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COMPOUNDS & ADVANCED SILICON

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SiC making further inroads into silicon for EV powertrains

Bosch acquiring TSI • Coherent cutting jobs in Newton Aycliffe
ST to supply SiC devices to ZF • Emcore shuts Broadband unit

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p11 SiC and GaN power-switching & RF device maker Wolfspeed's Durham HQ hosted the first stop of US President Joe Biden's 'Invest in America' tour.

p36 Aided by Invest Ontario, micro-LED display firm VueReal is investing $40m to grow its manufacturing workforce and support R&D, creating 75 new jobs over three years.

Cover image: US-based onsemi has announced a long-term supply agreement to provide its EliteSiC silicon carbide power devices to increase the powertrain efficiency of smart electric vehicles made by ZEEKR (the global premium electric mobility brand of China-based Geely). **p15**

editorial

SiC supply chain gearing up for EVs

Driven by the accelerating adoption of electric vehicles, the last few months have seen large-scale investment in silicon carbide (SiC) power device manufacturing for use in EV drivetrains etc. For example, US-based Wolfspeed is to build a second 200mm-wafer device fab, this time in Germany, in partnership with investment from Germany-based automotive system supplier ZF (aided by state funding). Wolfspeed is already pioneering volume production of SiC devices on 200mm wafers at its Mohawk Valley device fab in Marcy, NY (opened in April 2022) and is currently building a new 200mm SiC wafer manufacturing center in North Carolina. The firm's key role in both the supply chain and device manufacturing for the USA's initiative to boost domestic chip-making was highlighted by its headquarters on 28 March hosting the first stop of US President Joe Biden's 'Invest in America' tour (see page 11).

Also in Europe, STMicroelectronics has agreed a multi-year deal to supply SiC devices for ZF's new modular inverter architecture, entering volume production in 2025 (see page 14).

Fellow German automotive system supplier Robert Bosch began volume production of SiC power semiconductors last December, in addition to its long-standing production of silicon chips (as part of a €3bn investment in its semiconductor division announced last July). Now, the firm says that it is acquiring US-based 200mm-wafer silicon chip foundry TSI Semiconductors, in which it will invest over $1.5bn to convert it to SiC device processing, targeting production from 2026 (see page 9).

In Japan, Mitsubishi Electric said in mid-March that it is doubling its investment plan (for the five-year period to March 2026), mainly for constructing a new SiC power device fab, using 200mm wafers. In early April, automotive supplier DENSO said it has developed its first SiC-based traction inverter, using technology jointly developed with Toyota for Lexus' first dedicated battery electric vehicle (see page 12). On 9–11 May at PCIM Europe 2023 in Nuremberg, Germany, Japan's ROHM is showcasing its 4th-Generation SiC MOSFETs (being used in Japanese automotive parts maker Hitachi Astemo's EV inverters), as well as new molded SiC power modules (see page 15).

In recent months US-based onsemi has agreed to supply its EliteSiC power modules for EV traction inverters to, respectively, South Korea's Kia (in January) and Germany's VW (January) and BMW (March). Now, the firm is to supply 1200V EliteSiC MOSFETs to ZEEKR (the global premium EV brand of China-based Geely) — see page 15. Onsemi had previously (in May 2022) agreed to supply SiC power modules to Chinese EV maker Nio.

While the USA, Europe and Japan are gearing up SiC device manufacturing to supply their EV sectors, none can ignore the burgeoning EV market in China. This is especially due to the expected market launch in 2023-2024 by EV makers BYD, XPeng, Great Wall Motors and GAC of a large number of models operating at the higher voltage of 800V (rather than 400V), for which 1200V SiC devices are required (see pages 64–67).

Chinese EV makers are also in the process of entering the European market, for which Nio, for example, is planning the launch in 2024 of a dedicated brand of small cars. While the USA, Europe and Japan have established SiC device supply chains, Chinese EV makers may make inroads into overseas EV markets — unless, of course, the restrictions on semiconductor exports to China are extended to SiC too.

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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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- conference reports;
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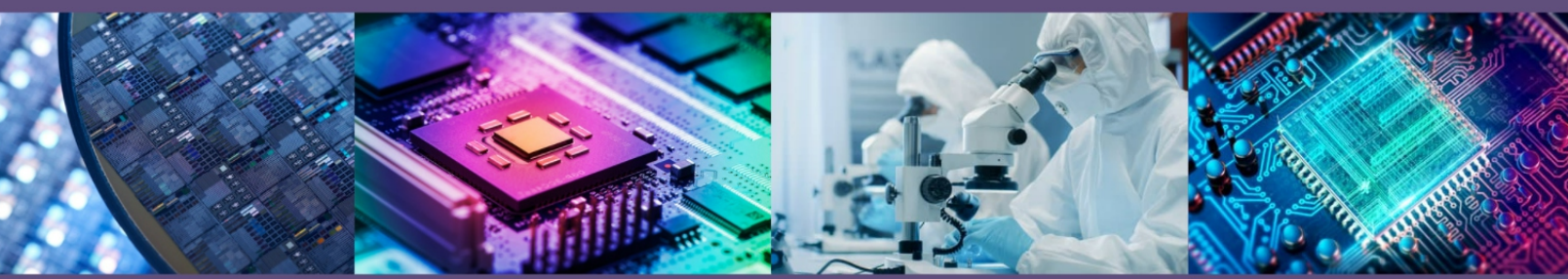

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Compound semiconductor market growing at 6.1% CAGR to $61.911m by 2030

Gallium nitride market share over 30%; silicon carbide driving growth

The compound semiconductor market was $38.552bn in 2022 and is rising at a compound annual growth rate (CAGR) of 6.1% to $61.911bn in 2030, forecasts a report issued by P&S Intelligence. Growth is ascribed primarily to the rising demand for silicon carbide (SiC) devices in power electronics.

GaN dominant among electronics applications

However, the market is currently dominated by gallium nitride (GaN), which has a market share of over 30%, and this situation will remain unchanged in the years to come, it is reckoned. High breakdown voltage and low conduction resistance are maintained by GaN, allowing the miniaturization of equipment and high-speed switching. Furthermore, due to their compactness, high electron mobility and densities are easily supported by GaN devices.

Moreover, compared with silicon variants, advantages of GaN devices such as higher energy efficiency, faster device speed, lower costs, high power density, operability at higher temperatures, higher frequency and higher operating voltage are likely to drive market progress.

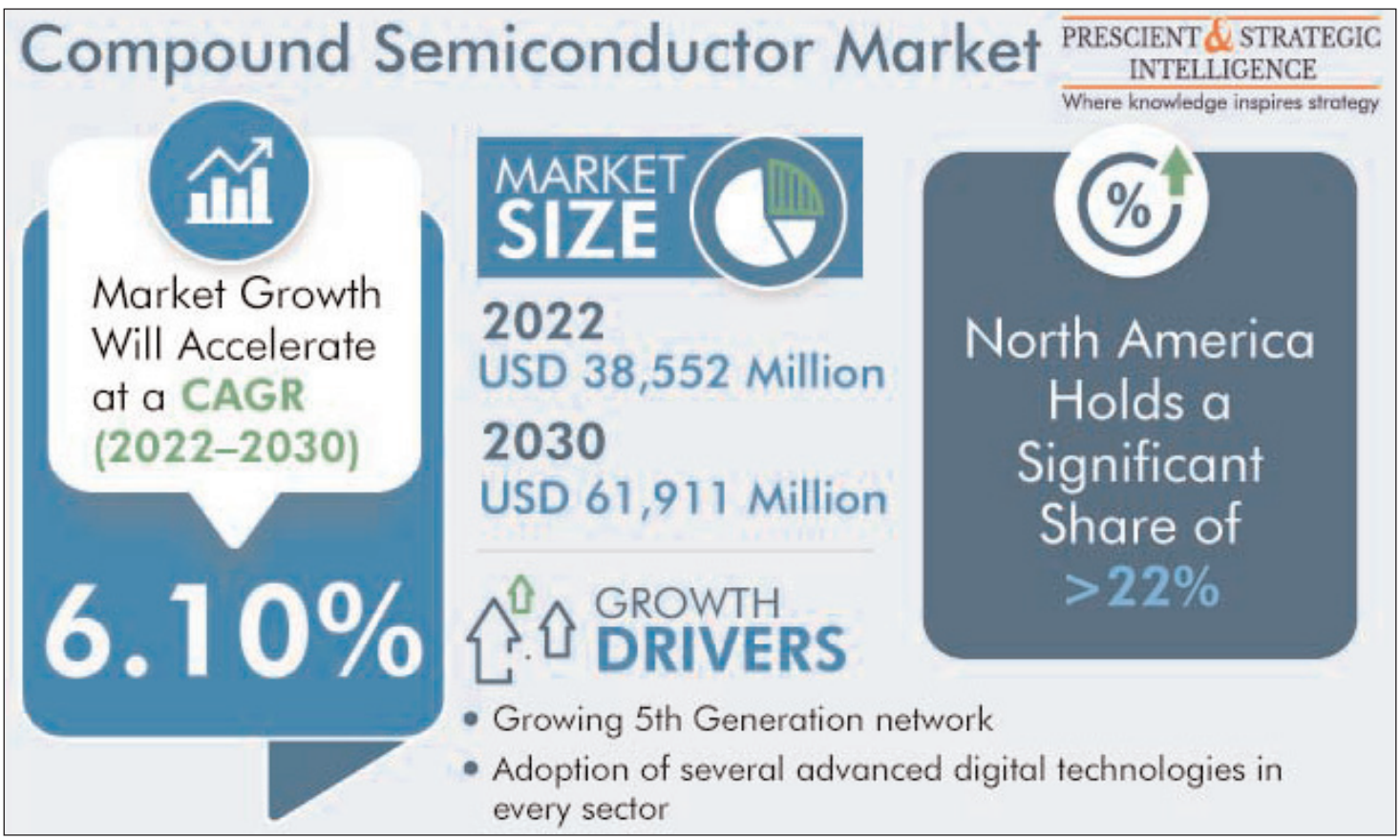
In addition, the penetration of GaN in RF devices in power applications is likely to intensify market growth, due to the demand for smartphones, tablets, laptops, gaming consoles, surveillance systems, computers, TVs, networking equipment, and IoT devices. Along with this, rapid infrastructure development is driving demand for power amplifiers.

Also, rising demand for ADAS (advanced driver assistance systems) around the globe can be seen as a growth opportunity for players in the optoelectronics sector. For example, both the USA and the European Union (EU) have mandated that all new vehicles be installed with forward-collision warning systems and autonomous emergency braking systems.

Power electronics largest application sector

The power electronics sector dominated the compound semiconductor market in 2022 and is expected to remain the largest application sector over the next few years, due to the increasing use of compound semiconductors in smart-home appliances and cutting-edge consumer electronics, it is reckoned.

GaN has become a significant building block for power electronics, helping to improve the energy effi-



ciency of LEDs, mobile devices, and other appliances.

Moreover, SiC devices have three times the thermal conductivity and ten times the breakdown electric field strength of silicon-based devices. These features reduce the complexity and cost of the device, improve its reliability, and allow it to be used in several high-voltage applications, such as solar inverters, power supplies, and wind turbines. The market for silicon carbide power devices is growing significantly because of the rising demand for power electronics, including in the aerospace & defense sector.

In addition, the electric vehicle (EV) market is a key growth driver because semiconductors are essential to modern EVs. In the same way, military systems, sensor systems, solar power inverters, wind turbines and many other types of system are increasingly being equipped with SiC devices. Seeing the rising demand, in August 2022 Infineon Technologies AG and II–VI Inc signed a multi-year agreement for SiC wafers.

Telecoms to be largest application in future

The telecoms category comprised the largest share, of 44%, in 2022, and is expected to remain the largest over the next few years. The increasing use of gallium arsenide (GaAs), silicon germanium (SiGe), indium phosphide (InP) and gallium nitride (GaN) compound semiconductor devices in mobiles and other wireless communication products is boosting market growth. This is itself due to the growing demand for 5G networks, which will transform the wireless communication sector.

Demand for higher bandwidths is rising because of booming mobile data usage, which implies greater stress on networks for the availability of the wireless spectrum. Mobile data traffic is expected to reach 10 Exabytes per month by 2025.

The telecom sector is therefore looking for extremely high-frequency bands, which fulfill the need for large bandwidths and high data rates. For instance, AT&T Inc introduced its millimeter-wave 5G network with the launch of the Galaxy S20 Plus and S20 Ultra by Samsung Electronics Co Ltd in March 2020.

Additionally, the high speed and efficiency of compound semiconductors over silicon are the main driving factors for the former's use in enhanced communication devices. Moreover, the advancement in multiple emerging technologies, such as the Internet of Things (IoT), artificial intelligence (AI) and machine learning, is driving demand for semiconductor technologies.

Moreover, GaAs devices are frequently used in power switches, amplifiers and cell phones. Further growth in the usage of GaAs in wireless communications would be due to its superior speed and efficiency over silicon. The material is also widely used in the aerospace & defense sector for a broad range of applications, such as power supplies for space equipment and aircraft, VLF transmitters, and solid-state relays and contactors. In this regard, increasing defense spending and rising usage of electronic components in fighter jets, tanks and armored personnel carriers are expected to drive market growth.

The power electronics sector dominated the compound semiconductor market in 2022 and is expected to remain the largest application sector over the next few years, due to the increasing use of compound semiconductors in smart-home appliances and cutting-edge consumer electronics, it is reckoned.

GaN has become a significant building block for power electronics, helping to improve the energy efficiency of LEDs, mobile devices, and other appliances.

The market for silicon carbide power devices is growing significantly because of the rising demand for power electronics…

The EV market is a key growth driver

North America over 22% of compound semiconductor market in 2022

North America has a significant position in the of compound semiconductor market, generating over 22% of revenue in 2022, and is expected to remain dominant over the next few years. Demand is rising mainly because of measures of the US and Canadian governments to enhance their military capabilities and communications infrastructure. Therefore, players are increasing their investment in order to boost the output of smart devices for telecom, consumer electronics, and IT applications. For example, in May 2022, JX Nippon Mining & Metals USA Inc received financial help from Japan Bank for the construction of a new establishment in Arizona, USA.

Device demand in Europe to grow at a steady rate

European is expected to grow at a steady rate, led by the UK, which dominated the compound semiconductor market in the region in 2022 and is projected to do so during the forecast period.

Germany is the fastest-growing market in Europe because of the improvements in the automobile sector, which drive the use of microelectronics. In this regard, the electrification of vehicles, introduction of AI and digitalization are the main factors driving growth in Germany.

www.psmarketresearch.com/market-analysis/compound-semiconductor-market

Qorvo's RF Fusion22 wins 2023 GTI Award

Global TD-LTE Initiative recognizes technical innovation in 5G chipsets

Qorvo Inc of Greensboro, NC, USA (which provides core technologies and RF solutions for mobile, infrastructure and defense applications) says that its RF Fusion22 chipset has won the 2023 GTI Innovative Breakthrough in Mobile Technology Award. The award recognizes Qorvo's technical innovation in 5G chipsets, which combine compact, high-performance 5G functionality for leading smartphone manufacturers. This is the third time that Qorvo's 5G offerings have been recognized with the GTI Award.

The Global TD-LTE Initiative (GTI) is an open global association of operators and vendors dedicated to promoting the development of TD-LTE and 5G. The GTI Awards program recognizes the most outstanding achievements and success in the industry and encourages the development of innovative products, services and applications. Qorvo previously won GTI's Innovative Breakthrough in Mobile Technology Awards in 2020 for its RF Fusion 5G chipset and in 2018 for its 5G RF Front End (RFFE).

"This award underscores Qorvo's commitment to technology and product leadership in 5G RF front ends," says Frank Stewart, president of Qorvo's Advanced Cellular business. "We are proud to offer designers an outstanding solution that fits their new 5G smartphone designs."

Qorvo says that its Fusion22 solution enables next-generation, high-performance functionality to support the continued expansion of 5G into all tiers of the mobile device market. The chipset draws from bulk acoustic wave (BAW), silicon-on-insulator (SOI) and gallium arsenide (GaAs) heterojunction bipolar transistor (HBT) technologies and deep experience in radio architecture to provide a high-performance solution for the next generation of 5G handsets. Each module is optimized and tested as a complete reference design, enabling manufacturers to leverage pre-validated interoperability and high levels of integration to minimize engineering effort and lower design risk.

www.qorvo.com

Guerrilla RF implements one-for-six reverse stock split

Firm prepares for proposed uplisting to national securities exchange

Guerrilla RF Inc (GRF) of Greensboro, NC, USA — a provider of radio frequency (RF) and microwave communication solutions for wireless OEMs — implemented a one-for-six reverse split of its outstanding and authorized common stock, effective on 17 April. The common stock continues trading under the temporary symbol 'GUERD' on a reverse stock-split-adjusted basis on the OTCQX market.

The reverse stock split was approved by the firm's board of directors and shareholders on 5 April, for the purpose of filing an application to uplist Guerrilla RF's common stock to a national securities exchange. The reverse stock split is intended to fulfill the stock price requirements for initial listing.

"Uplisting to a national securities exchange will allow us greater access to capital, better liquidity, and more visibility for our brand as we embark on the next phase of our commercialization strategy," believes Sam Funchess, VP of investor relations. "This coincides with our focus on expanding the depth and breadth of our product pipeline and moving into the highly lucrative industry verticals — 5G, automotive connectivity, cellular boosters and DAS, military radios, and wireless audio," he adds. "This is an important step in our previously announced capital markets strategy to increase the liquidity and visibility of Guerrilla RF's common stock and better serve our shareholders."

http://guerrilla-rf.com

Bosch acquiring US chipmaker TSI, adding California plant to Reutlingen and Dresden fabs in Germany

Plan to invest $1.5bn in converting fab to production of silicon carbide chips on 200mm wafers from 2026

As part of expanding its semiconductor business into silicon carbide (SiC) chip manufacturing, Robert Bosch GmbH of Reutlingen, Germany plans to acquire TSI Semiconductors of Roseville, CA, USA.

As an application-specific integrated circuit (ASIC) foundry with 250 staff, TSI currently mainly develops and produces large volumes of chips on 200mm silicon wafers for applications in the mobility, telecoms, energy, and life sciences sectors. In the next few years, Bosch intends to invest more than $1.5bn in the Roseville site and convert the TSI manufacturing facilities to silicon carbide (SiC) processes, targeting production of chips on 200mm wafers from 2026.

Bosch hence aims to have significantly extended its global portfolio of SiC chips by the end of 2030, as the global boom and ramp-up of electro-mobility is resulting in huge demand, says Bosch. The full scope of the planned investment will be heavily dependent on federal funding opportunities available via the US CHIPS and Science Act as well as economic development opportunities within the State of California. The transaction is subject to regulatory approval.

"With the acquisition of TSI Semiconductors, we are establishing manufacturing capacity for SiC chips in an important sales market while also increasing our semiconductor manufacturing globally," says Dr Stefan Hartung, chairman of the Bosch board of management. "The existing cleanroom facilities and expert personnel in Roseville will allow us to manufacture SiC chips for electro-mobility on an even larger scale," he adds.

"The location in Roseville has existed since 1984. Over nearly 40 years, the US company has built up vast expertise in semiconductor production," notes Bosch board member Dr Markus Heyn, chairman of the Mobility Solutions business sector. "We will now be integrating this expertise into the Bosch semiconductor manufacturing network," he adds.

TSI Semiconductors' plant in Roseville, California.

"We are pleased to join a globally operating technology company with extensive semiconductor expertise," comments TSI's CEO Oded Tal. "Our Roseville location will be a significant addition to Bosch's SiC chipmaking operations."

Acquisition creates new manufacturing capacity

The new location in Roseville will reinforce Bosch's international semiconductor manufacturing network. Starting in 2026, following a re-tooling phase, the first SiC chips will be produced on 200mm wafers in a facility with about 10,000m^2 of cleanroom space.

