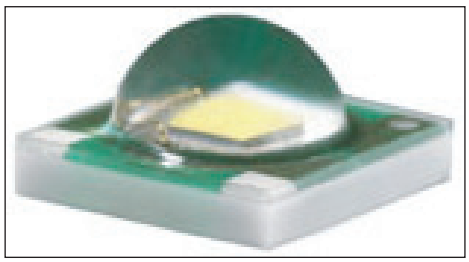
www.hkexnews.hk/listedco/listconews/sehk/20101227/LTN20101227003.pdf

Cree launches High-Efficiency White LED to cut initial lighting fixture cost

LED chip, lamp and lighting fixture maker Cree Inc of Durham, NC, USA has announced commercial availability of XLamp XP-E High Efficiency White (HEW) LEDs. The new high-efficiency components extend the light output and efficacy of the XLamp XP-E LED family, enabling fixture designs that can use up to 50% fewer LEDs, which can help drive down costs for fixture and bulb manufacturers while delivering the same system performance, says Cree.

XP-E HEW LEDs are optimized to lower initial costs for diffuse lighting applications, such as LED replacement lamps and downlights (e.g. an A-19 lamp that uses XP-E LEDs could be re-designed to use half as many XP-E HEW LEDs while maintaining the same efficacy).

"One of the major barriers to LED lighting adoption and design remains upfront cost," says Paul Thieken, director of marketing, LED components. "By enabling designers to use brighter, precisely optimized LEDs for each particular application, Cree is helping lower costs and further simplifying and shortening the LED fixture design cycle," he adds.



Cree's XLamp XP-E white LED.

XP-E HEW LEDs are the first high-power LEDs featuring Cree's new Direct Attach LED chip technology, which delivers higher flux, lower forward voltage, and lower thermal resistance. "With 500% more die-attach area and an order-of-magnitude less die under-fill, Direct Attach technology is far more robust than any other LED flip chip technology in the market," claims John Edmond, director of advanced optoelectronics. "These attributes, combined with the performance advantages of Direct Attach technology, can translate to brighter, more reliable lamps and fixtures, developed at a lower cost."

XP-E HEW LEDs deliver up to 148 lumens in cool white (6500K) and 114 lumens in warm white (3000K) at 350mA. In addition to light output and efficacy improvements, they have a reduced thermal resistance of 6°C/W. XP-E HEW LEDs are available in the same white variations as XP-E LEDs, including Standard White, Outdoor White and 80-CRI White.

The new LEDs are available now in sample and production quantities with standard lead times. IES LM-80 data for measuring lumen maintenance of LED light sources, for XP-E HEW LEDs, is targeted for availability in February.

IN BRIEF

First all-LED Habitat home complete

Habitat for Humanity's first house lit entirely with LED fixtures and bulbs has been completed. Cree sponsored construction and its staff helped as volunteers.

Sited in Durham, the house includes Cree's CR6 downlight, and other products from MSi and TESS featuring its LEDs.

As well as the local partnership with Habitat Durham, in May Cree announced a three-year, $1.5m pledge to provide LED downlights for all new Habitat homes built in the USA.

"We thank Cree and its employees for their dedication to supporting and building this house," says Miguel Rubiera, executive director of Habitat for Humanity of Durham.

www.habitat.org

Cree launches first lighting-class LED arrays

Cree has launched what it claims is the industry's first lighting-class LED array.

The XLamp CXA20 LED array is the first lighting-class array aimed at accelerating the LED lighting revolution and can enable a 60W A-lamp equivalent while consuming just 11W, it is claimed.

"They combined lighting-class performance, unequaled in the market, with an ease-of-use that will enable us to quickly develop both our new A19 lamp and downlight products," comments PK Li, director of product development at OPTILED Lighting International Ltd.

With a single, uniform optical source, compact 22mm x 22mm footprint, and simple two-screw attachment, the CXA20 array can simplify the manufacturing process for users requiring a single component in their light-engine design, says Cree. When used in a traditional downlight application, luminaires based on the CXA20 are delivering 38% more illumination than a 26W compact fluorescent lamp (CFL) or a 100W incandescent bulb, while consuming just 14W, the firm adds.

"Cree continues to bring the broadest family of lighting-class LEDs to market, ensuring that lighting applications have optimized LED light sources," says Norbert Hiller, Cree's VP & general manager, LED Components.

The CXA20 LED array delivers 1050lm at 11W, or 2000lm at 27W, with a 3000K warm-white color temperature. Samples are available now with standard lead times, with production volumes targeted for late first-quarter 2011.

www.cree.com

SemiLEDs' IPO to fund 6" LED wafer development

In its initial public offering of stock on the NASDAQ Global Select Market on 9 December, LED chip and component maker SemiLEDs Corp of Boise, ID, USA (which fabricates chips in Hsinchu Science Park, Taiwan) sold 5.25 million shares at $17 each (above the planned $14.50–16.50). This raised $89.25m (9.7% more than the expected $81.4m). Net proceeds were about $79m.

The underwriters' over-allotment option for an extra 787,500 shares takes total net proceeds to $91.4m.

Founded in 2005, SemiLEDs' proprietary blue, green and UV 'metal vertical photon' (MvpLED) chip design has a vertical LED structure on a patented copper alloy base (after sapphire substrate removal) that gives what is claimed to be the best thermal resistance on the market (0.4°C/W) — allowing better heat removal than retaining the substrate — as well as electrical and optical advantages such as greater luminous efficacy (over 120lm/W) and longer lumen maintenance. Also, sapphire reclaim allows reductions in both manufacturing cost and the dependence on sapphire (for which the current short supply increases cost). The firm also believes that its technology will aid its migration to larger (6") wafer sizes.

SemiLEDs makes LED chips mainly for packagers in Asia (China, Taiwan) or distributors selling to packagers. It also packages some chips into LED components for sale to distributors and end-customers in select markets (mainly for general lighting, including street lights and commercial, industrial and residential lighting).

For fiscal 2010 (to end August), profit was $10.8m on revenue of $35.8m, more than tripling from fiscal 2009's $11.6m (which made a loss of $3.7m). Gross margin grew from just 4.6% to 45.1%.

IPO proceeds will be used for expanding production capacity in Taiwan, R&D expenses related to chip production based on 6" wafers, and general corporate purposes (working capital and capital expenditures). The firm is already building extra capacity via a chip-making joint-venture China SemiLEDs (Xurui Guangdian Co Ltd) formed in January in Foshan, Guangdong Province (paying $14.7m for a 49% stake). Manufacturing facilities should be operational after January.

SemiLEDs may also acquire or invest in complementary technologies, solutions or businesses (or obtain rights to them).

To mark the IPO, on 10 December, SemiLEDs' chairman & CEO Trung T. Doan visited the NASDAQ MarketSite in Times Square and presided over the opening bell. SemiLEDs' stock opened for trading under the symbol 'LEDS' at a price of $24.01 (41% over the IPO price of $17).

www.semileds.com

Osram doubles green LED brightness for office projectors

Market launch targeted for summer

Osram Opto Semiconductors GmbH of Regensburg, Germany says that the prototype of a green LED based on its OSTAR platform is twice as bright as its predecessors and has a luminous surface that is perfectly uniform.

The single-chip LED benefits from the latest chip technology and a green phosphor converter. Initial samples are available, and finding partners to develop appropriate LED office projectors is under way. Osram expects the LED to be launched on the market in summer.

Now that RGB LEDs have conquered the market for pico projectors, the next segment in sight is that of office projectors, says Osram Opto. This has been enabled by the enormous increase in brightness of green LEDs. The prototype with a single chip achieves luminous flux of 410lm and emits at a wavelength of 553nm.

Since a greater proportion of green than red or blue is needed in a projector to produce white light, the increase in brightness of the green LED has a significant effect on the overall system brightness. With these LED prototypes it is possible to produce systems that provide the system brightness of 2000lm that is needed for office projectors, reckons Osram Opto. LED projectors will therefore be powerful enough for large diagonals of more than 2m. Such applications have previously only been possible with projectors that use conventional light sources such as high-intensity discharge (HID) lamps.

OSRAM LEDs target office projectors.

"Doubling the brightness of the green LED is a giant leap forward and removes the restriction that LEDs are suitable only for small projectors," says Volker Mertens, director Marketing Industry at Osram Opto. Apart from providing brilliant image reproduction with saturated colors, LEDs enable projectors to be virtually maintenance-free because they have a life of 30,000 hours. By contrast, high-intensity discharge lamps need to be replaced after only about 400 hours. Projectors with LEDs also respond more quickly to on/off switching, and support stepless dimming. They can therefore adapt very easily to ambient light conditions and reduce energy consumption. The color space can be set with a high degree of flexibility thanks to electronic control of the individual colors.

Due to new high-brightness green LEDs, future projectors will be able to produce images with diagonals of several meters, reckons Osram Opto. The projected images themselves will appear brighter for the same lumen value than those produced by conventional light sources thanks to the saturated colors of the LEDs used, the firm adds.

www.osram-os.com

Wavien and Osram to co-develop recycling RGB LEDs for projection

Wavien Inc of Valencia, CA, USA is collaborating with Osram Opto Semiconductors to develop red-green-blue (RGB) LEDs for projection applications. The joint effort aims to combine Osram's LED technology with Wavien's proprietary LED recycling (RLT) to provide low-cost, high-output LED solutions for pocket projectors and pico-projectors small enough to be integrated into cell phones.

Wavien's RLT technology recaptures light lost in standard optical systems and recycles it back to the system output, transforming it back into usable light. An output improvement as high as 100% can be achieved, it is claimed.

Besides providing greatly enhanced screen brightness, the unique recycling technology extends battery life for portable systems, and reduces the heat load for ease of cooling, Wavien adds.

This performance improvement is provided by either adding a simple reflector with an aperture to standard LED packages or by adding a unique imaging light pipe with an aperture. The dimensions of the apertures, which determine the amount of recycling, and the total size of the reflector or light pipe can be scaled to meet the user's needs.

"Wavien's LED light recycling technology offers outstanding brightness by recovering and recycling high-angle light from the LED that is normally wasted with traditional LED coupling systems," states Wavien's president & CEO Dr Kenneth Li, who is also the inventor of the recycling technology. "This unique design enables LED-based projectors to have increased total brightness by up to 100%," he adds. "With such improvements in cost and performance, projectors will be used in locations that were previously not feasible."

www.wavien.com

Osram Opto launches TOPLED Compact with expanded color space coverage for LCD backlighting

After adapting its TOPLED packaging technology to the special needs of backlighting applications, Osram Opto Semiconductors GmbH of Regensburg, Germany has launched the TOPLED Compact 5630 LED which, the firm says, can enhance monitor and TV screens of all sizes. The 5630 is the second product in the TOPLED Compact family, joining the existing TOPLED Compact 4520.

Two new versions of the 5630 are available with different coverage of the color space (according to the sRGB standard) to meet various requirements.

The ultra-white version has a luminous efficiency of 76lm/W at an operating current of 120mA. Color space coverage is up to 100% sRGB, depending on the color filters used in the display. A specially optimized phosphor is used as conversion material to ensure high stability of the white point over time and across a wide temperature range. Also, a multi-white version achieves 67lm/W for the same operating current and covers up to 120% of the sRGB color space. Both versions measure just 5.6mm x 3.0mm x 0.9mm in size and offer uniformly high quality in the product and in the application, says Osram Opto.

"Televisions backlit by LEDs offer brilliant colors and high contrast," says Winfried Schwedler, marketing manager, Consumer Applications, at Osram Opto. "The TOPLED Compact provides superb color space coverage, and its high white-point stability ensures that colors remain consistent over its operating lifetime," she adds. "The multi-white TOPLED in particular exhibits a linear response that sets new standards."

The ultra-white version offers 13% higher efficiency, so fewer LEDs are required for screen backlighting units to achieve comparable brightness.

Osram Opto says that both TOPLED Compact 5630 LEDs make it easy for monitor and TV manufacturers to meet strict energy consumption standards of Energy Star 2010/2012 and EuP Class A 2010/2012.

The new LEDs are flat-encapsulated, have no integrated lens, and provide high efficiency for injection into light guides, says Osram Opto.

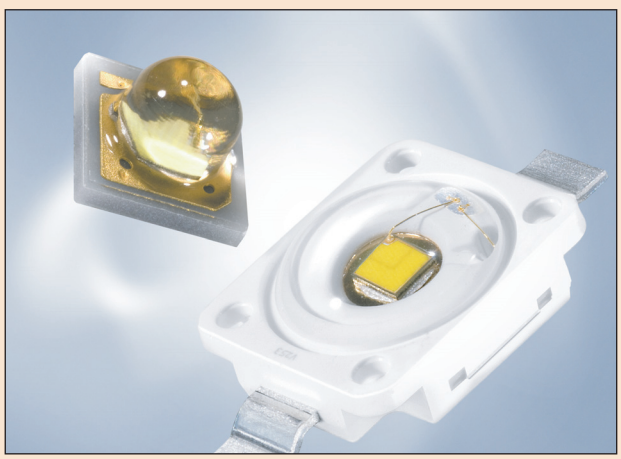
www.osram-os.com

LM-80 reports released for OSLON SSL and Golden DRAGON Plus

Osram Opto Semiconductors says that it is one of the first firms to have met the criteria of the LM-80 (lumen maintenance) test requirements with two different product families: the ceramic OSLON SSL and the Golden DRAGON Plus premold families of high-power LEDs.

For LED lamp, light engine and luminaire manufacturers to receive an Energy Star certificate for their products, the US Environmental Protection Agency (EPA) requires that the LEDs used in such products must comply with LM-80 test requirements. LM-80 test reports provide evidence that the LED component can be assessed and compared across all LED makers.

Inaugurated by the Illuminating Engineering Society (IESNA), the LM-80 test offers luminaire manufacturers a means of comparing the performance of LEDs from different suppliers based on reliable and comparable data. Successful completion of the LM-80 test is an essential step toward receiving an Energy Star certificate from the EPA.



Both the OSLON SSL (left, with ceramic package) and Golden DRAGON Plus (right, with premold package) have completed the LM-80 test.

LM-80's aim is to demonstrate, in an abbreviated test of 6000 hours (about 9 months), a consistent industry method of measuring lumen maintenance of solid-state lighting (SSL) sources, such as LED packages, arrays and modules. LM-80 specifies that LEDs are tested at three different temperatures to assure performance in various conditions. In addition to the two pre-defined temperatures of 55°C and 85°C, Osram has used a third temperature of 105°C to simulate the requirements of highly demanding applications.

"Other products are already in the test phase, so in the near future all our high-power LEDs for general lighting will comply with LM-80 testing requirements," says Artur Groesbrink, who is responsible for standardization at Osram Opto. "Luminaire manufacturers will then have an important platform for Energy Star certification by the EPA," he adds. "The Energy Star certification is essential if companies want to market their products successful in the US."

www.osram-os.com/standardization

IN BRIEF

Luminus' LEDs light live HDTV stage set

Luminus Devices Inc of Billerica, MA, USA, which develops and manufactures large-chip PhlatLight (photonic lattice) LEDs for illumination applications, says that its CBM-380-RGBW product used inside VARI*LITE VLX Wash Luminaires are lighting the stage for NBC's TV program 'America's Got Talent'.

"I am constantly evaluating new products to improve my shows and LEDs are the future in many industries, including entertainment," says Kieran Healy, lighting designer for America's Got Talent. "Unfortunately, my experience until now with LED lighting demonstrated it was not ready for primetime TV," he adds. "However, by incorporating the Luminus big-chip LEDs into the VLX Wash Luminaire, the entertainment industry now has remarkable, next-generation lighting."

Containing seven CBM-380-RGBW LEDs, the VLX Wash Luminaire delivers total light output of 14,000 white lumens with an LED lifetime of more than 10,000 hours at maximum output.

"It's gratifying to see the continued validation of the groundbreaking design from leading lighting designers and industry awards," says Don McDaniel, director, global entertainment, at Luminus. "VLX Wash Luminaires with Luminus' big-chip LEDs provide Healy and other lighting designers with color uniformity and beam control not previously available with solid-state lighting technology," he claims.

"I love the beautiful range of rich color that the VLX produces with the LEDs from Luminus," Healy adds. "It has a great flat field which is very important for TV."

www.vari-lite.com
www.luminus.com

Osram Opto Semiconductors team receives Beckurts Prize for developing direct green-emitting laser

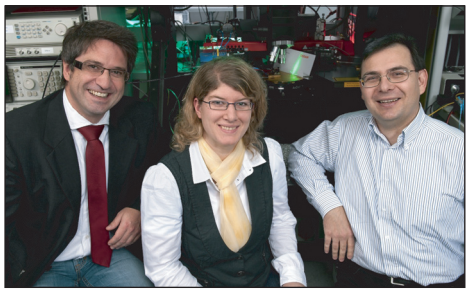
The annual Beckurts Prize of the Karl Heinz Beckurts Foundation — honoring outstanding scientific and technical achievements giving rise to discernible impetus for industrial innovations in Germany — has been awarded to Osram Opto Semiconductors GmbH of Regensburg, Germany for "pioneering work in researching direct green semiconductor lasers" (which can open up new markets such as ultra-compact mobile RGB laser projectors, says Osram Opto).

The availability of very small and low-cost red, blue and green semiconductor lasers is crucial for large-scale diffusion of RGB laser projection, says the firm. The laser diodes enable the production of low-cost, compact and efficient pico-projectors, which can be incorporated into mobile devices such as smart-phones or digital cameras. Due to the beam properties of lasers, the projectors have unlimited depth of sharpness and extremely high resolution, beyond that of LED solutions, adds Osram Opto. Also, the low spectral bandwidth of semiconductor lasers enables life-like display of colors plus sharp contrast.

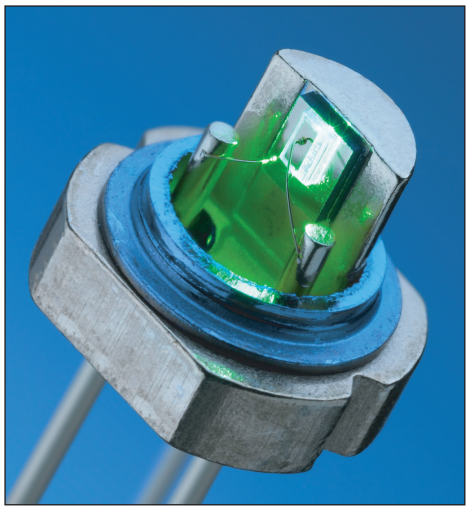
The firm only started developing direct blue laser diodes for RGB laser projection in 2006. These are now being used in the first devices on the market. Based on the findings for the blue laser using the indium gallium nitride (InGaN) material system, the team managed within a short time to achieve emission at green wavelengths beyond 500nm. In 2009, it achieved optical output power of more than 50mW from a direct green laser diode emitting at a wavelength of more than 515nm.

The development of blue and green laser diodes and research into the miniaturization of systems in mobile laser projection is supported by the project MOLAS (technologies for ultra-compact and mobile laser projection systems) as part of the 'Optical components and systems for volume markets' funding initiative of the German Federal Ministry of Education and Research. Osram also works on nitride lasers in collaboration with several German universities and research institutes (Désirée Queren, for example, wrote her dissertation based on a collaboration with the University of Erlangen). The foundation for the results with the semiconductor lasers was laid as early as 1998 through development work with ultraviolet (UV) lasers, in particular in the project 'Blue laser based on GaN for innovative storage systems'.

www.osram-os.com



Prize winners (left to right) Stephan Lutgen, Désirée Queren and Adrian Avramescu of Osram Opto.



Osram Opto's direct green laser diode.

Soraa demos green lasers for >20lm pico projectors with minimal speckle

UCSB spin-off displays green and blue lasers at CES

Soraa Inc (formerly Kaai Inc) of Goleta CA, USA, which is commercializing green and blue laser diodes, says it has demonstrated green laser diodes (LDs) suitable for >20 lumen pico projectors. The direct-emitting green lasers have produced images that exhibit much reduced speckle compared with conventional green lasers based on second-harmonic generation (SHG).

Soraa's green laser diodes output more than 75mW of continuous-wave (cw) power in the 520–525nm range, are single spatial mode and multi spectral mode. They can also be directly modulated at the high speeds required for high-resolution displays with minimal speckle. The firm says that the laser diodes are suitable for all pico-projector display generating technologies, including LCOS, scanning MEMS mirrors DLP, and other diffractive approaches. The new green devices also complement Soraa's previously announced blue 450nm laser diodes, which already exhibit what is claimed to be industry-best efficiency and power.

Soraa was founded in 2008 (as parent company to Kaai Inc) by University of California Santa Barbara (UCSB) professors Shuji Nakamura, Steve DenBaars, and Jim Speck. The management team is led by former Intel and Samsung executive Eric Kim, and consists of commercial laser industry veterans. Soraa is funded by Khosla Ventures and NEA, and operates vertically integrated fabrication facilities in Silicon Valley and Santa Barbara.

Soraa's lasers are based on indium gallium nitride (InGaN) technology and are fabricated on non-polar and semi-polar GaN substrates. The firm says that its direct-diode green and blue lasers offer improvements in performance, size, weight and cost over conventional gas or solid-state lasers for consumer projection displays, defense pointers and illuminators, biomedical instrumentation and therapeutics, and industrial imaging applications.

Soraa displayed green and blue laser diodes in its private suite at the Consumer Electronics Show (CES 2011) in Las Vegas, NV (6–9 January).

www.soraa.com

MicroVision and Pioneer to jointly commercialize laser display products

MicroVision Inc of Redmond, WA, USA, which provides ultra-miniature laser display technology, has entered into a memorandum of understanding (MOU) with Pioneer Corp, an original equipment manufacturer (OEM) of audio, video and computer equipment for the home, car and business markets, to develop, manufacture and distribute display engines and display engine subsystems for consumer and in-vehicle head-up displays (HUDs) using MicroVision's PicoP pico-projector laser display technology.

Earlier in 2010, the two firms executed a joint development agreement to develop two critical components of the PicoP display engine: a laser light source module using direct red, blue and green lasers and a separate display engine subsystem based on MicroVision's patented PicoP laser scanning technology. Both are key pieces of the next-generation PicoP display engine that MicroVision says will offer OEMs commercial advantages in price, size, power and performance for embedded solutions ranging from cell phones and eyewear to airplanes and automobiles.

The MOU establishes the framework of a future manufacturing and commercial distribution agreement for PicoP-based display engines to be used in consumer, after-market and embedded automotive products. Pioneer is targeting commercial introduction of an in-vehicle HUD using PicoP technology into the consumer market in 2012.

"Pioneer has a strong history of bringing cutting-edge technologies to mass markets," says MicroVision's president & CEO Alexander Tokman. "By combining our respective market and product development capabilities, and leveraging best practices in manufacturing, MicroVision and Pioneer can accelerate introducing next-generation laser display products while reducing the total cost for both companies in getting there," he believes.

Both Pioneer and MicroVision were recognized as finalists for last October's CEATEC Innovation Awards for 2010. Pioneer was recognized in the Automotive category for its demonstration of a HUD using laser scanning technology provided by MicroVision, and MicroVision was recognized in the Components category for its SHOWWX laser pico projector, powered by the PicoP display engine.

www.microvision.com

Putting on a bow-tie for higher-energy nitride laser performance

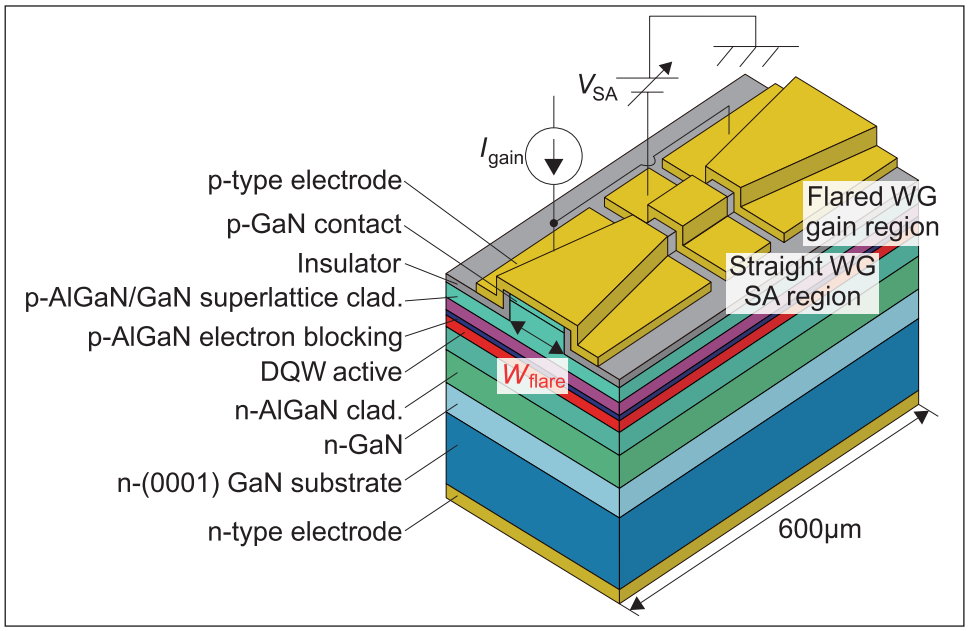
Sony and Tohoku push self-pulsating laser towards 3D optical storage

Japan's Sony Corp and Tohoku University's New Industry Creation Hatchery Center (NICHe) have added bow-tie waveguide structures to increase the energy output of nitride semiconductor self-pulsating laser diodes (SP-LDs) to 310 pico-Joules/pulse (pJ/pulse) [Hideki Watanabe et al, Appl. Phys. Express, vol3, p122103, 2010].

The researchers are seeking laser diode technology that can meet the needs of next-generation volumetric (i.e. three-dimensional rather than two-dimensional) optical storage based on multi-photon absorption. Memory media for such technology has already been developed, but operation at present needs large, expensive solid-state lasers, such as those using titanium-doped sapphire, which are only found in research laboratories.

The Sony–NICHe group has previously succeeded in operating volumetric optical storage using a laser system consisting of two parts: a mode-locked gallium nitride (GaN) laser diode and a semiconductor optical amplifier (SOA) to generate 100W peak power. High power is needed to achieve the multi-photon absorption process that is required to create the changes in the storage medium. Also, a short wavelength is desired to increase storage densities.

Rather than using multi-stage systems, a single laser diode that provides the necessary energy is sought. With this in mind, the Sony–NICHe group has a developed a self-pulsating laser diode (SP-LD) with a bow-tie ridge waveguide (WG) structure (see Figure). The hope was to boost output powers over SP-LDs with straight WGs (<10W). The 'bow-tie' reduces field densities in the output facet regions, suppressing gain saturation and catastrophic optical damage (a common cause of laser diode failure).



Structure of GaN-based bow-tie SP-LD.

The Sony–NICHe group has previously produced a non-tapered SP-LD structure with 10W peak power and pulses of energy 150pJ. Using the bow-tie structure, this has been increased to 20W peak and 310pJ/pulse. A previous record (1994) for bow-tie laser diodes in another material system obtained 7W peak and 100pJ/pulse.

The Sony–NICHe SP-LD was grown on n-GaN using MOCVD. The double quantum well (DQW) active region consisted of $Ga_{0.92}In_{0.08}N$ wells and $Ga_{0.98}In_{0.02}N$ barriers.

The ridge waveguide (WG) structuring was performed using reactive ion etching (RIE). The cavity was 600μm long, and the GaN-based saturable absorber (SA) region had a ridge WG that was 1.5μm wide and 10μm long. The bow-tie flared regions had a width at the two facets of up to 5μm (W_{flare}). These regions were 292μm long. Laser diodes with 2.5μm W_{flare} and non-tapered WGs were also produced for comparison purposes.

The p-type ohmic electrode was removed between the gain and the SA to electrically separate these regions. The front and rear facets were coated with Al_2O_3 and TiO_2/Al_2O_3 dielectric multi-layers, offering reflectivities of 5% and 95%, respectively. The laser diode chip was put in a 5.6mm-diameter can and, during testing, was kept at 25°C using a Peltier cooling system.

Peak operation was obtained with a gain current of 550mA and an SA reverse-bias of −10V. The optical pulse duration was 15.5ps and the repetition rate was 0.84GHz. The average output power at a lasing wavelength of 406nm was 260mW. Measurement of the near-field pattern at the front facet indicated that a single mode was generated.

Although the results obtained are promising, wider bow-tie structures are expected to make it difficult to maintain a single tranverse mode, control of which needs further investigation.

http://apex.jsap.jp/link?APEX/3/122103

Author: Mike Cooke

AFRL engineer receives Harold Brown Award for GaAs-based terahertz imaging sources

Dr Candace Lynch, a senior scientist at Hanscom Air Force Base, Massachusetts, has received the 2010 Harold Brown Award for her research in pioneering new infrared technology that will augment aircraft defense and impact numerous Defense Department systems.

Lynch strengthened aircraft protection from heat-seeking missiles by developing counter-measure device technology involving laser material, specifically with the growth of orientation-patterned gallium arsenide.

The research physicist extended her technology to generate terahertz sources used in future imaging systems that enable the warfighter to see through brown-out conditions during helicopter landings or to image concealed weapons through clothing.

"Lynch's technology breakthrough is not only a national asset, but a testament to her dedication to science with a focus on national security," says Dr David Jerome, director of the sensors directorate in the Air Force Research Laboratory (AFRL) at the Wright-Patterson Air Force Base, Ohio.

Secretary of the Air Force Michael Donley (left) presents the 2010 Harold Brown Award to Candace Lynch (right) at the Pentagon. (US Air Force photo/Jim Varhegyi).

Lynch's efforts as part of the sensors directorate supported the science and technology necessary for superior US air and space systems in intelligence, surveillance, reconnaissance, precision engagement and electronic warfare, Jerome said.

Having published more than 20 journal articles and eight conference presentations, Lynch received her Bachelor of Science from Massachusetts Institute of Technology and her doctorate of philosophy from Brown University in Providence, RI.

The Harold Brown Award recognizes significant achievement in R&D that have led to or demonstrated the promise of a substantial improvement in operational effectiveness of the US Air Force. The award's namesake was a physicist who served as Air Force secretary from 1965 to 1969 and as Defense secretary from 1977 to 1981. Lynch is the first female recipient of the award since the program began in 1969.

www.afrl.af.mil

Opnext offers first built-in monitor photo-diode on high-power 637nm laser diode for industrial and military applications

Optical module and component maker Opnext Inc of Fremont, NJ, USA, which offers a family of high-power, low-operating-current red and infrared laser diodes, says that customers are currently sampling its new HL63142DG 637nm, 120mW high-power red laser with a built-in monitor photo-diode for use in industrial and military applications.

Using a proprietary design, the HL63142DG built-in monitor photo-diode allows system designers to control the optical performance by monitoring the photo-diode current and adjusting for temperature and power variants in real time. Performance monitoring capabilities are essential for maintaining constant laser output power in construction systems and biomedical and other applications that experience changes in their operating environments. The HL63142DG operates at a temperature range up to 50ºC and 120mW in the 637nm wavelength band in a 5.6mm-diameter TO industry-standard package.

"We expect to see initial demand for this high-quality laser with built-in monitor photo-diode to come from military target acquisition-type applications where precise laser control is an important performance parameter," says Tadayuki Kanno, president of Opnext's devices business unit. "The industry trend is moving toward producing laser diodes that are high power, while consuming less energy," he adds.