Bosch says that it invested in the development and production of SiC chips at an early stage. Since 2021, it has been using its own proprietary processes to mass produce them at its Reutlingen plant near Stuttgart. In the future, Reutlingen will also produce them on 200mm wafers. By the end of 2025, the firm will have extended its cleanroom space in Reutlingen from about 35,000m^2 to more than 44,000 m^2. "SiC chips are a key component for electrified mobility," notes Heyn. "By extending our semiconductor operations internationally, we are strengthening our local presence in an important electric vehicle market."

Demand for chips for the automotive industry remains high. By 2025, Bosch expects to have an average of 25 of its chips integrated in every new vehicle. The SiC chip market is also continuing to grow rapidly — by 30% annually, on average. The main drivers are the global boom and ramp-up of electro-mobility. In electric vehicles, SiC chips enable greater range and more efficient recharging, as they use up to 50% less energy. Installed in these vehicles' power electronics, they ensure that a vehicle can drive a significantly longer distance on one battery charge — on average, the possible range is 6% greater than with silicon-based chips.

www.tsisemi.com
www.bosch.com

Wolfspeed and NC A&T to establish joint silicon carbide R&D facility

Partnership with North Carolina Agricultural and Technical State University expanded to bolster compound semiconductor advances while developing a new generation of innovators

At an event attended by US President Joe Biden, it was announced that Wolfspeed Inc of Durham, NC, USA — which makes silicon carbide materials as well as silicon carbide (SiC) and gallium nitride (GaN) power-switching & RF semiconductor devices — and North Carolina Agricultural and Technical State University (America's leading historically Black college or university) are to apply for CHIPS and Science Act funding to build a new R&D facility on the North Carolina A&T campus, focused on SiC to support the next generation of compound semiconductors. Wolfspeed and A&T intend to submit the project for federal investment as part of the CHIPS and Science Act when the Notice of Funding Opportunity for R&D facilities is released this fall.

"Wolfspeed has been working with North Carolina A&T to develop a workforce of the future, and we are excited to expand that partnership to develop the technology of the future," says Wolfspeed's president & CEO Gregg Lowe. "The R&D facility will enable the next generation of innovators to explore new processes, applications and breakthrough advancements to support the global transition from silicon to silicon carbide technology and achieve new levels of sustainability and energy efficiency across a variety of industries."

The R&D facility is intended to augment Wolfspeed's establishment of the John Palmour Manufacturing Center for Silicon Carbide (the world's largest silicon carbide crystal growth facility, currently under construction in Siler City, North Carolina). Phase-one construction is expected to be completed in 2024. Upon completion of the full build-out and combined with the firm's ongoing materials expansion at its Durham headquarters, this will increase Wolfspeed's material production by more than 10x and create 1800 new jobs. The facility will supply 200mm SiC wafers to Wolfspeed's Mohawk Valley Fab in Marcy, NY (which opened in April 2022 as the world's first 200mm SiC fabrication facility).

US Secretary of Commerce Gina Raimondo and North Carolina Governor Roy Cooper were also in attendance at the event. "As one of the top three public research universities in North Carolina and the nation's largest HBCU [historically black college and university], we are keenly interested in the future of the semiconductor chip industry in our state," says NC A&T's chancellor Harold L Martin Sr. "As a research and education partner with Wolfspeed, we bring deep academic and scientific strengths in STEM disciplines to our collaboration, as well as the fact that we produce more Black engineers than any university in the nation," he adds. "This new facility will integrate our research and development interests toward major economic and social impact, not just in North Carolina, but globally."

Wolfspeed has recognized A&T, one of the nation's leading engineering institutions, as a critical component of its talent development strategy. In 2020, Wolfspeed committed $4m over five years to the HBCU (the single largest donation in the university's history at the time) to create the Wolfspeed Endowed Scholars Program. In September 2022, the two entities announced a partnership to develop comprehensive education and training curricula, including undergraduate and graduate credentials in silicon carbide semiconductor manufacturing, as well as training and career advancement programs for existing semiconductor manufacturing workers.

To further support Wolfspeed's growing talent needs, the company is working with several schools within North Carolina's robust community college system to develop the skills required for its advanced manufacturing needs. This includes apprenticeship and pre-apprenticeship opportunities, customized training curricula, career and college promise pathways for high-school students, and work-based learning programs.

www.wolfspeed.com

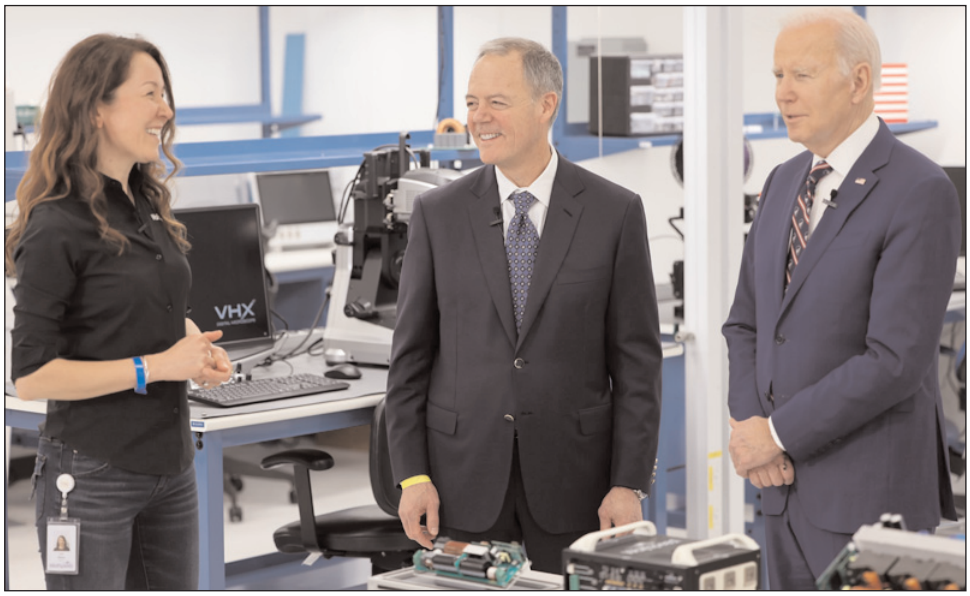
Wolfspeed's Durham HQ hosts first stop on Biden's 'Invest in America' tour

Biden highlights the role of Wolfspeed in initiatives targeted at growing the US economy

At its headquarters in Durham, NC, USA, Wolfspeed Inc — which makes silicon carbide materials as well as silicon carbide (SiC) and gallium nitride (GaN) power-switching & RF semiconductor devices — hosted the first stop of US President Joe Biden's 'Invest in America' tour, in which he highlighted initiatives designed to boost US manufacturing, rebuild the nation's infrastructure and strengthen supply chains. US Secretary of Commerce Gina Raimondo and North Carolina Governor Roy Cooper were also in attendance at the event.

As a US company at the forefront of the transition from silicon to silicon carbide to enhance technology efficiency and energy savings, Wolfspeed believes that initiatives like the CHIPS & Science Act that are investing in and advancing the semiconductor industry will help to propel the transition to electric vehicles, the move to faster 5G networks, the evolution of renewable energy and energy storage, and the advancement of industrial applications.

"Silicon carbide is at the heart of what we do — it's essential to accelerating the adoption of EVs, delivering energy savings to consumers, and meeting global emission reduction targets," notes Wolfspeed's president & CEO Gregg Lowe. "Wolfspeed is proud to play a critical role in fulfilling the objectives of the CHIPS & Science Act and the Inflation Reduction Act, and to reinforce US leadership in the energy transition and the semiconductor industry."



From left to right: Wolfspeed's chief technology officer Elif Balkas and its CEO Gregg Lowe, with President Joe Biden.

At its headquarters in Durham, NC, Wolfspeed currently produces more than 60% of the world's silicon carbide materials. However, the firm is engaged in a $6.5bn capacity expansion effort to dramatically increase production. This includes the opening of its 200mm Mohawk Valley device fab in Marcy, NY in April 2022, and construction of The John Palmour Manufacturing Center for Silicon Carbide, a 445-acre SiC materials facility in North Carolina, which will expand the firm's existing materials capacity by over 10x. Phase-one construction for the materials facility is expected to be completed in 2024. In February, Wolfspeed also announced plans to build a highly automated 200mm SiC fab in Saarland, Germany.

DENSO develops its first inverter using silicon carbide power semiconductors

BluE Nexus' eAxle electric driving module being used in Lexus' first battery electric vehicle

Automotive supplier DENSO Corp of Kariya, Aichi prefecture, Japan has developed its first inverter based on silicon carbide (SiC). Incorporated in the eAxle (an electric driving module developed by BluE Nexus Corp), the inverter will be used in the new RZ, Lexus' first dedicated battery electric vehicle (BEV) model, released on 30 March.

DENSO says that SiC power semiconductors with its unique trench-type metal-oxide-semiconductor (MOS) structure improve the output per chip due to reducing the power loss caused by heat generation. The structure achieves high voltage and low on-resistance operation.

Based on technology jointly developed with Toyota Central R&D Labs Inc, DENSO says that it utilizes SiC epitaxial wafers incorporating the results of work commissioned by New Energy and Industrial Technology Development Organization (NEDO). As a result, the firm reckons that it has halved the number of crystal defects that prevent the device from operating normally due to the disorder of the atomic arrangement of the crystal.

Reducing the crystal defect density ensures the quality of silicon carbide power semiconductor devices used in vehicles and their stable production, says the firm.

DENSO calls its SiC technology 'REVOSIC' and is using it to develop technologies for products ranging from wafers to semiconductor devices and modules such as power cards.

www.globaldenso.com
www.denso.com

Nexperia launches 650V SiC diodes for demanding power conversion applications

Merged PiN Schottky structure delivers robustness and efficiency

Nexperia B.V. of Nijmegen, the Netherlands (a subsidiary of Wingtech Technology Co Ltd) has introduced a 650V silicon carbide (SiC) Schottky diode designed for power applications that require ultra-high performance, low loss, and high efficiency.

The 10A, 650V SiC Schottky diode is an industrial-grade part that addresses the challenges of demanding high-voltage and high-current applications. These include switched-mode power supplies, AC–DC and DC–DC converters, battery-charging infrastructure, uninterruptible power supplies (UPS) and photovoltaic inverters and allow for more sustainable operations. Data centers, for example, equipped with power supplies designed using Nexperia's PSC1065K SiC Schottky diode will be better placed to meet rigorous energy-efficiency standards than those using solely silicon-based solutions.

The PSC1065K delivers what is claimed to be leading-edge

performance with temperature-independent capacitive switching and zero recovery behaviour, culminating in an outstanding figure-of-merit (Q_C x V_F). Its switching performance is almost entirely independent of current and switching speed variations. The merged PiN Schottky (MPS) structure of the PSC1065K provides additional benefits, such as outstanding robustness against surge currents that eliminates the need for additional protection circuitry. These features significantly reduce system complexity and enable hardware designers to achieve higher efficiency with smaller form factors in rugged high-power applications.

The SiC Schottky diode is encapsulated in a Real-2-Pin (R2P) TO-220-2 through-hole power plastic package. Additional package options include the surface-mount (DPAK R2P and D2PAK R2P) and through-hole (TO-247-2) with a real 2-pin configuration that enhances reliability in high-voltage applications at temperatures up to 175°C.

"In an increasingly energy-conscious world, we are bringing greater choice and availability to the market as demand for high-volume, high-efficiency applications increases significantly," says Katrin Feurle, senior director of Nexperia's SiC Product Group.

Samples and production quantities of the new SiC diodes are available now. Nexperia plans to continuously augment its portfolio of SiC diodes by including automotive-grade parts that operate at 650V and 1200V voltages with currents in the 6–20A range.

www.nexperia.com/sic_diodes

Diodes Inc adds N-channel MOSFET to silicon carbide product portfolio

Industrial-grade 1200V SiC MOSFET enables higher efficiency and power density

Power semiconductor product supplier Diodes Inc of Plano, TX, USA has added to its portfolio of silicon carbide (SiC) products with the DMWS120H100SM4 N-channel SiC MOSFET, which addresses demand for higher efficiency and higher power density for applications such as industrial motor drives, solar inverters, data center and telecom power supplies, DC–DC converters, and electric vehicle (EV) battery chargers.

The DMWS120H100SM4 operates at a high voltage (1200V) and drain current (up to 37A) while maintaining low thermal conductivity (R_{JC} = 0.6°C/W), making it suited to applications running in harsh environments. The MOSFET has a

low $R_{DS(ON)}$ on-resistance (typical) of only 80mΩ (for a 15V gate drive) to minimize conduction losses and provide higher efficiency. In addition, the device has a gate charge of only 52nC to reduce switching losses and lower the package temperature.

The new product is said to be the first SiC MOSFET on the market in a TO247-4 package. The additional Kelvin sense pin can be connected to the source of the MOSFET to optimize the switching performance, enabling even higher power densities.

The DMWS120H100SM4 is available at $21.50 in 20-unit quantities.

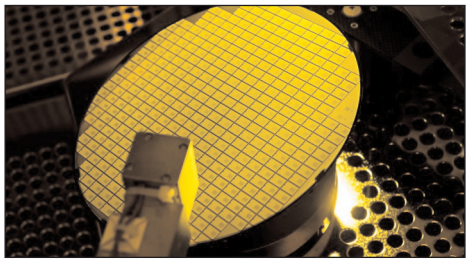
www.diodes.com/part/view/DMWS120H100SM4

Multi-year deal signed for ST to supply silicon carbide devices to ZF

ST's SiC devices to be integrated into ZF's future inverter platform, in series production from 2025

STMicroelectronics of Geneva, Switzerland has signed a multi-year contract to supply a volume of double-digit millions of silicon carbide devices that will be integrated into the new modular inverter architecture of Germany-based ZF Friedrichshafen AG (one of the world's largest suppliers to the automotive industry) that is going into series production in 2025. ZF aims to leverage ST's vertically integrated silicon carbide manufacturing in Europe and Asia to secure customer orders in electro-mobility.

"With this strategically important step, we are strengthening our supply chain to be able to securely supply our customers," says Stephan von Schuckmann, member of ZF's board of management responsible for electro-mobility as well as materials management. "Our order book in electro-mobility until 2030 now amounts to more than €30bn. For this volume, we need several reliable suppliers for silicon carbide devices," he adds. "In STMicroelectronics, we now have a supplier whose experience with complex systems meets our



requirements and who, above all, can produce the devices in exceptionally high quality and at the required quantities."

With this agreement, ZF has gained a supplier for silicon carbide technology in addition to ZF's existing partnership agreement on silicon carbide technology announced in February with Wolfspeed.

"As a vertically integrated company, we are investing heavily to expand capacity and develop our silicon carbide supply chain to support our global and European customer base across automotive and industrial sectors, as they pursue electrification and decarbonization targets," says Marco Monti, president of ST's Automotive and Discrete Group. "The key to success in electric vehicle technology is greater scalability and modularity with increased efficiency, peak power and affordability," he adds. "Our silicon carbide technologies help deliver these benefits and we are proud to work with ZF, a leading automotive supplier for electrification, to help them differentiate and optimize the performance of their inverters."

ST will manufacture the SiC chips at its production fabs in Italy and Singapore with packaging of the chips into STPAK, an advanced package, and testing at its back-end facilities in Morocco and China.

ZF can connect a variable number of devices together to match customers' performance needs

ST will supply ZF from 2025 with double-digit millions of third-generation silicon carbide MOSFET devices. ZF can connect a variable number of such devices together to match customers' performance requirements without changing the design of the inverter. Among other things, ZF will use the technology in inverters for vehicles of a European car manufacturer whose production start is planned for 2025.

www.zf.com
www.st.com

Alpha and Omega Semiconductor demonstrates power management solutions at APEC

Latest 650V and 750V SiC MOSFET platform targeted at automotive and industrial applications

Power semiconductor designer and developer Alpha and Omega Semiconductor Ltd (AOS) of Sunnyvale, CA, USA exhibited its 650V and 750V silicon carbide (SiC) MOSFET platform for industrial and automotive applications and its complete line of advanced power management solutions at the Applied Power Electronics Conference (APEC 2023) in Orlando, FL, USA (20–22 March).

Specifically, Alpha and Omega Semiconductor has expanded its SiC MOSFET portfolio with new 650V/750V/1200V SiC MOSFETs for industrial and automotive applications. The new 650V/750V MOSFETs are AEC-Q100 automotive qualified and deliver what is claimed to be industry-leading $R_{DS(ON)}$ ranges from 15mW to 500mW.

Highlights included AOS expanding its SiC MOSFET portfolio with new 650V/750V/1200V SiC MOSFETs for industrial and automotive applications. The new 650V/750V MOSFETs are AEC-Q100 automotive qualified and deliver what is claimed to be industry-leading $R_{DS(ON)}$ ranges from 15mΩ to 500mΩ.

www.aosmd.com

onsemi and ZEEKR sign long-term supply agreement for silicon carbide power devices

EliteSiC devices to help extend range of ZEEKR's smart EVs

Power semiconductor IC supplier onsemi of Phoenix, AZ, USA has announced a long-term supply agreement (LTSA) to provide its EliteSiC silicon carbide (SiC) power devices to increase the powertrain efficiency of smart electric vehicles (EVs) made by ZEEKR (the global premium electric mobility brand of China-based Geely Holding Group). Adoption of the devices should result in improved performance, faster charging speeds and extended driving range.

ZEEKR began delivering its first product, ZEEKR 001, in October 2021, followed by the ZEEKR 009 MPV in early 2023. In April, the 100,000th ZEEKR car rolled off its manufacturing base in Ningbo, China. ZEEKR plans to start delivering cars in Europe in fourth-quarter 2023.

To support its expanding portfolio of high-performance EVs, ZEEKR will adopt the M3E variant of onsemi's 1200V EliteSiC MOSFET, which has enhanced electrical and mechanical performance and reliability. The power devices deliver improved power and thermal efficiency, which should reduce the size and weight of the traction inverter and enhance the range of the automaker's EVs.

"ZEEKR will be able to offer electric vehicles with improved performance and even lower carbon emissions," says Andy An, CEO of ZEEKR Intelligent Technology. "As a brand committed to sustainability, ZEEKR will continue to explore different ways to accelerate the transition towards new energy vehicles." Utilizing Geely's Sustainable Experience Architecture (SEA), ZEEKR develops in-house battery technologies, battery management systems, electric motor technologies and electric vehicle supply chain support.

The new LTSA is expected to enable both firms to build a stronger supply chain relationship to support ZEEKR's growth over the next decade.

"A reliable supply chain is critical to business success and, after significant investments in our SiC end-to-end supply chain, onsemi can offer this strategic value to customers," says onsemi's president & CEO Hassane El-Khoury. "This agreement will help our continued ramp of SiC operations, enabling us to offer industry-leading power devices that help our customers deploy the most efficient and highest-performing EVs on the market."

www.onsemi.com

ROHM presents SiC- and GaN-based solutions for e-mobility and energy conversion at PCIM Europe

Fourth-generation silicon carbide MOSFETs and molded silicon carbide power modules highlighted

At the Power, Control and Intelligent Motion (PCIM) Europe 2022 trade fair in Nürnberg Messe, Nuremberg, Germany (9–11 May), ROHM Semiconductor is showcasing its new power semiconductors that advance sustainable technologies — including high-performance solutions for the e-mobility sector and beyond.

At PCIM, ROHM is presenting solutions for key technologies — revolving around energy-saving, miniaturization, functional safety, innovation, and sustainability. Specific product highlights include:

- 4th-Generation SiC MOSFET: ROHM's silicon carbide (SiC) MOSFET technology realizes what is claimed to be industry-leading low ON-resistance (R_{DSon}), minimizing switching losses and supporting 15V and 18V gate–source voltage. It is said to contribute to miniaturization and low power consumption in various applications including automotive inverters and various switching power supplies.
- New molded SiC power modules: ROHM has expanded its package portfolio with HSDIP20 and DOT247, incorporating the latest 4th-generation SiC MOSFET 750V and 1200V devices with various values of R_{DSon}. Both achieve up to 30kW power application, depending on conditions.
- Built-in 1700V SiC-MOSFET: the BM2SC12xFP2-LBZ series is a quasi-resonant AC/DC converter that provides an optimum system for all products that have an electrical outlet.
- 150V GaN HEMT: ROHM's 150V gallium arsenide (GaN) HEMT GNE10xxTB is optimized for power supply circuits in industrial and communication equipment for what is claimed to be industry-highest (8V) gate breakdown voltage technology.

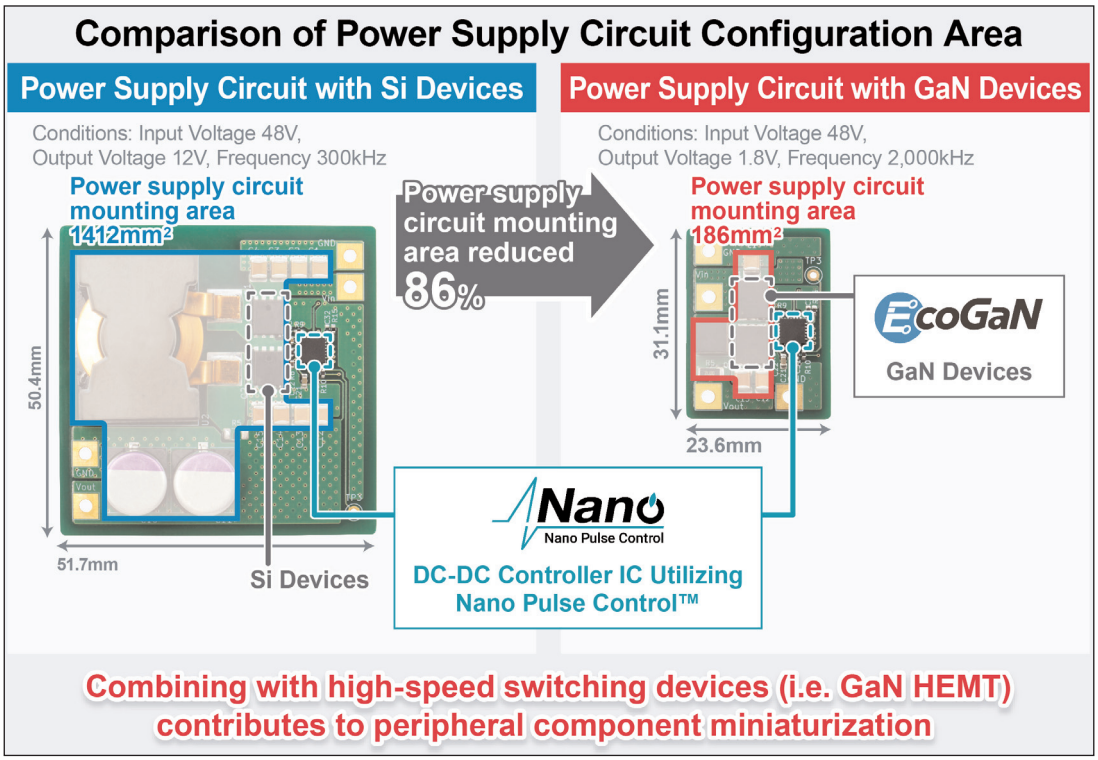
At PCIM, ROHM is also exhibiting enhancements to its IGBT and GaN product portfolio.

In addition, the firm's representatives are participating in panel discussions, conference presentations and presentations at its booth, as well as in poster sessions.

www.mesago.de/en/PCIM/main.htm
www.rohm.com/pcim

ROHM's ultra-high-speed control IC technology maximizes performance of GaN switching devices

Greater energy savings and miniaturization in power supply applications by combining GaN devices and Control ICs



Due to their superior high-speed switching characteristics the adoption of GaN devices has expanded in recent years. However, the speed of control ICs (for directing the driving of these devices) has become challenging.

In response, Japan-based power semiconductor maker ROHM Co Ltd has further evolved its ultra-high-speed Nano Pulse Control technology (which is designed for power supply ICs), improving the control pulse width from the conventional 9ns to what is claimed to be an industry-best of 2ns. Leveraging this technology allowed ROHM to establish its ultra-high-speed Control IC technology, which can maximize the performance of GaN devices.

Miniaturizing the power supply circuit requires a reduction in the size of the peripheral components through high-speed switching, says ROHM. Achieving this requires a control IC that can take advantage of the drive performance of high-speed switching devices such as GaN.

To propose solutions that include peripheral components, ROHM established ultra-high-speed Control IC technology optimized for GaN devices utilizing proprietary Nano Pulse Control analog power supply technology. ROHM's ultra-high-speed pulse control technology achieves a switch-ON time (control width of the power supply IC) on the order of nanoseconds, making it possible to convert from high to low voltages using a single IC — unlike conventional solutions requiring two power supply ICs.

ROHM is working to commercialize Control ICs utilizing this technology, with plans to start sample shipment of 100V one-channel DC–DC Control IC in second-half 2023. Its use, in conjunction with ROHM's EcoGaN series of GaN devices, is expected to result in significant energy savings and miniaturization in a variety of applications, including base stations, data centers, FA (factory automation) equipment, and drones.

"GaN has been highly anticipated for many years as a power semiconductor material that can achieve energy savings, but there are obstacles such as quality and cost," notes professor Yusuke Mori, Graduate School of Engineering, Osaka University. "Under these circumstances, ROHM has established a mass-production system for GaN devices that deliver improved reliability while also developing Control ICs that can maximize their performance. This represents a huge step towards the widespread adoption of GaN devices," he adds. "I hope to contribute to achieving a decarbonized society by collaborating our GaN-on-GaN wafer technology."

Control IC technology

ROHM says that the Nano Pulse Control technology in its new Control IC has been cultivated by utilizing its vertically integrated production system to combine advanced analog expertise spanning circuit design, processes and layout. Using a unique circuit configuration to significantly reduce the minimum control pulse width of the Control IC from the conventional 9ns to 2ns makes it possible to step down from high voltages (up to 60V) to low voltages (down to 0.6V) with a single power supply IC in 24V and 48V applications. Also, support for smaller drive peripheral components for high-frequency switching of GaN devices shrinks mounting area by about 86% compared with conventional solutions when paired with an EcoGaN power supply circuit.

www.rohm.com/support/nano

Infineon showcasing power semiconductors and wide-bandgap technologies at PCIM

In booth #412 (Hall 7) at the Power, Control and Intelligent Motion (PCIM) Europe 2023 trade fair in Nuremberg (9–11 May), Infineon Technologies AG of Munich, Germany is showcasing how its latest solutions in power semiconductors and wide-bandgap technologies provide answers to the current challenges of green and digital transformation. Under the motto 'Driving decarbonization and digitalization. Together.', the firm is giving demonstrations, live TechTalks, and the opportunity to discuss design challenges with experts. Alternatively, industry professionals can register for the Infineon's virtual platform, available around the clock from 27 April onwards.

WBG technologies for increased energy efficiency

Infineon's wide-bandgap (WBG) portfolio offers comprehensive options with high efficiency and power density. Highlights include CoolGaN-based USB-C adapters and chargers, as well as solutions for e-mobility with CoolGaN SG HEMTs, EiceDRIVER gate driver ICs and XENSIV sensors. New chip technologies including HybridPACK Drive CoolSiC G2 simplify automotive electrification, and packaging innovations for silicon, SiC and GaN power technologies with topside cooling (TSC) enable pushing the limits of efficiency and power density in high-performance industrial and automotive applications.

Energy transition technologies

With power semiconductors that improve the efficiency and miniaturization of wind and photovoltaic plants, Infineon says that it not only supports the most climate-friendly forms of energy generation but also promotes the competitiveness of renewable energies. Feasible storage solutions are also enabled by the firm's power portfolio, which is an important factor in their economic viability. In addition, Infineon experts are presenting its product range for sustainable hydrogen technologies – such as the broad IGBT and thyristor portfolio for hydrogen electrolysis.

EV charging solutions

Infineon's power solutions for traction inverters, on-board chargers, DC–DC converters and battery management systems support the rapid expansion of e-mobility and e-transport along with the corresponding charging infrastructure. One highlight is a modular 50kW CoolSiC reference design for fast DC charging systems for electric vehicles. In addition to Infineon's complete range of traction inverters, charging solutions such as the first wall-mounted DC charger, the alpitronic HYC50 bi-directional 50kW charging station, is also being presented at the PCIM booth.

Energy-efficient industrial automation

Growing demand for electricity, combined with the intermittent nature of renewable energy sources, means that advanced power management is essential for maintaining stable grid operations. The most effective way to meet these challenges is through intelligent power management, enabled by the use of intelligent protection components at all levels. While traditional electro-mechanical components have performance limitations, semiconductor solutions offer unprecedented control and protection capabilities. New and advanced power semiconductors are enabling cost-effective and reliable solid-state implementations across the board.

Smart home & smart building

With its technology portfolio of tailored, ready-to-use solutions, Infineon supports manufacturers in developing system designs for homes that meet the growing demand for smart, connected and energy-efficient living experiences. Among other things, Infineon is presenting its reference solution for IoT-connected air conditioners, which are equipped with sensors to monitor their surroundings and respond to the needs of people. In this way, the air-conditioning system can be dynamically controlled as needed, which also regulates energy demand.

AI-powered analysis of machines and industrial equipment

With the acquisition of Berlin-based startup Industrial Analytics, Infineon has strengthened its software and services business in the field of artificial intelligence for predictive analysis of machines and industrial plants. Industrial Analytics develops artificial intelligence solutions that monitor and optimize machines and plants in order to detect critical developments at an early stage based on the analysis and evaluation of vibrations. Industrial Analytics' AI solutions not only evaluate data for predictive maintenance, but also provide recommendations for action.

In addition to the demonstrations, Infineon has organized a comprehensive series of nine TechTalks at its booth, spanning a wide range of topics including solid-state circuit breakers, energy storage systems, EV charging, heat pumps, hydrogen production, solar and traction inverters as well as CoolSiC and CoolGaN solutions. In addition, Infineon experts are participating in the PCIM conference and poster sessions.

At the PCIM Europe 2023 tradeshow, Infineon is showcasing product-to-system solutions for applications that will power the world and shape the future. Company representatives are also giving several presentations at the accompanying PCIM Conference and Industry & E-Mobility Forum with live and on-demand video presentations, followed by discussions with the speakers.

www.mesago.de/en/PCIM/main.htm
www.infineon.com/green-energy

Mouser to distribute Navitas' wide-bandgap semiconductor products globally

Distributor to stock complete range of GaN and SiC power ICs

Gallium nitride (GaN) power IC and silicon carbide (SiC) technology firm Navitas Semiconductor of Torrance, CA, USA has signed an agreement with global semiconductor and electronic component distributor Mouser Electronics Inc (a Berkshire Hathaway company).

The new worldwide agreement will see Mouser stock Navitas GaNFast and GeneSiC wide-bandgap (WBG) semiconductor technologies. GaNFast power ICs integrate GaN power and drive, with control, sensing and protection to enable faster charging, higher power density and greater energy savings. Complementary GeneSiC power devices are optimized high-power, high-voltage and high-reliability SiC solutions. Focus markets include mobile, consumer, data center, electric vehicle (EV), solar, wind, smart grid, and industrial.

"The pressure on designers and system architects to improve application performance while minimizing size and driving down energy use is creating a rapidly growing global demand for efficient and integrated WBG semiconductors," says David Carroll, senior VP worldwide sales at Navitas. "Mouser's global reach means this agreement will give electronic design engineers and buyers improved access to the advanced Navitas technologies that are playing a key role in addressing this demand and meeting the needs of a market that is potentially worth $22bn a year," he adds.

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"Mouser is pleased to add this strong industry leader to our line card, and to deliver these innovative power devices to our customers," comments Kristin Schuetter, Mouser's VP of supplier management. "Design engineers now have easy access to Navitas' advanced components, backed by Mouser's unsurpassed customer service and best-in-class logistics."

www.mouser.com
www.navitassemi.com

Navitas displaying expanded portfolio of GaN and SiC power semiconductors at PCIM

EV, solar, home appliance and industrial solutions highlighted

At the Power, Control and Intelligent Motion (PCIM) Europe 2023 trade fair in Nuremberg, Germany (9–11 May), Navitas Semiconductor of Torrance, CA, USA is introducing and displaying an expanded portfolio of gallium nitride (GaN) and silicon carbide (SiC) power products.

In exhibition booth #525 (Hall 9) visitors can discover how GaN and SiC deliver the performance, functionality, reliability and ease-of-use demanded by next-generation electric vehicles (EVs), solar, energy storage, home appliance and industrial drives. Highlights include GaNFast power ICs that integrate GaN power, sensing and control in a single device, and robust, high-voltage, high-efficiency GeneSiC silicon carbide optimized for reliable operation in harsh-environment, high-power designs.

"Navitas' demonstrations, papers and panel discussions provide critical insight into how next-generation GaN and SiC deliver power-conversion and fast-charging solutions that could reduce global CO_2 emissions by as much as six Gigatons per year by 2050," says Alessandro Squeri, senior director for European sales.

Navitas is participating in the following conference sessions:

9 May

- 'GaN Power ICs Drive Efficiency and Size Improvements in BLDC Motor Drive Applications' by Alfred Hesener, senior director, Industrial Applications (11.40am: GaN Devices Session, Brüssel 1);
- 'GaN Power ICs Enable 300cc 700kHz 300W AC–DC Converter' by Tom Ribarich, senior director strategic marketing (11.40am: Power IC Session, München 2);
- 'GaN-based High-Frequency, High-Power-Density, 2-in-1 Bi-directional OBCM Design for EV Applications' by Bin Li, senior applications manager, for Minli Jia Sr, staff applications engineer (Power Electronics for Electric Cars Poster Session, Foyer, NCC Mitte).

10 May

- 'Wide Bandgap Design with GaN HEMT and Vertical GaN' (panel) by Stephen Oliver, VP corporate marketing & investor relations (1:05pm, Hall 7, #480).

11 May

- 'Reliability and Quality Requirements for SiC and GaN Power Devices' (panel) by Stephen Oliver, VP corporate marketing & investor relations (12:10pm, Hall 7, #480);
- 'High-Frequency High-Efficiency LLC Module with Planar Matrix Transformer for CRPS Application Using GaN Power IC' by Bin Li, senior applications manager (2:20pm, DC–DC Converters Session, Brüssel 1).

www.mesago.de/en/PCIM/main.htm

Navitas launches GaNSense Control ICs

Integration of high-speed, high-voltage GaN and low-voltage silicon system-controller chips enables easy-to-use, high-efficiency, fast-charging power systems

Navitas Semiconductor has launched a family of GaNSense Control ICs that deliver what it claims are unprecedented levels of performance and integration.

Power systems require an optimized, high-speed, low-voltage (LV) silicon system controller, which Navitas has developed and integrated with its high-performance GaN ICs to create the first GaNSense control IC technology.

The initial range of GaNSense Control ICs features high-frequency quasi-resonant (HFQR) flybacks supporting operation in QR mode, discontinuous conduction mode (DCM), continuous conduction mode (CCM) and multiple-frequency, hybrid-mode with frequencies up to 225kHz. The range is provided in a single, surface-mount QFN package (NV695x-series) or as a chip-set (NV9510x + NV61xx) for maximum designer flexibility. On the secondary side, integrated synchronous rectifier (SR) power ICs (NV97xx) achieve maximum efficiency at any load condition compared with conventional rectifiers.

Integrated features such as loss-less current sensing, high-voltage (HV) start-up, frequency-hopping, low standby power, and wide V_{DD} input voltage deliver small, efficient, cool-running systems with fewer components and no R_{SENSE} hot-spot. An array of integrated protection features including 800V transient voltage, 2kV ESD, over-voltage, over-current, and over-temperature protection create a robust power IC and reliable power systems, says Navitas.

Initial applications span 20–150W including smartphone, tablet and laptop chargers, consumer and home appliances, point-of-sale, and auxiliary supplies in high-power data center power and 400V electric vehicle (EV) systems. Over a million units have already been shipped.

"Strategically adding high-speed, analog and mixed-signal silicon controller technology to our existing GaN, SiC and digital-isolator technology platforms creates a design foundation for optimized power systems, adding over $1bn/year to the addressable market opportunity," says chief operating officer/chief technology officer & co-founder Dan Kinzer. "We're starting with GaNSense Control for fast-chargers and consumer appliances, as well as auxiliary supplies in servers and data centers. In the future, we can expand the portfolio to address higher-power applications in renewable energy, energy storage, and electric vehicles," he adds. "Navitas is uniquely positioned to influence customer architecture decisions with our advanced system design centers in those markets. Through those, we are able to maximize the system benefits and Navitas' value whether using GaN or SiC in next-generation power electronics."

www.navitassemi.com/gansense-control

Navitas and realme launch first 240W ultra-fast-charging phone at Mobile World Congress

Navitas' GaNFast technology has been adopted for the 'in-box' 240W ultra-fast charger provided with the recently announced realme GT3 smartphone.

Launched at Mobile World Congress (MWC) Barcelona 2023 at the end of February, realme's GT3 is a new Android device and said to be the first smartphone to offer the power of 240W charging.

The dual-port SUPERVOOC fast charger included with the GT3 is fully certified by TÜV Rheinland and built around two Navitas NV6138 GaN power ICs in critical-conduction-mode (CRM) power-factor correction (PFC) and high-frequency, quasi-resonant (HFQR) flyback topologies. With a form factor of only 57mm x 58mm x 30mm (99cc) and weighing just 173g, the charger has a power density of 2.42W/cc and can fully charge the GT3's 4600mAh battery in just 9 minutes and 30 seconds. A charge of 50% is possible in just 4 minutes, while a quick-shot 30 second charge delivers 2 hours of talk-time.

GaNFast power ICs integrate a high-performance GaN FET with GaN gate-drive to achieve high-frequency, high-efficiency operation. Additional GaNSense technology enables real-time, accurate sensing of voltage, current and temperature with autonomous control. Loss-less current sensing eliminates external current-sensing resistors and hot-spots, while increasing system efficiency.

"With the GT3 we have eliminated battery anxiety by providing the world's most powerful smartphone-charging solution that delivers the maximum power that USB Type-C will support," says Chase Xu, realme vice president and president of realme global marketing. "Navitas GaNFast ICs featuring GaNSense technology are the key to realizing this world's first," he adds.

www.realme.com

Transphorm showcases GaN power conversion solutions

Transphorm Inc of Goleta, near Santa Barbara, CA, USA — which designs and manufactures gallium nitride (GaN) field-effect transistors (FETs) for high-voltage power conversion — says that, in booth 108 (Hall 7) at the Power, Control and Intelligent Motion (PCIM) Europe 2023 trade fair in Nuremberg, Germany (9–11 May), its showcase will underscore its expanding footprint in market applications spanning the power spectrum. Devices on display demonstrate Transphorm's ability to support low- to high-power systems with GaN power conversion solutions offering manufacturability, designability, drivability, and reliability.

Driving down BOM costs

The WT7162RHUG24A, the recently announced SuperGaN SiP (system-in-package) developed with Weltrend Semiconductor, is again on display following its first showing at the Applied Power Electronics Conference (APEC 2023). It is being shown alongside Weltrend's high-efficiency, single-stage 65W USB-C PD 3.0 + PPS power adapter reference design built with the new integrated circuit. With an overall peak efficiency of ~94.0% and a power density of 26W/in^3, the board presents a total, cost-effective solution for programmable adapters.

System performance increases

Transphorm's device portfolio offers various options for engineers seeking power conversion performance. These devices come in performance packages or, if drop-in replacements are desired, pin-to-pin compatible industry-standard packages.

An on-site static demonstration will show how replacing TSMC e-mode devices with Transphorm FETs in a currently available gaming laptop charger significantly improved the system's performance.