Opnext offers laser diodes spanning 635–850nm. Its red and infrared laser diodes are proven to consume a low operating current, which extends battery life while maintaining the integrity of the laser diode power in applications such as gun sights, rangefinders, line leveling construction systems and biomedical applications.

Opnext is demonstrating end-application products that use its laser diode technology at the Photonics West 2011 conference (25–27 January) in San Francisco, CA, USA.

www.opnext.com

Terahertz QCL operated at higher temperature

Scattering-assisted injection allows emission at 1.8THz up to 163K

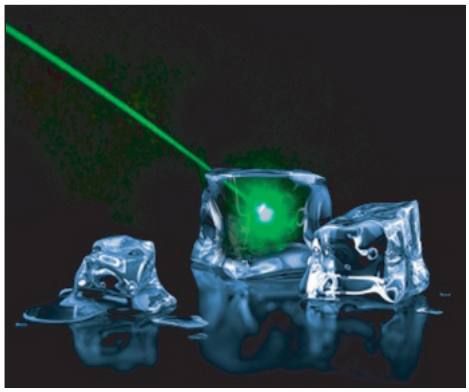
Terahertz (THz) rays — radiation between microwaves and infrared rays on the electromagnetic spectrum — are a promising means of detecting explosives, but they've proven hard to generate cost effectively. So far, solid-state lasers (quantum cascade lasers, or QCLs) have been unable to produce THz rays unless they're supercooled, which makes them impractical for mass deployment.

Some researchers had even begun to suspect that a room-temperature, solid-state terahertz laser was physically impossible. The performance of experimental terahertz lasers built in the lab has suggested a linear correlation between operating temperature and frequency, in which halving the frequency requires roughly halving the temperature. This led some to speculate that frequency and temperature are linked by some fundamental physical law, i.e. a strict proportionality that couldn't be violated.

However, researchers at Massachusetts Institute of Technology (MIT) and Sandia National Laboratories' Center of Integrated Nanotechnologies have now reported a solid-state terahertz laser that operates at nearly twice the temperature that that proportionality would have predicted (Nature Physics (2010) doi:10.1038/nphys1846). That temperature is still too low to be practical for airport scanners or devices in a bomb squad's tool kit, but it suggests that the quest for room-temperature terahertz lasers shouldn't be called off just yet.

"There are many naysayers saying that they can never be made operational at room temperature," says Qing Hu. "We break this psychological, empirical barrier by a factor of two. No one will say that it's a barrier anymore."

At low frequencies, the gaps between an electron's energy states become smaller, which



makes it harder to coax electrons into exactly the right state for photon emission. Lower temperatures, in turn, allow for more precise control of the electrons' energy levels. "In physics, there's a standard way of thinking, that temperature equals energy, and if you want to go to smaller energies, and see quantum effects, you better go to smaller temperatures," says Benjamin Williams, director of UCLA's Terahertz Devices and Intersubband Nanostructures Laboratory, who wasn't involved in the research. "And that's the type of thinking that informs this idea about this limit."

To address the problem of shrinking gaps between energy states at low frequencies, Hu — together with postdoc Sushil Kumar (now at Lehigh University), graduate student Ivan Chan, and Sandia's John Reno — fabricated a laser in which the applied voltage causes electrons to jump into an even higher energy state than usual. Through scattering, the electrons then release some of that energy as physical vibration rather than light. However, they remain in an excited state and release most of their remaining energy as photons.

By using such a scattering-assisted injection scheme, rather than the resonant-tunneling injection mechanism of all previous terahertz QCLs), the researchers were able to achieve lasing at frequencies below 2THz (specifically, a 1.8THz QCL operating at temperatures up to 163K).

Like existing terahertz lasers, the new laser is also built from gallium arsenide (GaAs) and aluminum gallium arsenide (AlGaAs), deposited in alternating layers. Each loss of energy occurs in a different layer, and the thickness of the layer determines how much energy the electron loses.

"This design technique circumvents one of the problems that have been limiting the temperature," Williams says. "Going to this new design path may give lots of benefits that will take us higher and higher in temperature," he adds. "Does this result say that we're right around the corner from getting to room temperature? Probably not. But it points a possible path, and it raises a lot of hope."

A decade ago, it was widely believed that terahertz rays could provide a safer, more useful replacement for x-rays during airport security screening. Not only can they penetrate clothing but, unlike x-rays, they also interact with a wide range of chemical compounds in distinctive and detectable ways. Hu says, however, that the frequencies of terahertz rays that are good for identifying chemicals can't penetrate materials even as thick as a suitcase wall, and they don't reflect well off of human flesh, so even after penetrating clothing, they might never reach a detector. They could, however, detect traces of explosives — a few molecules of a chemical wafting from a shoe bomb, for instance, or clinging to the side of an abandoned vehicle — with extraordinary sensitivity.

Hu believes that, when room-temperature terahertz lasers are ultimately developed, they will be used in conjunction with other existing and emerging technologies. "There is no single silver bullet," he says. "There have to be as many modalities as possible to cross-correlate, in order to increase sensitivity and, more importantly, to reduce false alarms."

www.nature.com/nphys/journal/vaop/ncurrent/full/nphys1846.html

Luxtera sells active optical cable business to Molex

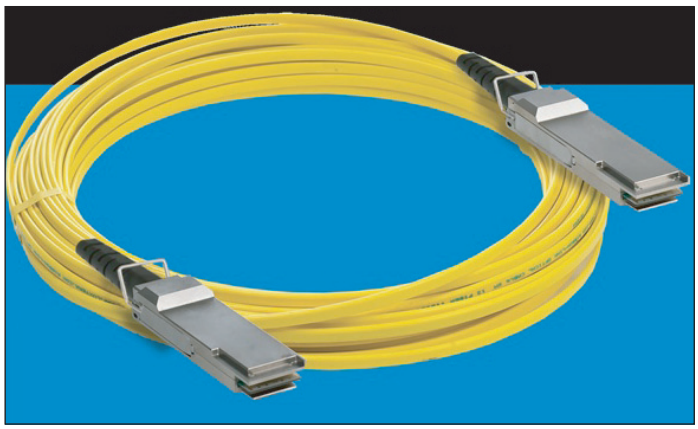
Silicon photonics firm focusing on chip development and supply

High-speed fiber-optic interconnect firm Molex Inc of Lisle, IL, USA has acquired the active optical cable (AOC) business of fabless CMOS silicon photonics firm Luxtera of Carlsbad, CA, USA.

Luxtera will transfer all aspects of its existing and future AOC business to Molex, including current QSFP+ (quad small-form-factor pluggable) 40Gbps Ethernet and InfiniBand products and customers, adding QSFP AOCs to Molex's existing portfolio of active optical connectivity products.

Founded in 2001 by researchers and technology managers drawn from the communications and semiconductor industries and funded by venture capitalists including August Capital, New Enterprise Associates, Sevin Rosen Funds and Lux Capital, Luxtera claims to be the first firm to overcome the complex technical obstacles involved with integrating high-performance optics directly with silicon electronics on a mainstream CMOS chip, bringing direct 'fiber to the chip' connectivity to market.

Established in 1938, Molex operates 39 manufacturing locations in 16 countries, and delivers complete interconnect solutions for markets including datacoms, telecoms, consumer electronics, industrial, automotive, medical, military, lighting and solar.



Luxtera's Blazar active optical cable.

The strategic acquisition will help Molex boost its share of the global fiber-optic assemblies market, says Doug Busch, VP & general manager of Molex's Global Fiber Optic Products Group.

The deal includes an exclusive agreement for Luxtera to develop and supply chip-sets for future Molex products based on silicon photonics technology, including next-generation 14Gbps and four-channel 25Gbps products for the 100Gbps Ethernet and InfiniBand markets. The firms will work together on future product planning to provide interconnect solutions at data rates of 10Gbps, 14Gbps, 25Gbps and above.

"The combination of our interconnect expertise with Luxtera's long-reach, low-power and low bit-error-rate optical solutions will enable us to offer the highest level of photonics integration and performance available," claims Busch.

The partnership aligns with the strategic direction and long-term goals of both companies, comments Luxtera's CEO Greg Young. "This agreement is a milestone validating the growing commercial significance of silicon photonics," he adds. "Luxtera will continue to accelerate its growth by focusing on our core silicon photonics technology platform, while at the same time expanding the reach of our technology to global markets and customers. Partnering with Molex will help us to bring the benefits of silicon photonics to customers worldwide."

www.molex.com
www.luxtera.com

Opnext makes chairman Bosco interim CEO following resignation of Bouchard

Optical module and component maker Opnext Inc of Fremont, NJ, USA says that Gilles Bouchard has resigned as CEO & president as well as board member.

Harry Bosco assumes the post of CEO & president on an interim basis, while also remaining non-executive chairman of the board of directors. Prior to becoming chairman in April 2009, Bosco had been CEO & president since Opnext's formation in November 2000. The board expects to start a search for a permanent successor to Bouchard in first-half 2011. "Opnext has an experienced management team that will ensure the transition is seamless to our customers," says Bosco.

Outgoing CEO Bouchard.

"We are grateful to Gilles for all of his contributions to Opnext since he joined the company in 2007," comments Bosco. "Gilles made numerous operational improvements to the company and helped set the future direction," he adds.

"Bosco has been an integral part of the company's leadership since 2000," says co-chairman Dr David Lee. "He is a proven leader with deep knowledge of our company and the industry, and he has played a key role in positioning Opnext for growth," he adds.

www.opnext.com

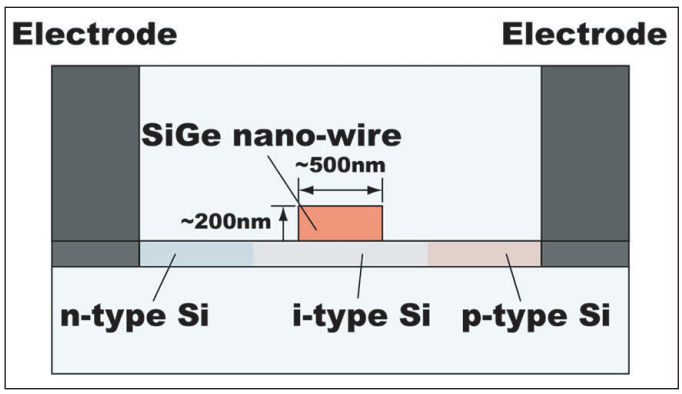
Fine-patterned SiGe halves power consumption of optical waveguide switch in network equipment

At the 23rd Annual Meeting of the IEEE Photonics Society (PHO 2010) in Denver, CO (7–11 November), Japan's Fujitsu Laboratories Ltd is reporting that it has been able to halve the power consumption of an optical waveguide switch based on silicon photonics through what is claimed to be the first use of fine-patterned silicon germanium (SiGe) for this application, rather than conventional silicon (Si). The firm says that the achievement should enable high-speed optical switches capable of operating across a wide range of wavelengths, while featuring the world's lowest power requirements.

Fujitsu says that its new technology will help to contain power consumption while supporting large-volume network traffic, enabling high-end services linking multiple cloud networks and ultra-high-definition video-conferencing, among other applications.

With the spread of data-intensive network services such as cloud computing and ultra-high-definition video distribution, the volume of data being transmitted over networks looks set to rise continuously. Accordingly, the amount of electricity consumed by networking equipment in 2025 is predicted to be 13 times the 2006 figure if no energy-saving measures are taken (according to the Japan Ministry of Economy, Trade and Industry's 'Green IT Initiative' report, December 2007), leading to concerns about potentially serious energy shortages in the future.

Conventionally, switching between optical network paths requires that signals be converted from light to electricity and back again to light in order to be processed, requiring considerable power. An optical switch that processes optical signals as they are — without the need for conversion to electricity — would therefore greatly reduce its power requirements. This issue has spurred ongoing R&D for next-generation networks.



Cross section of refractive-index modulator.

A optical waveguide switch is a design that arrays multiple optical switching elements in series, between an optical-signal input point and output point. By combining the operations of each optical switching element, a desired optical signal path can be created.

An optical waveguide switch employing silicon photonics uses well-established silicon fabrication technology, allowing inexpensive mass production. Furthermore, optical switch devices based on nanometer-scale waveguides and control electronic circuits can be aligned in large numbers on the same substrate, so large-scale optical switches can be fabricated compactly, measuring just a few centimeters squared.

Large-scale optical-waveguide switches operate multiple optical switching elements simultaneously. However, the heat that this generates can degrade device performance, necessitating the lowest possible power consumption for each optical switching element.

With optical switching elements, the application of an electrical current to the refractive-index modulator causes electrons to accumulate in fine waveguides, which modulates the refractive index and switches the output port. With conventional optical switching elements made using fine-patterned silicon, the electron-accumulation efficiency in fine silicon waveguides is low, necessitating more current to achieve sufficient electron accumulation, increasing power consumption.

Fujitsu has therefore developed what it reckons is the first optical switching element that uses fine-patterned SiGe in the refractive-index modulator (see Figure). Forming fine-patterned SiGe (which has a narrower energy bandgap than silicon) on top of silicon allows more efficient electron accumulation, and hence less power is required for switching.

Prototype optical switch devices developed by Fujitsu operated on 1.5mW of power (about half the power required for conventional fine-patterned silicon optical switching elements), representing what is claimed to be the lowest power requirement in the world for an optical switching element capable of high-speed operation across a wide range of wavelengths.

Fujitsu says that it aims to proceed with the development of large-scale integration as well as the integration technology for control electronic circuits, in order to realize large-scale optical switches enabling next-generation networks.

Part of Fujitsu's research was undertaken as part of the 'Vertically Integrated Center for Technologies of Optical Routing toward Ideal Energy Savings' (VICTORIES) project, under the program 'The Formation of Innovation Center for Fusion of Advanced Technologies' sponsored by the Special Coordination Funds for Promoting Science and Technology, of Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT).

http://jp.fujitsu.com/labs/en

GigOptix and Civcom win US–Israel bi-national grant to develop highly integrated 40Gb/s transponder

GigOptix Inc of Palo Alto, CA, USA and Civcom Devices and Systems Ltd of Petach-Tikva, Israel, which manufactures dynamic opto-electronic components and modules, have been awarded a US–Israel Bi-national Industrial Research & Development (BIRD) Foundation grant to develop low-power, highly integrated components and modules for next-generation 40Gb/s and 100Gb/s communication systems.

The grant will initially help to fund the development of a small form factor (SFF) 40Gb/s RZ-DQPSK transponder. GigOptix will develop an integrated 40Gb/s RZ-DQPSK optical modulator and the corresponding broadband amplifiers to drive the modulator, while Civcom will develop and manufacture the 40Gb/s RZ-DQPSK SFF transponder.

The BIRD Foundation provides free assistance in locating strategic partners from both countries for developing joint projects, working in cooperation with the chief scientist's office at the Ministry of Trade, Industry and Employment in Israel, and with the US Commerce Department's National Institute of Standards and Technology (NIST).

"The BIRD Foundation acts to encourage collaboration between Israeli and American companies in various fields of technology," says its executive director Eitan Yudilevich Ph.D. "Consumers' use of smartphones and the advent of cloud computing are requiring network operators to upgrade to faster 40Gb/s infrastructure to keep pace with increasing bandwidth demand," he adds. "GigOptix and Civcom are combining outstanding US and Israeli human resources and technologies to develop an industry-leading telecommunications solution to address these demanding network operator requirements."

Under the grant, GigOptix will leverage its Thin Film Polymer on Silicon (TFPS) technology to implement an integrated 40Gb/s RZ-DQPSK optical modulator in a single package. Currently, 40Gb/s RZ-DQPSK optical modulation is implemented using two separate lithium niobate modulators: the first implements RZ modulation and the second DQPSK modulation. The integrated GigOptix solution will be significantly smaller to the discrete approach (smaller than one of the competing lithium niobate modulators). Furthermore, GigOptix's broadband RF driver and optical modulator teams will optimize the interoperability between the modulator and the driver to enable further reduction in power consumption and overall footprint of the electro-optic transmission system. This size and power reduction will enable Civcom to shrink the size of its 40G RZ-DQPSK transponder to the size of current 10G transponders.

"The BIRD Foundation has helped many technological collaborations come to fruition between US and Israeli companies," states GigOptix's chairman, CEO & president Dr Avi Katz. "Close cooperation with Civcom, an optical transponder pioneer, on this innovative 40Gb/s transponder will significantly help in improving our TFPS technology and accelerate the time to market of our innovative solutions."

www.civcom.com
www.birdf.com
www.gigoptix.com

Solekia to distribute GigOptix' ASICs in Japan

GigOptix Inc of Palo Alto, CA, USA, which designs modulator and laser drivers and transimpedance amplifier (TIA) ICs based on III-V materials as well as polymer electro-optic modulators for fiber-optic communications systems, has signed Solekia Ltd (a distributor of electronic components and information technology) to expand its application-specific integrated circuit product distribution in Japan.

Solekia will offer GigOptix' Structured ASIC devices and Standard Cells along with local design and sales support to Japanese customers, focusing particularly on the industrial and medical markets. Midoriya Electric Co will continue be the sole distributor for GigOptix' optical and RF sales in Japan.

"They have excellent technical expertise and deep customer relationships, with over 20 years of experience in providing ASIC solutions to Japanese customers, particularly in the industrial and medical markets," comments Anil Chaudhry (GigOptix' director of marketing for ASIC products) about Solekia.

GigOptix has taped out more than 2000 designs. "Our Structured ASIC technology is particularly suited for the industrial and medical applications in Japan," reckons Chaudhry. "Solekia's reputation for providing dedicated customer service and superior technical support to the ASIC customers will greatly enhance GigOptix' cost-effective solutions and best-in-class service for the Japanese market," he adds.

"This partnership will enable us to provide our customers with an enhanced and cost-effective portfolio of Structured ASIC and Standard Cell solutions for the industrial and medical applications," says Takashi Miura, general manager, System Business Group of Solekia in Japan. "GigOptix' ASIC technology and market focus closely aligns with Solekia's expertise," he concludes.

www.solekia.com/English

3S grows revenue 9% in fiscal 2010

For its fiscal 2010 (to end-June), 3S Photonics of Nozay, France, which makes laser chips, optical discrete modules and passive components for telecom networks, has reported revenue of €25.22m, up 9% on €23.04m in fiscal 2009 (which had been down 10% on fiscal 2008).

3S notes that, due to increasing global Internet traffic, the terrestrial and submarine long-distance transmission market has grown strongly. The firm has benefited from these favorable conditions, since it has 80% market share in submarine pumps, and has won 7% of the terrestrial pump market in two years.

Due to a rise of 10% in overall operating revenue from €32.6m to €36m, operating profit has soared from €0.11m in 2009 to €1.98m in 2010. Net profit was €2.2m, raising the firm's equity capital from €20m to €22.28m.

For fiscal 2011, 3S aims to reduce operating expenses by €1m, and expects 10% growth in revenue due to the recovery of the submarine market from the economic slowdown in 2009 as well as the introduction of new products dedicated to the optical transmission market.

The past year was also marked by February's acquisition of optical telecom component firm Avensys Inc of Montreal, Quebec, Canada. "We already achieved synergies between both companies in terms of product development, and the strategy of locating our Canadian subsidiary in North America is an important building block for our international expansion," says president & CEO Alexandre Krivine. Synergies are expected to boost growth in revenue to US$70m for the consolidated group.

"Next year, we will also concentrate on our expansion policy and strategic partnerships in order to strengthen our international position," adds Krivine.

www.3Sphotonics.com

JDSU recruits SVP business services

Optoelectronic chip and module maker JDSU of Milpitas, CA, USA says that Rex Jackson has joined its executive management team as senior VP, business services, reporting to president & CEO Tom Waechter and leading JDSU's corporate and business development, corporate marketing, legal and information technology organizations.

The firm says that Jackson has a successful track record as a strategic planning executive and leader of business-enabling corporate functions.

He joins JDSU from Symyx Technologies, where he served as executive VP & chief financial officer with responsibility for finance, legal, IT and other corporate functions, and drove the firm's acquisition of MDL Information Systems Inc and the recent merger with Accelrys Inc.

Previously, Jackson was senior VP & general counsel for Avago Technologies, and held senior executive positions with Synopsys Inc, AdForce Inc and Read-Rite Corp.

Jackson has experience in areas key to JDSU's growth plans, says Waechter. "He brings additional depth to our senior management team that will help JDSU efficiently scale as we address expanding growth opportunities around the globe," he adds.

The firm has also promoted Andrew Pollack (who has been leading its legal team on an interim basis since July) to general counsel. Pollack has been a member of JDSU's legal department since 2000. "He has contributed to JDSU's transformation in many ways while directing legal strategy for mergers and acquisitions, securities and compliance, commercial contracts, litigation and intellectual property management," says Waechter.

www.jdsu.com

IN BRIEF

Finisar raises $118m on close of public offering

Fiber-optic communications component and subsystem maker Finisar Corp of Sunnyvale, CA, USA has closed its public offering of 4,140,000 shares of its common stock (announced on 20 December) at a price of $28.54 per share.

This included 3,600,000 shares originally offered plus 540,000 additional shares sold upon the full exercise of the over-allotment option by the sole underwriter Credit Suisse Securities (USA) LLC.

Total gross proceeds of the offering are $118,155,600. Net proceeds to the company are $117,900,000, after deducting estimated offering expenses.

The firm intends to use the proceeds for general corporate purposes, including working capital. Part of the net proceeds may be used for the repurchase and/or repayment of outstanding indebtedness, which may include a portion of its outstanding convertible notes.

The firm may also use part of the proceeds to acquire or invest in complementary businesses, products or technologies (although it has no present agreements or commitments with respect to any such acquisitions or investments).

Finisar's previous public offering, of 7,200,000 shares initially, closed on 22 March (after being raised to 8,640,000 shares, plus 1,296,000 shares in over-allotments). At $14 per share, that raised proceeds of $139.1m gross ($131.2m net).

Subsequently, in September, Finisar acquired the transceiver manufacturer Broadway Networks Ltd.

www.finisar.com

Emcore's loss slashed as quarterly revenue grows 16%

ITC parallel optics ruling to hit sales next quarter

For fiscal 2010 (to end-September), Emcore Corp of Albuquerque, NM, USA, which makes components and subsystems for the fiber-optic and solar power markets, has reported revenue of $191.3m, up 8% on fiscal 2009's $176.4m. By segment, Fiber Optics was $121.7m (up 7% on $114.1m) and Photovoltaics was $69.6m (up 12% on $62.3m).

Fiscal Q4 revenue was $54.1m, up 16% on $46.6m last quarter and 34% on $40.5m a year ago. By segment, Photovoltaics rose 30% on $15.1m last quarter to $19.7m (36% of total sales, up from 33%), driven mainly by base solar power generation products. Fiber Optics rose 9% from $31.5m to $34.4m (64% of sales, down from 67%), driven mainly by higher sales of integrable tunable laser assemblies (ITLAs), active optical cable (AOC), and CATV products. This was despite the effects of the US International Trade Commission (ITC) issuing a limited exclusion order and a cease and desist order on parallel optics device products found to have infringed patents belonging to Avago Technologies.

However, gross margin has fallen from 27.5% last quarter to 23.6%. By segment, Photovoltaics margin fell from 30.7% to 29.3%, due mainly to higher manufacturing expenses and certain contract losses, offset by leverage from higher volume. Fiber Optics margin fell from 25.9% to 20.4%, due mainly to higher material costs and an unfavorable shift in product mix while customers migrate to newer technology platforms.

Nevertheless, net loss has been cut from $16.3m a year ago and $9.2m last quarter to just $0.9m. For full-year fiscal 2010, net loss was $23.7m, cut from $138.8m in fiscal 2009, due partly to gross margin improving from –3.6% in to 26.5%.

During the quarter, cash and cash equivalents rose from $14.4m to $19.9m, and working capital rose from $33.1m to $34.9m. Compared with consuming $29.6m of cash in fiscal 2009, in fiscal 2010 Emcore generated $3.4m in cash, due mainly to improved operating performance and working capital management as well as an increase in customer deposits and advanced payments.

During fiscal Q4, order backlog rose 6% from $67.6m to $71.3m, including $52.9m for Photovoltaics (up 25% on $42.5m, due to significant wins in the satellite business) and $18.4m for Fiber Optics (down 27% from $25.1m, due mainly to the parallel optics device business).

For fiscal Q1/2011 (to end-December 2010), Emcore expects revenue to fall slightly to $50–53m due to a drop in Fiber Optics sales (a short-term effect, due to the ITC ruling).

During fiscal 2010, management implemented a series of measures, and continues to evaluate opportunities intended to align the cost structure with revenue forecasts.

The end of July saw agreement with San'an Optoelectronics Co Ltd of Xiamen, Fujian province to form the joint venture Suncore Photovoltaics Co Ltd in China. All activities for concentration photovoltaic (CPV) receivers, modules, and systems at both San'an and Emcore's Langfang, China manufacturing facilities will be transferred to Suncore.

While Emcore will continue to make CPV cells in Albuquerque, Suncore will serve as its low-cost/high-volume manufacturing base for receivers incorporating its CPV cells, and for modules and systems to support both Emcore's and San'an's worldwide sales efforts. With production expected to begin in September, Suncore will start work supplying immediate demand for 12MW of systems for San'an's current customers and 3MW of components for projects sourced by Emcore. Also, Emcore and San'an are pursuing multiple CPV project opportunities in China's emerging market, including the 280MW solar energy plan in six western regions announced by the Chinese government.

"With the JV taking on the execution of manufacturing as well as the business development in China, Emcore can focus on continued development of our next-generation CPV products and solar business development in North America and Europe," notes president & CEO Dr Hong Q. Hou.

Also to improve liquidity, in November Emcore entered into a three-year $35m asset-backed revolving credit facility with Wells Fargo Bank, which can be used for working capital, letters of credit and other general corporate purposes.

www.emcore.com

Emcore regains compliance for continued NASDAQ listing

The NASDAQ Listing Qualifications Department says that Emcore has regained compliance with NASDAQ Listing Rule 5250(c)(1), which requires firms to file their periodic financial reports with the US Securities and Exchange Commission (SEC) on a timely basis.

On 30 December, Emcore had received a letter from the NASDAQ Stock Market saying it was not in compliance due to not filing its annual report on Form 10-K for fiscal 2010 (to end September).

Filing was delayed since its prior auditor Deloitte & Touche LLP had not completed its reviewing its audit procedures on the firm's goodwill and intangible assets accounts for the fiscal years ended 30 September 2008 and 2009.

Because Emcore has now been able to regain compliance with the rule before the deadline of 28 February, the firm is no longer required to submit a plan to NASDAQ for regaining compliance.

Huainan City lures Emcore–San'an China JV Suncore

Grants, tax holiday & rebate to support 1000MW capacity over 5 years

Emcore Corp of Albuquerque, NM, USA, which makes components and subsystems for the broadband, fiber-optic, and solar power markets, has entered into an investment and cooperation agreement with San'an Optoelectronics Co Ltd of Xiamen, Fujian province, China and Huainan municipal government that calls for Emcore and San'an to register and operate their China-based joint venture Suncore Photovoltaics Co Ltd in Huainan, a prefecture-level city with 2.4 million inhabitants in the hinterland of east China and the center of Anhui province.

Huainan is the center of Southeast China's chief coal-mining region, with an annual output greater than 80 million tons, as well as operating several large-size coal-fired power plants with a total capacity of 10GW.

San'an currently designs, manufactures and supports products including full-wavelength-range high-brightness LED chips and wafers, solar cells, and PIN photodiodes. Operating over 250,000m^2 of facilities in Xiamen, Fujian province, Wuhu, Anhui province, and Tanjin, its annual LED production capacity has reached 650,000 wafers (20bn LED chips), making it China's largest LED epiwafer and chip maker. Its total number of installed MOCVD reactors for LED production will exceed 150 once its operation in Wuhu is in full production, while its 1MW CPV power plant in Qinghai province is China's largest installation.

The agreement to form the joint venture (owned 40% by Emcore and 60% by San'an) was announced on 30 July, with the purpose of developing, manufacturing and distributing high-concentration photovoltaic (CPV) receivers, modules and systems for terrestrial solar power applications. Emcore and San'an previously planned to establish Suncore's primary manufacturing operations in Wuhu City, Anhui province. Suncore's new location is expected to expedite the schedule for the construction and start of operations as well as providing other economic incentives for the joint venture.

The agreement provides for Suncore's engineering, manufacturing, and distribution operations for CPV components and systems to be established in the Economic and Technology Development Zone of Huainan City, which is pursuing renewable energy industry opportunities to balance their industry mix. Suncore is expected to establish a total of 1000MW of manufacturing capacity at the site over the next five years, including 200MW to be ready by the end of 2011, 300MW by the end of 2013, and the remaining 500MW by the end of 2015. Total capital expenditure and working capital investment is estimated to be RMB8bn ($1.2bn).

In addition, to support start-up and on-going operations, Huainan will provide a land grant of 1600mu (263 acres), extended tax holidays, and other financial incentives. Also, within three days of the start of plant construction, Huainan will provide a cash grant of RMB500m ($75m), restricted to use solely for capital equipment purchases to support the establishment of Suncore operations. For the first 1000MW, Huainan will also provide a RMB1.4 ($0.21) cash rebate to Suncore for every watt of CPV systems manufactured in Huainan and sold in China.

"China is viewed as one of the most promising markets for CPV solar power. This agreement demonstrates Huainan's strategy and commitment to the growth of its renewable energy industry," comments Emcore's president & CEO Dr Hong Q. Hou. "These financial incentives will accelerate the commercialization of Emcore's CPV technology and production ramp," he adds. "This investment by Huainan and the establishment of Suncore's low-cost manufacturing operation will enable our CPV technology to become a cost-effective solution for commercial and power utility applications," Hou believes.

Emcore and San'an are currently pursuing Suncore's business registration in Huainan, and plan to start plant construction in early 2011.

www.Sanan-e.com
www.emcore.com

NASA awards $10m contract for MMS spacecraft's solar panels

NASA Goddard Space Flight Center (GSFC) of Greenbelt, MD, USA has awarded Emcore a contract worth about $10m (including options) to manufacture, test and deliver solar panels for the Magnetospheric Multiscale (MMS) mission.

Emcore expects to deliver a total of 32 solar panels using its third-generation triple-junction (ZTJ) InGaP/InGaAs/Ge solar cells to power four MMS spacecraft. With a conversion efficiency nearing 30%, the ZTJ solar cell is claimed to be one of the highest-performance space-qualified multi-junction solar cells on the market.

"Under a previous contract, we successfully delivered solar panels for NASA GSFC's Lunar Reconnaissance Orbiter mission, which is currently powering the spacecraft orbiting the Moon," says Emcore's chief operating officer Christopher Larocca. "Winning this new contract accelerates Emcore's efforts to be the premier supplier of solar panels for demanding spacecraft power systems," he adds.

www.gsfc.nasa.gov

IN BRIEF

BluGlass outsources InGaN PV processing to Rainbow

BluGlass Ltd of Sydney, Australia has commissioned the foundry services of Rainbow Optoelectronics Materials (Shanghai) Co Ltd to provide device fabrication and processing services for the purpose of creating a nitride solar cell prototype designed by BluGlass.

Spun off from the III-nitride department of Macquarie University in 2005, BluGlass has developed a low-temperature process using remote plasma chemical vapor deposition (RPCVD) to grow materials including GaN and InGaN on glass substrates for the production of LEDs, with what is reckoned to be great low-cost potential and inherent scalability. In May 2009, the firm said it aims to develop high-efficiency group III nitride solar cells as a supplementary market for its RPCVD technology.