Simplifying GaN use in 3kW inverter systems

The recently announced TDINV3000W050B-KIT, a 3.0kW DC-to-AC non-isolated full-bridge inverter evaluation board, is on display for the first time. It pairs Transphorm's TP65H050G4WS SuperGaN FET with Microchip Technology's dsPIC33CK digital signal controller (DSC) board. The DSC board is equipped with pre-programmed firmware to enable understanding and quicken development of SuperGaN solutions in industrial and renewable power systems.

Diversifying automotive GaN

Transphorm says that its technology expertise has enabled it to set key industry benchmarks for automotive-focused GaN power conversion solutions. The firm was first to market with an AEC-Q101-qualified 650V device. It is also the only GaN device maker to release an AEC-Q101 device qualified to 175°C. Also, at PCIM, Transphorm will again achieve a critical milestone by unveiling design resources for the 1200V GaN device first demonstrated a year ago. This device will complement the firm's existing 650V solutions, enabling various electric vehicle applications.

Speaking engagement

At PCIM on 10 May (1:05pm CEST) during the Bodo's Power Systems session on the Industry Stage (Hall 7, booth 480), Philip Zuk, senior VP, business development and marketing, is giving a presentation on the panel 'Wide Bandgap Design with GaN HEMT and Vertical GaN'.

www.mesago.de/en/PCIM/main.htm
www.transphormusa.com

GaN products exceed 125 billion field operating hours

Transphorm says that in February its GaN semiconductor products exceeded 125 billion field hours.

Transphorm says its SuperGaN platform is backed by an IP portfolio encompassing over 350 directly owned and over 1000 overall fundamental materials through applications patents, appraised at about $170m (based on Intracom Group Intellectual Property Solutions' patent valuation models).

The firm claims its GaN FETs:

- offer best-in-class performance from low power to high power and across a variety of topologies, with ease of use and interface with standard drivers and controllers;
- offer superior dynamic performance, resulting in higher efficiency with a smaller chip size versus other GaN products, or higher power from the same or smaller die size;
- offer a much higher voltage rating, 650V, 900V and 1200V (under development), all exceeding the performance of SiC MOSFETs (650V, 1200V) and other GaN devices where such are available (i.e. at 650V lower power).

Transphorm says its expanding network of blue-chip partners, including controller & integrated driver IC partners, allows it to efficiently expand its reference designs and solutions footprint, placing it in a strategic position to take full advantage of a growing market opportunity with best-in-class technology — performance of GaN with the look and feel of silicon (easy to use/interface).

"This milestone demonstrates our industry-leading reliability for both low-power and high-power applications of our GaN power solutions," says president, chief operating officer & co-founder Primit Parikh. "The past year proved to be a critical step in positioning the company to reach this operating goal," he adds. "From a business growth standpoint, exceeding 125 billion operating hours with very low sub-0.2 FIT rates across the power range, coupled with high performance of our patented solutions, further supports our confidence for growth from our fast-growing $500m+ long-term pipeline."

Power Integrations launches 900V GaN flyback switcher ICs

PowiGaN InnoSwitch ICs target industrial applications and 400V-system automotive power supplies to 100W

Power Integrations Inc of San Jose, CA, USA, which provides high-voltage integrated circuits for energy-efficient power conversion, has announced a 900V gallium nitride (GaN) extension to its InnoSwitch3 family of flyback switcher ICs.

Featuring the firm's proprietary PowiGaN technology, the new ICs deliver up to 100W with better than 93% efficiency, eliminating the need for heat sinks and streamlining the design of space-challenged applications.

InnoSwitch3 designs also offer what is said to be exceptional light-load efficiency, making them suitable for providing auxiliary power in electric vehicles during low-power sleep modes. The AEC-Q100-qualified InnoSwitch3-AQ family is particularly suitable for EVs based on 400V bus systems where the 900V PowiGaN switch provides more power and increased design margin — required for 12V battery-replacement systems — with enhanced efficiency over silicon-based converters.

"The dominant bus voltage for electric vehicles is 400V," says Peter Vaughan, automotive business development director. "EV manufacturers are optimizing their new generation of 400V systems and re-engineering various power stages in the vehicle, such as the on-board charger. The 900V PowiGaN switch is extremely beneficial because it easily accommodates inductive noise spikes, yet it can operate from as low as $30V_{DC}$, enabling systems to meet functional safety active discharge requirements," he adds. "The extra power delivered by our GaN technology matches the increasing power demands of EV manufacturers, moreover, efficiency in power conversion — even in auxiliary systems — is important for both range extension and thermal management."

In the industrial space, extra power and increased efficiency are extremely advantageous in applications such as appliances, three-phase motors and auxiliary power supply units (PSUs) in servers. The new 900V parts are pin-for-pin compatible with existing 725V and 750V InnoSwitch3-EP parts and offer increased safety margin, which is ideal for countries with unstable line voltages.

"Our ability to deliver GaN parts rated at up to 900V demonstrates the reliability and ruggedness of our PowiGaN technology," says Silvestro Fimiani, senior product marketing manager at Power Integrations.

The new 900V InnoSwitch3-EP and InnoSwitch3-AQ off-line CV/CC flyback switcher ICs use synchronous rectification, a valley switching discontinuous conduction mode (DCM) and continuous conduction mode (CCM) flyback controller. FluxLink communication technology enables the IC package to bridge the isolation barrier, optimizing efficiency and eliminating the need for optocouplers. PowiGaN technology enables InnoSwitch3-EP ICs to deliver up to 100W (230V alternating current [V_{AC}] plus or minus 15%) without heat sinks. InnoSwitch3-EP devices incorporate multiple protection features including line over- and under-voltage protection, output over-voltage and over-current limiting, and over-temperature shutdown. Devices are available with standard and peak power delivery options. Automotive InnoSwitch3-AQ devices can also deliver 100W from a 400V bus and provide performance and protection features similar to those of the popular 1700V silicon carbide InnoSwitch3-AQ ICs currently used in 800V EV systems.

Pricing for the new 900V GaN InnoSwitch3-EP devices for industrial applications start at $2 for 10,000-unit quantities.

www.power.com/products/

Virginia Tech shows ruggedness of ICeGaN technology

Cambridge GaN Devices Ltd (CGD) says that independent, third-party research by Virginia Tech University has demonstrated that its ICeGaN gallium nitride technology is more reliable and robust than other GaN platforms. Presented by researchers from Virginia Tech and CGD's director of Innovation & Research Daniel Popa at the Applied Power Electronics Conference (APEC 2023) in Orlando, FL, USA (19–23 March), the paper 'A GaN HEMT with Exceptional Gate Over-Voltage Robustness' provides experimental evidence that shows that ICeGaN high-electron-mobility transistors, enabled by smart protection circuitry, show exceptionally high over-voltage margin of over 70V (comparable to state-of-the-art traditional silicon devices) and possibly even higher.

"Accidental high drive voltage is a critical concern for the gate reliability and driver design of GaN HEMT devices," says Popa. "State-of-the-art GaN HEMTs survive around 25V, which can be within gate voltage overshoots in applications such as converters, resulting in device failure," he adds. "Until ICeGaN, higher breakdown voltage values of 70V and more were only possible with state-of-the-art SiC [silicon carbide] and superjunction devices."

CGD claims that ICeGaN HEMTs possess a unique set of intrinsic capabilities that, together, elevate device reliability well above current state-of-the-art GaN devices from competitors, while approaching the ruggedness of state-of-the-art silicon devices. As well as the hugely elevated dynamic gate breakdown capability, enabled by the inclusion of fully integrated GaN smart circuitry, and confirmed by the Virginia Tech research, ICeGaN technology has a higher voltage threshold of 3V, higher voltage range (0–20V), and a stronger gate voltage clamping action at lower temperatures.

Also, a novel Miller-clamp design, integrated within the smart ICeGaN circuitry, ensures immunity against high-dV/dt and high-dI/dt events and obviates the need for negative gate voltages for turning off (and keeping off) the HEMT, which in turn reduces exposure to dynamic R_{on} stress.

"The two major advantages of CGD's ICeGaN technology are ease-of-use and reliability," says chief commercial officer Andrea Bricconi. "Our design, which integrates smart protection circuitry fabricated in GaN on-chip with the HEMT, facilitates both these key benefits, enabling devices to be driven like a MOSFET — without the need for special gate drivers, complex and lossy driving circuits, negative voltage supply requirements or additional clamping components — and to survive rugged and challenging application conditions."

www.camgandevices.com

CGD presents GaN-based power electronics at APEC

At the Applied Power Electronics Conference (APEC 2023) in Orlando, FL, USA (19–23 March), Cambridge GaN Devices Ltd (CGD) — which was spun out of the University of Cambridge Department of Engineering's Electrical Power and Energy Conversion group in 2016 by CEO Dr Giorgia Longobardi and professor Florin Udrea and designs, develops and commercializes power transistors and ICs that use GaN-on-silicon substrates — presented several papers covering strategic views on sustainability and deep-dive technology analysis. Executives from the firm chaired two sessions, and CGD presented demos using proven reference designs and evaluation boards plus new and established GaN eco-system partnerships.

"The power electronics community and the wider world are now accepting that gallium nitride technology can play a huge role in enabling sustainable electronics solutions that are more efficient, have high performance and are more compact," says Longobardi. "At important international events such as APEC, we have an opportunity to explain and demonstrate our technology to an audience drawn from many different industries and markets."

Papers presented at APEC were:

- 'An Overview of GaN Dynamic $R_{ds(ON)}$ and Quantifying Performance Benefits of 0V GOFF in Real Applications' by director of applications engineering Peter Comiskey;
- 'Meeting Carbon Goals with GaN' by CEO Giorgia Longobardi;
- Exhibitor Seminar: 'ICeGaN 650V Power GaN ICs bring efficiency, robustness and reliability for high power applications to the next level' by CEO Giorgia Longobardi.
- 'A GaN HEMT with Exceptional Gate Overvoltage Robustness' by Virginia Tech University and director of innovation & research Daniel Popa.

Also, Peter DiMaso, VP business development Americas, chaired session IS19 on WBG applications, and Peter Comiskey, director of applications engineering, chaired session IS25 on Wide-Bandgap (WBG) devices.

CGD presented demos to showcase what is said to be the industry's first easy-to-use and scalable 650V GaN HEMT family. ICeGaN H1 single-chip eMode HEMTs can be driven like a MOSFET, without the need for special gate drivers, complex and lossy driving circuits, negative voltage supply requirements or additional clamping components. The displays included half-bridge, 350W LLC, 350W PFC, 65W QRF and 3kW LLC evaluation circuits, plus a thermal demo and an example of a 3kV photovoltaic solar inverter developed using GaN in partnership with Neways.

www.apec-conf.org

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Wise-integration & Powernet team on digitally controlled, compact, energy-efficient GaN power supply systems

WiseWare digital controller and Wisegan 650V E-mode GaN-on-Si IC to combine with Powernet's SMPS technology

Wise-integration of Meylan, France, which was founded in 2020 and designs and develops gallium nitride (GaN) integrated circuits and digital-control technologies for power supplies, and power supply maker Powernet of Seoul, South Korea, have agreed to build compact and energy-efficient technology for power supply applications that are currently limited to analog control.

The memorandum of understanding addresses the needs of OEMs that require compact digitally controlled power supply systems for faster, smaller and more energy-efficient electronic equipment in products ranging from USB PD fast chargers to monitors, TV sets and electric vehicles.

The system will combine Wise-integration's WiseWare digital controller and Wisegan (a 650V enhancement-mode GaN-on-silicon IC for power applications ranging from 30W to 3kW) with Powernet's switched-mode power supply (SMPS) technology that efficiently converts electrical power.

"We expect our collaboration to be the start of a new era in the power-supply industry by combining Powernet's well-established experience in productizing power supplies and Wise-integration's GaN IC and digital-control technologies," says Powernet's CEO Lee Don Ju. "This combination will deliver a much higher level of energy efficiency to mass-market products, while reducing their environmental impact," he adds.

"This partnership, guided by our long-term business and development roadmap, will bring Wise-integration's unique GaN IC and digital-control technologies to global markets and enable Powernet to increase the power density and reduce the size of its SMPS products," says Wise-integration's CEO Thierry Bouchet. "We will jointly deliver the high level of compactness and superior performance required for the mass-market applications."

Wise-integration claims to be the first company to bring digital control to the power supply market, where previously only analog controls were available. Original design manufacturers (ODM) such as Powernet are trying to meet growing demands from original equipment manufacturers (OEM), which require increasingly small and ultra-efficient power supplies for their future product lines. GaN is seen as a key material for delivering these features, but it is very difficult for power supply makers to go above switching frequencies of 300kHz with analog devices.

Composed of a standard MCU 32-bit-based controller and running the company's proprietary firmware, WiseWare manages the WiseGan devices and controls the power supply. Because fewer components are required than in analog controllers and thanks to high running frequency, the new power electronic architecture reduces weight and volume of standard solutions by 30% and significantly reduces production costs.

www.wise-integration.com
www.gopowernet.com

Odyssey delivers vertical GaN product samples to lead customers in Q1

Product development agreements expected to be signed in Q2

Odyssey Semiconductor Technologies Inc of Ithaca, NY, USA, which develops high-voltage vertical power switching components based on proprietary gallium nitride processing technology, says it delivered vertical GaN product samples to lead customers in first-quarter 2023, as planned, and remains on track to sign product development agreements with customers by the end of second-quarter 2023.

"We set an aggressive goal to deliver vertical GaN product samples in Q1. Now that we've delivered product samples to lead customers, we're focused in Q2/2023 on delivery of samples to additional customers and signing product development agreements with customers, which will lead to large-scale commercialization," says CEO Mark Davidson. "Lead customers have collaborated along the way and have validated the performance metrics expected from vertical GaN for power applications," he adds.

"We are actively engaged in multiple product definition conversations with leading EV automotive customers, as well as industrial motor and renewable energy customers. The market demand and interest are strong, and we remain focused on executing our commercialization roadmap," concludes Davidson.

Odyssey continues to take product sample requests. Customers can request information on the 650V and 1200V vertical GaN power devices at info@odysseysemi.com.

www.odysseysemi.com

NoMIS Power partners with Hyundai to evaluate and develop high-voltage power semiconductor device designs and packaging

SUNY Poly spin-off to evaluate Ga_2O_3 Schottkys, MESFETs and MOSFETs with different gate structures and field management approaches

NoMIS Power of Albany, NY, USA, which was spun off from State University of New York Polytechnic Institute (SUNY Poly) in 2020, has embarked on a new partnership with South Korea-based automotive firm Hyundai Group to evaluate and develop novel power semiconductor device designs and packaging for high-voltage power devices.

Working in collaboration with a network of partners across areas related to materials, device design, fabrication and packaging, the NoMIS team will explore the suitability of different novel device architectures and packaging approaches for high-voltage applications.

The project will evaluate gallium oxide (Ga_2O_3) Schottky diodes, metal–semiconductor field-effect transistors (MESFETs) and metal–oxide–semiconductor field-effect transistors (MOSFETs) with different gate structures and field management approaches to identify a path to next-generation performance in wide-bandgap power semiconductor devices. Ultimately, this means that the next-generation power semiconductor device could lead to potential applications that include improved electric vehicle motor drives and on-board/off-board chargers with enhanced power density and efficiency beyond the performance of existing technology.

The relationship with Hyundai Motor Company "brings together the experience and research interests of both groups while fostering a commercialization pathway for the developed technology," says NoMIS Power's CEO Dr Adam Morgan. "The electrification of high-power applications, particularly in the transportation space, motivates us to pursue the next generation of power semiconductor technology," he adds.

www.nomispower.com
www.sunypoly.edu

EPC releases Phase-15 Reliability Report

Projected GaN device lifetime in real-world applications

Efficient Power Conversion Corp (EPC) of El Segundo, CA, USA — which makes enhancement-mode gallium nitride on silicon (eGaN) power field-effect transistors (FETs) and integrated circuits for power management applications — has issued its Phase-15 Reliability Report, documenting continued work using test-to-fail methodology and adding specific reliability metrics and predictions for real-world applications including solar optimizers, light detection & ranging (LiDAR) sensors, and DC–DC converters.

The report presents the results of testing eGaN devices to the point of failure, which provides the information to identify intrinsic failure mechanisms of the devices. By identifying these, physics-based models that accurately project the safe operating life of a product over a more general set of operating conditions are developed. This is applied to information from

real-world experience to determine mission robustness for specific applications.

The report is divided into nine sections, each dealing with a different failure mechanism or application case:
1: Voltage/temperature stress on the gate;
2: Voltage/temperature stress on the drain;
3: Safe operating area (SOA);
4: Short-circuit robustness testing;
5: Mechanical force stress testing;
6: Thermo-mechanical stress;
7: Reliability test results for long-term LiDAR pulse stress conditions;
8: Using test-to-fail methodology to accurately predict how eGaN devices can last more than 25 years in solar applications;
9: Applying the physics-based model to real-world DC–DC converter use cases.

"The release of EPC's Phase-15 reliability report examines information from real-world experience that either confirms the laboratory-derived data or opens new questions about mission robustness that leads to a deeper understanding of the behavior of GaN devices over a wide range of stress conditions," notes CEO & co-founder Dr Alex Lidow.

www.epc-co.com/epc/design-support/gan-fet-reliability/reliability-report-phase-15

SGL Carbon reaches long-term offtake agreement to supply graphite components to Wolfspeed

SGL Carbon expanding capacities to support Wolfspeed's SiC growth

Based on their established and long-lasting business relationship, SGL Carbon has entered into a long-term offtake agreement to supply graphite components to Wolfspeed Inc of Durham, NC, USA for its US production, as it ramps up capacity to meet steepening demand for silicon carbide technology and devices.

SGL Carbon will provide materials for Wolfspeed's Mohawk Valley Fab (the world's first and currently largest 200mm silicon carbide wafer fab, opened last year) as well as its John Palmour Manufacturing Center for Silicon Carbide (the world's largest materials manufacturing facility, currently under construction in Siler City, North Carolina).

"We see SGL Carbon as a strong partner in graphite solutions that are needed for the expanding silicon carbide semiconductor demand," says Jeff Ferraro, senior

VP of global procurement and planning at Wolfspeed. "SGL Carbon's position in the market, their deep technical understanding, and comprehensive product portfolio are invaluable for the commercial ramp of the industry," he adds.

Silicon carbide demand is increasing worldwide because of its superior performance, allowing for more efficient power conversion, lighter and more compact designs, and overall system-design cost savings. In the SiC semiconductor production process, graphite components are essential ingredients. From the synthesis of the silicon carbide powder to the finished wafer, SGL Carbon offers customized solutions made of isostatic graphite and carbon composites, as well as insulation materials.

"Silicon carbide power semiconductors are more efficient and powerful, thus enabling, for example, higher bottom-line ranges in electric vehicles," notes Burkhard Straube, head of SGL Carbon's Graphite Solutions business unit. "It is a key technology for the future of e-mobility and also for 5G communication, stationary energy storage, and wind turbines. We are proud to make a substantial contribution with our graphite components and solutions."

www.wolfspeed.com
www.sglcarbon.com

ACM receives first purchase order for Ultra C silicon carbide substrate cleaning tool

Tool to ship to Chinese silicon carbide substrate maker by end-Q3/2023

ACM Research Inc of Fremont, CA, USA, which develops and manufactures wafer processing equipment for semiconductor device and advanced wafer-level packaging (WLP) applications, has — through its operating subsidiary ACM Research (Shanghai) Inc — received the first purchase order (PO) for its Ultra C silicon carbide (SiC) substrate cleaning tool. The platform leverages ACM's patented Space Alternated Phase Shift (SAPS) cleaning technology, which is designed to achieve more comprehensive cleaning without damage to device features. The PO was received from a "leading Chinese SiC substrate manufacturer" and is expected to ship before the end of third-quarter 2023.

ACM notes that increased demand for power semiconductors from industries such as automotive and renewable energy is driving growth in the SiC device market, which is expected to exceed $4bn by 2026, according to market analyst firm Yole Développement.

"The power semiconductor market is experiencing strong growth, with the electric vehicle market and related infrastructure seeing rapidly accelerating deployments," says ACM's founder & CEO David Wang. "This order represents the successful application of ACM's experience in advanced semiconductor wafer processing equipment to meet the unique requirements of SiC substrate manufacturing," he adds. "We remain committed to expanding our product portfolio to support additional market opportunities."

ACM Research's Ultra C SiC substrate cleaning tool uses SC1 (ammonia/hydrogen peroxide), SC2 (hydrochloric acid/hydrogen peroxide), DHF and other chemicals for the cleaning process, and can also be equipped with ACM's proprietary Smart Megasonix to achieve better cleaning performance. The tool is 6- and 8-inch compatible and is designed to achieve throughput of more than 70 wafers per hour. The tool has been optimized for handling fragile SiC substrates to minimize breakage.

www.acmrcsh.com

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Aehr reports record quarterly order bookings

Growth driven by demand for silicon carbide wafer-level test & burn-in for electric vehicle applications

For its fiscal third-quarter 2023 (ended 28 February), semiconductor production test and reliability qualification equipment supplier Aehr Test Systems of Fremont, CA, USA has reported revenue of $17.2m, up on $14.8m last quarter and 13% on $15.3m a year ago.

On a non-GAAP basis, net income has grown from $3.1m ($0.11 per diluted share) a year ago and $4.5m ($0.16 per diluted share) last quarter to $4.7m ($0.16 per diluted share).

Order bookings were a record $33.3m. Order backlog (as of end-February) was $31.6m. Effective backlog (including all orders received since the end of fiscal Q3) is $41m. Total bookings for fiscal 2023 to date (including over $9m in bookings received in March) were $72.5m.

"Our momentum in silicon carbide wafer-level burn-in continues to grow," notes president & CEO Gayn Erickson. "During the quarter, our second major silicon carbide semiconductor customer moved from an initial FOX-NP dual-wafer system for engineering and qualification to purchasing their first production FOX-XP multi-wafer test & burn-in systems including our new high-voltage option with high-voltage arc suppression technology. These systems will be upgraded to include our new fully integrated and automated WaferPak Aligner that we are beginning shipments of this quarter. Last week, we announced a follow-on order from this customer for production quantities of our WaferPak full-wafer Contactors that will be used with these systems. We believe that this major silicon carbide customer will purchase a large number of our FOX-XP systems to meet their publicly announced significant increase in planned capacity and revenue growth over the next several years and through the end of the decade," he adds.

"In addition, our lead silicon carbide customer continued to ramp up their production and their use of our FOX-XP production systems and WaferPak Contactors. During the quarter, we received a $25m order for a significant number of additional FOX-XP wafer-level test & burn-in systems scheduled to ship over the next 6–7 months to meet their increased capacity needs for producing silicon carbide devices for electric vehicles, chargers and electrification infrastructure. Earlier this month, we also announced a $6.7m follow-on order for WaferPaks from the same customer, representing about half of the total WaferPak full-wafer Contactors needed for these FOX-XP systems that each have the capacity to test & burn-in 18 full wafers of devices at a time," Erickson continues.

"We also continue to make great progress with our previously announced benchmarks and engagements with prospective new customers. We continue to work closely with one of the largest silicon carbide players in the world on a large wafer-level benchmark and qualification… This large wafer-level benchmark and qualification continues toward success as the silicon carbide supplier finishes their internal processes to complete the qualification. As with our other large silicon carbide customers, we expect this silicon carbide supplier to require significant capacity of wafer-level test & burn-in systems to meet the fast-growing demand for silicon carbide devices and electric vehicles over the next decade."

"We also had a very productive quarter in terms of new customer engagements, which has continued into this quarter," notes Erickson. "With essentially all Covid-related restrictions behind us throughout the world, our customer-facing meetings and our progress on new customer opportunities have grown substantially. Since last quarter's conference call, we have added commitments from three additional companies currently making silicon carbide to move forward with full-wafer level evaluations and/or directly to purchase our systems."

"In addition to our momentum in silicon carbide, we are also now engaged with several gallium nitride semiconductor suppliers ranging from radio frequency (RF) to power devices," says Erickson. "Since our last call, we also received a commitment from a very large multi-national semiconductor supplier to move forward with a full-wafer-level evaluation of gallium nitride devices. This evaluation includes our new high-voltage option for doing the critical high-temperature reverse bias (HTRB) stress test needed for gallium nitride MOSFETs and amplifiers. We believe gallium nitride will be a significant market, driven by some very high-volume applications such as RF amplifiers, consumer electronic power converters and chargers, solar power inverters, and charger and converter applications in standard and electric vehicles. Feedback from companies has been that several of these applications will require production burn-in to meet the applications' critical quality and reliability needs. With our proven FOX-XP wafer-level burn-in solution and its cost-effective ability to test thousands of devices in parallel and up to nine wafers at a time with high-voltage capability, we believe we are well positioned to capitalize on this opportunity and believe gallium nitride can expand our total addressable market in a meaningful way," he adds.

"We also continue to be enthusiastic about the silicon photonics market, especially as it looks to expand its use beyond fiber-optic transceivers to become an embedded application

that integrates fiber-optic technology into the chipsets. Multiple market leaders have publicly discussed their investments to integrate silicon photonics transceivers into their microprocessors, graphics processors, and chipsets. While we believe this transition is still several years out, we also believe the silicon photonics test & burn-in market can become significant and could grow to be as large or larger than the silicon carbide market later in this decade," says Erickson.

"We are very encouraged by the continued positive momentum and expanding growth opportunities we see with our current and prospective customers."

Fiscal 2023 financial guidance

For fiscal 2023 (to end-May), Aehr reiterates its prior guidance for revenue of at least $60–70m, up 18–38% year-on-year, with strong profit margins similar to fiscal 2022.

"We remain confident that our bookings will grow faster than revenue this fiscal year as the ramp in demand for silicon carbide and electric vehicles increases, setting us up with strong momentum heading into our fiscal 2024 that begins in June," says Erickson.

Update on At-The-Market offering

During the quarter Aehr received gross proceeds totaling $7.3m on the sale of 208,917 shares at an average price of $34.78 per share. This leaves $17.7m available under its previously announced offer to sell up to $25m of its common stock on the open market via an At-The-Market (ATM) offering. Under the terms of the ATM equity distribution agreement, the firm may not sell shares during its closed trading windows when it is deemed that the company may be in possession of material non-public information. The firm only plans to sell shares against the ATM during open trading windows and when it believes it would provide the best source of capital with minimal dilution to existing shareholders.

www.aehr.com

Aehr receives volume production order for WaferPak full-wafer Contactors

FOX system customer ramping test & burn-in for SiC device wafers

Aehr has received an order from its second major silicon carbide customer for production quantities of WaferPak full-wafer Contactors to be used with previously ordered FOX-XP systems for test & burn-in of SiC wafers in their production facility. Shipments will begin in Aehr's current fiscal fourth quarter that began on 1 March.

As previously announced, this customer has purchased Aehr's FOX multi-wafer test & burn-in systems for SiC wafers for devices such as electric vehicle drive unit inverters, EV chargers, and other devices for use in industrial and photovoltaic inverter applications. Aehr has installed both a FOX-NP system used for new product development and engineering characterization as well as the first of two FOX-XP systems already purchased that will be upgraded to include Aehr's new fully integrated and automated WaferPak Aligner for volume production test & burn-in of their silicon carbide devices. The new WaferPak AutoAligner will begin shipments in Aehr's current fiscal quarter.

The order reflects initial WaferPak purchases from this customer for use in volume production of devices to meet the demand for SiC power semiconductors used in power conversion applications for electric vehicles, says president & CEO Gayn Erickson. "We believe that this customer will purchase a large number of our FOX-XP systems to meet their publicly announced significant increase in planned capacity and revenue growth over the next several years and through the end of the decade," he adds.

"Forecasts from William Blair estimate that the silicon carbide market for devices in electric vehicles alone, such as traction inverters and on-board chargers, is expected to grow from 119,000 6"-equivalent silicon carbide wafers for electric vehicles in 2021 to more than 4.1 million 6"-equivalent wafers in 2030, representing a compound annual growth rate (CAGR) of 48.4%. This equates to almost 35 times larger in 2030 than in 2021. Also, 6"-equivalent SiC wafers for other markets such as solar, industrial and other electrification infrastructure are expected to grow to another 3 million wafers by 2030," Erickson continues.

"Aehr is adding infrastructure and capacity in design resources and tools, material suppliers and manufacturing and test of our FOX-XP WaferPaks to meet the anticipated significant growth in demand for these full-wafer contactors for the silicon carbide and gallium nitride power semiconductor test & burn-in markets as well as several other markets."

FOX-XP and -NP systems, available with multiple WaferPak Contactors (full-wafer test) or multiple DiePak Carriers (singulated die/module test) configurations are capable of functional test & burn-in/cycling of devices such as silicon carbide and gallium nitride power semiconductors, silicon photonics as well as other optical devices, 2D and 3D sensors, flash memories, magnetic sensors, micro-controllers, and other leading-edge ICs in either wafer form factor, before they are assembled into single or multi-die stacked packages, or in singulated die or module form factor.

CVD Equipment's revenues grow 50% year-on-year

PVT system orders boom for silicon carbide wafer manufacturing

For fourth-quarter 2022, CVD Equipment Corp of Central Islip, NY, USA (a designer and maker of chemical vapor deposition, physical vapor transport, gas and chemical delivery control systems, and other equipment and process solutions for developing and manufacturing materials and coatings) has reported revenue of $7.2m, up 53% on $4.7m a year ago. This took full-year revenue to $25.8m for 2022, up 57% on 2021's $16.4m.

Quarterly operating expenses have risen from $1.8m in Q4/2021 to $2.2m in Q4/2022, increasing full-year operating expenses from $7.7m in 2021 to $8.5m for 2022.

Quarterly operating loss has been cut from $1m in Q4/2021 to $0.22m in Q4/2022, helping to reduce full-year operating loss from $4.7m in 2021 to $1.8m for 2022.

Net income was $1.5m ($0.23 per share) in Q4/2022. However, this came entirely from the recognition of an Employee Retention Credit. This contrasts with Q4/2021's net loss of $1.2m ($0.18 per share). Full-year net loss of $0.22m ($0.03 per share) for 2022 contrasts with net income of $4.7m ($0.71 per share) in 2021, but that included gains of $6.9m on the sale of a building and $2.4m on forgiveness of a PPP loan.

During 2022, cash and cash equivalents have fallen from $16.7m to $14.4m.

"CVD Equipment Corporation's primary objective over the past two years has been to bring the company to profitability through a focus on products that serve high-growth markets, specifically high-power electronics, electric vehicle (EV) battery materials/energy storage and aerospace & defense — all of which have the objective of improving energy efficiency," says president & CEO Manny Lakios.

Order bookings were $9.2m in Q4/2022, taking full-year bookings to $33.1m. Order backlog was $17.8m at the end of 2022.

"In the high-power electronics market, we saw demand for silicon carbide wafers to support high-power electronics for energy storage and transmission/charging resulting in a multi-system order from a US-based silicon carbide wafer manufacturer," says Lakios. "Through 31 December 2022, we have received orders for 30 of our PVT150 physical vapor transport systems from this customer, which uses our systems to grow silicon carbide crystals that are made into 150mm silicon carbide wafers. During the second half of 2022, we initiated the marketing launch of the PVT150 on our website and at a leading trade show. We plan to increase our marketing efforts for the PVT product line as well as expand our product offerings to manufacturers of silicon carbide wafers," he adds.

"In battery materials and energy storage market, we experienced increased interest and demand for nanotechnology materials including carbon nanotubes (CNTs), graphene and silicon nanowires (Si-NWs) to support the development and manufacturing for battery materials used in electric vehicles," Lakios continues. "We received two system orders in 2021 to deposit coatings onto powders used in silicon-graphite anodes, including a production system and a second for research and material development. Both systems were completed in 2022."

www.cvdequipment.com

III-V Epi's CTO made Professor of Photonics at Aston

III-V Epi Ltd of Glasgow, Scotland, UK — which provides a fast-turn-around molecular beam epitaxy (MBE) and metal-organic chemical vapor deposition (MOCVD) service for custom compound semiconductor wafer design, manufacturing, test and characterization — says that its chief technology officer & technical advisor professor Richard Hogg is taking on a new role as Professor of Photonics at Aston Institute of Photonics Technology (AIPT) in Birmingham. The new role is a non-teaching position, allowing Hogg to focus more of his time on photonics research, development and commercialization. His CTO role with III-V Epi will be unchanged.

III-V Epi's CTO Richard Hogg.

AIPT conducts national and international research, industrial and commercialization projects in medical, healthcare, telecoms and datacoms. The institute has over 100 industrial partners, including Airbus, IBM, Infinera, Thales, BAE Systems and Nokia Bell Labs and collaborations with over 80 other photonic centers worldwide.

"I am delighted to be joining AIPT in a new role that not only progresses my academic career but also draws on my industrial experience at NTT Basic Research Laboratories, Toshiba Cambridge Research Laboratories, and Agilent Technologies," comments Hogg. "My CTO role at III-V Epi will continue, unchanged, along with the collaboration III-V Epi has with the James Watt School of Engineering at the University of Glasgow," he adds. "It is my hope that my role at AIPT will present an excellent opportunity to bring III-V Epi's fast-turnaround wafer design, manufacturing, test and characterization services to a new and wider audience."

www.aston.ac.uk/research/eps/aipt
www.iii-vepi.com

Aixtron receives TI's 2022 Supplier Excellence Award

Texas Instruments honors Aixtron for G10-GaN MOCVD system

Deposition equipment maker Aixtron SE of Herzogenrath, near Aachen, Germany has received the 2022 Supplier Excellence Award from Texas Instruments (TI). With this annual award, the global semiconductor company honors suppliers whose dedication and commitment in supplying products and services meet TI's high standards for excellence.

Recipients of the TI Supplier Excellence Award are chosen for their exemplary performance in cost, environmental and social responsibility, technology, responsiveness, assurance of supply and quality.

Aixtron received the TI award for its new G10-GaN metal-organic chemical vapor deposition system (MOCVD) system for producing gallium nitride (GaN)-based power devices. Besides best-in-class yield, uniformity, productivity and wafer cost, the new system is said to also offer an all-new design with significantly reduced cleanroom footprint requirements. The official market launch of the G10-GaN is scheduled for later this year.

"For us, it is a great achievement to be honored with this prestigious award from a true global semiconductor player, recognizing our innovative technology, production capabilities and our excellence in customer service," says Aixtron's CEO & president Dr Felix Grawert. "Aixtron has grown out of its roots in niche markets and, with this award, TI acknowledges our position as a major semiconductor equipment supplier capable of supporting their high-volume manufacturing ramp in gallium nitride (GaN) power electronics. This award also honors our long-term engagement with Texas Instruments and the high aspirations our joint teams have for the gallium nitride material system," he adds.

"TI looks to Aixtron to help us serve our customers, achieve our priorities, and ultimately become a company that we are personally proud to be a part of," comments Rob Simpson, TI's VP of worldwide procurement & logistics.

www.ti.com
www.aixtron.com

Welsh Government to expand Newport's compound semiconductor cluster

Economy Minister meets SPTS' parent firm KLA during trade visit to Silicon Valley

Following a trade mission to California's Silicon Valley last week, the Welsh Government's Economy Minister Vaughan Gething says that it is progressing with plans to expand the compound semiconductor cluster in Newport, South Wales.

The Welsh Government is working with Silicon Valley-based semiconductor equipment maker KLA Corp's SPTS division – which provides wafer processing solutions to semiconductor and microelectronic device manufacturers – to support its plans to expand its operations in Newport as part of an already announced $100m investment.

The firm, which currently employs over 550 people in the city, is developing its new base at Newport's Celtic Lakes, which is home to a cluster of companies including Vantage (Europe's largest data center), epiwafer and substrate maker IQE plc, and the Compound Semiconductor Applications Catapult.

Gething met the chief executive and other members of KLA's executive team during the trade visit to Silicon Valley, where he reiterated the Welsh Government's commitment to the sector.

The Welsh Government's plans include work to upgrade infrastructure on the Celtic Lakes site, skills development to ensure that a continued pipeline of talented staff is available to take up new jobs in the sector, and to develop local supply chains — helping to ensure that other local companies benefit.

Following the trade visit, the Welsh Government is calling on the UK Government to prove its commitment with a fully funded plan for the future of the semiconductor sector that drives up growth, reduces consumer costs and strengthens security at home.

The Economy Minister warned that the UK is falling behind the ambitious mission set in the USA, which is a national priority for the Biden Administration.

Welsh Government Economy Minister Vaughan Gething at KLA.

"We are serious about backing a semiconductor sector that will drive up growth, create jobs and lower costs for consumers," says Gething. "Wales is a global player in the industry that deserves the backing of UK plc as a whole. Newport's compound semiconductor and technology cluster supports hundreds of well-paid jobs in an industry that powers the technologies people across the globe rely on to live their lives," he adds. "During my visit to California's Silicon Valley, I promoted Wales' reputation as a nation with a thriving semiconductor cluster and our determination to keep it that way. The Welsh Government is now progressing plans at pace to allow KLA to expand its operations in Newport, which we expect to unlock hundreds of new jobs – supporting our ambition to create new green jobs in the industries of the future."

The Welsh Government is calling on the UK Government to prove its commitment with a fully funded plan for the future of the semiconductor sector

Gething is calling on the new UK Government Department for Science, Innovation and Technology to publish a long-awaited comprehensive and fully funded semiconductor strategy to support the sector, and to protect Welsh and British jobs. "It's time for the UK Government to get on the pitch with a plan that matches the commitment of our global partners," he stresses. "The new Secretary of State for Science, Innovation and Technology has a great opportunity to bring forward some good news and much needed certainty for the industry by publishing a new strategy that's fit for the future. We are ready to work in partnership to make this happen."

http://csconnected.com
www.spts.com
www.kla.com

Riber reports full-year net profit, despite electronic component sourcing constraints

Full-year revenue growth of 40% targeted for 2023

For full-year 2022, Riber S.A. of Bezons, France — which manufactures molecular beam epitaxy (MBE) systems as well as evaporation sources — has reported revenue of €27.8m, down 11% on 2021's €31.2m.

However, Riber stopped marketing a range of evaporators for the organic light-emitting diode (OLED) market. In addition, despite the firm's efforts to diversify its sourcing capacity, supply chain disruption affecting electronic components resulted in the deferral of the delivery of two research systems to 2023, totaling €2.9m.

MBE systems sales hence contracted by 15% from €17.4m to €14.8m, for six machines delivered, compared with eight in 2021.

Services & Accessories revenue fell by 6% from a high of €13.8m to €13m, representing 46.8% of revenue.

Gross margin was 35.2%, stable versus 2021's 35.4%. Operating expenditure is stable, at €9.8m. R&D investments totaled €3.2m (12% of revenue), stable compared with 2021. Sales & marketing costs are up by 18% (in line with the strong growth in order intake), while administrative costs are stable overall.

Compared with a €1.3m operating profit in 2021, operating income broke even in 2022, impacted by non-current charges of €1.3m, in particular due to the decision to discontinue the OLED evaporator product line, which led to the depreciation of inventories.

Net income has fallen from €1.5m in 2021 to €0.2m in 2022. This included €0.4m of financial income and expenses, linked primarily to the revaluation in euros of receivables denominated in US dollars and Yuan.

Reflecting the good level of cash flow from operations and the improvement in working capital requirements, the cash position at the end of 2022 was positive at €6.1m, up €0.2m from the end of 2021. Net financial debt has been reduced from €2.4m to €1.3m.

During 2022, shareholders' equity fell by €1m to €18.8m, linked to earnings for the year and the distribution of amounts drawn against the issue premium for 2021 to shareholders.

Distribution of amounts drawn against 'issue premium' account

At the general meeting on 20 June, Riber's Executive Board will submit a proposal to shareholders to approve a cash payout based on reimbursing part of the issue premium for €0.05 per share (to be released for payment on 5 July).