The deal with Rainbow enables BluGlass to outsource the processing of its InGaN solar cell designs to a dedicated group-III nitride firm without the need to invest in additional capital equipment during the research phase.

Alan Li, who joined BluGlass as a non-executive director in November 2009, is general manager of Rainbow, a device maker that provides nitride semiconductors (primarily LED displays) to more than 25 countries.

BluGlass says that InGaN solar cells promise to be long lasting, relatively inexpensive and the most efficient ever created. The firm is developing solar cell structure designs and aims to develop cell prototypes as part of a $4.9m grant awarded in 1995 for the 'High Efficiency Thin Film Solar Cell Project' under the Commonwealth government's 'Climate Ready' program.

www.bluglass.com.au

NYSERDA awards Magnolia second product development contract

Magnolia Solar Corp of Woburn, MA, USA, which develops nanostructure-based thin-film solar cells for terrestrial applications for defense and commercial applications, says that its subsidiary has received a second product development contract from the New York State Energy Research and Development Authority (NYSERDA). The baseline program award is $250,000, with Magnolia contributing matching funds.

The new program builds on previously announced and on-going NYSERDA program work at Magnolia. In October, Magnolia received funding from NYSERDA for Phase II of a three-phase $1m development program (begun in March with Phase I) to demonstrate high-efficiency nanostructured thin-film solar cells.

The latest contract (which lasts one year) aims to improve the performance of thin-film solar cells by incorporating light trapping techniques and nanostructured optical coatings. As part of the technical effort, Magnolia will collaborate with Technical Advisory Board member professor Fred Schubert and his team at the Rensselaer Polytechnic Institute (RPI) in Troy, NY to incorporate nanostructured-based coatings developed for light-emitting diodes into high-efficiency solar cell applications.

Principal investigator on the new NYSERDA program is Magnolia's chief technical officer Dr Roger E. Welser, who will lead development of nanostructured coatings that can scatter light horizontally into the active layers of thin-film solar cells. "Magnolia is aiming to revolutionize the power-generating capability of terrestrial photovoltaic systems by developing a low-cost, thin-film technology that delivers unprecedented levels of electrical energy per unit area," he notes.

Both higher current and voltage outputs are expected from thin-film solar cells combining Magnolia's unique material structure with nanoengineered optical coatings that scatter normally incident light laterally into the device. "Advanced light trapping structures are needed to improve the current output and efficiency of a variety of different thin-film technologies," Welser adds.

"Magnolia's nanostructured optical coatings, developed in collaboration with professor Fred Schubert, can both minimize reflection losses on the front surfaces of thin-film solar cells, and recycle photons that pass through the device back into the absorbing semiconductor thin film layers," Welser continues.

Magnolia's technology can also capture a larger part of the solar spectrum to produce high-efficiency solar cells, and incorporates a unique nanostructure-based antireflection coating technology to further boost the cell's efficiency, reducing the cost per watt. Magnolia's technology targets electrical power generation applications, such as power for electrical grids and distributed power applications ranging from commercial and residential lighting to specialized military applications.

"Commercially viable renewable energy has tremendous potential benefits for New York State in terms of security, economic growth, and the environment," comments Magnolia's president & CEO Dr Ashok K. Sood. "We are committed to growing in the Albany region, supported by the world-class intellectual and technological infrastructure at RPI and CNSE's Albany NanoTech Complex," he adds.

In October, Magnolia opened an office at the Albany Nanotech complex on the campus of the University of Albany (State University of New York) to allow staff to collaborate closely with the development team members at SUNY Albany's College of Nanoscale Science and Engineering (CNSE) as well as RPI, and to better capitalize on the characterization facilities available in the New York capital region.

www.magnoliasolar.com

Boeing to supply GaAs PV powered satellites to Mexico

Boeing (the parent firm of III-V-based solar cell maker Spectrolab Inc of Sylmar, CA, USA) has received a contract worth about $1bn from the government of Mexico to deliver an end-to-end satellite communications system, providing secure communications for the country's national security needs as well as enhanced coverage for civil telecoms.

The MEXSAT system will consist of three satellites, two ground sites, associated network operations systems and reference user terminals.

Boeing will deliver a complete turnkey satellite system comprising Boeing 702HP geomobile satellites MEXSAT-1 and MEXSAT-2 and one extended C- and Ku-band satellite, MEXSAT-3 (due to launch first, at the end of 2012), which will provide fixed satellite services from geosynchronous orbit.

Each Boeing 702HP satellite will supply 14kW of power through five-panel solar array wings that use triple-junction gallium arsenide solar cells. Both satellites will carry a 22m L-band reflector for mobile satellite services, complemented by a 2m Ku-band antenna.

Boeing will procure MEXSAT-3 and a spacecraft operations center from its supplier partner Orbital Sciences Corp. MEXSAT-3, an Orbital Star 2.4 satellite, will provide full coverage of Mexico and its patrimonial seas and relay civil communications for socioeconomic development.

"MEXSAT is the fourth generation of satellites Boeing has provided to Mexico for government and civilian satellite communications," says Craig Cooning, CEO of Boeing Satellite Systems International. "MEXSAT builds on Boeing's 13 years of experience in designing and delivering advanced geomobile systems."

Boeing also will develop two ground sites in Mexico with advanced beam-forming flexibility to direct mobile user spot beams to government agencies operating in Mexico and its patrimonial seas, including the Pacific Ocean and Gulf of Mexico.

Boeing has previously provided five satellites serving Mexico, starting with Morelos 1 and Morelos 2 (which were both launched in 1985); Solidaridad 1 and Solidaridad 2 (launched in 1993 and 1994); and Satmex 5 (launched in 1998). Solidaridad 2, which has exceeded its contract life, is still in service, and Satmex 5 is expected to end its service life in 2012.

www.spectrolab.com

Circadian hits temperature-corrected peak module aperture efficiency of 30%

Circadian Solar of Coventry, UK, which is developing concentrated photovoltaic (CPV) systems incorporating GaAs multi-junction PV cells, has achieved a temperature-corrected peak module aperture efficiency of 30% during trials at its test site in Lisbon. The DC module efficiency result was reproduced with a number of different modules over the course of the trials.

Circadian has been testing its system, which is designed for optimum performance in sunbelt regions, at the Faculty of Sciences of the University of Lisbon since June. The trials complement the firm's module evaluation program set up in Cyprus in late 2008. A further test site is being established in the Middle East, as part of the plan to demonstrate cost-effective energy yield in different regions and environments.

Circadian says that it has achieved the DC module efficiency by adopting its Ultra Power Density approach, in which all aspects of system design are engineered holistically to deliver the lowest possible cost of electricity generated. Focusing on the design at the full system level ensures that the CPV modules work most efficiently as part of the complete system. Integral to this has been the firm's proprietary tracker, which demonstrates outstanding accuracy, even under high wind loading, it is claimed. Circadian expects to announce results of its system testing in early 2011.

"We are seeing rapid progress," says CEO Jeroen Haberland. "Delivering high-efficiency, reliable electricity at an affordable cost level is of the utmost importance to us, and the latest efficiency result demonstrates that exceptional efficiencies can be delivered without sacrificing affordability," he adds.

Circadian's testing is expected to continue into mid-2011 as the firm builds up to manufacturing.

www.circadiansolar.com

IN BRIEF

Amonix partners with Flextronics

Amonix Inc of Seal Beach, CA, USA has chosen Singapore-based electronics manufacturing services (EMS) provider Flextronics as a manufacturing partner for its CPV utility-scale solar systems.

"Partnering with a proven world-class manufacturer for production will allow us to connect more customers to cost-effective solar power," says CEO Brian Robertson. "Flextronics' manufacturing capabilities right here in California and also in Nevada will enable us to reduce time-to-market and rapidly scale our business to meet the needs of customers in our target markets of California, Nevada, Arizona, New Mexico, Colorado, and other Southwestern US states with sunny and dry climates," he adds.

www.flextronics.com
www.amonix.com

OPEL Solar and Ecotech form JV OPEL Solar Asia

North America-based OPEL Solar Inc, which makes high-concentration photovoltaic (HCPV) panels (as well as roof- and ground-based solar trackers for mounting them) has formed the joint venture OPEL Solar Asia Ltd (OSA) in Hong Kong with Ecotech Environmental Technology Ltd.

As a division of Hong Kong-based E&K Holdings Group, Ecotech is a vertically integrated solutions provider spanning product development, system design, manufacturing, assembly & test, project management, installation, commissioning, and after-sales services. The firm has three business units in 'cleantech': Energy; LED Lighting; and Solar Applications and Devices.

OPEL says that the JV represents the beginning of a long-term goal to position it to enter East Asia, developing the HCPV market there and moving OPEL Solar's HCPV technology into what is reckoned to be the world's fastest-growing solar market, with years of strong growth projections ahead.

OSA's mission is to market OPEL's HCPV products throughout East Asia. The primary country targeted for CPV market penetration is China. "According to a recent posting on New Energy World Network, China's photovoltaic market is one of the largest in the world and has a robust growth projection," says OPEL Solar Inc's chief operating officer Frank Middleton. "With Ecotech, OPEL Solar found a well-established partner to advance our business into East Asia," he adds. "OPEL chose to enter this market with Ecotech because of their profound regional knowledge and client base, with the added advantage that, since Ecotech is established, it serves to minimize our start-up expense."

Exemplifying rising demand for HPCV in China, OSA's creation also involves an initial purchase order for 2MW of OPEL Solar's HCPV system products (both solar modules and tracker models). "These products are expected to fulfill immediate contracts Ecotech has secured within the People's Republic of China, and it represents a multimillion dollar revenue opportunity for OPEL Solar, which results in revenue during the first year of operations of the JV," says Middleton.

As well as the initial 2MW order, a continued strong ordering stream is expected for OSA. "The establishment of OPEL Solar Asia, with its anticipated order projection, represents significant value growth for OPEL Solar's stakeholders," says OPEL's CEO Leon M. Pierhal.

The burgeoning CPV solar market in East Asia may bring OPEL revenues approaching $100m over the next 4–5 years, he reckons.

"OPEL Solar has proven technology and a good product for the CPV market in East Asia," believes Michael Lam, chairman of Ecotech and chairman & CEO of the E&K Holdings Group. "There are challenges ahead, but the chance of capturing market opportunities in this region is very real," he adds. "We will work hand in hand with OPEL Solar and our strategic partners and customers in China to realize these goals."

The products shipped for the 2MW order will open the door for local manufacturing by OSA, as Ecotech has an established network of local manufacturers. Once the manufacturing processes attain efficiency, OSA will assume the full manufacturing process to install complete HCPV utility-grade solar farms.

"The decision to pursue a joint venture strategy to enter East Asia is one of the most important decisions we have made to support the rapid growth of the company," says Pierhal, stating that other worldwide joint ventures are in various stages of negotiations for 2011.

www.ecotech-sz.com.cn

OPEL wins order for turnkey 446kW solar field in Rhode Island

OPEL Solar Inc is to construct a 446kW power plant at the 70-acre headquarters in North Kingstown, RI, USA of Toray Plastics (America) Inc (Toray's first solar installation in the US and one of the largest utility-grade plants in Rhode Island).

OPEL says Toray Plastics chose it due to its higher energy production and lowest cost per kilowatt-hour generated. Higher system efficiency is largely due to OPEL's TF-800 utility-scale single-axis tracker.

The solar field will consist of 1650 PV panels mounted on 50 TF-800 trackers, and should result in 20% higher energy output than that of conventional fixed-mounted PV panels. It should generate 625MWh per year (equivalent to supplying electric power for a year to over 100 homes).

OPEL says that Toray Plastics is an example of using American Recovery and Reinvestment Act funds provided by both the Federal and state governments to create new clean energy sources and jobs. The project is eligible for both Federal funds and state funds awarded by the Economic Development Commission for the State of Rhode Island. Construction will begin in the spring.

"Toray has multiple locations throughout the US; thus we are optimistic that our successful collaboration in Rhode Island may lead to additional solar projects," says OPEL Solar's CEO Leon M. Pierhal.

Not only does the Toray agreement represent a multi-million dollar contract for OPEL, it is the first implementation of its new strategic business directions. In addition to the brownfield initiative announced several months ago, OPEL also aims to be a full service provider for select solar projects.

www.opelinc.com

Semprius installs demo microcell CPV system at TEP

Semprius Inc of Durham, NC, USA, which develops high-concentration photovoltaic (HCPV) panels, has installed the industry's first microcell-based HCPV research development & demonstration (RD&D) system.

Deployed in August at UniSource Energy Corp subsidiary Tucson Electric Power (TEP) — which provides power to over 400,000 customers in southern Arizona — the system combines Semprius' HCPV modules with an automated solar tracking system developed by Siemens. The TEP project is part of a joint development agreement signed in January by Semprius and Atlanta-based Siemens Industry Inc (the US affiliate of Siemens' global Industry Sector business) that will lead to deployment of many HCPV systems at test sites worldwide.

Siemens supplied the RD&D system's two-axis tracker, which uses its Simatic S7-1200 automation system and the Solar Positioning Algorithm of the US National Renewable Energy Laboratory (NREL), which provides a tracking accuracy of better than 0.2º. The Siemens industrial electronics components are designed to operate in Arizona's arid desert climate. The tracker also features built-in remote data acquisition capability that allows Semprius to monitor the performance of the system.

"Competitive project deployment cost for HCPV will be the key for the success of this technology," notes Peter Krause, business segment manager for Siemens Industry Inc. "By combining our advanced automation and control equipment with Semprius HCPV panel, we believe this project will demonstrate the technology's potential to deliver grid-level prices to utility customers."

Semprius RDD system at TEP.

Semprius says HCPV offers the lowest solar levelized cost of energy in sunny, dry climates of any photovoltaic technology by providing higher conversion efficiency and higher energy yield. Using a patented production process, the firm has developed microcells that increase system performance and reliability and decrease cost. The high-efficiency GaAs-based microcells, measuring just 600μm by 600μm in area and less than 10μm thick, are up to 300 times smaller than cells used by competing HCPV manufacturers, it is claimed. Optics concentrates the sunlight 1000 times so that just 0.1% of the module area is covered with the microcells. The microcell's small size enables use of low-cost optics and electrical interconnects, which remove the heat, eliminating costly thermal management solutions.

"Our technology's extremely small footprint and high efficiency play a key role in minimizing HCPV system cost and improving performance and reliability," says president & CEO Joe Carr. "This demonstration system will represent a major step forward in the continuing effort to drive down the cost of solar power," he believes.

"We're looking forward to learning how Semprius' HCPV technology performs in our service territory, particularly during periods of peak electric usage," says Steve Metzger, TEP's superintendent of distribution planning & technical services. "This collaborative project will contribute significantly to our efforts to evaluate and improve the performance of solar technologies employed by TEP customers."

www.semprius.com

French CPV start-up Heliotrop wins innovation awards

Concentrated photovoltaic (CPV) module maker Heliotrop S.A.S. of Paris, France has won two awards for its CPV units.

Formed in 2009, Heliotrop (which means Sunflower in Greek) was selected from among more than 400 start-ups to receive the 'Grand Prix de l'Innovation 2010 de la Ville de Paris' (Prize for Innovation, organized by Mairie de Paris, Paris-Développement and the laboratory Paris Région Innovation). The Grands Prix de l'Innovation aim to allow young, innovative companies (e.g. those developing a technology that can be disseminated on a large scale) to be encouraged, supported and validated.

The firm also received the 'Prix Spécial du Jury — Clean Tech Republic. Heliotrop was selected for this prize by renewable-focused online publication Clean Tech Republic from among over 70 start-ups.

The awards are a sign of recognition of Heliotrop's patented technologies, says the firm's Paul Bellavoine. "Our high-concentration photovoltaic (HCPV) modules (1024 suns, higher concentration than most CPV competitors) allow us to reach a Levelized Cost of Electricity under 15c€/kWh in high direct solar irradiance areas," he claims.

Heliotrop is currently commissioning its G2.0 CPV units in several countries (in Europe and North Africa) and will start to market CPV plants in 2011. It also installed a G1.0 unit in the south of France in summer 2010.

www.heliotrop.fr

www.innovation-paris.com

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Plutonic Power partners with GE Energy Financial Services to buy 50MW portfolio from First Solar

Plutonic Power Corp of Vancouver, British Columbia, Canada and GE business unit GE Energy Financial Services of Stamford, CT, USA have agreed to acquire from First Solar Inc a 50MW (alternating current) portfolio of three cadmium telluride (CdTe) photovoltaic solar facilities to be built in Ontario. Plutonic Power identifies, develops and operates clean power projects, and the deal marks its expansion into solar power as well as into Ontario.

The firm is expected to make an equity contribution of about CDN$6m and serve as the projects' managing partner. Project debt will be arranged by First Solar on behalf of Plutonic and GE Energy Financial Services and is expected to be in place at financial close, which will coincide with the start of commercial operation.

"Expanding into both a new market and a new technology represents significant growth for Plutonic," says its vice chairman & CEO Donald McInnes. "Our solid relationship with GE Energy Financial Services enabled this expansion into our third joint near-term operating asset," he adds.

"This transaction is GE Energy Financial Services' first solar investment in Canada, broadening our US$6bn renewable energy portfolio and supporting our strong partnership with Plutonic," says Mark Tonner, managing director and Canada business leader at GE Energy Financial Services. "We see significant growth potential for solar power worldwide, which continues to improve on technology costs and efficiencies, and helps balance wind-generated power, which peaks at different times."

First Solar will continue developing the facilities — Amherstburg (10MW), Belmont (20MW) and Walpole (20MW) — and will provide engineering, procurement and construction (EPC) services and operations and maintenance (O&M) services under long-term contracts. Permitting the projects under the province's Renewable Energy Approval process is expected this spring. Construction should begin by mid-2011.

"These projects will significantly expand Ontario's supply of clean, affordable, sustainable solar energy," says Frank De Rosa, First Solar's senior VP of project development for North America.

The projects will create more than 600 construction jobs, generate tax revenues for various levels of government and create economic benefits for local businesses. Power output will be sold to the Ontario Power Authority under 20-year energy purchase agreements and will interconnect to the province's distribution grid at five points. Combined, the facilities are expected to produce enough electricity to power about 6300 local homes and avoid 14,600 tons of carbon dioxide a year (equivalent to taking 3700 cars off the road).

Plutonic Power and GE Energy Financial Services also jointly own British Columbia's largest wind farm (the Dokie Wind Project) and British Columbia's largest independent run-of-river hydro project (the East Toba River and Montrose Creek hydroelectric project), which have a combined capacity of 340MW and have secured long-term Energy Purchase Agreements with BC Hydro.

In December, GE Energy Financial Services announced that it had reached its multi-year target of investing US$6bn in renewable energy projects, which now span 14 countries and include investments in wind farms, solar installations, hydroelectric projects, landfill gas facilities and projects involving other technologies across a wide spectrum of capital (from project equity to debt and venture capital).

www.plutonic.ca
www.geenergyfinancialservices.com

First Solar to supply modules to India's ACME for 15MW

First Solar Inc of Tempe, AZ, USA has agreed to supply its CdTe thin-film photovoltaic modules to ACME Tele Power Ltd (ATPL) of New Delhi, India, which provides solutions for alternative energy and wireless telecoms, for a 15MW (DC) solar power plant in the state of Gujarat. Delivery is expected to take place by March 2011 to fulfil the Gujarat government's expectations.

First Solar is one of the few firms in the world that possess a complete set of capabilities required to realise very large photovoltaic solar projects, comments ACME's chairman & managing director Manoj Kumar Upadhyay. "This agreement is in line with our endeavour of pioneering turnkey solar technologies in India," he adds.

"Our hope is that this project will mark the beginning of a long and mutually beneficial relationship between the two companies as we begin to develop the nascent Indian solar market and ACME demonstrates its expertise in engineering, procurement and construction of projects with First Solar modules," says ACME's executive VP Atul Sabharwal.

"We see India as a land of immense opportunity and potential," comments First Solar's executive VP of marketing & product management TK Kallenbach. "We are pleased to collaborate with a leader like ACME to contribute to the country through the development of clean, affordable, sustainable solar electricity."

www.acmetelepower.com

NRG to buy First Solar's 290MW Agua Caliente project

Plant to be world's largest solar field

NRG Energy Inc of Princeton, NJ, USA, via its subsidiary NRG Solar, has agreed to acquire the 290MW Agua Caliente solar project from First Solar.

The project is due to be completed by 2014 (when it is expected to be the world's largest operational PV site) and has a 25-year power purchase agreement with Pacific Gas and Electric Company.

Situated in Yuma County on 2400 acres of land between Yuma and Phoenix, AZ, Agua Caliente is expected to generate state and local tax revenues, provide wages for up to 400 construction jobs, and create economic benefits for many local businesses.

"Solar power is critical to transitioning our nation to having a greater emphasis on large-scale clean energy technologies and it is going to be projects of the scale of Agua Caliente that will help us achieve this ambitious goal," says NRG Energy's president & CEO David Crane. "This investment significantly increases our presence in the state and benefits the residents of Arizona while providing attractive returns to NRG's stakeholders."

NRG estimates that, at full capacity, the 290MW project will provide electricity for more than 225,000 homes, offsetting about 5.5 million metric tons of CO2 over 25 years (equivalent to taking more than 40,000 cars off the road annually). Agua Caliente will generate electricity with no air emissions, no waste production and no water consumption.

"Agua Caliente is representative of our mission to provide clean, affordable, sustainable solar energy, capitalizing on our advanced thin-film technology and the tremendous solar resource of Arizona," says First Solar's CEO Rob Gillette. "We are very pleased to further expand our relationship with NRG as the owner of Agua Caliente, the first of our multi-hundred-megawatt utility-scale projects to begin construction."

An application has been submitted to the US Department of Energy for a federal loan guarantee in connection with the financing of the project, which is expected to be one of the first in the US to start construction under the program. Closing of the acquisition is contingent on receiving the federal loan guarantee. NRG plans to invest up to $800m of equity in the project through 2014 through a potential combination of cash on hand in addition to third-party investor equity.

The Agua Caliente project has secured all necessary permits for construction and the early construction phases have begun. First Solar has developed the project and is the engineering, procurement and construction contractor, using its advanced thin-film PV modules. First Solar will provide operations and maintenance services.

Agua Caliente is the latest in a series of renewable energy developments by NRG in Arizona this year. The firm is also developing a 25MW PV project for Tucson Electric Power to help meet the state's energy demands with renewable energy. In September, NRG began an initiative with Kennedy Partners to develop solar arrays for Arizona schools to meet their own electricity needs while providing new teaching tools and shade for parking.

"Arizona is a key area of growth for NRG where our investment is creating local jobs and building infrastructure," says Tom Doyle, president of NRG Solar and a Phoenix resident. "It is very gratifying to be able to see the benefits of our partnerships with local schools, providing cooling and heating for local businesses and universities and developing solar fields like Agua Caliente and our project for Tucson Electric Power."

www.nrgenergy.com

IN BRIEF

EPIR receives business award

EPIR Technologies Inc of Bolingbrook, IL, USA, which develops infrared sensor, biosensor and solar photovoltaic products, has been honored by the Bolingbrook Chamber of Commerce as a winner of a 2010 Best of Bolingbrook Business (BoBB) award.

EPIR was founded in 1997 by chairman & CEO Dr Sivalingam Sivananthan who, at the University of Illinois at Chicago, pioneered the growth of single-crystal II-VI materials such as mercury cadmium telluride (HgCdTe) on silicon for infrared night-vision applications. EPIR is now building on this to also develop and manufacture high-efficiency, low-cost multi-junction solar cells for concentrated photovoltaic (CPV) applications.

Over the past three years EPIR has tripled in size as it expanded into manufacturing infrared night-vision products for defense and commercial applications and continued its product development for solar energy applications. The BoBB award was bestowed upon the Bolingbrook-based businesses that contributed the most to the community through innovative business practices, significant accomplishments, and corporate citizenship. The award was presented to EPIR by mayor Roger Claar at a banquet ceremony honoring all the nominees.

"This is a testament to the remarkable growth EPIR has experienced in some of the toughest times this nation has ever seen," says Dr Chelva Kumar, a member of EPIR's board of directors. "We have consistently added skilled jobs over the past three years and will continue to help stimulate the local economy with our planned transition into solar cell manufacturing."

www.epir.com

First Solar forecasts 46% growth in 2011 to $3.7–3.9bn

Operating cash flow of $1.0–1.1bn to help double production capacity

First Solar Inc of Tempe, AZ, USA, which makes thin-film photovoltaic modules based on cadmium telluride (CdTe) as well as providing engineering, procurement and construction (EPC) services, forecasts that in 2011 its net sales will be $3.7–3.9bn (up 46% year-on-year on the midpoint of 2010 guidance, provided on 28 October, of $2.58–2.61bn). This consists of $2.8–2.9bn of module sales and $0.9–1.0bn of EPC/project development sales.

EPS (earnings per fully diluted share) is forecasted to grow to $8.75–9.50 per fully diluted share (compared with guidance for 2010 of $7.50–7.65 for 2010). Consolidated operating income should be $875–975m (compared with 2010 guidance of $595–620m). These forecasts include $80–85m of manufacturing start-up expenses and $15–20m of factory ramp costs associated with plant expansions.

During 2011 First Solar expects to generate $1.0–1.1bn of operating cash flow. The firm also plans to invest $1.0–1.1bn of capital in order to nearly double production capacity by year-end 2012, to maintain existing capacity, and to add infrastructure to support growth.

"First Solar revenue and profit is continuing to grow in 2011," reckons CEO Rob Gillette. "We are benefiting from diversifying global partner demand and an increase in revenue from utility-scale projects."

www.firstsolar.com

Executive chairman Ahearn to become chairman of board; chief accounting officer Zhu made interim chief financial officer

On 1 January, Mike Ahearn transitioned from executive chairman of First Solar to chairman of the board of directors, which is described as a natural evolution of the leadership succession announced in 2009 when Rob Gillette was appointed CEO.

"We thank Mike for his unwavering dedication to First Solar and look forward to continuing to work with him," says Gillette.

Also, chief accounting officer James Zhu has been appointed interim chief financial officer, succeeding Jens Meyerhoff and overseeing financial operations until a new CFO is named. As announced in July, Meyerhoff is fully transitioned from his role as CFO to president of First Solar's Utility Systems business, which provides complete large-scale PV system solutions for utility customers.

"We are confident James will transition seamlessly into this new role given his deep experience and knowledge of our financials and financial systems," says Gillette. "This also frees Jens to be fully dedicated to running our global Utility Systems business and managing our 2.2GW captive project pipeline, which will be key drivers of our future growth."

Zhu joined First Solar in 2007 as VP & corporate controller and has been chief accounting officer since 2009. Previously, he held positions in accounting and controlling at Salesforce.com, Chiron Corp and KPMG LLP. He is a Certified Public Accountant and earned a B.A. in economics in China and an M.B.A. in accounting from Golden Gate University.

China Guangdong Nuclear to co-develop Ordos project

At a ceremony in Beijing, First Solar's president Bruce Sohn and Han Qinghao (president of China Guangdong Nuclear Solar Energy Development Co Ltd, or CGN SEDC) have signed a memorandum of understanding (MOU) to collaborate on the development of Phase 1 of the previously 2GW solar photovoltaic (PV) plant in Ordos City, Inner Mongolia, China.

The agreement is a key step forward for the Ordos project, following First Solar's MOU with the Ordos Government in September 2009, and the Chinese government's approval last September of the pre-feasibility study for Phase 1.

Founded in August 2009 as a subsidiary of China Guangdong Nuclear Power Group, CGN SEDC focuses on solar power investment, construction, operation and maintenance, and is actively involved in related industries. By the end of 2010, it had completed construction of solar facilities capable of producing 20MW, and is currently in the process of constructing facilities with a capacity of 70MW.

In the latest MOU, First Solar and CGN SEDC will work together to execute the 30MW AC first-phase demonstration project. CGN SEDC will be the majority project owner and operator, performing engineering, procurement and construction (EPC) functions. First Solar will supply its thin-film solar PV modules and will support CGN SEDC with EPC and operations and maintenance (O&M) advisory services.

"We look forward to working together to make the Ordos project a reality and to contributing to China's renewable energy goals and market development," says Sohn. Ordos is the first significant solar project to adopt advanced thin-film technology in China, comments Han Qinghao.

Ordos is also the first large-scale solar collaboration between China and the USA and an example of China–US bilateral cooperation.

www.cgnsedc.com.cn

First Solar buys utility solar tracker maker RayTracker

First Solar has acquired RayTracker Inc of Pasadena, CA, a tracking technology and balance-of-systems firm that is an operating company of Idealab, a creator and operator of technology firms.

RayTracker is also backed by The Quercus Trust and Phoenix Fire IV LLC (whose manager, Richard Klein, owns and operates Quixotic Systems Inc).

RayTracker was founded to meet the need for robust, reliable and cost-effective solar trackers, as well as software and hardware to enable the lowest-cost design, installation and operation of solar PV plants.

RayTracker's entire team will join First Solar's Engineering, Procurement and Construction (EPC) group, bringing expertise in solar technology innovation, reliability engineering, advanced PV system modeling, software engineering, product development and high-volume manufacturing. RayTracker's customers will be transitioned to First Solar, the firm says.

"Addition of RayTracker's people and technology will help accelerate our ongoing quest to enable a world powered by clean, affordable and sustainable solar electricity," says First Solar's president Bruce Sohn. "We welcome RayTracker's innovative associates to our advanced systems development team," he adds.

First Solar shares RayTracker's vision of reducing the levelized cost of solar electricity to that of fossil fuels, says RayTracker's president Mark Henderson. "From early on in our discussions with First Solar, it was very clear that there was great synergy between the capabilities and technologies of the two companies," he adds. Technology developed by RayTracker includes its GC-Series single-axis trackers, its unique PV-Platform Software Toolset for system design and operation, wireless infrastructure technology, and other PV balance-of-system innovations.

www.raytracker.com

NextEra buys 40MW of Canadian PV projects from First Solar

NextEra Energy Resources LLC (the competitive-energy subsidiary of NextEra Energy Inc of Juno Beach, FL, USA, and the largest generator in North America of renewable energy from the wind and sun) has agreed to buy four solar projects totaling 40MW in Ontario, Canada from First Solar.

As a provider also of engineering, procurement and construction (EPC) services, First Solar is continuing with development and construction of the Sombra and Moore Solar Energy Centers (in Sombra and Moore Townships, Ontario) using its thin-film solar modules. Each Solar Energy Center will consist of two 10MW PV projects. Once operational, NextEra Energy Resources' Canadian subsidiary, NextEra Energy Canada, will own and operate all four projects. All of the power from them will be sold to the Ontario Power Authority under long-term contracts.

The Solar Energy Centers will each use thin-film technology on a fixed tilt system. Each 10MW project will consist of more than 172,000 panels. Collectively, the centers will provide enough power to serve about 6440 homes, and are expected to help avoid nearly 45,000 tons of CO_2 annually (equivalent to removing nearly 8600 cars from the road every year for the life of the project).

Pending the necessary government approvals, construction on all four projects is expected to begin in first-quarter 2011, with commercial operation expected by the end of 2011.

"We're pleased to expand our position as North America's leading generator of solar power through the addition of our first Canadian solar projects," says NextEra Energy Resources' president & CEO Mitch Davidson. "Solar power will help promote a clean-energy economy in Ontario, reduce its dependence on fossil fuels, and address global climate change through the production of emission-free energy," he adds.

"We're pleased to forge this new customer relationship with NextEra Energy Resources, a company that shares our strong commitment to developing renewable energy in North America," says Frank DeRosa, First Solar's senior VP of North American project development.

www.NextEraEnergyResources.com

IN BRIEF

First Solar awarded CanSIA's 'Solar PV Project of the Year'

First Solar has been recognized by the Canadian Solar Industries Association (CanSIA) for developing and constructing Canada's largest PV power plant.

The 80MW Sarnia solar project, completed this October in Sarnia, Ontario, and purchased by Toronto-based energy distributor Enbridge Inc, is also said to be the world's largest operating PV facility.

Enbridge and First Solar jointly accepted the 'Solar PV Project of the Year' award at CanSIA's annual conference on 7 December. "Together with Enbridge, we are leading the development of utility-scale solar energy in Canada," claims Frank De Rosa, First Solar's senior VP of project development for North America.

Peter Carrie, First Solar's VP of business development in Canada, was also honored for his individual contribution to Canada's solar industry and received the 'Solar Leader of the Year' award.

www.firstsolar.com

5N Plus' sales match company record

Ge-related acquisitions to supplement CdTe boom

For its fiscal second-quarter 2011 (to end-November 2010), 5N Plus Inc of Montreal, Quebec, Canada has reported (in Canadian dollars) revenue of $19.7m, up 5% on fiscal Q1's $18.7m and up 24.8% on $15.8m a year ago (and equaling the firm's record of Q4/2010).

5N Plus produces high-purity metals such as tellurium, cadmium, selenium, germanium, indium and antimony. It also produces II-VI semiconducting compounds such as cadmium telluride (CdTe), cadmium sulphide (CdS) and indium antimonide (InSb) as precursors for the growth of crystals for applications including infra-red detectors for night-vision systems, radiation detectors for medical imaging, and thin-film photovoltaic cells for solar panels.

Net earnings from continuing operations were $4m, up 24.9% on $3.4m a year ago. "This is our fourth consecutive quarter in which sales and earnings have reached respectively in the $19m and $4m ranges, despite the appreciation of the Canadian dollar and some competitive pressures on margins," says president & CEO Jacques L'Écuyer.

The backlog of orders expected to translate into sales within 12 months is $62.6m, up on $57.4m last quarter and $53.3m a year ago (despite changes in currency exchange rates having an adverse impact of about $6.4m). "Our record backlog expanding by 18% in the past year reflects the continuing strengthening of our base business," says L'Écuyer.

"We continue to expect further strengthening of our base business, especially in the solar sector, as our main customer in this market continues to grow and to demonstrate leadership in terms of cost effectiveness," L'Écuyer says. "Developments made by our other customers in this market remain encouraging, and we were particularly delighted in this respect to hear of the recent announcement made by the US Department of Energy concerning the $400m loan guarantee granted to Abound Solar," he remarks. "Now that our new photovoltaic module recycling facility in Wisconsin is operational, we believe that we are uniquely positioned to service all of these customers and take advantage of the resulting anticipated growth in this market segment."

Construction is now almost complete on the new facility in Trail, British Columbia for the subsidiary Firebird Technologies Inc (which produces indium antimonide wafers as well as antimony, indium and tin pure metals), reports L'Ecuyer. "We expect the facility to be fully commissioned during the fourth quarter of the current fiscal year and Firebird to begin generating significant germanium-related revenues in the first quarter of fiscal 2012. Together with the investment made in Sylarus [which produces germanium substrates in Saint George, UT, USA] and announced recently, this will form the basis of our germanium-related activities and position us as one of the leading producers of germanium products for electronic applications," he believes.

www.5nplus.com

5N Plus converts $3m debenture to Sylarus into majority stake

5N Plus Inc of Montreal, Canada, a provider of high-purity metals, compounds and wafers for electronic applications, has agreed to convert the US$3m debenture provided on 21 June 2010 to Sylarus Technologies LLC of Saint George, UT, USA (which produces germanium substrates for manufacturing multi-junction compound semiconductor photovoltaic cells) into a 66.67% majority interest.

5N Plus has also agreed to provide additional funding of US$766,000 in the form of secured debt to enable the repayment of short-term debt contracted by Sylarus. In addition, 5N Plus intends to support Sylarus capital expenditures, working capital requirements and development expenses as needed.

Sylarus is a key customer of 5N Plus' subsidiary Firebird Technologies of Trail, British Columbia, Canada (acquired in December 2009), which provides high-purity germanium feedstock and corresponding recycling services for germanium-containing residues. 5N Plus' Jean Bernier will act as general manager of Sylarus until further notice.

"They are one of the very few germanium substrate manufacturers qualified for space applications and are well positioned to take advantage of the anticipated growth in concentrator photovoltaics [CPV] for terrestrial applications," says 5N Plus' president & CEO Jacques L'Écuyer. "5N Plus is now one of the leading producers of germanium, with a full range of related products for the infrared optics, LED and photovoltaic markets, as a result of Firebird's product portfolio and supply agreements with Teck Metals," he claims.

"Although the acquisition of Sylarus is not expected to be immediately accretive, as Sylarus gradually ramps up production and completes its development work we expect that, within a 24 month period, it will have a positive impact on the earnings of the group," L'Écuyer reckons.

http://sylarus.com

Abound closes $400m DOE loan guarantee and $110m equity investment

CdTe PV firm secures Indiana site for expansion to 840MW

Cadmium telluride (CdTe) thin-film photovoltaic (PV) module maker Abound Solar of Loveland, CO, USA has closed on a $400m loan guarantee from the Department of Energy.

It has also raised a extra $110m in equity financing from existing investors Invus Group, Bohemian Companies, DCM, and Technology Partners, joined by new investors BP Alternative Energy Ventures and West Hill Companies. This increases Abound's equity financing to about $260m since the firm's inception in 2007 (since when Abound has built its first production line in Longmont, CO and begun full-scale commercial operations in November 2009).

The debt and equity financings will enable Abound to expand capacity at both its Longmont facility (where it has already begun construction of a second manufacturing line to boost capacity to 200MW per year by the end of 2011) and later at a second site in Indiana which, when completed, will create 1200 new manufacturing jobs.

Abound has leased a 781,750ft^2 facility in Tipton, IN on a 104 acre site. An investment group led by real-estate development firm W.W. Reynolds Companies of Boulder, CO bought the facility from the trust of contractors that had held the property since the 2009 bankruptcy of former owner Getrag Transmission Manufacturing LLC. Abound has entered into a long-term lease with W.W. Reynolds Companies that enables it to make the necessary property improvements to facilitate the development (beginning in 2012) of a solar module manufacturing plant with an annual capacity of 640MW per year.

"We appreciate the support of the local community and its leaders that have helped to make this happen," says president & CEO Tom Tiller. When both plants are complete, Abound will be able to produce more than 840MW of solar modules annually.

"Abound Solar's strong partnership with a growing list of industry-leading customers gives us the confidence to make these large investments to meet the strong demand for our product," says Tiller.

"Over the past three years, the company's management team and employees have proven their ability to execute and build an innovative manufacturing platform that enables the company to significantly reduce the cost of solar electricity," claims chairman Doug Schatz.

www.abound.com

Surrey Satellite Technology wins €10.69m ESA contract; MCT to improve on InGaAs in SWIR detectors

Surrey Satellite Technology Ltd (SSTL) of Guildford, UK has won a €10.69m contract from the European Space Agency (ESA) via Dutch Space to provide a short-wave infrared (SWIR) spectrometer as part of the Tropospheric Ozone Monitoring Instrument (TROPOMI) for the Sentinel 5 Precursor atmospheric monitoring mission.

The Optical Payloads Group of SSTL (which is owned by EADS Astrium NV) will coordinate an industrial consortium including the Netherlands Institute for Space Research (SRON) and France's Sofradir — which makes cooled IR detectors based on mercury cadmium telluride (MCT/HgCdTe) for military, space and industrial applications — to procure and integrate the precision remote sensing instrument.

The SWIR spectrometer will be used to measure atmospheric carbon monoxide (CO) and methane (CH_4) — the latter being the second most important anthropogenic greenhouse gas. After completion of ESA's Envisat Mission, the Sentinel 5 Precursor mission aims to provide a source of accurate and detailed data, allowing scientists to continue to study both air quality and climate change until Sentinel 5 is launched in the next decade. "It is imperative that we maintain the excellent atmospheric and environmental data provided by Envisat," says SSTL's Dr Matt Perkins.

"Climate change and air quality are global issues requiring the best scientific and technical approaches and we are very proud that the UK has the technology and experience to lead such an important European space project," says Dr Ruth Boumphrey, head of Earth Observation at the UK Space Agency.

Sentinel 5 Precursor builds on developments of TROPOMI, which is led by Dutch Space as prime contractor. TROPOMI, which is co-funded by The Netherlands and ESA, includes much improved SWIR measurements compared to the SCIAMACHY instrument onboard Envisat. A push-broom replaces SCIAMACHY's scanning instrument, providing much smaller pixels (7km^2 x 7km^2 vs 120km^2 x 30km^2), and the measurement sensitivity is also greatly improved. Immersed grating technology will increase the effective resolution of the instrument without increasing the size and mass of the module.

Also, the MCT detectors should be less susceptible to in-flight radiation damage than the near-infrared (NIR) extended-wavelength InGaAs detector arrays on board Envisat.

www.sstl.co.uk

IN BRIEF

Ascent appoints new Norsk Hydro board member

Ascent Solar Technologies Inc of Thornton, CO, USA, which makes CIGS-based flexible thin-film photovoltaic modules, has appointed Hans Olav Kvalvaag to its board of directors to replace Einar Glomnes, who has resigned from the board.

Kvalvaag was designated for the appointment by largest stockholder Norsk Hydro Produksjon AS pursuant to a stockholder's agreement with Ascent. Norsk Hydro's prior board designee Glomnes was recently promoted to VP sales Europe and has assumed an expanded role with additional commitments within Norsk Hydro. He is therefore no longer able to devote adequate attention to his board position.

Kvalvaag joined Norsk Hydro in 2006 within its New and Alternative Energy group. He is currently part of the firm's Corporate Business Development team. He holds a law degree from Norway's University of Oslo, and finance diplomas from the Norwegian School of Business Administration and the University of Auckland. He has worked as a management consultant with McKinsey & Company and further as a lawyer with Norwegian law firm Selmer, focusing primarily on the Energy and Oil & Gas arena.

"I would like to thank Einar for his significant contributions to Ascent Solar's growth and progress. We wish Einar the very best as he expands his responsibilities at Norsk Hydro," says Ascent Solar's president & CEO Dr Farhad Moghadam. "We also welcome Hans to our board and look forward to benefitting from his expertise and insights, as well as continued support from Norsk Hydro."

www.ascentsolar.com

Solyndra enhances Italian architectural landmark with 370kWp rooftop PV system

Solyndra Inc of Fremont, CA, USA, which makes cylindrical copper indium gallium diselenide (CIGS) photovoltaic (PV) systems consisting of panels and mounting hardware for commercial rooftops, has completed a 370kWp rooftop solar system on an architectural landmark in Valenza Po, Italy owned by Finpiemonte Partecipazioni S.p.A., a holding of mixed private/public enterprises in the Piemonte region. The building holds the Palaexpo Jewelry Company.

Designed and built under a power purchase agreement (PPA) in conjunction with energy company ARDEA Energia S.r.l. and local utility firm EGEA, the 370kWp system consists of about 2030 panels and took about three weeks to be installed by Gruppo Caraglio, a local energy performance contractor (EPC) selected by ARDEA Energia. The system has been nominated as one of the best Italian rooftop PV installations for 2010.

"The Solyndra system also complements the fine architecture of our building in several important ways," says Dr Paolo Marchioni of Finpiemonte. "The lightweight system did not require additional engineering or penetrations of the roof. This protected the integrity of the building and the quick installation meant there was minimal disruption to our business," he adds.

"The Solyndra system allowed more power peak density than competitive systems, and therefore creates a greater revenue stream," says ARDEA's CEO Dr Pierpaolo Carini. "We were pleased with how quickly and easily the system could be implemented, and it is already generating power."

"This project is a great example of why Italy continues to be a strong market for Solyndra systems," says Clemens Jargon, Solyndra's president of EMEA and managing director Solyndra GmbH. "Working closely with ARDEA Energia and the local utilities, we were able to design a system that generates the most possible power from their rooftop to take advantage of government incentives, while not requiring re-engineering of this well known building."

www.solyndra.com

370kWp Solyndra system on a rooftop in the Piemonte Region of Italy.

DayStar eliminates $5m of debt as strategic partnership talks continue

At its 2010 Annual Shareholder meeting on 30 December, DayStar Technologies Inc of Milpitas, CA, USA, which is developing copper indium gallium diselenide (CIGS) thin-film photovoltaic products, announced that it has entered into a series of agreements with a number of its vendors to eliminate an additional $5m in debt from its balance sheet in exchange for shares of its common stock.

Last October, Socius CG II Ltd entered into agreements with 14 of DayStar's vendors to purchase about $1m of the firm's debt, and settled the resulting amounts owed in exchange for free-trading shares of DayStar's common stock.

At the meeting, shareholders elected six directors (Peter Lacey, Magnus Ryde, Jonathan Fitzgerald, Richard Green, William Steckel, and Kang Sun) to a one-year term. In addition, they approved the terms of certain convertible notes and warrants, including the issuance of shares upon conversion of such notes or exercise of such warrants. Shareholders also approved an amendment to the firm's Amended and Restated 2006 Equity Incentive Plan to increase the number of shares available for issuance under the plan, and the ratification of Hein & Associates LLP as independent auditors.

"The key support of our shareholders and creditors has helped us to maintain a key component of our attractiveness to strategic partners," says CEO Magnus Ryde. "We have made significant progress in restructuring our balance sheet which should better position us as we continue our discussions with potential strategic partners," he adds. "The partnerships we are pursuing, if consummated, could include joint ventures, licensing agreements, contract manufacturing agreements, a reverse merger with or an acquisition of DayStar."

"We appreciate the continued support of our vendors and other stakeholders," says Ryde. "This past year has had its challenges, but we are pleased with our progress towards completing crucial activities to enhance our ability to pursue strategic transactions to manufacture our CIGS modules."

Last July, Ryde said that, "while DayStar has accomplished significant innovations with our CIGS process and technology, we have encountered challenges in obtaining affordable capital for the build-out and operation of our facility in Newark... We are pursuing opportunities to manufacture our CIGS modules offshore and have begun discussions with several potential partners to implement this strategy."

www.daystartech.com

Avancis' PowerMax CIS photovoltaic module obtains MCS certification for UK market

Avancis of Torgau, Germany (a subsidiary of Saint-Gobain of Courbevoie, France since autumn 2009), which makes thin-film photovoltaic modules based on copper indium selenide (CIS), has completed key certification assessments for its PowerMax product line to ensure entry into the UK market.

The modules have been awarded the MCS (Microgeneration Certification Scheme) certificate, after having also recently passed salt water and salt spray certification tests. The panels are thus certified as being suitable for use in systems along coastal areas and are provided with incentives under the UK feed-in tariff system, the clean energy cash back scheme.

The MCS certificate has been awarded by the British Standards Institute (BSI), certifying that the panels comply with all approval conditions for sale in the UK. The British certification mark is an independent, internationally recognized symbol of product quality and safety. As well as strict product tests, the certification process also involved inspection and certification of the production facilities themselves.

Before obtaining BSI certification, the PowerMax panels passed the German certification body TÜV Rheinland's salt spray test in compliance with IEC 61701, meaning that they are specifically suitable for use in coastal areas, as they offer particularly effective resistance to salt water and salt spray.

"Thanks to its favourable performance in weak light conditions and the superior sensitivity spectrum of CIS technology, PowerMax offers British PV system operators optimum energy efficiency and high yields, even at low levels of sunlight and under diffused light conditions," says quality director Dr Tom Clarius. "The MCS certificate and the particular suitability of our modules for use in coastal areas ensure that we are ideal candidates for the British market as well as for other countries with coastal regions," he adds.

PowerMax panels are also certified in compliance with IEC standards 61646 and 61730 and are approved according to the strict requirements of the American UL 1703 standard. The CIS panels are also designed for areas exposed to high wind and snow loads, and are able to withstand 551kg/m.

Avancis also works with a large number of distributors who market PowerMax panels in the UK.

www.avancis.de/en

Sol Array unveils CIGS cell for 20MW pilot production

Sol Array LLC of San Francisco, CA, USA has unveiled its first copper indium gallium diselenide (CIGS) thin-film solar cell, which is made using a unique, highly adaptable process tailored for mass production.

The process uses commercially available, inexpensive soda-lime glass as substrate material, a simplified continuous in-line PVD process for deposition of all CIGS thin-film stacks, and a four-element compound target for simple one-step deposition. This eliminates the cumbersome co-evaporation of various CIGS elements for forming the active CIGS layer, ensuring consistency and repeatability in mass production, and achieving highly efficient and low cost manufacturing, it is claimed.

Sol Array has based its research in the US and its volume production in Dong Guan, China, where government stimulus funding is available. Headed by a veteran of the flat-panel display industry, Jimin Ma has assembled a team of thin-film technologists and automation specialists for product development and system engineering.

The global thin-film PV market is expected to reach $7.2bn by 2015, compared to just over $1bn in 2007, according to a report by NanoMarkets; annual thin-film solar production has now surpassed half the US market share and will do so worldwide by 2015. Also, within thin-film solar, CIGS should surpassed CdTe and amorphous silicon by 2012, reckons Information Network, manifested by the following:

- CIGS has the highest theoretical conversion efficiency; it can absorb over 99% of the solar spectrum and has the highest current density. Of all thin-film solar technologies, CIGS has the highest efficiency for laboratory samples (20.5% for small-area, experimental cells).
- CIGS is free from adverse environmental impact and is not threatened by poisonous by-products such as Te in CdTe thin film cells;
- CIGS has the potential to be the lowest cost for volume production, reckons Sol Array (amenable to large-area, automated production);
- CIGS films retain performance properties better than most other solar semiconductors.

In the commercial solar industry as a whole, there is a trend towards CIGS, claims Sol Array, with Honda Soltec, Shell, Daystar, Ascent Solar, Global Solar, HelioVolt, Miasole and Nanosolar all pursuing volume production.

In laboratory research, the pursuit of alpha-phase CIGS is approaching maturity, hovering at about 20%. The immediate challenge rests with commercializing CIGS cells, aiming for a high-volume, low-cost, repeatable process for economic vitality.

As well as drawing on a network of expertise in US and European research institutions for product development and patent revenue, Sol Array has established its main manufacturing base in China, not only for the benefit of long-term production cost control but also to tap growing market demand there.

Sol Array says that a 20MW pilot-production line using its process and system engineering will start up in early spring

Collaboration presently extends through the USA, Europe and China, with vacuum deposition facilities tailored to mass production.

Sol Array's core management was transferred intact from the former thin-film flat-panel display firm Lite Array Inc. Cross fertilization of the founding team between the thin-film display and thin-film solar industries has facilitated a high-yield, high-volume and cost-effective production process, says Sol Array.

To achieve a commercially viable production method and to attain alpha-phase CIGS thin-films, Sol Array says that it has overcome the following challenges:

- Repeatability in thin-film stack thicknesses and uniformity, where the combined thickness of the active layer is just 1.8μm, with the thinnest layer no more than 50nm (a precision-controlled, pulse DC sputtering process is an ideal approach);
- Repeatability in stoichiometry between thin-film layers is equally critical. An experiment at an affiliated research institute, using pulse DC sputtering for four-element compound deposition and without selenization, has delivered a high-density, pin-hole-free thin-film stack. The proportion of each element copper, indium, gallium and selenium in the active layer (where alpha-phase CIGS can tolerate no more than 0.5% deviation in atomic weight of any element) is equally critical — only a fully automatically controlled process can come close to delivering the required repeatability;
- Repeatability in crystal lattice arrangement — a stringent and difficult requisite for conventional evaporation techniques to synchronize is now replaced by Sol Array's PVD approach;
- Commercialization calls for large-scale, low-cost production; the use of a dense four-element solid CIGS target for uniform thin-film thickness and high-percentage material reclamation is best suited to Sol Array's in-line sputtering process, giving what is claimed to be the lowest material consumption for volume production;
- Use of a fully automated, in-line PVD system promises a highly synchronized and repeatable production process, ensuring a consistent interface between the p-type CIGS absorbing layer and the doped surface n-type layer near the interface CdS buffer layer, says the firm.

Sol Array says that a 20MW pilot-production line using its process and system engineering will start up in early spring, pending the infusion of additional capital (to be raised from on-going funding activities).

http://solarrayllc.com

SoloPower to build panel production plant in Oregon

$20m in Oregon State loan supplements $51.58m venture funding

SoloPower Inc of San Jose, CA, USA, which makes flexible, lightweight copper indium gallium di-selenide (CIGS) thin-film photovoltaic (PV) cells and modules using a proprietary roll-to-roll electro-deposition process, is to locate a new high-volume manufacturing plant in Wilsonville, OR.

The Small Scale Energy Loan Program (SELP) Advisory Committee recommended approval to the Oregon Department of Energy for a $20m loan to SoloPower. The firm has also applied for a Business Energy Tax Credit (BETC) of $20m from the State of Oregon.

The State funding supplements $51.58m in equity and warrant/option financing raised last month from existing investors Crosslink Capital (of San Francisco), Convexa A/S (of Oslo, Norway) and Hudson Clean Energy Partners LP (of Teaneck, NJ), according to a filing with the US Securities & Exchange Commission in order to expand SoloPower's existing 109,000ft^2 San Jose plant and finance construction of a new plant. Previously, SoloPower (which was founded in 2005) raised $230m in 2008 alone, followed by $44.9m in debt financing last February.

The Oregon State programs aim to enable the firm to rapidly scale up production, while providing an economic boost to the community, creating jobs and supporting local businesses. The initial phase of the expansion will be the construction of a 75MW manufacturing line that will create 170 jobs. Upon completion, the facility is expected to involve a total investment of about $340m, employ about 500 staff, and have capacity of 300MW, greatly enhancing SoloPower's ability to provide modules to its growing list of global customers. SoloPower is also in discussions with the US Department of Energy to obtain a loan guarantee under Section 1703 of the Energy Policy Act of 2005 to support the construction of the additional production lines.

"We are committed to supporting the solar industry help fulfill national and state goals furthering sustainability and energy independence," says Wilsonville's mayor Tim Knapp. "The City is partnering with Business Oregon with the help of Clackamas County to promote smart job-growth in the private sector," he adds.

"Over the past year, SoloPower has considered several alternative sites," notes CEO Tim Harris. "Oregon is an exceptional location for our long-term growth," he adds. "SoloPower greatly appreciates the partnerships it has formed with the State of Oregon, the Oregon Department of Energy, Clackamas County and the City of Wilsonville. Oregon's business friendly environment, excellent support programs, and highly skilled work force made locating our new manufacturing facility in Oregon an easy decision," Harris concludes.

www.solopower.com

SoloPower launches most powerful, certified flexible CIGS module

SoloPower has expanded its product line to include the newly certified SFX3 module.

Capable of producing up to 260Wp, the SFX3 is claimed to be the most powerful, certified, flexible thin-film CIGS module on the market. It complements the narrower SFX1 module, which was the first flexible CIGS module certified to both UL 1703 and IEC (61646 & 61730) standards.

"Achieving the certification of both our wide and narrow modules to the necessary UL and IEC standards [achieved through Intertek and TÜV SÜD America Inc, respectively] allows us to provide efficient and cost-effective solutions to a broad range of market channels and geographies," says CEO Tim Harris. "With the SFX3 module passing the same certification standards as the SFX1 recently did, we can deliver powerful, lightweight products optimized for use on both low-slope and standing-seam metal roof systems in Europe, North America and Asia," he adds.

At just under 0.5lb/ft^2, the SFX1 (up to 85Wp, 0.292m x 3.05m, 2.27kg/5lbs) and the SFX3 (up to 260Wp, 0.88m x 3.05m, 6.8kg/15lbs) weigh much less than traditional solar panels, which are often too heavy to be placed in large numbers on older buildings, the firm says.

SoloPower's aperture efficiency also continues to improve, with the US National Renewable Energy Laboratory (NREL) measuring flexible modules made on the firm's production line as high as 12.1%. "Breaking through the 12% aperture efficiency barrier for production line modules is an added bonus," says Harris. SoloPower has improved aperture efficiency from 11.2% to 12.1% over the past 6 months while beginning to deliver products to the global market.

"Our high power SFX3 panel enhances the company's position in the flexible solar segment and demonstrates our drive to lower the cost of solar power to grid parity," says chief technology officer Mustafa Pinarbasi.

SoloPower is in the process of shipping SFX1 and SFX3 modules to customers in Australia, Belgium, France, Germany, Japan and Korea and to multiple locations in North America. Packaged in a durable, lightweight, flexible form, demand is rising rapidly, says the firm.

Stion to site mass-production facility in Mississippi

State incentive lures San Jose-based CIGSSe PV firm

Stion Corp, which has initial 10MW-capacity manufacturing and R&D facilities for its nanostructure-based thin-film solar panels in San Jose, CA, USA, is to build its first mass-production facility in Mississippi as part of an incentive agreement with the state that includes a $75m loan and other tax and training incentives. The project will be the first thin-film solar panel factory in Mississippi.

Stion's product line features 65cm x 165cm glass–glass copper-indium-gallium-sulfide-(di)selenide (CIGSSe) PV panels using monolithically integrated circuits. With a form factor of 65cm x 165cm, efficiencies of at least 11% and power ratings of 110–120W, the modules are usable in all major markets, including commercial/government, residential, utility and off-grid.

The project's first phase includes a line with annual capacity of 100MW in Hattiesburg, MS — to come on line in 2012 — entailing over $100m of investment and creating 200 direct jobs in 2011 and 2012, says Stion. Over the next six years, the project should deliver more than 1000 jobs and $500m of investment.

"Together, the state of Mississippi, Forrest County, and the city of Hattiesburg offer a business-friendly location with a strong resource base for manufacturing," says Stion's president & CEO Chet Farris. "In partnering with them, we are pleased to help address this country's energy needs with clean technology, and support the region's and the nation's economy," he adds.

Founded in 2006 as Nstructures, Stion raised $15m in June 2007 in a Series B financing round led by Lightspeed Venture Partners and joined by General Catalyst Partners along with previous investors Khosla Ventures and Braemar Energy Ventures. Last June, these added $20m to $50m invested by the world's largest semiconductor foundry Taiwan Semiconductor (TSMC) — via its affiliate VentureTech Alliance — in a $70m Series D round of fundraising to help scale production (boosting the total raised since 2006 to $114.6m).

"Our expansion in Hattiesburg is an integral part of our capital-efficient scale-up plan," says Farris. "The cost and time-to-market advantage of building here will provide a significant competitive advantage," he reckons.

www.stion.com

W Solar to move to Wisconsin and enter production

CIGS PV panel maker gets $28m tax credits to help create 620 jobs

Wisconsin Governor Jim Doyle says privately owned W Solar Group Inc of Chatsworth, outside Los Angeles, CA, USA, which has developed copper indium gallium (di)sellenide (CIGS) thin-film photovoltaic panel technology, will receive up to $28m in Enterprise Zone tax credits from the state Department of Commerce to help it to set up a manufacturing facility in the state and to relocate its corporate headquarters and R&D facilities to Dane County.

W Solar was founded in 2009 and has less than 20 staff, all in R&D.

The firm is considering specific locations for the new site. "W Solar choosing to locate its manufacturing facility in Wisconsin is a testament to the hard work we've done over the past 8 years to build a strong sector of our economy around clean energy and high-end manufacturing," says Doyle. "This investment will create new business opportunities and jobs at suppliers throughout the region."

The firm expects to open its new headquarters and R&D facilities in first-half 2011 and to begin manufacturing in 2012. Conditions for the state incentives include targets for creating jobs in 2013 and 2014 prior to full-capacity production in 2015, when W Solar expects the number of full-time jobs created to reach 620 (mostly in production). Capital investment should amount to more than $300m. The firm says that the projected global market for solar panels is expected to grow more than tenfold over the next decade, and that it expects about half of its production to be exported to overseas markets.

"W Solar Group was attracted to Wisconsin early in our search for a project location," says W Solar's president & CEO Chris Hamrin. "We are impressed with the high-quality workforce, extensive supply chain, and the commitment to producing world-class products," he adds.

The firm has also made a commitment to buy materials and services from Wisconsin suppliers in an effort to create or retain additional jobs.

Wisconsin claims to be a national leader in solar installations, with firms assisted by the Department of Commerce previously including Cardinal Glass, 5N Plus, PDM Solar, ZBB Technologies, and Helios.

Last October, 5N Plus Inc of Montreal, Canada, which provides high-purity metals (including cadmium, indium and selenium) as well as related II-VI compounds such as cadmium sulphide, said that its US subsidiary 5N Plus Corp of DeForest, WI had been awarded $500,000 in funding from the State Energy Program of Wisconsin to support an expansion of its solar modules recycling and its manufacturing of specialty compounds for thin-film PV applications.

www.wsolar.com

AQT to site second manufacturing plant in South Carolina

Annual capacity of 1GW and 1000 jobs targeted by 2014

Privately held AQT Solar of Sunnyvale, CA, USA has selected a 184,000ft^2 LEED Silver Certified facility in the Carolina Pines development in Richland County, SC as the site of its second copper indium gallium diselenide (CIGS) thin-film solar cell manufacturing plant.

AQT opened its first R&D and manufacturing facility in Sunnyvale (close to the firm's former base in Santa Clara) just last August, with customer shipments starting in December. Annual capacity should rise from its initial 15MW to its full 30–40MW capacity by the end of 2011, only partly fulfilling AQT's existing order backlog of 160MW (50MW of which is due in 2011).

However, phased build-out of the new site in South Carolina will start with equipment installation in first-half 2011, targeting 30–40MW annual production capacity and the creation of 60 jobs this year (helping to meet the backlog). The facility should grow to annual capacity of about 1GW by the end of 2014, creating 1000 jobs in total.

AQT says that South Carolina's strong market for clean energy and favorable business climate make it an attractive location for its second plant, and the large number of universities and technical colleges in the region provide a trained labor force.

"AQT Solar has achieved significant growth in a short period of time [since being founded in 2007]," says CEO Michael Bartholomeusz. The firm uses a proprietary process (allowing continuous in-line production) together with manufacturing platforms field-proven in the hard-disk-drive industry. Last April, a strategic partnership was agreed for Santa Clara-based Intevac (which designs and makes high-productivity sputtering-based manufacturing systems) to supply equipment to AQT. Also last April, AQT closed a $10m second round of venture funding to finance construction of the Sunnyvale facility.

Exterior of AQT Solar's South Carolina facility.

"We are excited to work with the state of South Carolina as we begin this next phase of our company's development," adds Bartholomeusz. "We appreciate the extraordinary assistance we received from the South Carolina Department of Commerce, the Central SC Alliance and Richland County," he adds.

"Our team has been working with the company for the past several months on this competitive project," says Mike Briggs, president & CEO of Central SC Alliance (a not-for-profit public/private partnership that engages in the recruitment of capital investment and job creation in central South Carolina). "The University of South Carolina research initiatives and Innovista, Midlands Technical College and Richland County's business friendly attitude helped solidify this deal," he adds.

Led by a project management team, South Carolina's readySC workforce recruiting and training program is working with AQT to assist with recruitment as well as customized training design and delivery.

www.aqtsolar.com

AQT announces first customers shipment of modules

The first shipment of modules containing AQT's CIGS thin-film solar cells has been made. AQT has also shipped cells to several customers.