Order book

During 2022, new order intake improved significantly, including 14 systems (plus an option for an additional four systems) and a good level of orders recorded for services and accessories.

The order book has hence more than doubled from €14.8m to €29.9m, including €24.6m for 11 MBE systems and €5.3m for Services & Accessories.

This does not include the additional order for a production system announced on 20 February, or the option to buy announced on 8 June 2022 covering four production systems for which the firm orders will be confirmed in 2023 when the export license is obtained.

Outlook for 2023

Riber says that, in view of the above, it is confident that it can achieve 40% year-on-year revenue growth to about €40m in full-year 2023, and a significant improvement in profitability.

In a still buoyant market, with robust demand for its systems, Riber expects to continue taking orders in 2023, capitalizing on a strong pipeline of prospects.

www.riber.com

Christian Dupont appointed chairman of Executive Board

At a meeting chaired by Ms Annie Geoffroy, Riber's Supervisory Board appointed Christian Dupont as chairman of the Executive Board from 13 April, replacing Michel Picault, who is still a member of the Executive Board. Riber reckons that the appointment will make it possible to ramp up its robust growth and expansion in a buoyant market environment.

After graduating as an engineer from EPFL (École Polytechnique Fédérale de Lausanne), Christian Dupont began his career in 1988 with Texas Instruments, where in 1992 he helped create its Wireless business unit, which became the wireless semiconductor market leader for 15 years. He was a marketing manager before being appointed to head up the business unit wireless USA in Dallas and Nice, where he was in charge of the wireless business unit in Europe. From 2007 to 2010, he was CEO of the electro-optics startup Varioptic, which was sold to Parrot, before serving until 2015 as CEO of MEMS auto-focus firm PoLight in Norway, which listed on Oslo's stock market. From 2015 to 2021, he was chairman & CEO of CEO-CF, a collaboration platform for executives from high-growth European technology companies. In 2018, as CEO, he helped restructure and refinance semiconductor firm Dolphin Integration, which was taken over by Soitec and MBDA. From 2019, he was CEO of digital health firm Digitsole.

OIPT to supply KAUST with hardware upgrades and ALE systems, complementing ALD

UK-based Oxford Instruments Plasma Technology (OIPT) has announced an agreement with the Saudi Arabia-based King Abdullah University of Science and Technology (KAUST) Core Labs, a system of multi-disciplinary and interconnected research laboratories.

KAUST's Core Labs and research infrastructure benefits from the addition of two Oxford Instruments PlasmaPro100 Cobra atomic layer etch (ALE) systems to add to its existing Oxford Instruments FlexAL atomic layer deposition (ALD) capability. With both ALE and ALD modules, it is reckoned that KAUST is now better positioned to develop its technology research and bridge the gap between academia and industry by enhancing projects like their research on Oxford Instruments ALD equipment (the origin of interfacial charges plus highly suppressed interface traps in GaN HEMTs).

The agreement includes a substantial program of upgrades to OIPT deposition and etch equipment, including FlexAL, IonFab and inductively coupled plasma (ICP) etch systems, already installed at KAUST's research laboratories. The upgrade program includes the installation and ongoing support of X20 programmable logic controllers (PLCs), a hardware controller that enhances process development by enabling the full range of Oxford Instruments hardware capability. In addition, the modules will be updated with Oxford Instruments' latest intuitive software control application PTIQ, which enables sophisticated data logging and analysis for process diagnostics and preventative maintenance tracking. To accelerate the researchers' work and user experience, KAUST Core Labs engineers will attend OIPT's UK training facility for an extensive and bespoke tool maintenance and ALE-systems training program.

"The agreement continues KAUST's development of its state-of-the-art facilities and technical expertise that attracts the world's best researchers and brightest students," says Ken Kennedy, laboratory director at KAUST Nanofabrication Core Lab. "This investment emphasises KAUST's collaboration between its faculty and shared facilities, supporting the Kingdom in advanced scientific and technological education and research," he adds.

"This agreement is a great example of our ability to develop long-term strategic partnerships with key customers in the global research and development market, and support them with our extensive upgrade portfolio and service solutions," says Dean Furlong, quality & digital director of OIPT's Global Services. "This is a substantial investment from KAUST that will enhance its reputation as an internationally recognized user facility, and further support its cutting-edge ALD research with the addition of ALE capability."

www.kaust.edu.sa
www.oxinst.com

Taiyo Nippon Sanso selling lower-moisture RASIRC BRUTE-Hydrazine anhydrous material

Taiyo Nippon Sanso Corp (TNSC) is to sell anhydrous hydrazine (N_2H_4) material BRUTE-Hydrazine (made by California-based TNSC group company RASIRC Inc) with even lower moisture content than that of its existing product.

Contamination with impurities such as moisture during manufacturing can negatively affect the semiconductor crystal quality and electrical characteristics, which directly impact device characteristics and product yield. To resolve these issues, RASIRC has reduced the water concentration in the vapor phase of BRUTE-Hydrazine from 1/10 to 1/100 of that in conventional products by improving the purification technology. Due to the change in product specifications, sales of the existing product will be discontinued.

The latest specifications of BRUTE-Hydrazine comprise the following:

- Version 7.0, with a filling volume of 250g or 1000g, and a H_2O concentration in the N_2H_4 gas phase of <100ppb;
- Version 8.0, with a filling volume of 250g, and a H_2O concentration in the N_2H_4 gas phase of <10ppb.

BRUTE-Hydrazine is a liquid material that improves safety by mixing liquid anhydrous hydrazine with RASIRC's original organic solvents as stabilizers. Hydrazine vaporizes in the vessel headspace and is delivered to the point of use by carrier gases or vacuum transfer.

Compared with the usual nitridation source ammonia (NH_3), hydrazine is more reactive and lowers the temperature of the deposition process, improving deposition rate and electrical properties. Also, hydrazine can be applied not only as a nitridation source for film deposition but also for surface cleaning and film modification by taking advantage of its excellent reducing properties.

Going forward, TNSC aims to expand sales of BRUTE-Hydrazine, mainly for semiconductor manufacturing. Results for silicon nitride (SiN) film deposited via ALD using BRUTE-Hydrazine are being reported at the AVS 23rd International Conference on Atomic Layer Deposition (ALD 2023) in Seattle, WA, USA (23–26 July).

www.tn-sanso.co.jp/en

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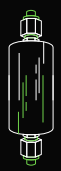
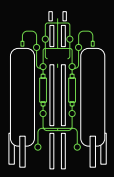
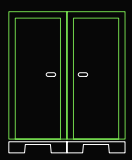


Point-of-Use Purifiers



Frame-Mounted Purifiers



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VueReal to create 75 new jobs over three years, aided by Invest Ontario and SDTC funding

Micro-LED display firm investing $40m to grow manufacturing workforce and support R&D

Invest Ontario is providing investment support to VueReal Inc of Waterloo, ON, Canada to enhance its technology manufacturing capabilities in the province. With funding assistance from Invest Ontario and Sustainable Development Technology Canada (SDTC), VueReal plans to create 75 new jobs over three years in the Kitchener-Waterloo area.

The project will boost commercial capacity for VueReal's micro-LED displays. Based on its microSolid semiconductor fabrication process, VueReal's printing technology platform enables it to offer customized display manufacturing services for both niche and mainstream markets. The firm's displays are used in various electronic products, including computers, phones, television and smartwatches, as well as monitors in the aerospace, automotive and medical technology industries.

Since micro-LEDs can reduce energy consumption in electronic displays, the micro-LED display market is forecasted to grow to US$11.5bn by 2026, according to Research and Markets. VueReal reckons it is positioned to capitalize on this growth and aims to become the North American leader in micro-LED production.

Invest Ontario is contributing a $2m grant – through the Invest Ontario Fund — subject to executing a definitive agreement, to boost VueReal's innovation and production in Canada's largest tech hub. The federal government is also providing $8.5m through its SDTC fund.

The collaboration between Invest Ontario and SDTC to fund VueReal's micro-LED technology project marks an important milestone in the evolution of both organizations, it is reckoned.

"Our focus is to strengthen the manufacturing supply chain and accelerate financial supports to companies like VueReal that can drive rapid growth and compete in a hyper-competitive market," says Invest Ontario's CEO Trevor Dauphinee.

Ontario's technology sector comprises over 408,000 skilled IT professionals and more than 65,000 STEM graduates each year. VueReal is one of almost 25,000 tech businesses in the province, contributing over $48bn annually to the technology sector's GDP.

"Canada's great universities, including the University of Waterloo, combined with government research funds, make it a prime location for developing cutting-edge and sustainable technologies," comments VueReal's CEO & founder Reza Chaji. "VueReal has leveraged this ecosystem to develop its microSolid printing technologies, which enable the creation of smart surfaces for next-generation displays and sensor applications," he adds.

"Moreover, a recent collaboration between VueReal, SDTC and Invest Ontario on a project worth approximately $40m highlights the potential to scale these technologies into full-scale production in the Waterloo Region and Ontario," continues Chaji. "These innovative technologies have a significant role in generating employment opportunities in today's modern economy and hold strategic importance for multiple industries, such as consumer electronics, healthcare, medical, security, automotive, aerospace and more."

Other major tech companies, such as Amazon, Blackberry, Cisco, Ericsson, Google, LG, OpenText and Shopify, have also established R&D operations in Ontario, making it the second-largest IT cluster in North America after California's Silicon Valley, it is reckoned.

www.vuereal.com
www.investontario.ca

VueReal staff.

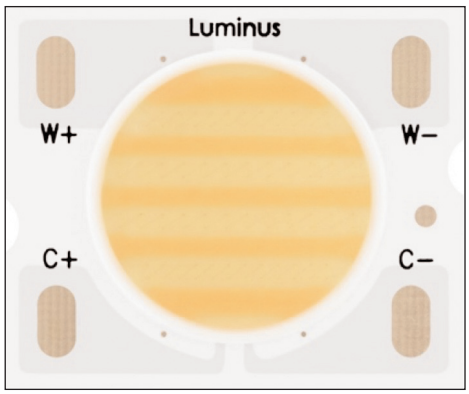
Luminus launches Gen 2 CCT tunable COB LEDs

CCTs of 6500–2700K suit applications including human-centric lighting

Luminus Devices Inc of Sunnyvale, CA, USA — which designs and makes LEDs and solid-state technology (SST) light sources for illumination markets — has expanded its chip-on-board portfolio with the introduction of Gen 2 CCT tunable COBs.

These dynamic COBs feature two independent channels with 90+ CRI (color rendering index) warm and cool white engineered in a multi-stripe design for excellent color mixing and high flux density for directional lighting. Customers can easily achieve system beam angles from 10º to 40º using standard secondary optics to deliver uniform color and quality of light. With a correlated color temperature (CCT) range of 6500–2700K and consistent white light <3SDCM (standard deviation of color matching), these COBs are suitable for both commercial and residential applications including human-centric lighting, museum and high-end retail, hospitality and circadian lighting.

To enable a smooth transition from Gen 1 to Gen 2, Luminus has kept the same footprint and thus enabled customers to use their existing ecosystem. New customers also have a large ecosystem of optics, holders and connectors to choose from, since these products use the industry-standard 12mm x 15mm and 20mm x 24mm footprints, which have been common for two-channel COB over many years. Included in that ecosystem is the upcoming Cuvee Systems two-channel driver, which is engineered to support Luminus' dynamic COBs with two 0–10V inputs and is available from Luminus' sales channels. Luminus also plans to grow the Gen 2 portfolio over the coming quarters to include other CCT ranges, Salud high-melanopic spectrums, larger LES (light-emitting surface) sizes, and dim-to-warm options.



Luminus' new Gen 2 CCT tunable COB LED.

"Luminaire makers and lighting specifiers are excited about the industry-leading efficacy and flux density of these Gen 2 products, which meet the emerging demand for tunable CCTs to provide healthy lighting environments with tones that can change with the time of day or season," says Tom Jory, VP, illumination marketing. "The quality of light is equally impressive, as narrow beams can now be achieved with smoother color mixing for a seamless dynamic directional lighting solution."

This product line is now available through Luminus' authorized distributors.

www.luminus.com/products/dynamic-cob/cct-tunable

Cree launches record-efficacy 228lm/W high-power LED

E Class added to J Series 5050 range of LEDs

Cree LED Inc of Durham, NC, USA (a company of SMART Global Holdings of Milpitas, CA) has launched J Series 5050C E Class LEDs, which have what is claimed to be the industry's highest efficacy for high-power LEDs of 228 lumens per watt (LPW) typical at 4000K, 70 CRI (color rendering index) and 1W.

The new J Series LEDs deliver what is reckoned to be up to three times the light output of competing 5050 LEDs at the same efficacy level. The LEDs are also designed with what is claimed to be superior corrosion resistance for the most challenging environments.

With the addition of the new E Class LEDs, Cree LED now offers four performance levels in the J Series 5050 LED portfolio to address most directional general lighting applications. Unlike other 5050s with asymmetric die layouts that reduce intensity through secondary optics, J Series 5050 LEDs feature optimized layouts that deliver peak intensities up to 12.5% higher than the competition, it is reckoned, as well as improved color-over-angle.

"The breakthrough performance of 5050C E Class LEDs enables substantial system cost savings through the reduction in optics, PCBs and chassis material. Up to 40% system cost savings and 57% reduction in size are possible when redesigning from a lower-performance 5050 LED to the 5050C E Class LED," says David Peoples, VP of marketing. "To speed up the design-in process, 5050C E Class LEDs are compatible with optics designed for existing square LES [light-emitting surface] 5050 LEDs."

Suitable for outdoor area, high/low-bay, roadway and indoor professional applications, the new 5050C E Class LEDs are available in 2200–6500K correlated color temperatures (CCTs) as well as 70, 80 and 90 CRI options for all CCTs.

Product samples are available now and production quantities are available with standard lead times.

www.cree-led.com/products/leds/j-series/5050

Silanna UV presenting 235nm far-UVC LEDs using new short-period superlattice technology

High power at short wavelengths and long lifetime highlighted at ICULTA

At the International Conference on UV LED Technologies & Applications (ICULTA 2023) in Berlin, Germany (23-26 April), as well as being a Silver sponsor UV-C LED maker Silanna UV of Brisbane, Australia presented new technology that is said to push the boundaries of far-UVC LEDs to emit at shorter wavelengths, at higher power, and with longer lifetimes.

On 24 April, product development manager William Lee gave a talk 'High Power 235nm far UVC LED using SPSL technology'. The firm also exhibited its SF1 series 235nm and SF3 series 255nm UV LEDs.

The new UVC LED technology offers advantages for applications as diverse as disinfection, water quality monitoring, gas sensing, liquid chromatography, and chemical and biological analysis.

Conventional aluminium gallium nitride (AlGaN)-based far-UVC LEDs in general suffer from poor carrier injection, low light emission and high drive voltage, due to the inherit limitations of high-aluminium-content AlGaN.

Silanna's new short-period superlattice (SPSL) far-UVC LED structure helps to overcome these issues. In an SPSL device, composed of repeating layers of AlN and GaN, the presence of GaN maintains the transverse electric (TE) dominance of the emission as well as lowering the activation energy of donors, resulting in more efficient devices compared with LEDs made with the conventional AlGaN technology. Furthermore, the emission wavelength can be easily tuned using the thickness of the GaN well. This process is significantly easier to control than tuning of Al composition in the barrier and well, notes Silanna UV.

www.iculta.com
www.silannauv.com/products

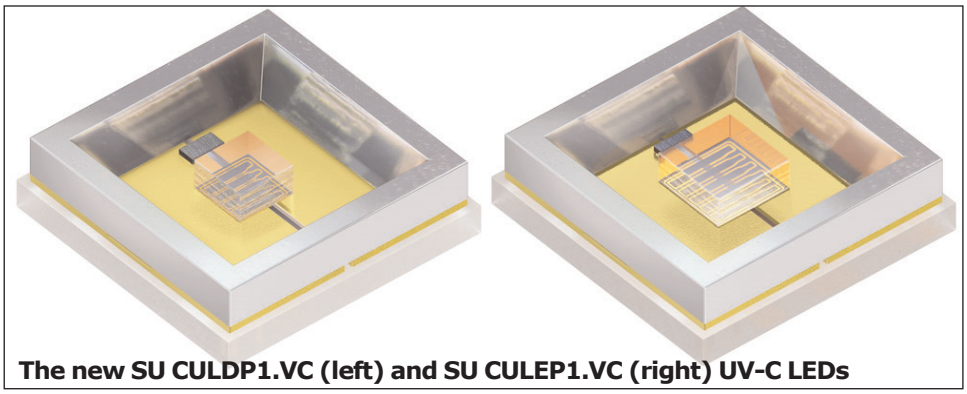
ams OSRAM adds OSLON UV 3535 series to mid-power UV-C LED range

New package with integrated reflector and no cover glass and lens reduces optical losses and optimizes radiation characteristics

ams OSRAM GmbH of Premstätten, Austria and Munich, Germany has launched the OSLON UV 3535 series of mid-power UV-C LEDs, meeting customers' requirements for longer lifetime, higher output power and easier system integration.

With a typical wavelength of 275nm, the OSLON UV 3535 LEDs combine a compact design with what is claimed to be leading efficiency and high quality, making them suitable for use in consumer or industrial applications such as water purification or air-conditioning systems. These products show a typical output power of 40mW at a drive current of 185mA for the SU CULDP1.VC, and 75mW at 350mA for the SU CULEP1.VC (both now available worldwide).

The new package design with no cover glass and an integrated reflector improves output by reducing optical losses and leads to a comparably high wall-plug efficiency of 3.7%. The reflector collects the die's emissions and directs the light forward with a viewing angle of 120°. A standard 3.5mm x 3.5mm footprint and the absence of cover glass and lens give system designers the flexibility to apply a standard UV-C lens and to optimize the light output for their application.



The new SU CULDP1.VC (left) and SU CULEP1.VC (right) UV-C LEDs

A further advantage of the SU CULDP1.VC and SU CULEP1.VC is an application-dependent lifetime. The package also includes an ESD protection device and a transparent dielectric coating as a protective element, contributing to the robustness of the LED.

"Manufacturers of UV disinfection equipment are competing to provide the most value to customers by producing the required disinfection dose with fewer and longer-lasting emitters," notes Pia Weinmann, senior product manager for UV-C. "The OSLON UV 3535 products offer a new competitive edge with their increased output power and lifetime."

ams OSRAM says that the enhanced performance of the OSLON UV 3535 LEDs is the result of innovations in package design and semiconductor technology. The new open package design is said to be robust, compact and flexible for use in applications that require medium to high UV-C output power.

The AlGaN-based flip chip is said to be a more reliable radiation source than traditional UV-C sources and provides flexibility in terms of wavelength, output power and switching. The products are part of a performance roadmap to further enhance the firm's position in the fast-developing UV-C market.

www.ams-osram.com/applications/lighting/uv-c-treatment

SemiLEDs' quarterly revenue almost halves year-on-year

Rebound expected for next quarter

For fiscal second-quarter 2023 (ended 28 February), LED chip and component maker SemiLEDs Corp of Hsinchu, Taiwan has reported revenue of $1.152m, down on $1.695m last quarter and almost halving from $2.18m a year ago. However this includes shutting down manufacturing production in Chunan, China, for one week (from 20 January to 29 January) due to the Chinese New Year holiday.

Gross margin fell back from 27% last quarter to 23%, below the 24% of a year ago.

Operating expenses have been cut from $0.902m a year ago and $1.117m last quarter to $0.964m. Despite this, operating margin deteriorated further, from –17% a year ago and –39% last quarter to –61%.

Net loss has rebounded slightly from $512,000 ($0.11 per diluted share) last quarter to $541,000 ($0.11 per diluted share), although this is still worse than $172,000 ($0.04 per diluted share) a year ago.

During the quarter, cash and cash equivalents fell from $4.5m to $3.9m, although this is still more than $3.7m a year ago.