The first shipment rounds out a year of rapid progress and growth, including opening a fully operational facility in Sunnyvale in August.

The commercial milestone was achieved in just two years and with a little over $20m in funding. The rapid path from inception to commercialization validates AQT's 'CIGS 2.0' business model as a capitally efficient solution that leverages partnerships to reduce costs and time to market while increasing scalability. Between revenue and order pre-payments, the firm is now generating cash.

As well as using 'off-the-shelf' equipment from Intevac, Sunnyvale's modular design allowed quick on-site deployment, with preparation, build-out, line implementation and qualification, and production initiation completed in under eight weeks. AQT says that the small footprint of each highly automated machine provides efficient use of space within the 20,000ft^2 facility. The firm can hence scale up the plant to an annual production capacity of 60MW in an area many times smaller than its nearest competitors, it is claimed.

Taiwan researchers make steps to improve LED output

Stepped quantum wells improve electron capture in active region, boosting output by 63%.

Taiwan's National Cheng Kung University (NCKU) have used a stepped series of quantum wells to improve electron injection into indium gallium nitride (InGaN) LEDs by 63% over a comparison conventional LED at 20mA current [Shyh-Jer Huang et al, Appl. Phys. Express, vol3, p122106, 2010]. The improvement over a non-stepped (dual-stage) structure was 20%.

The aim of the research was to improve electron capture rates in multi-quantum well (MQW) LED structures. The researchers relate their work to that carried out by NCKU with charge asymmetric resonance tunneling (CART, 2002) and dual-stage structures (2007) that are used to control the injection of electrons into the MQW light-emitting region. In particular, one wants to avoid overshoot of the electrons over the MQW region, which then recombine in the p-contact region, producing mainly heat and unwanted radiation.

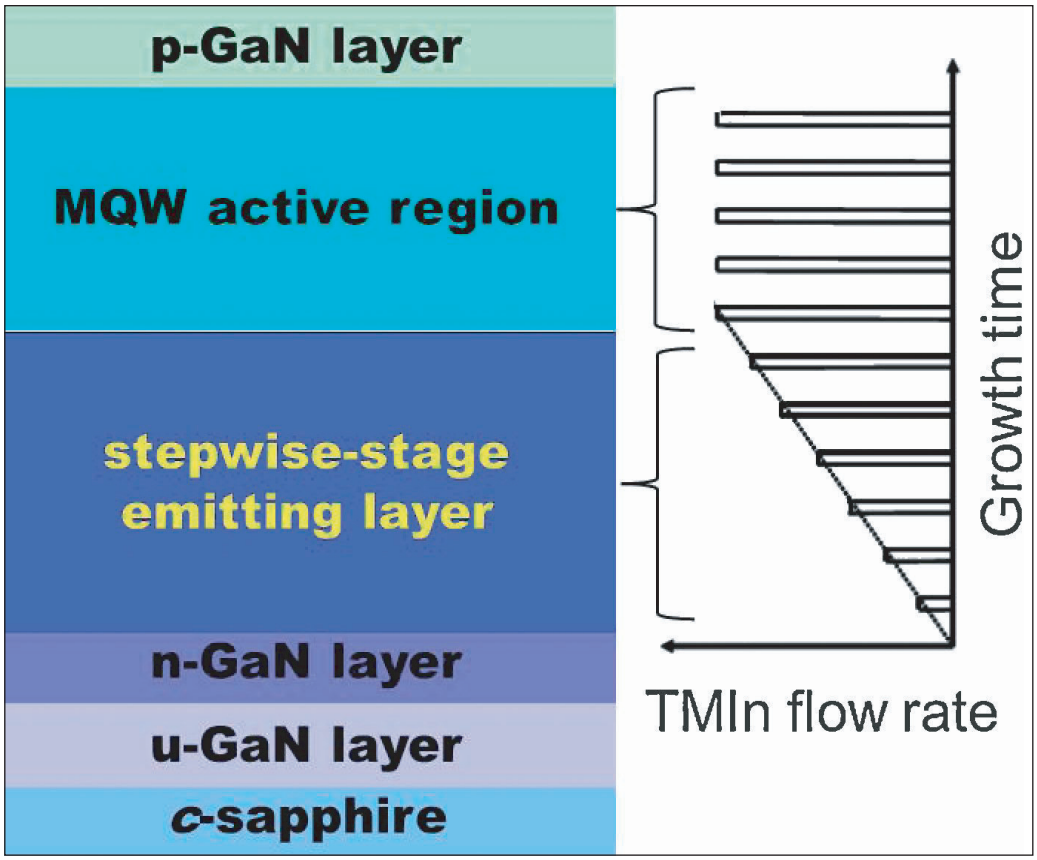

Figure 1. Stepped electron-emitting layer (EL) LED structure and illustration of flow rate for controlling In composition. EL with six QWs is taken as an example.

In CART, the 'electron-emitting layer' (EL) consists of a thick InGaN region, out of which the electrons are expected to tunnel into the MQW. However, thick InGaN tends to introduce defects into subsequent layers, killing performance.

The new work modifies the dual-stage approach where one has two sets of MQWs — one as an EL and the other as light-emitter/active region. The new variation grades the EL MQW structure from small wells near the n-GaN region to deeper ones next to the active region.

The researchers used metal-organic chemical vapor deposition (MOCVD) to create their epitaxial structure (Figure 1) on c-plane GaN substrates. Trimethyl-metals (TM-) were used for the In and GaN sources; ammonia provided the nitrogen. The magnesium p-doping was provided by bis(cyclopentadienyl) magnesium (Cp_2Mg) and the silicon n-doping by disilane (Si_2H_6).

A variety of LED structures were produced, including one without an electron-emitting layer (Sample A). Sample B was a dual-stage structure consisting of six 3nm undoped $In_{0.1}Ga_{0.9}N$ quantum wells with 12nm Si-doped GaN barriers. Three further devices were produced with stepped 3nm undoped $In_xGa_{1-x}N$ wells and 12nm Si-doped GaN barriers. The indium content of the wells was varied linearly (as determined by In source flow rate). Samples C, D and E had four, six and eight wells, respectively.

The MQW active region of all devices consisted of five $In_{0.21}Ga_{0.79}N$ wells and GaN barriers. The p-contact region consisted of 0.2μm of GaN. The structures were converted into devices using standard LED processes.

Before this, the structures were analyzed using high-resolution x-ray diffraction (HR-XRD) and photo-

luminescence (PL) from excitation by 325nm light from a helium–cadmium laser. The x-ray analysis suggests that the dual-stage and graded EL regions also act as strain relaxer/buffer, resulting in better material quality in the subsequent MQW active layers. The greater photoluminescence with EL layers over structures without EL layers supports this analysis.

In terms of electrical performance, the I–V curves show a reduced forward voltage for the EL devices. It is believed from this that a further benefit of the EL layer is to give a better spreading of current in the LEDs.

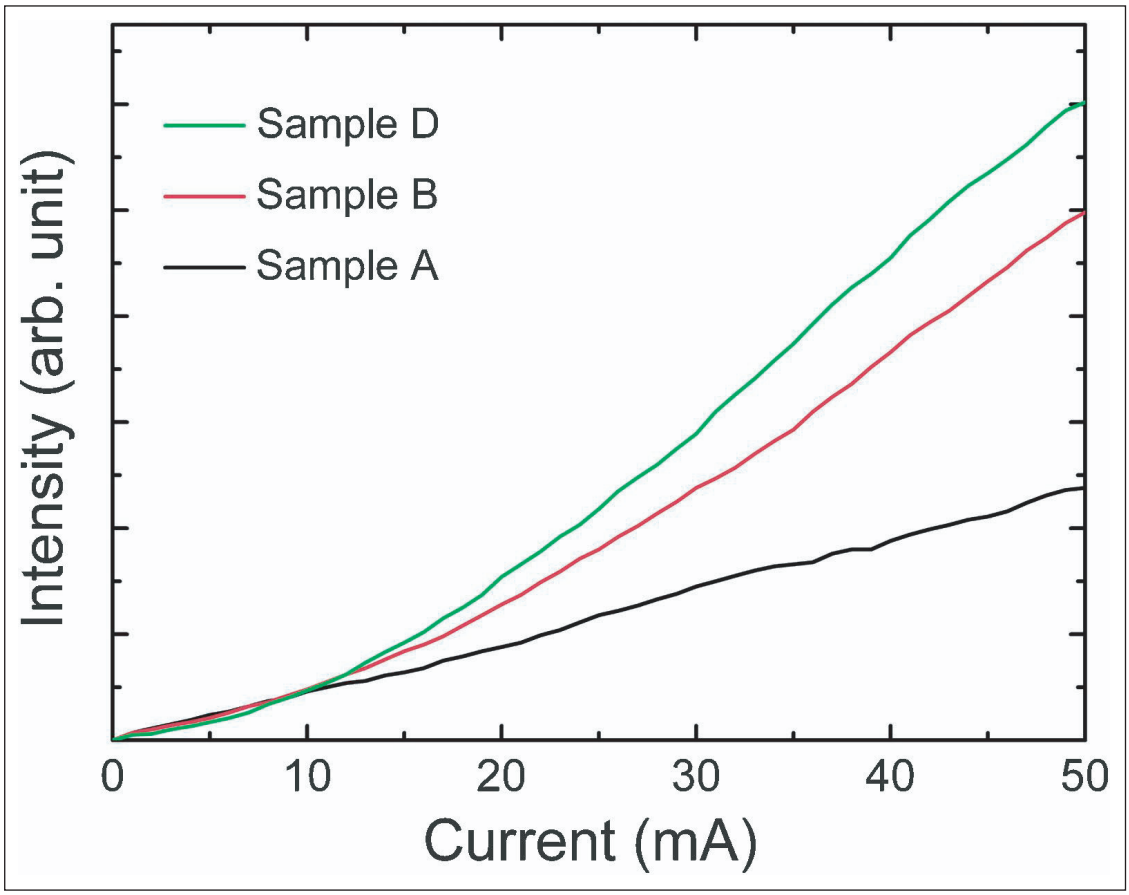

Figure 2. Light output vs current characteristics for conventional, dual-stage and stepped LEDs (samples A, B, and D, respectively).

At low currents (<10mA), the light outputs are similar. However, as the current increases the curves separate (Figure 2). The stepped structure gives the highest light output. At 20mA, the stepped LED has 63% and 20% increase in light output over the conventional and dual-stage devices, respectively.

In terms of the number of steps, the six-stage (Sample D) device is a significant improvement over the four-stage component (Sample C). However, going to eight stages offers only a minimal bump in light output.

The research was carried out with money from the university, "Lamp Development of White Light-Emitting Diode for Local Lighting" TDPA (Technology Development Program for Academia), and Taiwan's National Science Council.

Virginia Commonwealth University (VCU) has also recently been using a modified scheme to inject electrons into LED active regions (www.semiconductor-today.com/news_items/2010/AUG/VCU_160810.htm). The aim of the VCU approach was also to reduce the electron overspill into the p-GaN layer by cooling the electron distribution with a staircase injector. An MQW underlayer was employed to maintain material quality.

http://apex.jsap.jp/link?APEX/3/122106

Author: Mike Cooke

Modified p-type layer increases light output from nitride LED

Selective high barrier region under p-electrode boosts output by 12%.

Researchers at Taiwan's National Cheng Kung University and National Kaohsiung Marine University have used a selective high barrier region (SHBR) created under the p-electrode of a nitride semiconductor LED to increase light output power by 12% [Ting-Wei Kuo et al, Jpn. J. Appl. Phys., vol49, p116504, 2010].

The purpose of the SHBR is to reduce photon absorption in the p-type gallium nitride (p-GaN) hole injection layer and to reduce current crowding under the p-electrode thick metal pad. Current crowding is a particular problem for non-vertical/lateral current flows that are typical in LEDs produced on insulating sapphire substrates. In such cases, both the p- and n-electrodes have to be made from the 'top' of the device, and current crowding can occur near the ends of the current path (Figure 1). Localized high charge carrier densities can reduce luminous efficiency in GaN LEDs.

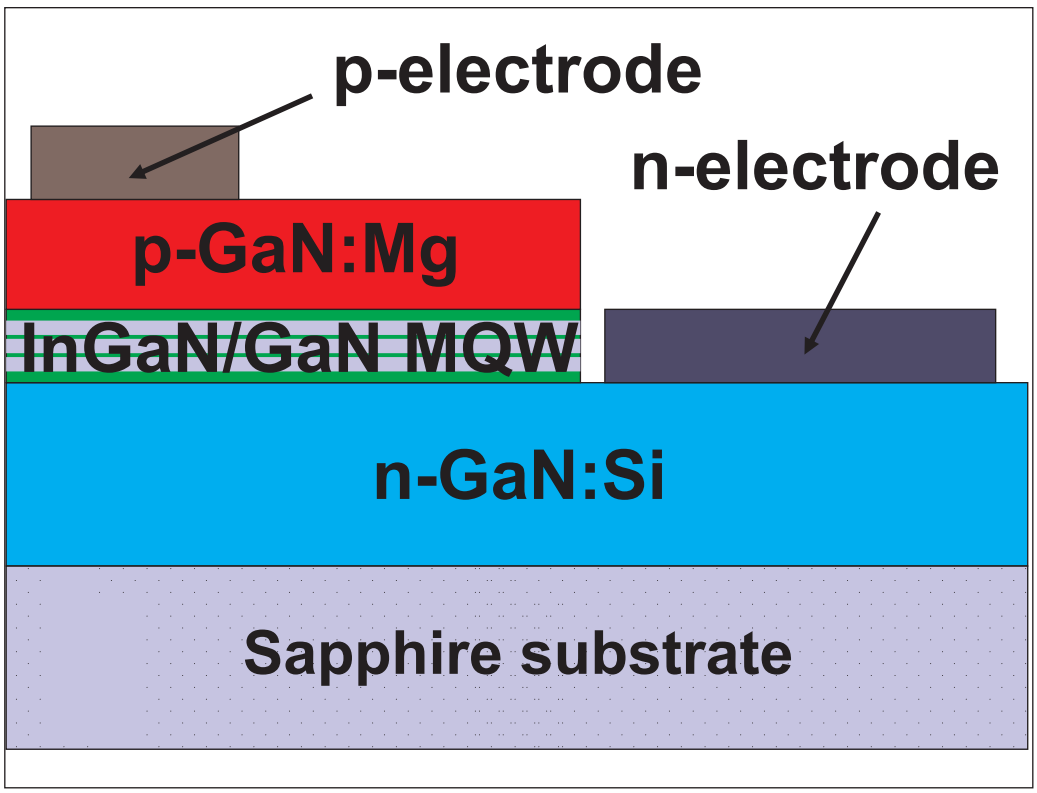

Figure 1. Cross-sectional sketch of traditional MQW LED on sapphire.

The SHBR was formed by using the inductively coupled plasma (ICP) etch process that is also used to make mesa structures in light-emitting devices and to reach the n-type contact in nitride LEDs produced on insulating sapphire substrates.

The effect of the ICP treatment was first investigated using x-ray photoelectron spectroscopy (XPS) on samples consisting of a magnesium-doped p-type gallium nitride (GaN) layer (0.9μm) on top of undoped GaN (1μm) and sapphire substrate. XPS is performed by measuring the energies of electrons ejected from a material by x-ray illumination.

The increased light output is due to an increase in the hole current injected into the active region and a reduction in optical absorption under the electrode

Two effects were found to result from ICP treatment. First, the Fermi level is moved away from the valence band edge (as reveled by a shift in the Ga 3d spectrum of 0.45eV). The effect of this would be to reduce hole carrier densities. Also, measurements of the nitrogen 1s level suggest that there is an increase in N vacancies in the GaN crystal structure. The Ga/N atomic ratio of the treated samples is found to be 1.42 relative to untreated samples that should have a ratio of 1.

Noise and current/voltage electrical measurements on these samples confirm that the treated GaN becomes highly resistive. Transmission line method measurements give a specific contact resistance of $9.49 \times 10^{-3} \Omega\text{-cm}^2$ for the untreated GaN, which increases to $5.41 \times 10^{-1} \Omega\text{-cm}^2$ for the treated sample.

The researchers used the treatment (in combination with photolithography) to create high-resistance regions in the p-GaN contact of a GaN-based LED. The light-emitting region consisted of a five-period indium gallium nitride (InGaN) multi-quantum well (MQW) structure with GaN barriers. The n-type GaN

layer under the MQW was silicon-doped. The layers were grown by metal-organic chemical vapor deposition.

The SHBR was patterned and then an ICP etch was applied using a chlorine (Cl_2):boron trichloride (BCl_3):argon 10:3:1 mixture. The pressure was 5mTorr and the etch power was 400W with a radio-frequency power of 30W. Comparison devices were also produced without the SHBR. An ICP etch was also used to dig down to the n-GaN layer, forming mesas.

The p-electrodes consisted of nickel-gold (Ni-Au). For the p-electrode a thin layer of Ni-Au (2.5nm/6nm) was deposited first over the p-GaN layer as a transparent conducting layer. Then, thicker layers (15nm/25nm) were used in a smaller area for a pad for wire bonding. The final step was annealing the devices at 400ºC in nitrogen for 10mins to create ohmic contacts between the p-GaN and metal layers.

The light intensity (Figure 2) was measured for both devices (Figure 3). While the SHBR device had a higher forward voltage of 3.23V (compared with 3.19V without) at 20mA drive current, the output intensity was increased by 12%. The slight increase in forward voltage is attributed to reduction in the conducting area of the SHBR p-GaN layer. The increased light output is due to an increase in the hole current injected into the active region and a reduction in optical absorption under the electrode, it is suggested. ■

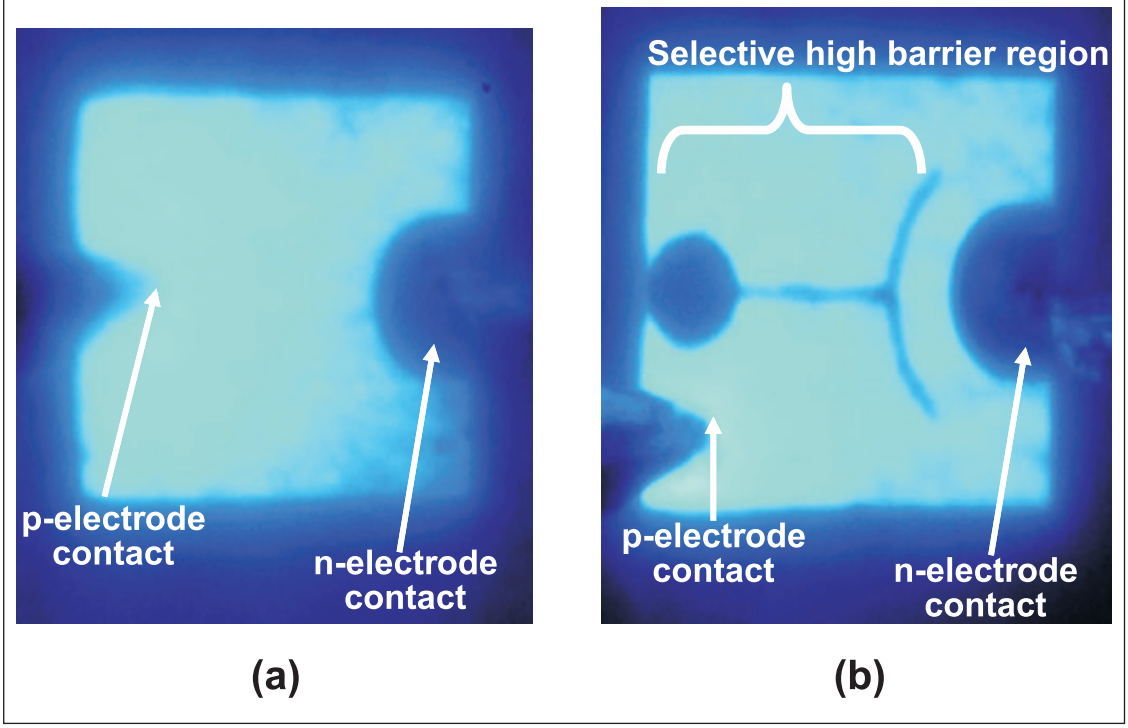

Figure 2. Light emission patterns of LED devices at 1mA forward current without SHBR (a) and with SHBR (b). Locations of n- and p-electrode contacts and SHBR can also be seen.

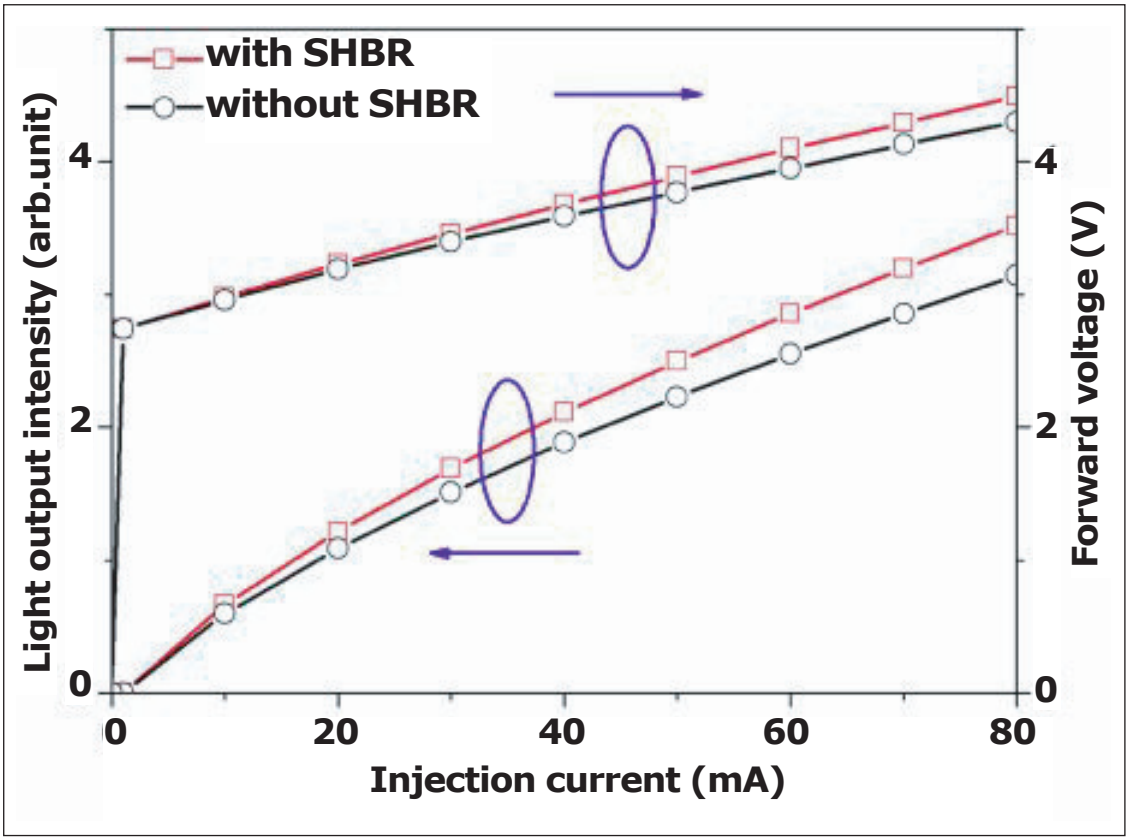

Figure 3. Comparisons of forward-bias current–voltage and light output–current characteristics of LEDs with and without SHBR.

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

UCSB uses more uniform InGaN for record efficiency semi-polar green LED

EQE boosted to 20.4% at 20mA by growing in (20$\bar{2}$1) direction.

Researchers at University of California Santa Barbara (UCSB) have produced semi-polar green light-emitting diodes (LEDs) with external quantum efficiencies of 20.4% [Shuichiro Yamamoto et al, Appl. Phys. Express, vol3, p122102, 2010]. The team also included one researcher each from Sharp Corp and Mitsubishi Chemical Corp.

The team produced both green and green-yellow LEDs using gallium nitride (GaN) crystal substrates oriented in the (20$\bar{2}$1) direction.

The electroluminescence of the green LED at 20mA had an output power of 9.9mW and external quantum efficiency (EQE) of 20.4% under pulsed operation (10% duty cycle). This changed only slightly by moving to DC operation, with 9.2mW output power and 19.1% EQE.

The researchers comment: 'To the best of our knowledge, these output powers and EQEs at a driving current of 20mA are the highest values that have ever been reported for green LEDs grown on semi-polar/non-polar planes.'

The yellow-green LEDs had 5.7mW output power and 12.6% EQE under a pulsed current of 20mA. The DC figures were 5.2mW and 11.6%, respectively.

The researchers conclude: 'These results suggest that (20$\bar{2}$1) GaN substrates could be one of the possible substrates for high-power and high-efficiency LEDs with green or even longer wavelengths.'

Researchers have been expending much effort to improve green nitride LED efficiency. For the most mature devices grown in the c-direction of the nitride crystal structure, an EQE of 30% was reached in 2007.

However, for these devices there are known effects that hamper further progress. The most prominent of these is the quantum-confined Stark effect (QCSE), where polarization electric fields due mainly to strain effects (piezoelectricity) tend to pull apart the electrons and holes that are desired to recombine into photons, reducing efficiency.

The QCSE gets worse as the desired wavelength of the device gets longer because one is trying to combine light-emitting layers of higher-indium-content indium gallium nitride (InGaN) with a gallium nitride (GaN) substrate lattice parameter. This creates a large strain in the InGaN and hence a large piezoelectric polarization electric field.

The past few years have seen a number of research groups exploring different growth directions in nitride semiconductors with reduced (semi-polar) or even zero (non-polar) polarization. These efforts have not as yet reached the efficiency of c-plane devices, partly due to the immaturity of knowledge of how to grow high-quality material, partly due to new intrinsic difficulties.

The substrates for the new UCSB (20$\bar{2}$1) LEDs were prepared by slicing a c-plane GaN bulk crystal in the appropriate direction. The bulk crystal was grown using hydride vapor phase epitaxy (HVPE).

The LED semiconductor layers (Figure 1) were grown using metal-organic chemical vapor deposition (MOCVD). The active region consisted of a single quantum well (SQW) of 3.5nm-thick InGaN sandwiched between GaN barriers. An electron-blocking layer (EBL) consisting of magnesium-doped AlGaN was used to keep the electrons in the well region, and thus to increase recombination as photons, rather than in the p-type Mg-doped GaN contact.

A 250nm tin-oxide-doped indium oxide layer (ITO) was applied by electron-beam deposition and annealing to make a p-type transparent contact. Metal contacts were then applied, first to the n-GaN layer and then to the p-GaN layer.

The backside of the GaN substrate was roughened to increase light extraction from the device. The diced LEDs were mounted on transparent zinc oxide material as a submount and then packaged in silicone resin in a 'vertical stand' configuration (www.semiconductor-today.com/news_items/2010/SEPT/UCSB_210910.htm).

The emission peak wavelength of the green device was 516.3nm at 20mA. The peak wavelengths at 1mA and 80mA were 529.9nm and 511.9nm, respectively. The shortening of the wavelength with current ('blue-shift') is attributed mainly to the effect of the applied bias on the QCSE.

An alternative explanation would be band-filling effects caused by potential fluctuations due to the inhomogeneity of the InGaN material. Band-filling is used to explain a marked narrowing of the emission line spectrum in green LEDs grown on (11$\bar{2}$2) substrates in the low cur-

rent range. However, this behavior was not seen in the (20$\bar{2}$1) green LEDs and the linewidths were about the same across the current range. The researchers believe that by growing on the (20$\bar{2}$1) plane they have 'substantially improved' the uniformity of the InGaN QW.

The blue-shift observed of 4.4nm between 20mA and 80mA was also smaller than that seen in (11$\bar{2}$2) devices, where a value of 12.4nm between 20mA and 100mA was previously reported.

For the yellow-green devices, peak wavelengths were 572.5nm, 552.3nm, and 544.2nm at 1mA, 20mA, and 80mA, respectively. The 20mA to 80mA blue-shift of 8.1nm is larger than for the green device, but still smaller than that of the (11$\bar{2}$2) green device.

Line-width narrowing is also not observed in the yellow-green LEDs. At 10mA, the line-widths for the green and green-yellow (20$\bar{2}$1) devices were 33.0nm and 40.8nm, respectively. The published (11$\bar{2}$2) green device had a 42.5nm linewidth. The narrower line-widths of the (20$\bar{2}$1) devices are again taken as indication that the InGaN layer had better uniformity and hence fewer potential fluctuations.

The operating voltages are rather high — i.e. 6.4V (green) and 6.8V (green-yellow) — indicating that the upper layers (p-GaN and ITO) need optimizing. ■

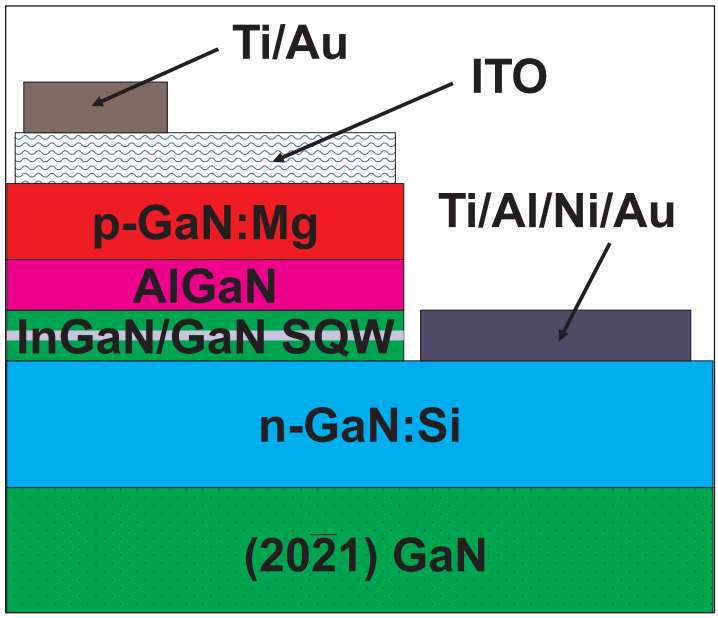

Figure 1. Schematic of UCSB's green and yellow-green LED device structures on (20$\bar{2}$1) substrate.

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

SEI's {20$\bar{2}$1} semi-polar green laser lowers threshold current by 2–3x

Improvement over c-plane nitride green lasers greater than expected.

Japan's Sumitomo Electric Industries (SEI) has presented detailed performance measurements of a series of green lasers diodes (LDs) based on its semi-polar {20$\bar{2}$1} free-standing gallium nitride (GaN) substrates [Masahiro Adachi et al, Appl. Phys. Express, vol3, p121001, 2010].

A number of companies and other research groups are racing to develop stable and efficient green laser diodes with a view to replacing bulky full-color projector systems that use an infrared diode to excite a second-harmonic generator material that creates green light. Single laser diode solutions are already used to create blue and red light. These are based on indium gallium nitride (InGaN) and aluminum gallium indium phosphide (AlGaInP) technologies, respectively.

The advantages of using a single laser diode based on nitride semiconductor technology are expected to be compactness and stability. Nitrides are presently preferred for this over II-VI semiconductor alternatives since they are expected to eventually have longer, practical lifetimes.

SEI produced the first true green nitride lasers diodes last year, with devices having emission wavelengths up to 531nm. Since then, other groups have achieved green lasing on traditional c-plane GaN. However, semi-polar devices are expected to perform better in many respects due to a reduced polarization electric field in the active layers.

Nitride semiconductors have both spontaneous and piezoelectric (strain-dependent) polarization. Differences in these properties between different layers of material give rise to effective surface charges and hence electric fields in addition to those applied externally. These fields tend to pull the electron and hole carriers apart in the active region, making recombination into photons (and hence laser light) more difficult. This quantum-confined Stark effect (QCSE) hence raises the threshold current for lasing. Hence, researchers are keen to reduce threshold currents and voltages, with a view to lower operating voltages and higher wall-plug efficiency.

The polarization fields are strongest in the c-plane direction. By growing nitride semiconductors in other crystal directions, the QCSE can be reduced. The lower density of states for holes and higher transition matrix elements for optical gain due to valence-band splitting are also seen as advantages of semi-polar structures. Experiment has also shown the quality of InGaN layers to be more homogeneous on {20$\bar{2}$1} material, compared with c-plane grown films.

SEI uses hydride vapor phase epitaxy (HVPE) to produce its {20$\bar{2}$1} substrates. The company has managed to reduce threading dislocation densities to less than 10^{-6}/cm^2. The material is n-type conductive and the resistivity (0.01Ω-cm) is such that back-contacts can be used for vertical current flow through the device (unlike with lasers diodes on insulating sapphire or more resistive GaN).

The epitaxial lasers diode layers with separate-confinement heterostructures (SCHs) were deposited using metal-organic chemical vapor deposition (MOCVD). Gain-guided (10μm waveguide width) and ridge-waveguide (2μm) lasers diodes were produced. The 600μm-long cavities were produced along the advantageous [$\bar{1}$014] direction. Appropriate dielectric mirrors were used to minimize losses.

Testing for thresholds was carried out using pulsed operation (0.5μsec pulse, duty cycle 0.5%) at room temperature for the gain-guided lasers diodes. Pulsed testing is often used to avoid self-heating effects. The ridge device were subjected to continuous wave (cw) operation.

The threshold current in the 520–530nm green range was nearly half that of traditional c-plane devices (Figure 1). The current density threshold varied between 3.4kA/cm^2 at 511nm and 5.4kA/cm^2 at the longest wavelength of 533.6nm. The researchers credit optimized quantum well structures and growth conditions for these achievements.

These results run in the face of theoretical expectations that {20$\bar{2}$1} lasers diodes will have threshold current of 65% that of the equivalent c-plane device. In the long-wavelength region (>520nm) the semi-polar device is much better (2–3x lower) than the c-plane devices, and in the short-wavelength region it tends to be about the same as the c-plane device.

The researchers comment: "The reason for the disagreement may be due to the differences in the crystal

quality between the semi-polar {20$\bar{2}$1} and the c-plane lasers diodes, i.e. the difference in the compositional homogeneities of the InGaN quantum wells, which is not considered in the theoretical studies".

They add: "We believe the experimental results in this work indicate that the deterioration of the crystal quality of the InGaN active layers over 520nm is much less severe for the {20$\bar{2}$1} plane compared to the c-plane".

The team also reports in more detail on 'a typical ridge-waveguide green LD in cw operation at RT lasing at the wavelength of 525.5nm'. The threshold current, current density and voltage were 51.1mA, 4.3kA/cm^2, and 6.38V, respectively. The slope efficiency was 0.15W/A. With the mirrors used, the output power was 36.4mW under cw operation at 25°C.

The researchers plan further optimizations for high-power operation, with a report due in the 'near future'.

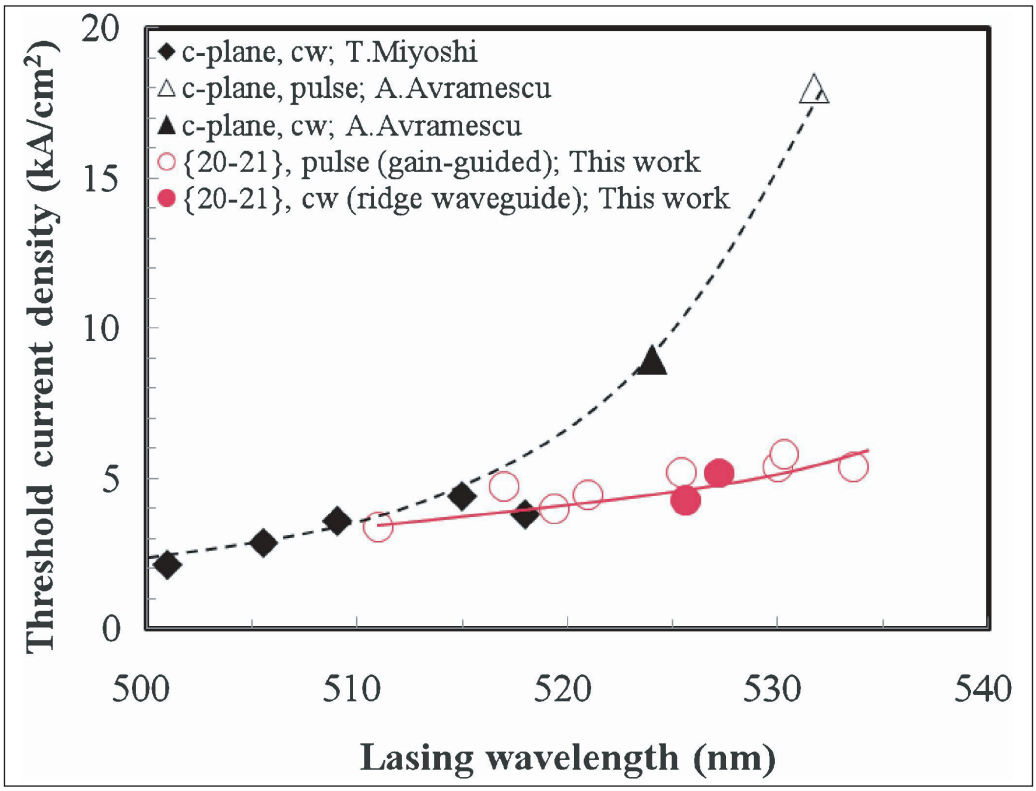

Fig. 1. Dependence of threshold current density on lasing wavelengths. Open and solid circles: gain-guided and ridge-waveguide green LDs on {20$\bar{2}$1} semi-polar planes, respectively. Triangle and diamond: LDs on c-plane published by Nichia and Osram Opto Semiconductors. Solid and open symbols, including triangles and circles: cw and pulsed operation, respectively. Solid and broken lines are trend guides for the eye.

The T_0 characteristic of the 525nm lasers diode threshold current temperature variation (proportional to $\exp(T/T_0)$) of 175K was measured using temperature control and pulsed operation. This compares with lower values for c-plane devices of 145K at 518nm and 120K at 515nm measured by the Nichia group. A higher T_0 indicates smaller variation of the threshold with absolute temperature.

Far-field pattern divergence was also measured at 2mW output and 25°C: the perpendicular and parallel divergence angles at half power were 24° and 11°, respectively. These are slightly larger than the corresponding measurements for Nichia's c-plane devices: 22.8° and 10.4°, respectively.

"This indicates that the symmetry and optical confinement of the {20$\bar{2}$1} green LD with InAlGaN cladding layer are comparable to the conventional c-plane InGaN LDs," says the researchers. ■

http://apex.jsap.jp/link?APEX/3/121001/

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

Corning probes optical losses in nitride laser at wafer level

Corning researchers finds that holes bound to Mg acceptors dominate waveguide loss in blue–green nitride lasers.

Corning Inc has developed a method to assess the internal optical waveguide loss of laser diode (LD) wafers at an earlier stage in the development process, compared with alternative techniques [Dmitry S. Sizov et al, Appl. Phys. Express, vol3, p122104, 2010].

Typically waveguide losses are found by creating laser cavities of varying length. The Corning method instead works with wafers before such cavities have been constructed (usually by some plasma etch process). The waveguide losses increase threshold currents, and reduce differential and wall-plug efficiencies.

The method (Figure 1) consists of exciting the material with a laser spot and measuring the photoluminescence at the edge of the wafer. By varying the position of the spot, the optical loss coefficient can be determined, by assuming an approximate 1/R dependence of the light intensity as expected for two-dimensional radiation confined to the waveguide layers. The researchers find that the 1/R approximation is good (i.e. non-confined transmission is negligible) for values of R (distance from spot to wafer edge) of more than 0.1mm and optical losses less than 100/cm.

The method's accuracy depends on 'bandtail' states that re-emit photons with energy below the absorption band edge of the system. Nitride semiconductor quantum well (QW) laser diodes constitute such systems with deep bandtails, giving Stokes shifts (i.e. red-shifts) of more than 100meV.

The Corning group applied its technique to blue to green laser diode wafers built on both c-plane and semipolar free-standing gallium nitride (GaN) substrates. The wafers, when formed into laser diodes, produced laser emissions in the wavelength range 480–525nm. The photoluminescence was created using 405nm blue laser diodes (as used in commercial HD DVD and Bluray optical storage systems).

A wafer for 'aquamarine' laser diodes (with a lasing wavelength of 497nm) was found to have an optical loss in the waveguide less than 2/cm before activation of the magnesium (Mg) doping used to create the hole injection p-type region of the device (Figure 2). The optical loss up to 520nm is attributed to the QW active region. Longer than 520nm (the QW absorption edge), the losses are attributed to light leakage from the guide and absorption by the guide material. As the

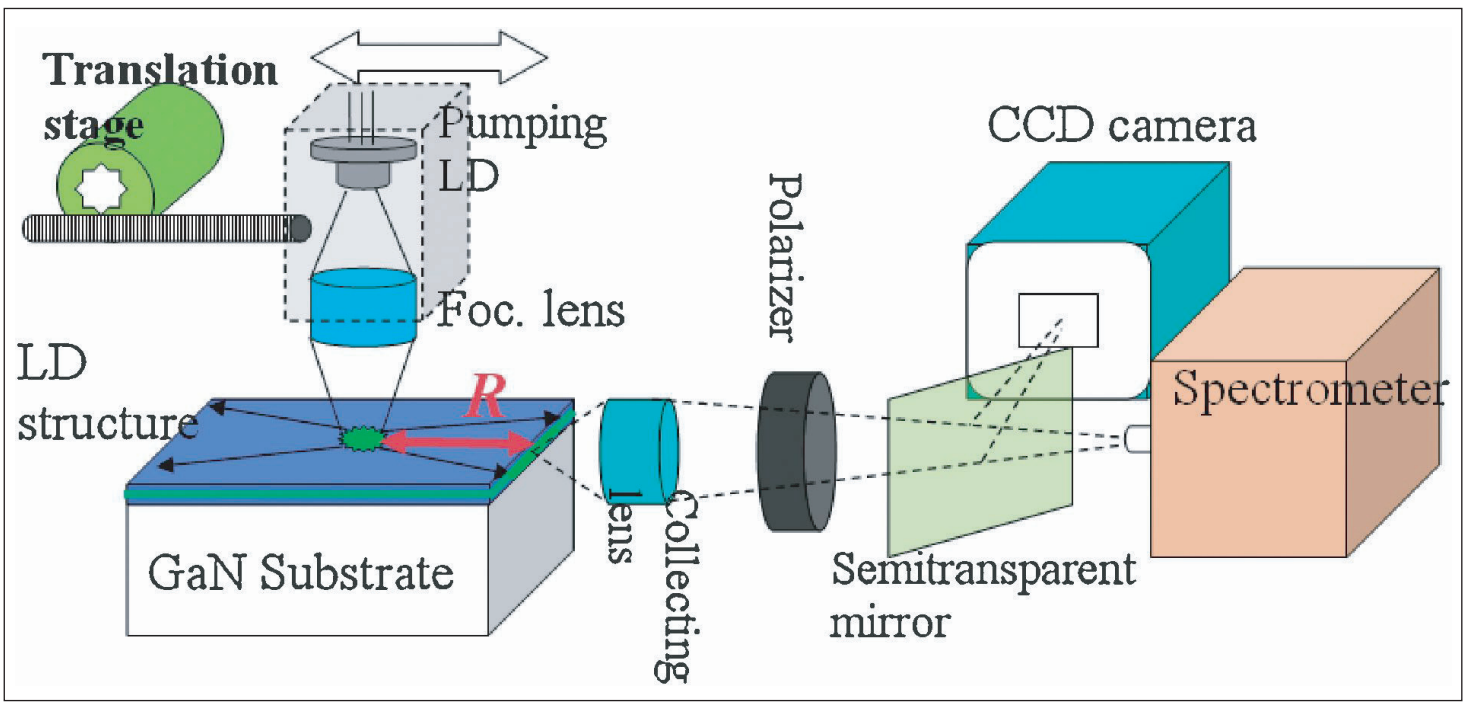

Figure 1. Schematic of internal optical loss measurement setup.

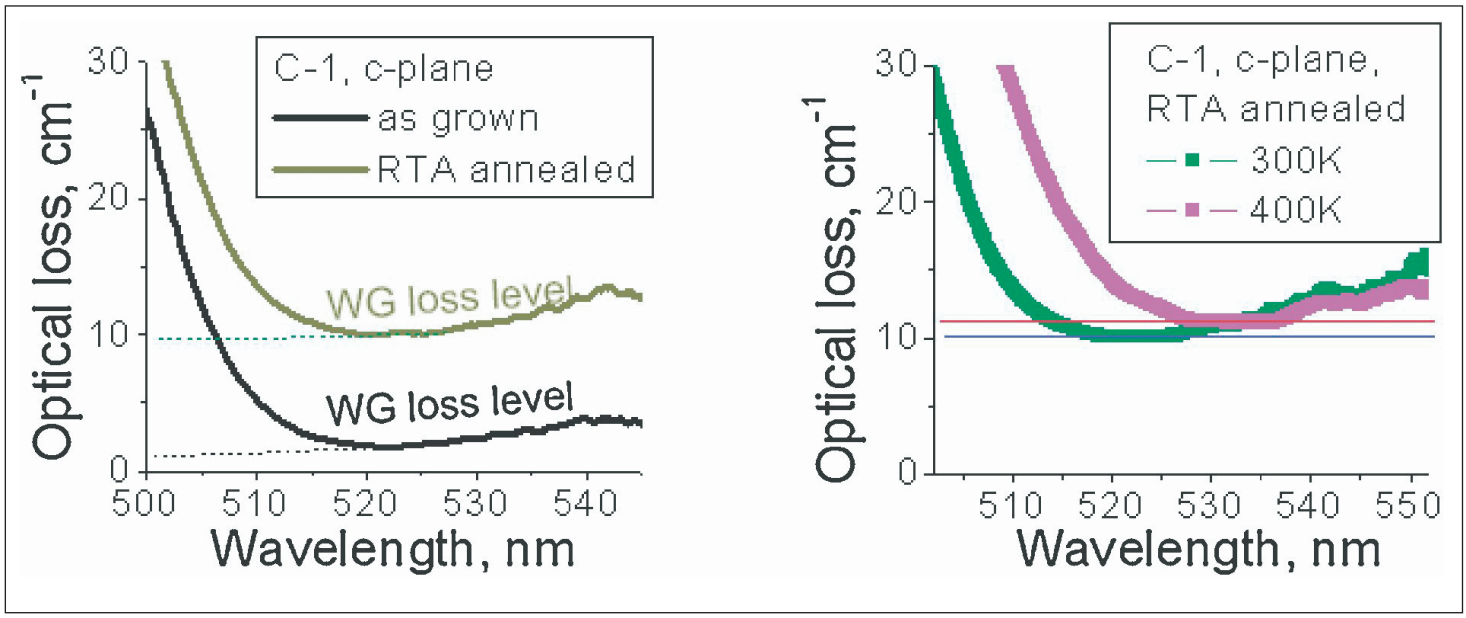

Figure 2. Optical losses of c-plane LD structure before and after p-type activation by rapid thermal annealing (a) and measured at 300K and 400K (b).

wavelength gets longer, the confinement into the waveguide weakens. The 2/cm loss figure for the waveguide is obtained by a suitable extrapolation back to the lasing frequency.

However, this loss is before activation of the p-type layer that is needed for such a device to operate as a laser diode. Before the activation, the Mg atoms are associated with hydrogen in complexes that make the material insulating. These complexes were removed by the Corning team using a conventional rapid thermal anneal (RTA) process in an oxygen/nitrogen atmosphere. The effect of this was to increase the optical losses of the waveguide structure to 8–9/cm. These compare with internal optical losses of more than 10/cm that have been published for state-of-the-art blue–green LDs.

The increase in optical losses consequent on activation is attributed to the p-type layer. This was confirmed in experiments where annealing was carried out on structures without Mg doping, where no increase in the optical loss coefficient was observed.

Although Mg doping is the most commercial technique for producing p-type layers in nitride semiconductor structures, it leaves much to be desired. In particular, the activation energy for holes to be released from the Mg acceptors (140–210meV in GaN) is high compared with typical thermal energies (~26meV at 300K, 'room temperature'). This means that the free hole concentration is about two orders of magnitude lower than the bound hole level (even at 400K).

Since the increase in temperature should increase the number of free holes significantly, the researchers come to the conclusion that they do not contribute significantly to the waveguide loss. Rather, it is the Mg-bound holes that dominate this behavior

Increasing the temperature of the structure to 400K only increased the loss slightly — the researchers comment: "Within the measurement accuracy there is no difference in waveguide loss between these two temperatures apart from the QW absorption edge shifting to longer wavelengths due to temperature-induced bandgap shrinkage". The researchers put their measurement error as being of the order of 1/cm.

Since the increase in temperature should increase the number of free holes significantly, the researchers come to the conclusion that they do not contribute significantly to the waveguide loss. Rather, it is the Mg-bound holes that dominate this behavior.

The researchers obtained similar loss results for structures grown on semipolar gallium nitride substrates. In the c-plane case, only transverse electric (TE) modes of the waveguide were considered to be important. In the semipolar case, modes with different electric field directions occur in waveguides. However, the losses within these modes fell within 2/cm of each other (with the TE mode propagating in the [0001] direction being highest), close to the measurement error.

The work underlines the well-known fact that Mg doping to obtain p-type conductivity in GaN is one of the weakest points of the nitride semiconductor application equation. Finding a method to lower ionization energies for holes to be released from nitride acceptors would reduce optical losses, among many other benefits. ■

http://apex.jsap.jp/link?APEX/3/122104

Author: Mike Cooke

Ohio boosts nitride tunneling current to 118A/cm² at –1V

'Highest current density reported for III-nitride tunnel diodes' open opportunities for low resistance contacts between devices.

Researchers at Ohio State University have achieved 'the highest current density reported for III-nitride tunnel diodes [Sriram Krishnamoorthy et al, Appl. Phys. Lett., vol97, p203502, 2010]. The work employed the narrower-bandgap material indium gallium nitride (InGaN) for the tunneling barrier rather than the usual wider-bandgap aluminum gallium nitride (AlGaN). At –1V, the current density of the new device was 118A/cm^2. The maximum current density was 9.2kA/cm^2 (limited by the capability of the measuring equipment).

Tunnel junctions can be used to create low-resistance connections between devices such as LEDs, laser diodes, multi-junction solar cells, and tunnel field-effect transistors (TFETs).

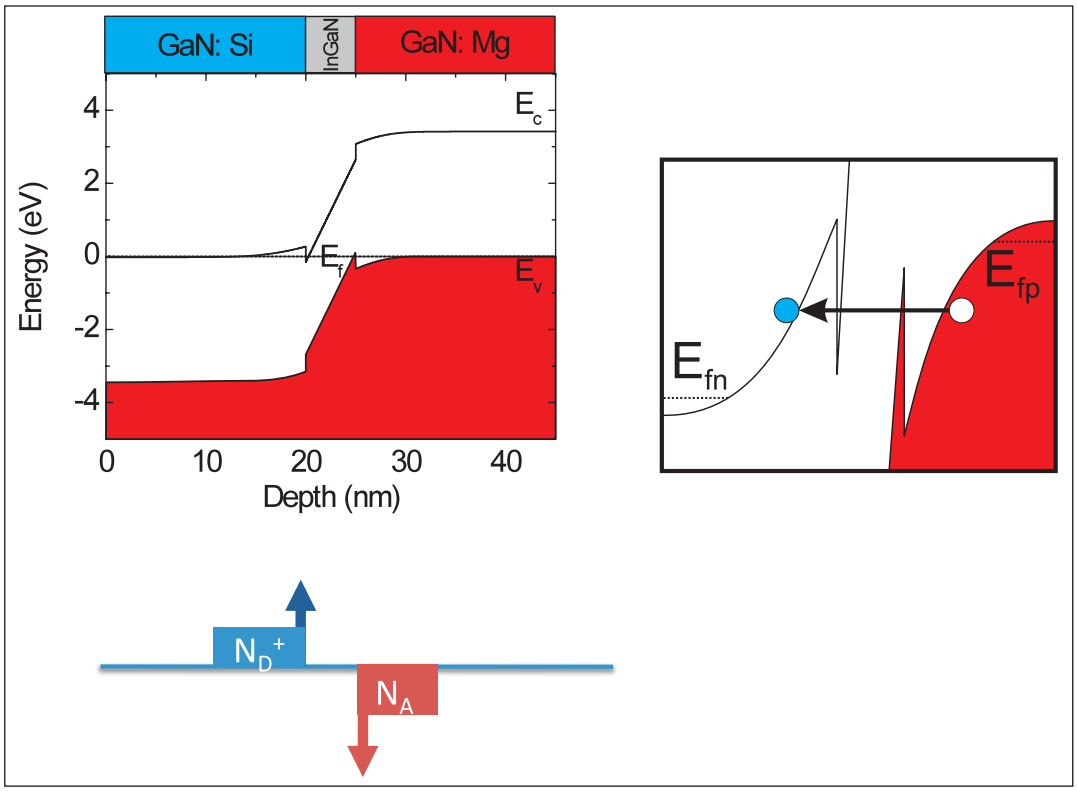

Figure 1. Left: schematic and equilibrium energy band diagram of GaN/InGaN/GaN (In 33%) zero-bias interband tunnel junction. Right: band diagram at reverse bias, showing interband tunneling.

In wide-bandgap nitride light-emitting devices, there are problems in creating low-resistance p-contacts especially, and here tunnel junctions could be useful in allowing n-type material to contact with the hole injection layer.

For example, Korean researchers from Lumimicro Co Ltd, Kyungpook National University, Korea Photonics Technology Institute, and Pukyong National University recently used an LED epiwafer from Epivalley with a three-period InGaN (In 17%) tunnel junction structure to give an n-type zinc oxide transparent conducting layer a suitable contact with the underlying p-GaN layer (www.semiconductor-today.com/news_items/2010/SEPT/LUMIMICRO_270910.htm). Unfortunately, the external quantum efficiency was quite low (~23%) compared with leading commercial devices (~60%).

The Ohio team designed its tunnel junction structure (Figure 1) by using simulations and semi-classical (Wentzel–Kramers–Brillouin = WKB) theory to understand how to use polarization electric fields (spontaneous and piezoelectric/strain-dependent) and band-bending effects to increase the tunneling probability and hence the current. These studies suggested that there was a critical thickness for the barrier. Below this, the conduction band on one side is not aligned suitably with the valence band on the other. Above the critical value, the tunneling probability is reduced by the thickness of the barrier.

The critical thickness is reduced (and hence the expected current increased) as the In molar fraction of the InGaN barrier is increased. However, it can be difficult to create high-quality InGaN with high In concentrations.

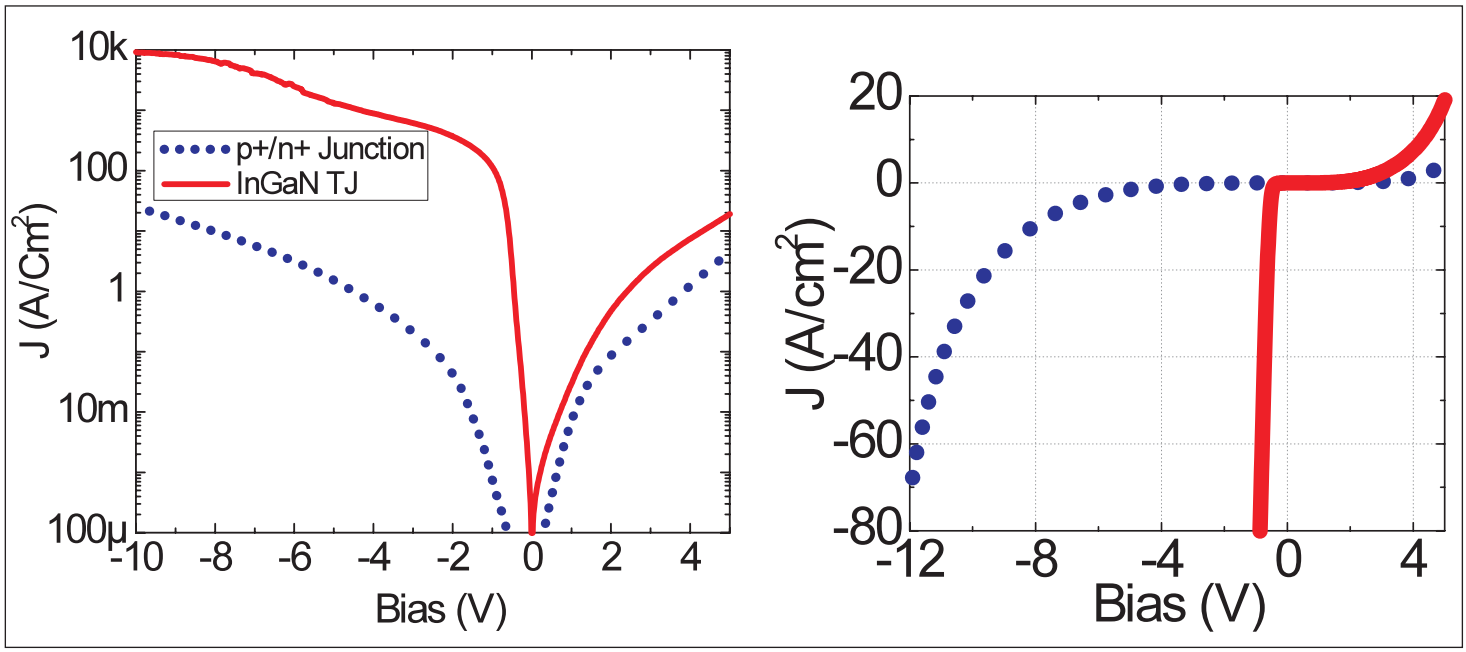

Figure 2. Left: log J–V characteristics of GaN/InGaN/GaN TJ (solid line) and standard p^+/n^+ junction (dotted). Right: same characteristics plotted using linear J-axis.

InGaN tunnel junctions were grown on an N-polar free-standing GaN substrate, using plasma-assisted molecular beam epitaxy (PAMBE). The growth system used was Veeco's Gen 930 tool. Lumilog supplied the LED-quality GaN template. The researchers used N-polar material because higher indium concentrations have been achieved with such material.

The n-type GaN layer was grown first with a heavy (n^+) silicon-doping donor density of $5x10^{18}/cm^3$ and 100nm thickness. This was followed by the InGaN layer, which was measured using x-ray diffraction to be 6.4nm thick with a 33.5% indium composition. The final p-type GaN layer was also 100nm and had a heavy (p^+) magnesium acceptor density of $1x10^{19}/cm^3$.

Reference p–n junctions, without the InGaN tunnel layer, were also grown. The metals used for the p-contact were nickel-gold, and for the n-contact, titanium-gold.

The tunnel junction (TJ) had higher current flow in both directions compared with the p-n junction (Figure 2). The reverse current of the tunnel junction was several orders of magnitude higher than that of the p–n reference.

The p–n junction shows the standard behavior, where the reverse bias current is lower than that under forward bias. The tunnel junction, by contrast (but as expected for such 'backward-diode' devices), has a higher current under reverse-bias compared with the forward condition.

The tunnel junction device has a steep turn-on region of 70–130mV/decade close to zero-bias for tunneling. The researchers comment: "Such a low turn-on voltage would be an ideal candidate to connect devices in series, especially in the case of multiple active-region emitters".

At 1V reverse bias, the current density is $118A/cm^2$ (the p–n current was five orders of magnitude lower). At higher reverse bias values the differential resistance increases significantly. The researchers suggest that increased series and contact resistance, along with self-heating effects, may be to blame, although 'further analysis is needed to understand the origin of this behavior.

Despite this, the researchers measured a maximum current density of $9.2kA/cm^2$ (limited by the capability of the measuring equipment). This value is claimed to be 'the highest current density reported for III-nitride tunnel diodes'.

The researchers plan to improve the structure with higher indium compositions and optimized barrier thicknesses. The team is also looking into 'further sophistication with graded GaN/InGaN interfaces, asymmetric junctions, and quaternary alloys, with a view to lower resistance and higher tunneling current. Improved understanding of the theory and modeling will also be pursued.

It is also suggested that other material systems might benefit from using narrower-bandgap tunneling materials such as AlGaN, AlN and ZnO.

The researchers conclude: 'The tunnel junction designs demonstrated here will enable the incorporation of tunnel junctions in several technologically relevant III-nitride devices such as LEDs, lasers, and solar cells, and provide a pathway to device structures such as tunnel FETs.'

Some of the funding for the research came from the US Office of Naval Research (ONR). ■

http://link.aip.org/link/APPLAB/v97/i20/p203502/s1

Author: Mike Cooke

SiN raises nitride HEMT breakdown voltage without current collapse

Bilayer approach uses combinations of different SiN films as passivation.

The University of Sheffield and the UK defense research company QinetiQ have developed techniques for using silicon nitride passivation to increase breakdown voltages without current collapse in nitride semiconductor high-electron-mobility transistors (HEMTs) [K B Lee et al, Semicond. Sci. Technol., vol25, p125010, 2010].

HEMTs using gallium nitride (GaN) with an aluminum gallium nitride (AlGaN) barrier layer grown on silicon carbide substrates have achieved a record 41W/mm power density at 4GHz. However, at high frequencies the current that can pass through such devices collapses, impacting device performance. These devices have also been developed for high-power operation, where a high breakdown voltage is desired.

Different types of silicon nitride (Si_xN_y) films have been used both to mitigate 'current collapse' and to increase breakdown voltages. However, the effects of the different films work against each other. The Sheffield–Qinetiq research was directed at finding ways to combine the different films to produce high breakdown voltages without current collapse.