For fiscal third-quarter 2023 (to end-May), SemiLEDs expects revenue to rebound to about $2m+/-10%.

www.semileds.com

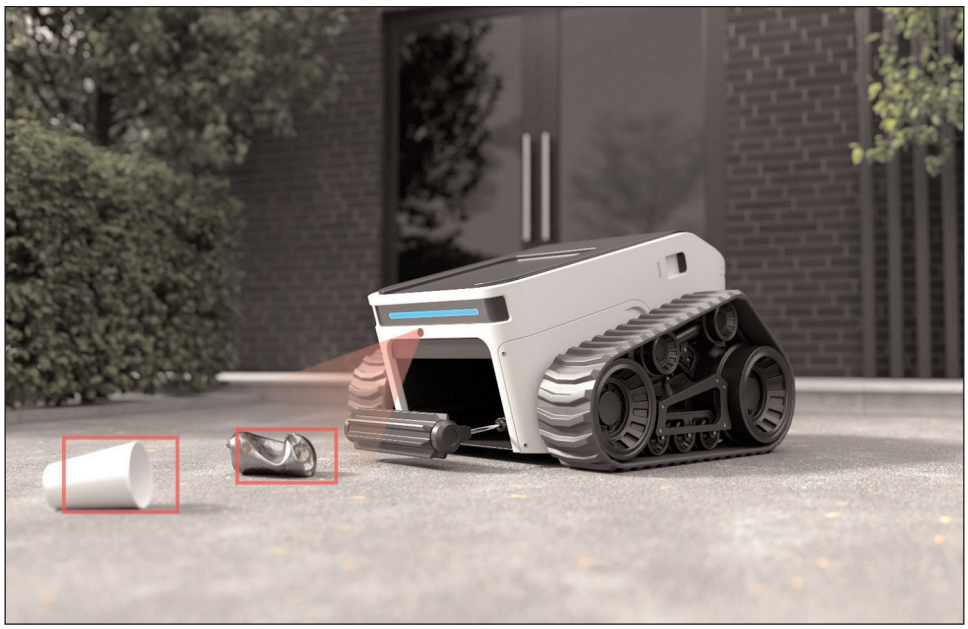
OSRAM adds 905nm edge-emitting laser with low-cost plastic package for consumer and industry applications

SPL PL90AT03 infrared laser offers 75W peak power and narrow 110µm aperture for long-distance LiDAR and ToF sensing applications

ams OSRAM GmbH of Premstätten, Austria and Munich, Germany has added a higher-performance infrared laser targeting cost-conscious consumer and other applications with the introduction of a 75W edge-emitting laser in a cost-effective radial plastic package. The firm says that the SPL PL90AT03's high peak output power and narrow 110µm aperture result in superior performance in long-distance ranging applications and easier optical integration.

The new edge-emitting laser diode's low-cost plastic package is suitable for use in high-volume applications. Featuring the same footprint as the previous generation of SPL PL90 series laser diodes, the SPL PL90AT03 is said to provide an easy upgrade to higher efficiency, due to its state-of-the-art chip technology. It also produces a narrower emission width and enables easier optical design because of the device's 50% smaller aperture versus its predecessor.

The single-channel SPL PL90AT03 features ams OSRAM multi-junction technology, consisting of three vertically stacked emitters in a single laser die mounted inside a radial plastic package. This technology enables the laser to produce optical peak output power in a 30ns pulse of 75W at the device's maximum forward current of 25A. The laser diode can produce short laser pulses ranging from a few ns to 100ns.



Available now, the SPL PL90AT03 pulsed laser features a peak wavelength of 905nm and a spectral bandwidth (FWHM) of 5nm. Beam divergence is just 12° (parallel) x 25° (perpendicular), enabling efficient beam shaping with its small 110µm aperture.

The high optical power output in a narrow emission area makes the SPL PL90AT03 suitable for ranging and distance-measurement applications that operate over long distance, such as robots, drones, plus home and factory automation equipment. In time-of-flight (ToF) sensing and LiDAR applications, the high performance of the SPL PL90AT03 enables the production of more precise and accurate depth maps for 3D optical sensing and simultaneous localization and mapping (SLAM) systems.

"The growing ams OSRAM portfolio of high-performance edge-emitting IR lasers now includes a new option for customers that need a low-cost package," says Jouni Riihimaeki, product marketing manager for industrial lasers. "The SPL PL90AT03 features the narrow aperture and high output power of other edge-emitting lasers in the family, but with a radial plastic package that is ideal for high-volume applications."

www.ams-osram.com/products/lasers/ir-lasers-eel/osram-radial-t1-34-spl-pl903

Coherent cutting over 100 jobs at Newton Aycliffe UK plant by end-May

Restructuring of operations prompted by drop in demand

Materials, networking and laser technology firm Coherent Corp of Saxonburg, PA, USA (formerly II-VI Inc before it acquired Coherent in July 2022) has announced job losses at its plant in Aycliffe Business Park in Newton Aycliffe, County Durham, UK, according to a report in The Northern Echo newspaper.

Covering 310,000ft^2 of space (comprising a 100,000ft^2 manufacturing area, including 50,000ft^2 of Class 100 cleanroom), the semiconductor fabrication plant was opened by Fujitsu in 1991, then bought by Filtronic Compound Semiconductors in 1999 then RF Micro Devices in 2008 then Compound Photonics in 2013, before being acquired by Kaiam Corp in 2017 and sold within months to II-VI. What is now Coherent uses the facility to make III-V compound semiconductor RF microelectronic and optoelectronic devices for communications and aerospace & defence customers.

"A fall in business demand is prompting a restructuring of operations with a focus on reducing costs. As a result, the company expects to reduce its Newton Aycliffe workforce by more than 100 employees by 31 May," stated Coherent in a letter to staff on 23 February. "The company will also conduct a strategic assessment to determine the future of the facility," it added. "We are open-minded about alternatives to redundancy and will consider all feasible options. But these are difficult circumstances and the options are likely to be limited."

www.Coherent.com

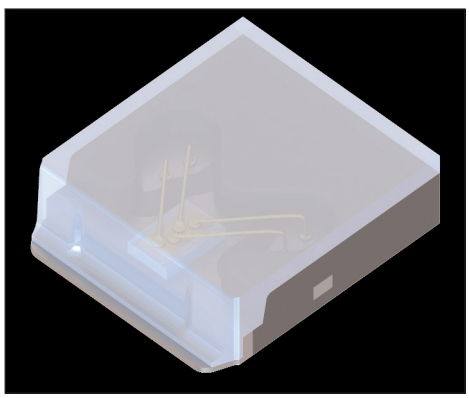
ams OSRAM launches compact surface-mount edge-emitting laser with narrow 110µm aperture

Narrow emission width boosts performance and eases optical integration in long-distance LiDAR

ams OSRAM GmbH of Premstätten, Austria and Munich, Germany has extended its edge-emiting laser diode portfolio by introducing a compact surface-mount device with a small aperture size. The SPL S1L90H_3 offers improved performance at long range and easier optical integration in light detection & ranging (LiDAR) and long-distance industrial ranging applications.

The SPL S1L90H_3 is said to be one of the first surface-mount edge-emitting lasers to have an aperture as small as 110µm. The small aperture enables the application to produce a narrow beam. The 905nm infrared technology is optimized for short-pulsed LiDAR applications such as drones and robots as well as in building and factory automation equipment.

The single-channel SPL S1L90H_3 features ams OSRAM's multi-junction technology, consisting of three vertically stacked emitters in a single laser die mounted inside the device's 2.3mm x 2.0mm x 0.69mm package. This enables the laser to produce peak output power of 65W.



ams Osram's new SPL S1L90H_3 laser.

These features result in better illumination of the target area at long range in distance measurement, 3D optical sensing and simultaneous localization and mapping (SLAM) applications. This is valuable in products such as drones and robots, as well as in building and factory automation equipment, says the firm.

"High-volume consumer and industrial products need the convenience of a laser in a small surface-mount package that can be assembled by automated production equipment," says Jouni Riihimaeki, product marketing manager for industrial lasers. "Now, the SPL S1L90H_3 extends our portfolio to include a lower-power surface-mount device for industrial markets, and with an aperture half the size of previous devices."

Optimized package design

The optimized, power-efficient pulsed laser SPL S1L90H_3 enables a maximum pulse width of 50ns. Beam divergence is just 10° (parallel) x 25° (perpendicular), enabling efficient beam shaping with its small aperture.

The SPL S1L90H_3's inductance-optimized package is suitable for pulses shorter than 2ns. The robust surface-mount package is suitable for use in industrial environments as well as in consumer applications and home and building automation. It is specified for corrosion robustness to class 3B, and offers low thermal resistance for easier system thermal design.

www.ams-osram.com

NUBURU expects revenue to double to over $3m for 2023

Newly public company to engage with financial markets to strengthen balance sheet

For full-year 2023, NUBURU Inc of Centennial, CO, USA expects revenue to more than double year-on-year to over $3m.

Founded in 2015, NUBURU is a developer and manufacturer of industrial blue lasers that leverage their high-brightness, high-power design to produce fast, high-quality laser materials processing, including laser welding and additive manufacturing of copper, gold, aluminium and other industrially important metals. The firm's industrial blue lasers are claimed to produce defect-free welds up to eight times faster than the traditional approaches — all with the flexibility inherent to laser processing.

"We exited 2022 with commercial success as we began making deliveries to our key customers including Essentium and AFWERX. Early in 2023, we launched our latest product, the NUBURU BL Series, which we expect to start shipping in Q2," says CEO & co-founder Dr Mark Zediker. "We expect 2023 to be another year in which we achieve critical milestones that continue to enable the customer adoption of our solutions in our rapidly evolving markets," he adds.

"We continue to review and make necessary adjustments to our product development roadmap to be aligned with our current and prospective customer relationships and to best utilize our company resources," Zediker continues. "As such, we expect our 2023 revenues to be weighted towards the second half of the year. We anticipate that momentum will provide the critical foundation for additional revenue acceleration in 2024."

Also for full-year 2023, NUBURU expects EBITDA (earnings before interest, taxes, depreciation and amortization) of negative $21–23m and free cash flow of negative $24–26m. "As we've completed our transition to being a public company and look to solidify our competitive position, we expect to engage with the financial markets to strengthen our balance sheet," notes chief financial officer Brian Knaley. "We intend to utilize additional funding sources to allow NUBURU to accelerate our growth trajectory by enabling us to further invest in technology and other resources designed to drive our growth in 2023 and beyond."

www.nuburu.net

NUBURU gains patents for blue laser welding and multi-kilowatt blue lasers

NUBURU has received additional patents that expand its intellectual property portfolio, broadly covering blue lasers for use in welding and other applications.

"These new patents expand our broad patent estate around blue lasers, particularly for welding copper and other metals," says CEO & co-founder Dr Mark Zediker. "These patents also cover technologies like multi-kilowatt-class blue lasers that have significant advantages compared to infrared lasers available from industry incumbents."

NUBURU believes its intellectual property provides strong protection to its blue laser technology and processes. Despite the significant advantages and efficiencies of blue lasers, major incumbents IPG Photonics, Coherent, Lumentum and nLIGHT have not released an industrial blue laser, relying on infrared technology instead, notes the firm.

On 28 March, the US Patent and Trademark Office (USPTO) granted NUBURU's patent for 'Methods and systems for welding copper and other metals using blue lasers' (US Patent 11,612,957), which describes NUBURU's blue laser technology and processes for welding multiple metal types and alloys including copper, aluminium and stainless steel. The firm says this patent provides technology and processes for more efficiently manufacturing batteries for electric vehicles (EV), cell phones and other electronic devices.

On 14 April, the European Patent Office (EPO) granted NUBURU's patent for 'Multi KW Class Blue Laser System" (European Patent EP 3704772). As explained in the patent, "embodiments of the present inventions relate to a multi-kW-class blue fiber-coupled laser systems used for materials processing and laser welding applications, and in particular wavelengths in the wavelength range of about 400nm to about 495nm". This unique beam combination methodology results in a laser source that is ideal for 3D printing applications as well as welding copper and other materials for building electric vehicles, cell phones, and other electronic products, says NUBURU.

As of end-March, NUBURU has 190+ granted and pending patent applications globally. The granted patents and pending applications cover all aspects of the firm's technology and processes. NUBURU says that it continues to prosecute the pending applications through to granted patents across multiple geographies to further protect its technology and processes for use in what it estimates to be a multi-billion-dollar serviceable addressable market (SAM).

Vector Photonics' £1m ZEUS project to commercialize 1-Watt artificial intelligence PCSEL

24-month project spans design, simulation, manufacture and test

Vector Photonics Ltd (which was spun off from Scotland's University of Glasgow in 2020, based on research led by professor Richard Hogg) has won ZEUS, a £1m industrial research project to commercialize its 1Watt, all-semiconductor photonic-crystal surface-emitting lasers (PCSELs) for artificial intelligence (AI) applications.

The ZEUS project leverages Vector Photonics' existing datacoms PCSEL commercialization work and is a collaborative fund split comprising £700,000 from the UK Government agency Innovate UK (which provides funding and support for business innovation as part of UK Research and Innovation) and £300,000 from the UK Innovation & Science Seed Fund (UKI2S).

The AI PCSEL will have the increase in computer processing power necessary to overcome the data transmission bottleneck faced by existing AI solutions. At 1W, the PCSEL's optical power will be at least ten times that of incumbent distributed feedback (DFB) lasers, which currently operate at a maximum of 100mW. So, where existing AI chips use multiple DFB lasers to achieve a single data-transmission channel of suitable optical power, Vector Photonics' PCSEL is being developed to support up to 20 data channels per chip. Vector Photonics claims that PCSELs are increasingly the only realistic enabler of next-generation AI data transmission, where DFBs are approaching their practical limit.

"ZEUS is a 24-month project covering the design, simulation, manufacture and test of a 1W AI PCSEL," notes chief technology officer Dr Richard Taylor. "The full impact of a 1W PCSEL on AI chip design is not yet quantified, as the entire architecture of the chips and systems will change, but it brings countless manufacturing and energy-saving benefits," he adds. "Power consumption, heat and latency are reduced; the PCSEL's symmetrical far-field requires less operational power for equivalent performance, so a further power reduction can be expected here; and the vastly reduced laser count per chip makes manufacture simpler and the chip smaller, which will undoubtedly improve yield and reliability."

www.vectorphotonics.co.uk

Sivers Photonics demos CW-WDM MSA-compliant DFB laser arrays at OFC

8-wavelength DFB laser array integrated into Ayar Labs' SuperNova multi-wavelength optical source

IC and integrated module supplier Sivers Semiconductors AB of Kista, Sweden says that its subsidiary Sivers Photonics of Glasgow, Scotland, UK exhibited and gave a live demonstration of its CW-WDM MSA-compliant 8-wavelength O-band DFB laser arrays on 7–9 March at the Optical Fiber Communication Conference & Exhibition (OFC 2023) in San Diego, CA, USA. Sivers says that the laser technology is enabling integrated photonics to support the growing demand for improved internet services at lower power consumption and reduced costs.

Following a successful demo at last September's European Conference on Optical Communication (ECOC 2022), Sivers Photonics once again partnered with silicon photonics-based chip-to-chip optical connectivity firm Ayar Labs of Santa Clara, CA, USA, demonstrating the 8-wavelength DFB laser array integrated into Ayar Labs' SuperNova multi-wavelength optical source. This technology is driving advanced ultra-high-speed optical interconnects for use in next-generation applications, including co-packaged optics (CPO), high-performance computing (HPC) and artificial intelligence (AI).

"This ongoing partnership is crucial for driving leading-edge, ultra-high-speed optical interconnect solutions for next-generation applications," says Sivers Photonics' managing director Billy McLaughlin.

"Demonstrating our 8-wavelength DFB laser arrays at OFC allows us to showcase how far we have come with our DFB technology," says Sivers Semiconductors' group CEO Anders Storm. "Our indium phosphide (InP) lasers are showing world-class performance, underpinned by our great partner Ayar Labs using our DFBs to show their one-of-a- kind solution with their SuperNova light source in combination with the TeraPHY optical I/O chiplet," he adds.

Sivers also showcased the ongoing work with its partners imec and ASMPT on high-precision III-V laser flip-chip assembly for silicon photonics. Flip-chip-bonded DFB lasers/RSOAs from Sivers' InP100 product platform, with precision bonding from partner ASMPT, allow imec to extend the capability of its iSiPP silicon photonics platform with validated interfaces for hybrid laser integration, accelerating the adoption of silicon photonics at scale.

www.ofcconference.org
www.sivers-semiconductors.com

POET reports highlights of Q4/2022

For fourth-quarter 2022, POET Technologies Inc of Toronto, Ontario, Canada — designer and developer of the POET Optical Interposer, photonic integrated circuits (PICs) and light sources for the data-center, telecom and AI markets — had NRE (non-recurring engineering) revenue of $200,000 versus $233,000 last quarter and $nil a year ago. In 2022, POET provided NRE contract services to multiple customers, one of which continued to contract services from the prior year. The revenue relates to unique projects that are being addressed utilizing the capabilities of the POET Optical Interposer.

Net loss has risen from $3.7m ($0.10 per share) a year ago and $4m ($0.11 per share) last quarter to $6.3m ($0.17 per share). This included R&D costs of $2.7m, up from $2m a year ago and $1.9m last quarter. However, fluctuations in R&D costs for a firm of this size and stage of growth is expected as it transitions from technology development to product development.

Operating cash flow was –$2.7m, compared with –$3.2m a year ago and –$2.5m last quarter.

During the quarter, POET:

- Completed a non-brokered private placement of 1,126,635 units of the corporation at a price of C$3.81 (US$2.78) per unit for gross proceeds of C$4,292,479 (US$3,184,332).
- Released to production four optical engine products, advancing the firm's commercialization goals. Products included transmit and receive optical engines for 100G CWDM4 plus receive optical engines for 200G FR4 and 400G FR4.
- Developed multi-engine 100G CWDM4 and 100G LR4 chip-on-board solutions for lead customer ADVA Optical Networking SE. ADVA will use POET's multi-engine transmit & receive chips in a pluggable solution that packs the functionality of four independent 100Gb/s interfaces into a single QSFP-DD housing that is scalable to high volume and higher data rates.
- Began sampling 400G FR4 and 800G 2xFR4 receive optical engines in partnership with Luxshare Technology Co Ltd, a global technology provider for datacom facilities and enterprise-level products, to enable the sale of power-efficient and cost-optimized 400G and 800G transceiver solutions.
- Amended the terms of 1,764,720 common share purchase warrants with an expiry date of 11 February and an exercise price of C$11.50 to expire on 11 May at an exercise price of C$4.25. By 10 March, the firm had received US$5,475,102 from the exercise of 1,758,716 of these warrants.
- Demonstrated 800G optical engines and light source products at the Optical Fiber Communications (OFC) event. It introduced and showcased a live demonstration of 'POET Infinity', a new chiplet-based transmitter platform for 400G, 800G and 1.6T pluggable transceivers and co-packaged optics solutions.
- Entered into an agreement with Beijing FeiYunYi Technology Ltd (BFYY) to design optical engines for deployment of optical modules in the telecom market globally, beginning in China. Worth up to $1m over a two-year period, the deal includes NRE for POET and an initial purchase order for 10,000 units that will be used to sample customers. BFYY has forecasted optical engine purchases from POET's joint venture Super Photonics Xiamen (SPX) at over $30m over three years.
- Announced a collaboration with Vanguard Automation GmbH, the developer of 3D-nanoprinted Photonic Wire Bond and Micro-Lens technology and manufacturer of software-defined equipment for photonic integration and packaging, to enable the integration of Micro-Lenses on the Optical Interposer platform to maximize coupling efficiency while maintaining POET's wafer-level passive assembly process.
- Several current and former directors holding warrants that expire on 3 April have exercised their warrants.

"In January, we released to production four optical engines, marking a significant commercialization milestone for both POET and Super Photonics. Having recently completed product design verification and reliability testing on these optical engines, we are now working closely with multiple customers on the internal qualifications for their end customers," notes chairman & CEO Dr Suresh Venkatesan.