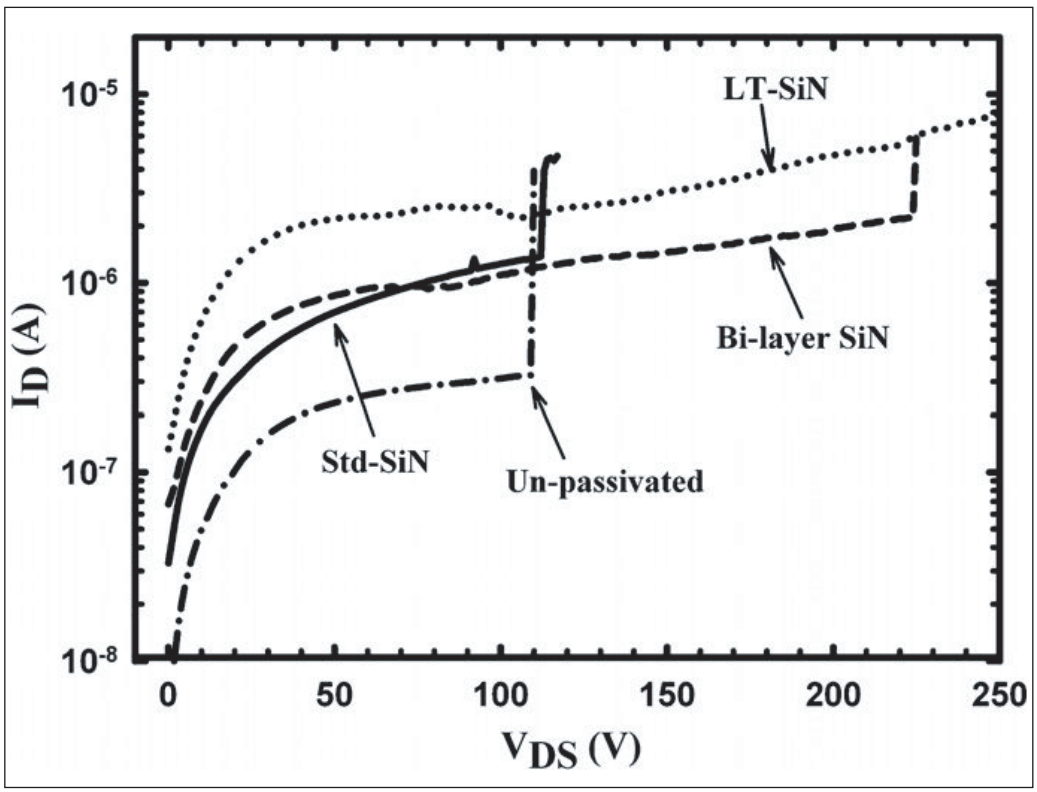

Figure 1. Three-terminal breakdown measurements for HEMT devices passivated with various Si_xN_y films at pinch off (V_{gs} = −7 V). Thickness ratio for std-SiN-LT-SiN bilayer passivated device is 1:3. Total thickness of passivation film is 200nm.

The Sheffield–Qinetiq HEMT device structures consisted of $Al_{0.22}Ga_{0.78}N$/GaN/sapphire substrate (2-inch diameter), grown using metal-organic chemical vapor deposition (MOCVD). The carrier density of the two-dimensional electron gas (2DEG) that forms at the AlGaN/GaN interface was $6.5x10^{12}cm^2$, with a mobility of $1200cm^2$/V-s.

This material was used to create HEMTs with 0.25μm gate length and 0.48μm gate–drain separation. Some test structures were also made to allow the researchers to separate out the impacts of surface and bulk leakage currents on performance.

The HEMT mesas were formed using inductively coupled plasma etching. The ohmic source/drain contacts consisted of titanium-aluminum-titanium-gold layers. The Schottky gate metal structure was nickel-gold.

The silicon nitride bilayer passivation consisted of stoichiometric Si_3N_4 (std-SiN) followed by low-temperature Si_xN_y (LT-SiN). The passivation was deposited in a plasma-enhanced chemical vapor deposition (PECVD) system at 300°C and 30°C, respectively. Various thicknesses for these layers were investigated (including zero).

The three-terminal breakdown measurements were carried out on at least 50 devices. In one test for breakdown (Figure 1), devices with 200nm SiN passivation were compared with unpassivated devices at a gate voltage (V_{gs}) of –7V. Three types of passivation were compared: std-SiN, LT-SiN, and a bilayer with std-SiN:LT-SiN of 1:3. Both the unpassivated and std-SiN devices showed breakdown occurring around 120V source–drain voltage (V_{ds}).

The breakdown performance was more than doubled to 250V by using LT-SiN passivation. The bilayer device also showed improved breakdown performance, sustaining up to around 225V.

Such improvement using LT-SiN has been seen before and has been attributed to the suppression of conduction and the ionization of surface states on the AlGaN barrier layer. However, the Sheffield/Qinetiq researchers are skeptical of this interpretation on the basis of surface-leakage and capacitance–voltage (CV) measurements on their test structures: "We propose that the increase of the breakdown voltage in the LT-SiN passivated structure is caused by the moderation of the electric field at the drain edge of the gate". The moderation is likened to that achieved using field-plate structures.

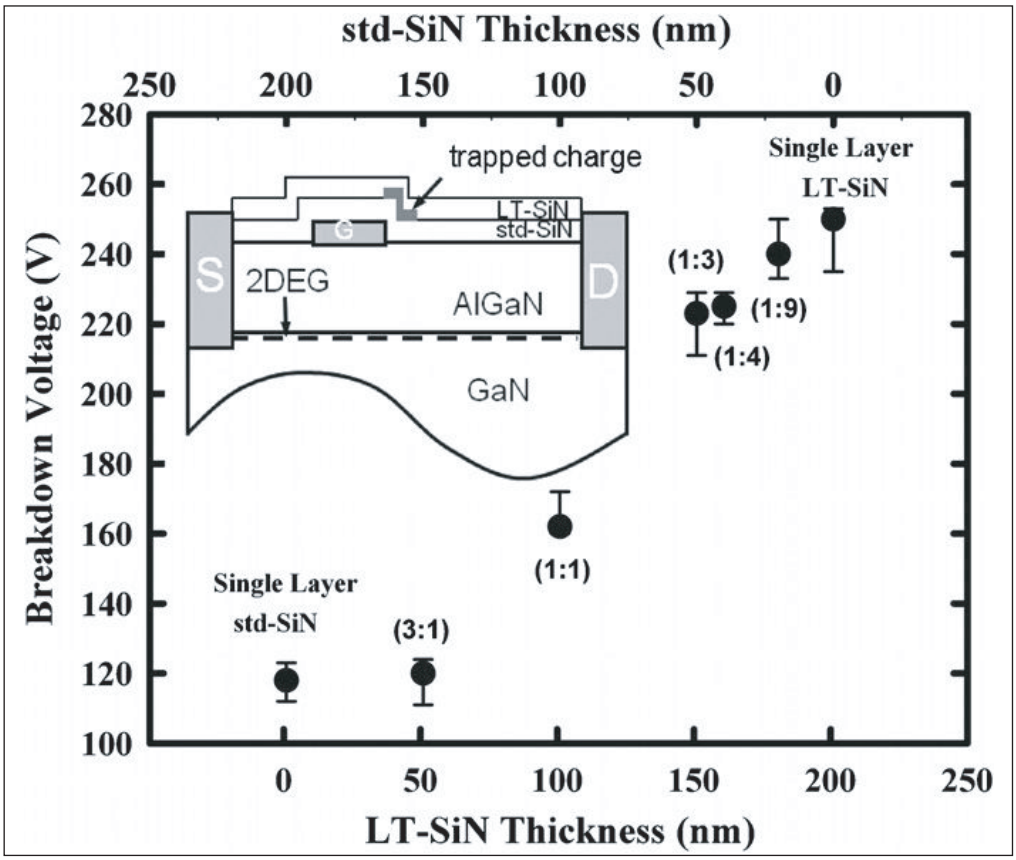

Figure 2. Std-SiN:LT-SiN thickness ratios dependent breakdown voltage, V_B, of the bi-layer Si_xN_y passivated HEMTs at pinch off, V_{gs} = –7V. The total thickness of the SixNy film is 200 nm. Inset: bi-layer passivated devices with charge trapped at the interface between LT-SiN and std-SiN.

In fact, the surface leakage current increases by about one order of magnitude after LT-SiN passivation. By contrast, std-SiN reduces surface leakage by about two orders of magnitude. The CV measurements carried out at 10kHz and 1MHz indicate that the LT-SiN passivation has a higher surface trap density compared with std-SiN.

The Sheffield/Qinetiq research suggests that the electric field moderation comes about through tunneling of carriers from the gate into the LT-SiN trap states at pinch-off. These trapped charges reduce the peak field, increasing the breakdown voltage.

Current collapse was gauged using pulsed measurements with devices being kept below pinch-off and then the gate voltage is pulsed for 400ns to full channel current. The headline figure in these measurements is the 'gate lag response' (GLR), the fraction of the pulsed current of the normal DC value. In unpassivated devices, the GLR was 50%. With 200nm passivations, the GLR was near 100% for std-SiN but less than 40% for LT-SiN. The GLR was maintained at near 100% for bilayers with std-SiN:LT-SiN ratios of 1:3 and 1:1.

Various bilayer combinations were tested for breakdown (Figure 2). Clearly decreasing the std-SiN thickness is advantageous for high breakdown voltage. With 20nm of std-SiN, the breakdown is at 238V. With a std-SiN layer of more than 150nm, the breakdown settled to a value of ~120V — that of the single std-SiN layer device. The thickness of the LT-SiN is found to be less critical — devices with std-SiN layers of 50nm but different LT-SiN layers of 150nm and 350nm had breakdowns at about 225V. This suggests that the charge trapping that gives a field-plate-like effect occurs predominantly at and/or near the interface between the two materials.

The point seems to be that the thinner the std-SiN, the nearer the trapped charge is to the semiconductor, allowing the charges to more effectively modify the electric field and thus increase the breakdown voltage.

The Sheffield/Qinetiq work was funded by the Electro-Magnetic Remote Sensing (EMRS) Defence Technology Centre, established by the UK Ministry of Defence and managed by a consortium of companies — Selex, Thales Defence, Roke Manor Research and Filtronic.■
http://dx.doi.org/10.1088/0268-1242/25/12/125010
Author: Mike Cooke

AlGaN-channel with more than 50% Al achieves 1800V breakdown voltage

High-Al-content HEMT layers on AlN allow high-power applications.

Researchers at University of Fukui, Sharp Corp and Sumitomo Electric Industries Ltd have produced high-electron-mobility transistors (HEMTs) with aluminum gallium nitride (AlGaN) channels with Al content of more than 50% for the first time [Hirokuni Tokuda et al, Appl. Phys. Express, vol3, p121003, 2010]. The team is aiming to produce higher-power semiconductor devices. The new devices achieved a breakdown voltage of 1800V, which is the highest value reported so far among AlGaN-channel HEMTs, according to the researchers.

HEMT devices using the conducting electron sheet (two-dimensional electron gas) formed at the interface between an AlGaN barrier and GaN channel have variously achieved power densities of 32.2W/mm in the C-band (4–8GHz) and maximum oscillation frequencies of up to 300GHz. Such performance characteristics are of great interest for microwave and millimeter-wave applications (communications, radar, etc).

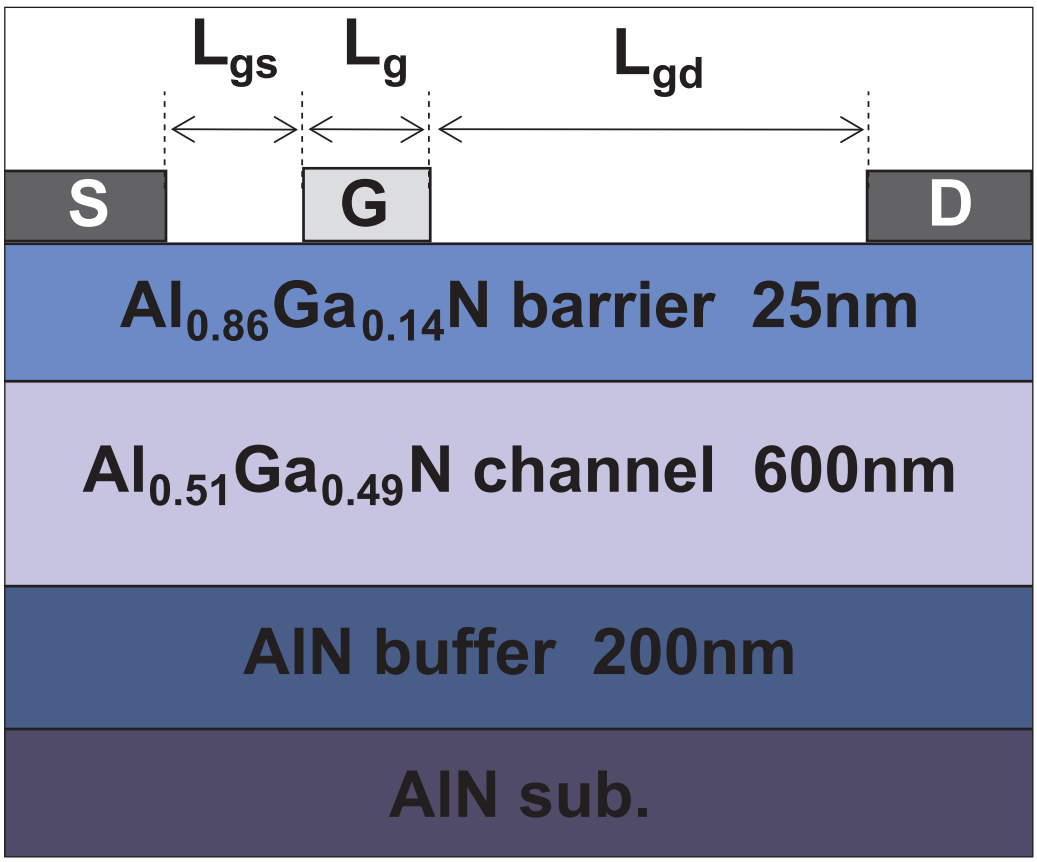

Figure 1. Schematic cross-section of fabricated AlGaN-channel HEMT.

High-power applications for nitride semiconductor devices have recently come to prominence, for example with companies developing inverter systems (DC-to-AC conversion) for hybrid electric vehicles and for renewable energy (solar, wind) plumbing into a smart electric power grid. These devices need to have high breakdown voltage and may need to operate at high temperature.

HEMTs with AlGaN channels have been proposed as providing a way to achieve these properties. These devices have a wider bandgap of AlGaN compared with GaN. A wider bandgap is generally associated with both higher breakdown electric fields and an ability to operate at higher temperature. However, high-Al-content AlGaN is difficult to grow with high quality on traditional substrates.

The researchers used free-standing single-crystal c-plane aluminum nitride (AlN) pieces as the substrate, typically measuring 10mm x 10mm. The substrate material was chosen in order to allow better epitaxial growth quality for the high-Al-content AlGaN layers. AlN has a smaller lattice mismatch with such high-Al-content layers, compared with more traditional substrate materials such as silicon carbide and sapphire. MOCVD was used as the epitaxial growth technique (Figure 1). None of the layers of the AlGaN-channel

HEMT were intentionally doped.

Since suitable ohmic contacts were not obtained using traditional titanium/aluminum stacks, the researchers employed a recently developed system combining zirconium, aluminum, molybdenum and gold (Zr/Al/Mo/Au, 15/60/35/50nm). The stack was processed with a 950ºC anneal for 30secs.

The Schottky gate contact consisted of nickel-gold. The gate length was 9μm. The gate–source spacing was 3μm. The widths of the devices were 515μm. The gate–drain distance was varied between 5μm and 15μm, allowing the breakdown voltage variation with this parameter to be studied. A comparison device consisted of an $Al_{0.25}Ga_{0.75}N$/GaN (GaN-channel) HEMT produced on silicon.

An AlGaN-channel HEMT with gate–drain distance of 10μm had a maximum drain current of 13.0mA (25.2mA/mm) at a drain voltage of 50V. The drain saturation current (i.e. at zero gate voltage) was 4.7mA (9.1mA/mm). The maximum transconductance was 2.4mS (4.7mS/mm). The threshold for pinch-off was –5.5V.

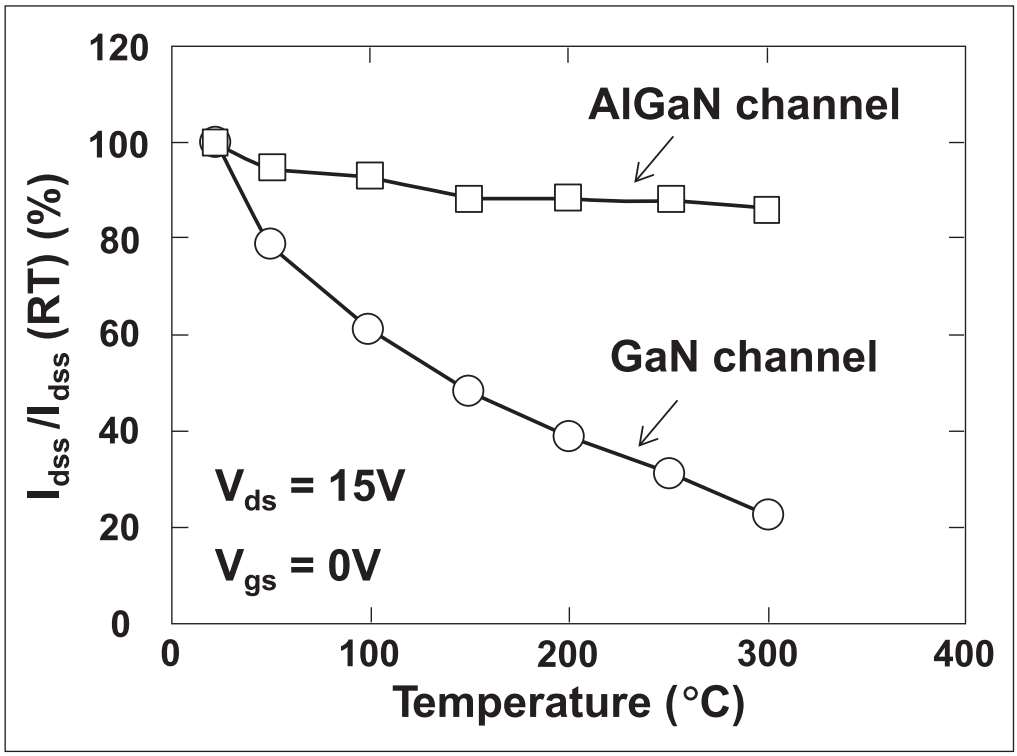

Figure 2. Temperature dependence of drain saturation current. Current is normalized at room temperature. Square and circle symbols are obtained from the developed AlGaN-channel and conventional GaN-channel HEMT, respectively.

The current and transconductance were smaller than previous AlGaN-channel HEMTs (with lower Al contents) reported in 2007–2008. This is attributed to a high channel resistance. Room-temperature transmission line model measurements gave an ohmic specific contact resistance of $4.8x10^{-2}\Omega$-cm^2. The sheet resistance was found to be 2900Ω/sq. C–V profiling was used to estimate the electron concentration at the barrier/channel interface, giving a value of about $5x10^{19}$/cm^2.

Since the channel resistance is relatively high, the researchers believe that this is caused by low mobility of the AlGaN material. However, this cannot be confirmed directly by Hall measurements since the sample size is too small. The researchers comment: 'Further work is needed to improve epitaxial layer quality and structure, such as introducing a low-resistive cap layer.'

The breakdown voltage grew linearly with the gate–drain distance, reaching 1800V for 15μm gate–drain devices. These experiments were carried out at gate voltage –20V, giving a fully pinched-off channel. The breakdown of 1800V compares with a value of 1650V achieved by Mitsubishi using an $Al_{0.38}Ga_{0.62}N$ channel.

The Fukui–Sharp–Sumitomo researchers also found that the AlGaN-channel device maintained its saturation drain current performance more effectively at high temperature than the GaN-channel comparison (Figure 2).

The fall in current over the range from room temperature to 300°C for the AlGaN-channel device was 20%. The GaN-channel comparison device current fell 80% over the same range.

Given the long gate length, the researchers see this as reflecting the temperature dependence of the channel electron mobilities of the respective devices. Further investigation would require studying devices with different gate lengths at varying temperatures, the researchers comment.

'The temperature-insensitive characteristic of AlGaN-channel HEMT is a great advantage for stable high-temperature device operation in many practical applications,' the researchers add.

The contact resistance also decreased as the temperature increased to 300°C, falling to $1.5x10^{-2}\Omega$-cm^2 for the AlGaN-channel device. The GaN-channel device also benefitted from this effect — the contact resistance was $6x10^{-6}\Omega$-cm^2 at room temperature and $5.8x10^{-7}\Omega$-cm^2 at 300°C. ■

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

Power, speed and other highlights at IEDM

Mike Cooke rounds up developments reported at December's 2010 IEEE International Electron Devices Meeting (IEDM) in San Francisco.

The past few years have seen growing interest in using nitride semiconductors as components in power systems. The wide bandgaps (> 3.4eV) of gallium nitride (GaN) and aluminum gallium nitride (AlGaN) mean that the breakdown electric field is large compared with more traditional semiconductors such as silicon (Si) or gallium arsenide (GaAs). The wider bandgap also allows such devices to maintain their performance characteristics to higher temperatures.

The 2010 International Electron Devices Meeting (IEDM) in early December had a special focus on power electronics, where gallium nitride technologies were to the fore. The themes of these presentations were energy efficiency and supply for green technologies.

Session 13 was titled 'Emerging Technologies — Next Generation Power Devices and Technology', while 'Advanced Power Devices and Reliability' from the perspective of quantum and compound semiconductor technology was also the topic of session 20.

The earlier of these sessions was concerned mainly with sifting through potential applications and matching them to suitable potential technologies. Applications include battery control (e.g. switching and charging), motors (e.g. in hybrid electric vehicles, industrial processes etc), renewable energy distribution into the electric grid, etc.

For many of these uses, silicon is the favored option due to its long development and low cost. However, some companies such as Toyota [session 13.5] and consultant Dr Michael A. Briere of ACOO Enterprises LLC [13.6] see potential for the application of GaN and silicon carbide (SiC) to automotive, and even voltage regulator modules for multi-processor CPU power control. Some key features of these devices are higher power efficiencies and higher power densities. High temperature operation is also a useful factor and is of much interest for aerospace applications, as well as automotive and electric grid applications.

Toyota is a leading producer of hybrid electric vehicles, known internationally for its Prius range, which the US Environmental Protection Agency has determined is the most fuel-efficient gasoline car sold in the USA (achieving 51 miles per gallon in cities, according to www.fueleconomy.gov/feg/best/bestworstNF.shtml). The company sees improved economy being made available by the introduction of silicon carbide and/or gallium nitride power devices in inverters, boost and buck converters, and for AC/DC charger units (Figure 1). Vertical devices (Figure 2) are preferred for the higher-power applications (inverter, boost converter), but are

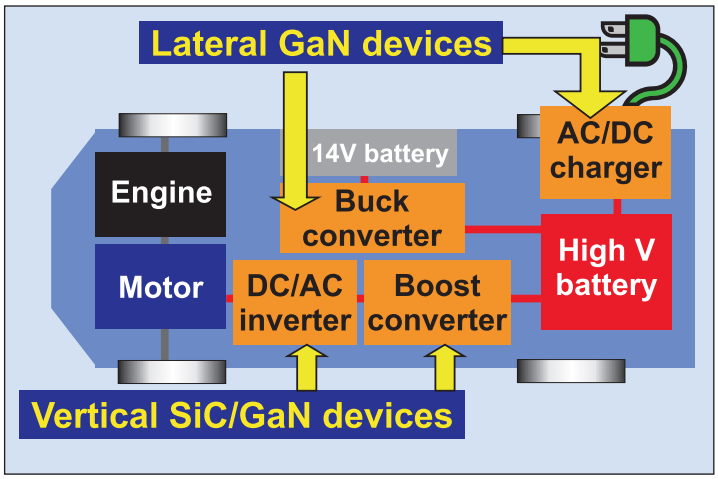


Figure 1. Prospect of SiC/GaN application in future plug-in hybrid electric vehicles, according to Toyota researchers. The lateral power switch devices may need to be bidirectional (for AC/AC matrix conversion) or high frequency (for buck).

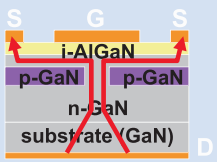
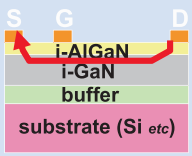
	vertical	lateral
structure		
cost	high	low (on Si)
speed	relative high	high
main issues	quality of sub. *etc.*	current collapse *etc.*
power	high (>10kW)	middle (~kW)
application	inverter *etc.*	bi-directional sw. high-f converter.

Figure 2. Relative merits of vertical and lateral structures for GaN transistors, according to Toyota researchers.

more costly to produce. Lateral devices can be manufactured on silicon, reducing costs, but are restricted to mid-range powers that are acceptable for AC/DC chargers and buck converters.

Session 20 reported actual structures and technologies for high-power/voltage operation, mainly in nitride semiconductors, but also with some silicon technology. Some of the nitride research is aimed at characterizing traps that can impact performance [Ohio State University, Wright Patterson Air Force Base, Wyle Labs, 20.1], or looking for degradation mechanisms [MIT, 20.2; IMEC, University of Padova, 20.3; Hong Kong University of Science and Technology, Nitronex, 20.4] of nitride high-electron-mobility transistors (HEMTs).

MIT found that RF stress created more degradation compared with a comparable DC voltage. IMEC and Padova applied for the first time the time-dependent dielectric breakdown (TDDB) technique that is used in CMOS reliability assessments to give lifetime extrapolations.

HKUST et al reported the on-state reliability of HEMTs that were treated with fluorine plasma to shift the threshold voltage to 'enhancement mode', i.e. normally-off operation, which is desirable for lower power consumption. A critical voltage was found that seemed to be caused by impact ionization of the fluorine ions in the barrier layer.

Also, new high-power device structures were presented such as Panasonic's new method to increase the blocking voltage of GaN power switching transistors on silicon substrates to 2200V [20.5; see Semiconductor Today news at www.semiconductor-today.com/news_items/2010/DEC/PANASONIC_081210.htm]. The method consists of putting selectively formed p-type regions on the surface of the Si substrate to block electron current flows that occur at the interface between the GaN and Si layers of the device. This allows the Si to also contribute to the blocking voltage. The 2200V blocking voltage is about five times that achieved by usual GaN power transistors grown on silicon substrates. The researchers believe that increasing the thickness of the epitaxial nitride semiconductor structures could increase blocking to 3000V.

Panasonic says that the new GaN transistor extends the operating voltages of a variety of power switching systems including inverters for industrial use and uninterruptible power supplies. The company has filed applications for 99 domestic and 64 overseas patents on the technology.

In the same section, North Carolina State University and Nitronex presented a normally-off nitride semiconductor transistor that included a silicon dioxide (SiO_2) gate tunnel dielectric and tantalum nitride (TaN) floating gate layers [20.6]. The structure (Figure 3) is described as being a metal-oxide-semiconductor-heterostructure field-effect transistor (MOS-HFET). The channel layer

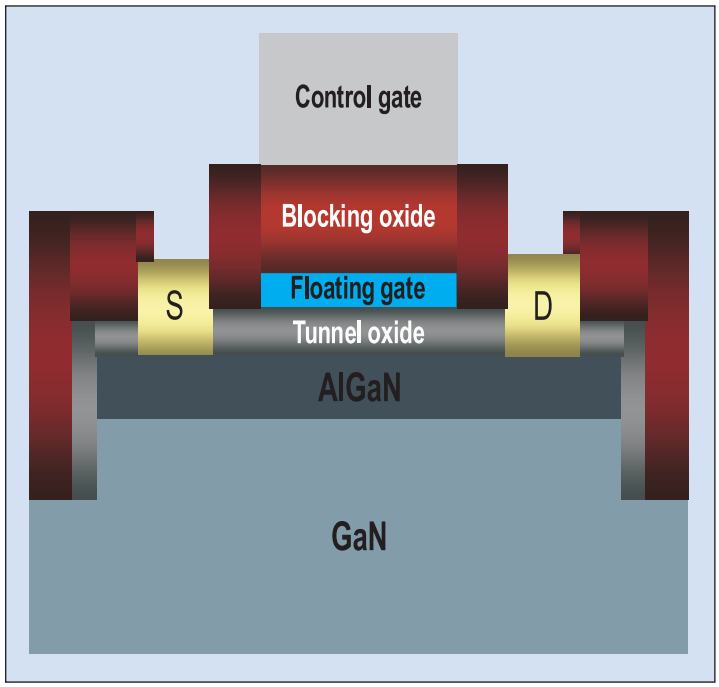


Figure 3. Schematic NCSU nitride semiconductor MOS-HFET.

was GaN and the barrier was AlGaN (26% Al).

The enhancement-mode operation is achieved by injecting charge into the floating gate (rather like in Flash memory devices), shifting the threshold voltage. In fact, a floating gate stack of SiO_2(tunnel oxide)/TaN/HAH (blocking oxide), where HAH=$HfO_2/Al_2O_3/HfO_2$, entered enhancement mode after a 15V pulse for 500ms. The charge retention of the floating gate was such that less than 10% was lost after 10,000 seconds. Threshold voltage shifts of up to 6V were achieved, representing a charge density in the floating gate of $1.2x10^{13}/cm^2$.

One would normally expect a nitride HFET/HEMT to be depletion mode (normally-on) and that adding insulation to reduce gate leakage (MOS-HFET) would shift the threshold in a negative direction, making the device harder to turn off and putting it further from enhancement behavior.

Although a floating gate structure had been suggested previously as a way to shift thresholds to enhancement mode in nitride HEMTs, this had not been experimentally demonstrated before. A combination of atomic layer deposition and RF magnetron sputtering (floating gate) was used to create the stack.

Compounding digital performance

Digital devices built in compound semiconductor material continue to be of interest, particularly as a possible means of overcoming the increasing problems of developing traditional complementary metal oxide semiconductor (CMOS) silicon technology that controls most consumer electronics today.

The main material here is indium gallium arsenide (InGaAs). For example, Intel and epitaxial wafer

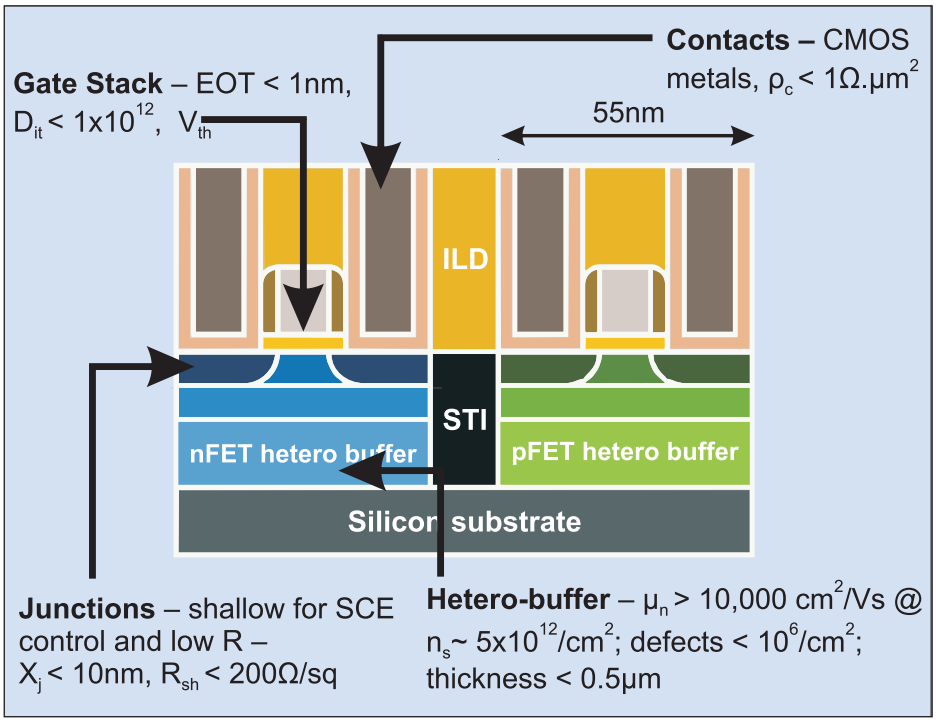


Figure 4. Module targets for III-V at 11nm and below. SEMATECH's process meets the targets for contact (1Ω-cm^2) and junction (100Ω/sq) resistance, and for junction depth (10nm). However, work is needed on interface trap density (D_{it}), nFET hetero buffer mobility (μ_n, 8900cm^2/V-s) and buffer thickness (1.4μm).

producer IQE last year developed an InGaAs FinFET (i.e. a long thin channel with a wrap-around gate). The advantage of InGaAs is a higher mobility than silicon. Intel/IQE research in 2010 has improved the device structure with a fin that was 35nm wide and reduced the gate–source and gate–drain distances to 5nm. The researchers claim 'more enhancement-mode threshold voltage and significantly improved electrostatics' from their new device.

Meanwhile [3.1], the University of Tokyo, working with Japan's National Institute of Advanced Industrial Science and Technology (NAIST) and Sumitomo Chemical, produced ultra-thin InGaAs-on-insulator MOSFETs using direct wafer bonding techniques (i.e. the layers are grown on another substrate and transferred to a silicon wafer for further processing such as wiring, etc.). The insulator consisted of a buried aluminum oxide layer. The thickness of the InGaAs channel was 3.5nm and that of the oxide was 9nm. Using a double gate, the on/off current ratio was 10^7.

The US-based SEMATECH industry consortium produced self-aligned III-V MOSFETs on 200mm silicon wafers using standard silicon industry tools for the first time [6.2]. The gate length was 0.5μm (500nm, rather than the tens of nanometers used by present-day CMOS). The maximum external transconductance ($g_{m,ext}$) was 1005μS/μm and the on-current was 1μA/μm at 1V operating voltage. The researchers comment: 'We present statistically significant data demonstrating that III-V on Si devices can be processed on a Si line with controlled contamination, uniformity and yield while demonstrating good device performance.' The team is targeting the introduction of III-V devices with critical features around 11nm (Figure 4).

III-V MOSFETs tend to be n-MOS. For CMOS circuitry, one also needs p-MOS. Generally, it is expected that these devices will be provided by germanium channels. However, Stanford University, Stanford Linear Accelerator Center, and the Naval Research Lab reported on indium gallium antimonide (InGaSb) devices that had 100% (910cm^2/V-s) improved buried mobility for holes, compared with germanium, over the entire sheet charge range [6.4]. The surface mobility was 50% better (620cm^2/V-s). The researchers produced transistors with on–off current ratios of 10^4 with a subthreshold slope (SS) of 120mV/dec. The SS is desired to be as close as possible to the 60mV/dec limit at room temperature (log(10)kT/q) for a sharp turn-on. Various devices were produced to optimize hole transport, using aluminum oxide gate insulation in a self-aligned gate-first process (Figure 5).

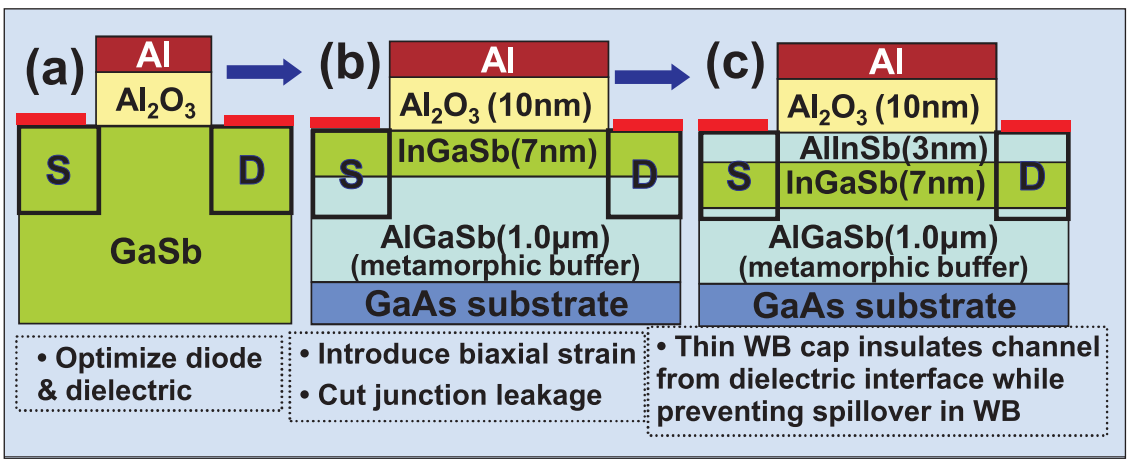


Figure 5. Different channel designs to separate the impact of different issues and enhance transistor performance. Top surface is terminated with two monolayers of GaSb in each case to maintain high-quality interface with Al_2O_3. WB = wide bandgap.

Support for the research came from Office of Naval Research and Intel.

Quantum well devices are also being developed to incorporate III-Vs into silicon. On the n-side, Pennsylvania State University, Naval Research Lab, and Israel Institute of Technology University have worked with $InAs_{0.8}Sb_{0.2}$ wells to produce a drive current of 380μA/μm at 0.5V [6.3]. A high-k gate stack consisted of 3.3nm of aluminum oxide and 1nm GaSb, giving an equivalent oxide thickness of 4.2nm. Intel has worked on p-type QWFETs with a strained germanium channel and an EOT (equivalent oxide thickness) of 1.5nm [6.7]. The hole mobility (770cm²/V-s at sheet carrier density of $5x10^{12}$/cm²) was found to be four times that of standard strained silicon. The researchers comment: 'This suggests the Ge QWFET is a viable p-channel option for III-V CMOS.'

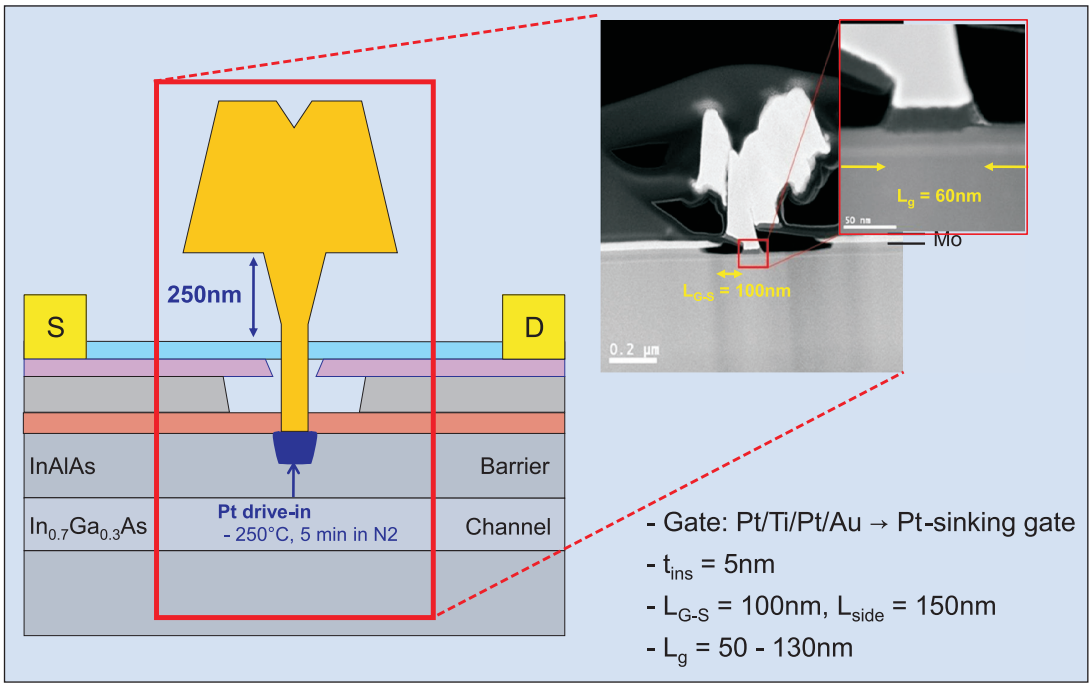


Figure 6. Cross-section of MIT device structure.

Speedsters

More traditional III-V transistors were also presented, targeting and achieving frequency characteristics up to 1 terahertz (1000GHz = 1THz). Such devices are of interest for millimeter and sub-millimeter radio wave transmissions used for defense and communications, e.g. for signal generation/detection and high-power amplification (GaN or SiC) at high frequency.

The highest characteristic of 1THz was for the maximum oscillation frequency of a 50nm gate-length enhancement-mode $In_{0.7}Ga_{0.3}As$ pseudomorphic HEMT on 100mm InP substrate, produced by Teledyne Scientific (with Jesús del Alamo of MIT) [30.6]. According to the researchers, this is the first demonstration of such a performance for enhancement-mode PHEMTs. To establish this result the researchers had to understand some abnormal peaky behavior that could have led to over-estimation of f_{max}.

A platinum gate-sinking process was used to reduce the effective gate–channel distance and to shift the threshold to positive values for enhancement-mode (normally-off) behavior. The transconductance was 1.7S/mm at 0.75V 1THz input. The subthreshold region was 'very sharp', with a swing of 80mV/dec and drain-induced barrier lowering of 80mV/V. The 1mA/mm current turn-on voltage was more than 0.5V.

In a related presentation, MIT separately reported on its work with 60nm self-aligned-gate InGaAs HEMTs (Figure 6) with a cut-off (f_T) of 580GHz and maximum oscillation (f_{max}) of 675GHz [30.7]. This was achieved using a molybdenum-based self-aligned gate process (Figure 7) that 'yields outstanding contact resistance,

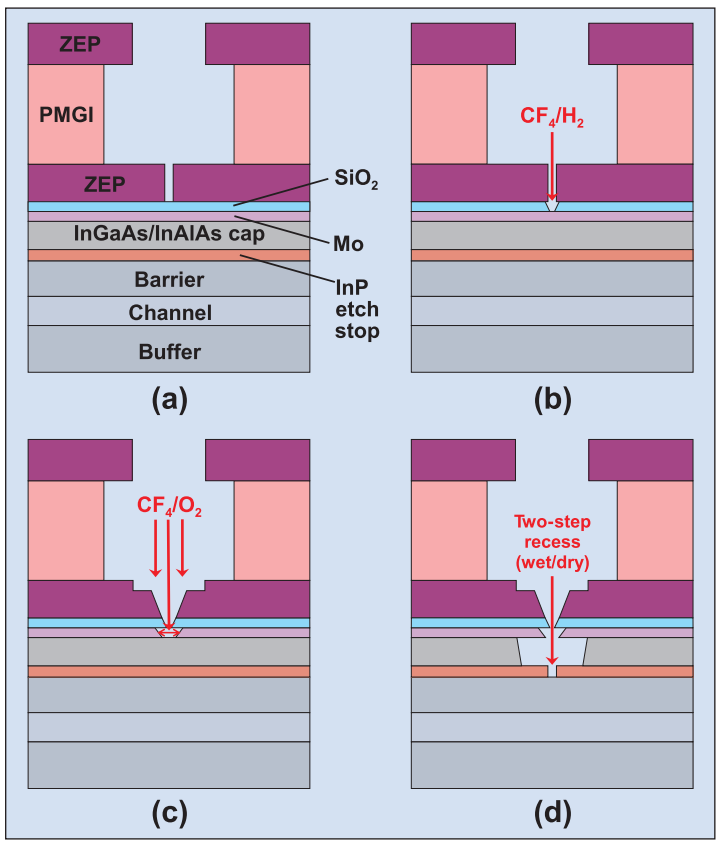


Figure 7. Process flow for self-aligned gate (SAG) structure: (a) double electron-beam exposure/development of photoresist; (b) silicon dioxide etch; (c) molybdenum lateral etch; (d) two-step citric acid solution/argon plasma etches to expose barrier.

source resistance, transconductance and high-frequency characteristics'. Many of the measured values were records, or near the record value.

The purpose of using non-alloyed molybdenum is to create ohmic source–drain contacts with low parasitic resistance and capacitance, allowing high-frequency operation. One important feature of reducing the parasitic characteristics is to shrink the footprint of InGaAs devices from the typical micron-scale needed for contacts and ~100nm separation distance from the gate. The transconductance was 2.1mS/μm at a source–drain voltage of 0.5V. The work was part sponsored by Intel.

For GaN HEMT performance, a speed record beyond 400GHz has been achieved by HRL Laboratories with NASA's Jet Propulsion Laboratory [30.1]. A double heterostructure with barriers above and below the GaN well (AlN/GaN/AlGaN) was used. The gate length was 40nm. The cut-off frequency was 220GHz and the maximum oscillation was 440GHz. Silicon carbide substrates were used. To improve the ohmic contact with the source and drain regions of the device, a re-growth process involving molecular beam epitaxy (MBE) was used.

Further nitride semiconductor HEMT developments were reported by MIT Microsystems Technology Laboratories [30.2], and by University of Notre Dame, TriQuint Semiconductor, and IQE RF LLC [30.4]. The MIT group has developed a gate recess/oxygen plasma treatment to reduce collapse effects in terms of transconductance, enabling an f_T of 225GHz. Notre Dame et al produced 144nm gate enhancement-mode and depletion-mode devices on the same wafer, producing ring oscillators with a 15.3psec/stage delay.

GaN nanowires transistors also made a showing, with National Taiwan University presenting a depletion-mode device that operated at 100GHz [30.3]. The channel consisted of the two-dimensional electron gas formed at the interface with a gallium oxide (Ga_2O_3) nanowire region.

AlGaN/GaN MOS-HEMTs have also been produced for the first time in research in Singapore [11.3], by the University of Singapore (NUS), the Institute of Materials Research and Engineering, and the Data Storage Institute. The device used a diamond-like carbon (DLC) liner with high compressive stress to enhance the performance, increasing saturation currents by up to 30% at 10V (gate at 2V). Peak transconductance was increased by 22% at 5V by using the DLC liner. The gate lengths of the devices were less than 500nm. The researchers believe that the shift of the threshold by 1V in the positive direction suggests the potential of strain engineering for achieving enhancement-mode operation.

High-speed electronics was not exclusively the preserve of III-V devices at IEDM. IHP — Innovations for High Performance Microelectronics (Leibniz-Institut für innovative Mikroelectronik) presented a silicon germanium heterojunction bipolar transistor with f_T/f_{max} of 300GHz/500GHz, a breakdown voltage of 1.6V, and 2psec minimum CML ring oscillator gate delay [30.5]. The researchers attribute these improved results over previous SiGe HBTs to 'reduced specific collector–base capacitance and base resistance and scaling of device dimensions'.

Light handlers

Another area where III-Vs tend to dominate is light-emitting devices. At IEDM, Dartmouth College and MIT reported lasers created through band engineering germanium on silicon (both group IV elements). These group IV materials normally have indirect bandgaps that make light emission difficult. By compensating the energy difference between the direct and indirect bandgaps, Dartmouth–MIT created laser emission at 1590–1610nm wavelengths using optical pumping (i.e. energy is delivered into the device through an external light source). However, the researchers also report direct-gap electroluminescence from Ge/Si heterojunction diodes, indicating that electrical pumping is at least possible. The wavelength range was 1450–1650nm at room temperature. In combination with traditional CMOS, the light emitters could be a 'desirable choice for monolithic electronic–photonic integrated circuits'.

In the light-detection arena, European researcher center IMEC, France's CRHEA-CNRS,and the Royal Observatory of Belgium presented an AlGaN-on-silicon imager to detect extreme ultraviolet radiation (EUV) [14.5]. The detectors have a wavelength cut-off of 280nm from using AlGaN with 40% Al, giving a 4.2eV bandgap; the device is thus intrinsically blind to wavelengths longer than this. An array of such detectors was formed into a 256x256-pixel focal plane array with a 10μm pixel-to-pixel pitch. The device also contains 0.35μm CMOS read-out circuitry to which the AlGaN on Si detectors are flip-chip bonded. The nitride material was deposited using MBE.

The structure of the device is such that the illumination came through the 'back-side' – i.e. through the locally thinned silicon wafer. The sensitivity of the device down to a wavelength of 1nm was verified using synchrotron radiation.

Ultraviolet detection is of particular interest for solar science, EUV microscopy and advanced EUV lithography tools. In fact, the devices were produced within the framework of the BOLD project of the European Space Agency [http://bold.sidc.be/-BOLD-GSTP-AlGaN-.htm]. The ultimate aim is to produce 1000x1000-pixel arrays for use on future solar missions.

The use of the wide-bandgap nitride semiconductor AlGaN makes the devices more rugged in terms of UV damage compared with devices using silicon. Also, such devices do not need filters to block the visible and infrared radiation that is needed for 'solar blindness'. ■

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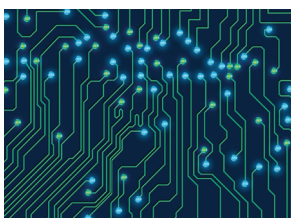

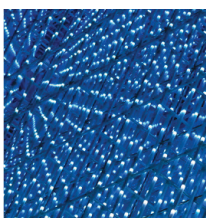

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Tel: +1 408 734 0459
Fax: +1 408 734 0961
www.samcointl.com

SPP Process Technology Systems Ltd
Imperial Park, Newport NP10 8UJ,
Wales, UK
Tel: +44 (0)1633 652400
Fax: +44 (0)1633 652405
www.spp-pts.com

TECDIA Inc
(see section 16 for full contact details)

Tegal Corp
2201 S McDowell Boulevard,
Petaluma, CA 94954, USA
Tel: +1 707 763 5600
www.tegal.com

Veeco Instruments Inc
(see section 6 for full contact details)

9 Materials & metals

Goodfellow Cambridge Ltd
Ermine Business Park,
Huntingdon,
Cambridgeshire PE29 6WR, UK
Tel: +44 (0) 1480 424800
Fax: +44 (0) 1480 424900
www.goodfellow.com
Goodfellow supplies small quantities of metals and materials for research, development, prototyping and specialised manufacturing operations.

TECDIA Inc
(see section 16 for full contact details)

10 Gas and liquid handling equipment

Air Products and Chemicals Inc
(see section 7 for full contact details)

Cambridge Fluid Systems
12 Trafalgar Way, Bar Hill,
Cambridge CB3 8SQ,
UK
Tel: +44 (0)1954 786800
Fax: +44 (0)1954 786818
www.cambridge-fluid.com

CS CLEAN SYSTEMS AG
Fraunhoferstrasse 4,
Ismaning, 85737,
Germany
Tel: +49 89 96 24 00 0
Fax: +49 89 96 24 00 122
www.cscleansystems.com

Power + Energy Inc
106 Railroad Drive,
Ivyland,PA 18974, USA
Tel: +1 215 942-4600
Fax: +1 215 942-9300
www.powerandenergy.com

SAES Pure Gas Inc
4175 Santa Fe Road,
San Luis Obispo,
CA 93401,
USA
Tel: +1 805 541 9299
Fax: +1 805 541 9399
www.saesgetters.com

11 Process monitoring and control

k-Space Associates Inc
3626 W. Liberty Rd.,
Ann Arbor,
MI 48103,
USA
Tel: +1 734 668 4644
Fax: +1 734 668 4663
www.k-space.com
k-Space Associates Inc specializes in in-situ, real-time thin-film process monitoring tools for MBE, MOCVD, PVD, and thermal evaporation. Applications and materials include the research and production line monitoring of compound semiconductor-based electronic, optoelectronic, and photovoltaic devices.

KLA-Tencor
One Technology Dr,
1-2221I, Milpitas,
CA 95035,
USA
Tel: +1 408 875 3000
Fax: +1 408 875 4144
www.kla-tencor.com

LayTec GmbH
Seesener Str.
10–13,
10709 Berlin,
Germany
Tel: +49 30 39 800 80 0
Fax: +49 30 3180 8237
www.laytec.de
LayTec develops and manufactures optical in-situ and in-line metrology systems for thin-film processes with particular focus on compound semiconductor and photovoltaic applications. Its know-how is based on optical techniques: reflectometry, emissivity corrected pyrometry, curvature measurements and reflectance anisotropy spectroscopy.

Optical Reference Systems Ltd
OpTIC Technium,
St Asaph Business Park,
St Asaph, LL17 0JD,
UK
Tel: +44 (0)1745 535 188
Fax: +44 (0)1745 535 186
www.ors-ltd.com

WEP (Ingenieurbüro Wolff für Elektronik- und Programmentwicklungen)
Bregstrasse 90, D-78120
Furtwangen im Schwarzwald,
Germany
Tel: +49 7723 9197 0
Fax: +49 7723 9197 22
www.wepcontrol.com

12 Inspection equipment

Bruker AXS GmbH
Oestliche Rheinbrueckenstrasse 49,
Karlsruhe, 76187,
Germany
Tel: +49 (0)721 595 2888
Fax: +49 (0)721 595 4587
www.bruker-axs.de

13 Characterization equipment

J.A. Woollam Co. Inc.
645 M Street Suite 102,
Lincoln, NE 68508,
USA
Tel: +1 402 477 7501
Fax: +1 402 477 8214
www.jawoollam.com

Lake Shore Cryotronics Inc
575 McCorkle Boulevard,
Westerville, OH 43082, USA
Tel: +1 614 891 2244
Fax: +1 614 818 1600
www.lakeshore.com

14 Chip test equipment

Keithley Instruments Inc
28775 Aurora Road,
Cleveland, OH 44139,
USA
Tel: +1 440.248.0400
Fax: +1 440.248.6168
www.keithley.com

SUSS MicroTec Test Systems
228 Suss Drive,
Waterbury Center, VT 05677,
USA
Tel: +1 800 685 7877
Fax: +1 802 244 7853
www.suss.com

15 Assembly/packaging materials

ePAK International Inc
4926 Spicewood Springs Road,
Austin, TX 78759, USA
Tel: +1 512 231 8083
Fax: +1 512 231 8183
www.epak.com

Gel-Pak
31398 Huntwood Avenue,
Hayward, CA 94544, USA
Tel: +1 510 576 2220
Fax: +1 510 576 2282
www.gelpak.com

Williams Advanced Materials
2978 Main Street, Buffalo, NY 14214,
USA
Tel: +1 716 837 1000
Fax: +1 716 833 2926
www.williams-adv.com

16 Assembly/packaging equipment

Ismeca Europe Semiconductor SA
Helvetie 283, La Chaux-de-Fonds, 2301,
Switzerland
Tel: +41 329257111
Fax: +41 329257115
www.ismeca.com

J P Sercel Associates Inc
220 Hackett Hill Road,
Manchester, NH 03102,
USA
Tel: +1 603 518 3200
Fax: +1 603 518 3298
www.jpsalaser.com

Kulicke & Soffa Industries
1005 Virginia Drive,
Fort Washington, PA 19034,
USA
Tel: +1 215 784 6000
Fax: +1 215 784 6001
www.kns.com

Palomar Technologies Inc
2728 Loker Avenue West,
Carlsbad, CA 92010, USA
Tel: +1 760 931 3600
Fax: +1 760 931 5191
www.PalomarTechnologies.com

TECDIA Inc
2700 Augustine Drive, Suite 110,
Santa Clara, CA 95054, USA
Tel: +1 408 748 0100
Fax: +1 408 748 0111
www.tecdia.com
Tecdia is a manufacturer of single-layer chip capacitors, chip resistors, DC boards, bias-Ts, diamond scribing tools and dispensing nozzles.

17 Assembly/packaging foundry

Quik-Pak
10987 Via Frontera,
San Diego, CA 92127, USA
Tel: +1 858 674 4676
Fax: +1 8586 74 4681
www.quikicpak.com

18 Chip foundry

Compound Semiconductor Technologies Ltd
Block 7, Kelvin Campus,
West of Scotland, Glasgow,
Scotland G20 0TH, UK
Tel: +44 141 579 3000
Fax: +44 141 579 3040
www.compoundsemi.co.uk

United Monolithic Semiconductors
Route departementale 128,
BP46, Orsay, 91401, France
Tel: +33 1 69 33 04 72
Fax: +33 169 33 02 92
www.ums-gaas.com

19 Facility equipment

MEI, LLC
3474 18th Avenue SE,
Albany, OR 97322-7014, USA
Tel: +1 541 917 3626
Fax: +1 541 917 3623
www.marlerenterprises.net

20 Facility consumables

W.L. Gore & Associates
401 Airport Rd,
Elkton, MD 21921-4236, USA
Tel: +1 410 392 4440
Fax: +1 410 506 8749
www.gore.com

21 Computer hardware & software

Ansoft Corp
4 Station Square, Suite 200,
Pittsburgh, PA 15219, USA
Tel: +1 412 261 3200
Fax: +1 412 471 9427
www.ansoft.com

Crosslight Software Inc
121-3989 Henning Dr.,
Burnaby, BC, V5C 6P8, Canada
Tel: +1 604 320 1704
Fax: +1 604 320 1734
www.crosslight.com

Semiconductor Technology Research Inc
10404 Patterson Ave., Suite 108,
Richmond, VA 23238, USA
Tel: +1 804 740 8314
Fax: +1 804 740 3814
www.semitech.us

22 Used equipment

Class One Equipment Inc
5302 Snapfinger Woods Drive,
Decatur, GA 30035, USA
Tel: +1 770 808 8708
Fax: +1 770 808 8308
www.ClassOneEquipment.com

23 Services

Henry Butcher International
Brownlow House, 50–51
High Holborn,
London WC1V 6EG, UK
Tel: +44 (0)20 7405 8411
Fax: +44 (0)20 7405 9772
www.henrybutcher.com

M+W Zander Holding AG
Lotterbergstrasse 30,
Stuttgart, Germany
Tel: +49 711 8804 1141
Fax: +49 711 8804 1950
www.mw-zander.com

TECDIA Inc
(see section 16 for full contact details)

24 Consulting

Fishbone Consulting SARL
8 Rue de la Grange aux Moines,
78460 Choisel,
France
Tel: + 33 (0)1 30 47 29 03
E-mail: jean-luc.ledys@neuf.fr

25 Resources

SEMI Global Headquarters
3081 Zanker Road,
San Jose,
CA 95134,
USA
Tel: +1 408 943 6900
Fax: +1 408 428 9600
www.semi.org

Yole Développement
45 rue Sainte Geneviève,
69006 Lyon,
France
Tel: +33 472 83 01 86
www.yole.fr

event calendar

If you would like your event listed in *Semiconductor Today*'s Event Calendar, then please e-mail all details to the Editor at mark@semiconductor-today.com

1–3 February 2011
Transformations in Lighting: 2011 DOE Solid-State Lighting R&D Workshop
San Diego, CA, USA
E-mail: solidstate@courtesyassoc.com
www1.eere.energy.gov/buildings/ssl

16 February 2011
PHOTON's 3rd Thin Film Conference
San Francisco, CA, USA
E-mail: info@photon-expo.com
www.photon-expo.com/en

16–19 January 2011
2011 IEEE Radio & Wireless Symposium (RWS)
Renaissance Glendale, Phoenix, AZ, USA
E-mail: info@flyevents.net
http://rawcon.org

20–24 February 2011
IEEE International Solid State Circuits Conference (ISSCC 2011)
San Francisco, CA, USA
E-mail: isscc@ieee.org
http://128.100.10.145/isscc

22–24 February 2011
Strategies in Light 2011
Santa Clara Convention Center, CA, USA
E-mail: lubah@pennwell.com
www.strategiesinlight.com

22–24 February 2011
SNEC PV POWER EXPO 2011
Shanghai, China
E-mail: info@snec.org.cn
www.snec.org.cn

27 February – 1 March 2011
Industry Strategy Symposium (ISS Europe 2011): 'Europe – Exploiting its Strengths'
Grenoble, France
E-mail: clee@semi.org
www.semi.org/isseurope

1–4 March 2011
LED CHINA 2011
Guangzhou, China
E-mail: led-trust@ubm.com
www.LEDChina-gz.com

6–10 March 2011
OFC/NFOEC 2011 (Optical Fiber Communication Conference and Exhibition/ National Fiber Optic Engineers Conference)
Los Angeles Convention Center, CA, USA
E-mail: info@ofcconference.org
www.ofcnfoec.org

13–17 March 2011
OTST 2011: International Workshop on Optical Terahertz Science and Technology
Santa Barbara, CA, USA

advertisers' index

E-mail: support.otst@gmail.com
http://otst2011.itst.ucsb.edu

15–17 March 2011
LASER World of PHOTONICS CHINA
Shanghai, New International Expo Centre (SNIEC), China
E-mail: laser@mmi-shanghai.com
www.world-of-photonics.net/en/laser-china/start

15–17 March 2011
SEMICON China 2011
Shanghai New International Expo Centre (SNIEC), China
E-mail: semichina@semi.org
www.semi.org/scchina-en

20–23 March 2011
Euro-MBE 2011: 16th European Molecular Beam Epitaxy Workshop
Alpe d'Huez, France
E-mail: embe2011@grenoble.cnrs.fr
http://embe2011.neel.cnrs.fr

21–23 March 2011
SEMATECH Surface Preparation and Cleaning Conference (SPCC 2011)
Austin, TX, USA
E-mail: spcc@sematech.org
www.sematech.org/meetings/spcc

21–24 March 2011
GOMACTech-11 (36th annual Government Microcircuit Applications and Critical Technology conference)
Orlando, FL, USA
E-mail: john.franco@dtra.mil
www.gomactech.net

28 March 2011
3rd Thin Film Solar Summit Europe
Berlin, Germany
E-mail: matt@thinfilmtoday.com
www.thinfilmtoday.com/europe

4–6 April 2011
CPV-7 International Conference on Concentrating Photovoltaic Systems
Las Vegas, NV, USA
E-mail: info@cpv-conference.org
www.cpv-conference.org

13–15 April 2011
11th Fiber Optics Expo (FOE 2011)
Tokyo Big Sight, Japan
E-mail: foe@reedexpo.co.jp
www.foe.jp/en

14–15 April 2011
3rd Photovoltaics Thin-Film Week, including: — International Workshop on CIGS Solar Cell Technology — 3rd Thin-Film Industry Forum (TIF 2011)
Berlin, Germany
E-mail: info@solarpraxis.de
www.solarpraxis.de/en/conferences

16 – 21 April 2011
54th Society of Vacuum Coaters Annual Technical Conference (2011 SVC TechCon)
Chicago, IL, USA
E-mail: svcinfo@svc.org
www.svc.org

18–20 April 2011
Semiconductor and Integrated Opto-Electronics Conference (SIOE'11)
Cardiff University, Wales, UK
E-mail: K.A.Shore@bangor.ac.uk
www.astro.cardiff.ac.uk/research/pm/events/?page=sioe

18–21 April 2011
SPIE Optics & Optoelectronics
Prague Congress Centre, Czech Republic
E-mail: customerservice@spie.org
http://spie.org/x25077.xml

18–21 April 2011
Photonica: Lasers, Optics & Application 2011: 6th International Specialized Exhibition for Laser, Optical & Optoelectronic Technologies
ZAO Expocentre, Moscow, Russia
E-mail: ak@expocentr.ru
www.photonics-expo.ru/en

25–29 April 2011
SPIE Defense, Security, and Sensing 2011
Orlando, FL, USA
E-mail: customerservice@spie.org
http://spie.org/defense-security.xml?WT.mc_id=RCal-DSSW

25–29 April 2011
MRS 2011 Spring Meeting
Moscone West and San Francisco Marriott, CA, USA
E-mail: info@mrs.org
www.mrs.org/s_mrs/sec.asp?CID=21379&DID=246341

26–28 April 2011
ISSTT 2011: 22nd International Symposium on Space Terahertz Technology
Tucson, AZ, USA
E-mail: info@nrao.edu
www.nrao.edu/meetings


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