"We were also pleased to announce POET's optical engines enabling ADVA's unique MicroMux Quattro pluggable device. The opportunity to work with ADVA serves to further validate the company's optical engines. As additional evidence of our progress, in February we announced our partnership with Luxshare Technology, which is focused on leveraging POET's highly integrated Infinity chiplet platform to expand its 400G and 800G pluggable transceiver solutions for the data-center market. Also notable was the signing of key supplier arrangements in the fourth quarter with Lumentum Holdings for its directly modulated lasers."

"We also showcased our POET Infinity chiplet-based transmitter platform for 400G, 800G and 1.6T pluggable transceivers and co-packaged optics solutions. Our team was extremely pleased with the high level of interest and engagement at OFC, which we anticipate to lead to expanded product sampling and customer qualifications in the coming quarters," continues Venkatesan. "We continue preparations to ramp volume production in second-half 2023," he believes. "Additionally, we are making important advancements on our targeted products for AI-ML applications at an ideal time as market demand rapidly expands for new scalable, cost-effective solutions."

www.poet-technologies.com

Salience hires former Imagination Technologies chief product officer

Chris Porthouse to lead productization of multi-chip photonics

Silicon photonics company Salience Labs of Oxford, UK has appointed semiconductor industry veteran Chris Porthouse as chief product officer.

Spun out from the University of Oxford and Germany's Münster University in 2021, Salience has developed an ultra-high-speed, super-low-latency multi-chip processor that packages a novel photonics chip with standard electronics to accelerate exponential advances in AI and other compute-intensive applications.

Porthouse has a track record of growing and transforming businesses, most recently as CPO for Imagination Technologies and previously as VP & general manager at Arm. At Imagination he delivered the annual five-year strategy and business plan, and the roadmap of GPU, AI and CPU products licensed to mobile, consumer, data-center and automotive customers worldwide. At Arm, Porthouse delivered significant growth in Mali GPU, helping win first deals worldwide and latterly in cloud services.

As CPO, Porthouse will lead Salience Labs' product strategy and product-market fit, as the business scales following its $11.5m seed funding round in 2022. The firm is funded by investors including Cambridge Innovation Capital, Oxford Sciences Enterprises, Oxford Investment Consultants, Silicon Catalyst, Deeptech Labs and leaders from the global semiconductor industry including Dialog Semiconductor's former CEO Jalal Bagherli and the Goh Family Office in Singapore.

"Salience Labs will bring high-speed, low-latency, efficient photonics compute to market at scale," says Porthouse. "I am excited to join this phenomenally talented team as we enter a new phase of growth and leverage our differentiated photonics multi-chip architecture to enable applications beyond the horizon of the established CMOS roadmap," he adds.

"Chris has over 25 years' experience in the semiconductor industry across a range of markets," notes co-founder & CEO Vaysh Kewada. "His proven leadership and experience in developing novel compute solutions that solve customer problems will enable us to usher in a new era of ultra-high-speed, super-low-latency processing where supercompute applications become ubiquitous".

www.saliencelabs.ai

Sivananthan Labs completes Phase II STTR program

Contract to develop, fabricate and evaluate GaAs-based nano-structured source emitting entangled photons at 1550nm

Sivananthan Laboratories Inc of Bolingbrook, IL, USA, a business incubator in infrared sensing and imaging, has completed a $1.5m award from the Small Business Technology Transfer (STTR) Phase II program for the development of an entangled short-wavelength infrared (En-SWIR) photon source. The contract was awarded to further the development, fabrication and evaluation of a gallium arsenide (GaAs)-based nano-structured source emitting entangled photons at the standard optical communication wavelength of 1550nm and for the development of metasurface-enhanced detectors at the same wavelength.

This follows a Phase I that established proof of concept and demonstrated the potential of the fast-emerging field of quantum sensing, which promises many orders of magnitude enhancements in imaging, sensing, computing, metrology and communication, in addition to offering opportunities to further the understanding of fundamental physics.

The entangled photon source proposed by Sivananthan Laboratories has the potential for several orders of magnitude enhancement in efficiency and brightness over state-of-the-art sources, it is reckoned.

"When used as part of the imaging system envisioned by our company, En-SWIR provides increased signal-to-noise ratio, allowing for non-direct-line-of-sight imaging of distant objects with increased image quality and low power consumption, making it ideally suitable for space-based applications," says project lead Dr Paul Boieriu.

"The developments from this phase of study will provide critical assistance to our national efforts to produce entangled photon sources operating at room temperature," adds Dr Srini Krishnamurthy, STTR contract program manager at Sivananthan.

Featuring advanced image processing algorithms, the En-SWIR entangled photon source and detector system envisioned by Sivananthan Laboratories ultimately promises to be an enabling technology for rapid and effective decision making, increasing the speed and reach of disruption of any defense forces. It is consistent with Sivananthan Laboratories' business model and long-standing commitment to developing advanced technology for the US military.

www.sivananthanlabs.us

New Origin secures €6m PhotonDelta funding to create independent photonic chip foundry

Netherlands-based production facility to supply silicon nitride chips

New Origin of Enschede, the Netherlands, which was spun out of the MESA+ NanoLab as a subsidiary of University of Twente Holding, has secured €6m in funding from integrated photonics industry accelerator PhotonDelta — a cross-border ecosystem of photonic chip technology organizations.

The capital will be used to create the Netherland's first independent photonic chips foundry producing silicon nitride chips. The funding is part of the contribution that the Province of Overijssel has made available to PhotonDelta for a national photonics program.

New Origin says that its foundry will enable companies to produce their own photonic chips, overcoming a hurdle for the photonics industry by substantially reducing costs while also increasing the availability of photonic chips. Applications include data communications, autonomous vehicles (AVs), food production, medical equipment, and aviation.

PhotonDelta's investment in New Origin is the latest step in its goal to create a world-leading photonics industry in the Netherlands. Last year, PhotonDelta secured €1.1bn in public and private investment to scale up production, build 200 startups, create new applications for photonic chips, and develop infrastructure and talent. So far, PhotonDelta has invested in companies including Scantinel Photonics, Smart Photonics, LioniX International, Quix Quantum and EFFECT Photonics. PhotonDelta has, along with a consortium of investors, invested €335m into photonics companies in total.

New Origin believes that the insights gained from the new foundry will open the door to the large-scale production facilities that will be needed to meet future demand.

"We already have a strong cluster in the region, united in Chiptech Twente, which we can boost considerably this way," says professor Guus Rijnders, scientific director of MESA+. "Many companies want to experiment with or integrate photonics into their products, however this can be very difficult due to the cost and complexity of producing chips. Our foundry will significantly lower the bar to entry, facilitating more innovation and help the European photonics industry to grow."

"New Origin's foundry is going to play an important role in building Europe's photonic chip industry," believes PhotonDelta's CEO Ewit Roos. "Not only will it help to meet existing demand for chips, it will also gather invaluable insights into how we can create large-scale production facilities. This is a vital step in both making Europe less dependent on other regions for chip technology and unlocking the full potential of integrated photonics," he adds.

"We can be proud of the strong cluster of companies and knowledge institutions in our province that continue to invest together in the future of European chip technology," states Eddy van Hijum, Deputy Economy, Finance and Europe Minister at the Province of Overijssel. "Examples include the earlier launch of the Chips Act and now this production facility."

www.photondelta.com

Lumentum reduces March-quarter revenue guidance from $430–460m to $380–384m

For its fiscal third-quarter 2023 (ended 1 April), Lumentum Holdings Inc of San Jose, CA, USA (which designs and makes optical and photonic products for optical networks and lasers for industrial and consumer markets) has reduced its revenue guidance from the prior $430–460m to $380–384m (down on $395.4m a year previously).

"Late in our fiscal 2023 third quarter, a network equipment manufacturer who represented more than 10% of our fiscal second-quarter revenue informed us that, due to their inventory management, they would not take the shipments we had originally projected for the quarter. This shortfall is the primary reason that our fiscal 2023 third-quarter revenue will be below the low end of our prior guidance range," says president & CEO Alan Lowe. "Looking ahead, we expect a similar level of shipments to this customer in our fiscal Q4, as we saw in Q3. Nevertheless, our customer relationship remains strong, and we continue to work together closely to help them achieve success," he adds.

"We have confidence in our long-term strategy and operating model, and today we are announcing an increase in our share repurchase program," Lowe continues.

Lumentum's board of directors recently approved an increase in its share repurchase program authorization to an aggregate $1.2bn and extended its duration through May 2025. The firm's previously announced authorization was $1bn through May 2024. As of 1 April, $615.5m had been used to repurchase 7.4 million shares. Lumentum expects to fund the repurchases under the extended share repurchase program out of its existing cash balance.

www.lumentum.com

Emcore restructuring to focus on aerospace & defense

Broadband business to be shut down and defense optoelectronics product lines discontinued

Emcore Corp of Alhambra, CA, USA — the world's largest independent provider of inertial navigation products to the aerospace & defense industry — has announced a restructuring program as the final phase of Emcore's transition to Aerospace & Defense. The firm is AS9100 aerospace quality certified at its manufacturing facilities in Budd Lake, NJ and Concord, CA.

"After months of discussions with several interested parties to divest non-strategic product lines, we will now shut down the Broadband business segment (cable TV, wireless, sensing, and chips) and discontinue our defense optoelectronics product lines. We will continue to build QMEMS and lithium niobate chips, but will close down our indium phosphide (InP) wafer fabrication facility in Alhambra," says president & CEO Jeff Rittichier. "These actions will eliminate product lines that are no longer part of our future and enable Emcore to focus entirely on scaling our inertial navigation business."

We will continue to build QMEMS and lithium niobate chips, but will close down our indium phosphide wafer fabrication facility in Alhambra

Designed to reduce annual costs and expenses by about $12m, the restructuring program includes a reduction in the workforce of about 100 staff primarily in Alhambra and China, as well as consolidating facility space by downsizing the space being occupied at the Alhambra campus from five to two buildings, relocating Concord personnel to the operations area from the adjacent office building, and closing the manufacturing support and engineering center in China. The firm expects restructuring actions to be substantially completed by end-September. A restructuring charge covering severance, facility consolidation and other related items is expected to be finalized and recorded in the fiscal third-quarter 2023 (to end-June).

www.emcore.com

OpenLight announces availability of first PDK sampler to accelerate component testing

Lab-testing flexibility and enhanced PIC design accuracy to accelerate time to market

To enhance familiarity with process technologies and increase the accessibility of photonic integrated circuits (PICs), OpenLight of Santa Barbara, CA, USA (which launched as an independent company in June 2022, introducing the world's first open silicon photonics platform with heterogeneously integrated III–V lasers) has announced general availability of its process design kit (PDK) Sampler.

After announcing general availability of its PDK last November, the PDK Sampler is a unique, die-level PIC that contains OpenLight's standard PDK components, enabling customers to comprehensively test PDK elements in their own lab and validate models to enable first-pass success in a PH18DA tapeout. Components include OpenLight's heterogeneous laser, optical amplifier, 100G PAM4 EAM modulator, and other active and passive components on Tower's PH18DA process.

The adoption of new process technologies often involves a steep learning curve and is a frequent challenge for customers, especially with recent advancements in the silicon photonics arena, notes OpenLight. This new industry offering is said to provide a shortcut for customers to test individual PDK elements immediately by getting direct lab data prior to taping out a custom PIC design. By being able to test PDK components in their own labs, customers can gain increased confidence in the Tower PH18DA process and can optically and electrically probe PICs.

"With this 'one-of-everything' PIC made available through Tower Semiconductor, customers have a better vantage point to sample every PDK component available through our open platform," says OpenLight's CEO Dr Adam Carter. "OpenLight's mission is to be the first to enable the industry with the right design tools and accelerate the use of PICs at scale in a wide variety of markets and applications," he adds.

"OpenLight continues to complement Tower's existing open foundry offering," says Dr Marco Racanelli, senior VP & general manager of Tower Semiconductor's Analog business unit. "As OpenLight's partner, this move will make Tower's PH18DA process more accessible for mutual customers and help them make the most of our technology."

www.openlightphotonics.com

Infinera unveils coherent optical subsystems and pluggable optical engines

New portfolio include TROSAs, programmable DSPs and intelligent pluggable optical transceivers

Infinera Corp of Sunnyvale, CA, USA, a vertically integrated manufacturer of digital optical network systems, has unveiled a new portfolio of coherent optical subsystems and coherent pluggable optical engines designed to help network operators cost-effectively keep up with the relentless growth in bandwidth demand while streamlining operations and reducing carbon footprint.

The new solutions include a line of high-performance transmit–receive optical sub-assemblies (TROSAs), programmable digital signal processors (DSPs), and a line of high-performance, intelligent pluggable optical transceivers.

Infinera's line of in-house-developed optical subsystems leverages a building-block approach whereby subsystems can be mixed and matched flexibly, maximizing the value of each element, providing more solution options for customers, and simplifying integration into in-house and third-party optical engines.

Building-block components include:

- Advanced coherent TROSAs – leveraging Infinera's US-based, in-house indium phosphide (InP) fab, the new line of TROSAs is based on unique monolithically integrated photonic integrated circuits (PICs). The TROSAs reduce loss between components, provide increased control over optical functions, and enable greater flexibility in component design. The resulting solution produces what is claimed to be industry-leading size, power efficiency, flexibility and optical performance, with 0dBm output power levels to support a greater number of network applications. The initial set of products includes three TROSAs: ICTR32, ICTR64 and ICTR140, with nominal baud rates of 32Gbaud, 64Gbaud, and 140Gbaud, respectively.
- Intelligent programmable coherent DSPs – designed with innovative features, generational interoperability and what is claimed to be leading performance, Infinera says that its line of DSPs provides a robust set of capabilities and flexibility to bring unique value to networking solutions. As part of the firm's advanced coherent subsystem offerings, the new line of high-performance DSPs includes the Wa'a 100, Wa'a 400 and Tahoe 800, supporting a range of point-to-point and point-to-multipoint applications.

Infinera's line of in-house-developed optical subsystems leverages a building-block approach whereby subsystems can be mixed and matched flexibly, maximizing the value of each element

Pluggable coherent optical engines

Based on Infinera's vertically integrated subsystem building blocks, Infinera's line of ICE-X coherent pluggable solutions is designed to support a diverse set of network applications, including point-to-point and point-to-multipoint applications in DCI, access, metro and regional networks. In addition to record-setting performance, Infinera's ICE-X line of pluggables supports a unique level of intelligence, automation and programmability to enable network operators to deploy coherent solutions more effectively in routers, switches and servers without compromising on performance, visibility or network resiliency. Additionally, with support for 100Gb/s+ single-fiber bidirectional configurations and PON overlays, ICE-X can unleash the potential of existing fiber assets, enabling new revenue-generating high-speed services. Included in the line of ICE-X pluggables are 100G XR, 400G XR, 400G ZR+ and 800G ZR/ZR+ modules.

All products in the Infinera ICE-X portfolio adhere to the open and collaborative approach to the management of pluggable coherent optical engines defined by the Open XR Forum's Management Architecture Specifications.

"There is significant growth in demand for increased capacity and capabilities of coherent technology, both in the core and closer to the network edge, driving the need for new innovations in coherent solutions optimized for these types of traffic patterns and deployment scenarios," says Tom Burns, general manager of the Optical Modules & Coherent Solutions Group at Infinera. "Our portfolio of programmable TROSAs, coherent DSPs and ICE-X pluggables provides network operators with connectivity solutions that are compact, efficient, programmable and streamlined in operations without sacrificing network integrity, visibility or reliability."

Infinera's lines of TROSAs, DSPs and coherent pluggable transceivers will all be independently commercially available. Available now are ICE-X 100G- and 400G-based subsystems and pluggables, with the 800G-based solutions beginning to become available in first-half 2024.

Infinera's latest generation of pluggable optical transceivers and subsystems were showcased at the Optical Fiber Communications conference (OFC 2023) in San Diego, CA, USA (5–9 March).

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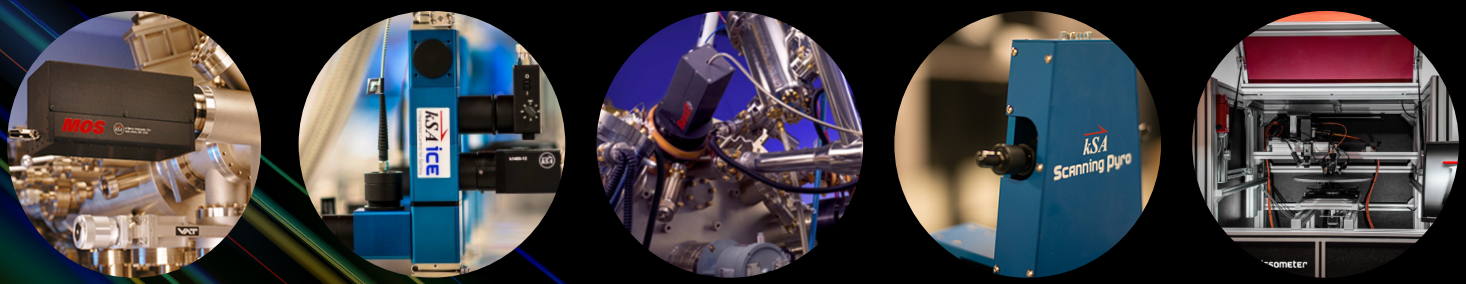

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India awards financial incentives to First Solar's Tamil Nadu manufacturing facility

3.4GW plant to be commissioned in second-half 2023

Cadmium telluride (CdTe) thin-film photovoltaic (PV) module maker First Solar Inc of Tempe, AZ, USA says that its manufacturing facility in India has been awarded financial incentives under the Indian government's Production Linked Incentive (PLI) program. First Solar was one of only three manufacturers selected to receive the full range of incentives, which are reserved for fully vertically integrated manufacturing. The incentives are subject to the facility meeting product efficiency and domestic value creation thresholds, which will be evaluated on a quarterly basis from second-quarter 2026 through 2031.

The PLI program is intended to promote the manufacturing of high-efficiency solar modules in India and to reduce India's dependency on foreign imports of solar modules. Under the scheme, manufacturers are selected through a competitive bid process and receive certain cash incentives over a five-year period following the commissioning of their manufacturing facilities. Among other things, such incentives are based on the efficiency and temperature coefficient of the modules produced, the proportion of raw materials sourced from the domestic market, the extent to which the manufacturer's operations are fully integrated within India, and the quantity of modules sold from such manufacturing operations.

First Solar's new facility, expected to be commissioned in second-half 2023, is located in the state of Tamil Nadu and will have an annual nameplate capacity of 3.4GW$_{DC}$. Designed using the manufacturing template established by First Solar's newest factory in Ohio, the facility will produce the company's Series 7 modules.

Said to be unique among the world's ten largest solar manufacturers for being the only US-headquartered company, for not using a crystalline silicon (c-Si) semiconductor, and for not manufacturing in China, First Solar produces its thin-film PV modules using a fully integrated, continuous process under one roof and does not rely on Chinese c-Si supply chains. The firm's CdTe PV module technology is claimed to have the lowest carbon and water footprints of any PV module available today.

First Solar is the only one of the world's ten largest solar manufacturers to be a member of the Responsible Business Alliance (RBA), the world's largest industry coalition dedicated to supporting the rights and well-being of workers and communities in the global supply chain, and the company says that it has zero tolerance for forced labor in its manufacturing or its supply chains. First Solar is also the first PV manufacturer to have its product included in the Electronic Product Environmental Assessment Tool (EPEAT) global registry for sustainable electronics.

First Solar is also expanding its US manufacturing footprint, from over 5GW of annual nameplate capacity (in three operating factories in Ohio) to over 10GW by 2025 (when it completes its new $1.1bn factory in Alabama and a $185m expansion of its existing capacity in Ohio). The firm expects to have over 20GW of annual global nameplate manufacturing capacity by 2025.

www.firstsolar.com
https://pib.gov.in

5N Plus solar cells powering ESA's mission to Jupiter

AZUR's 3G28 solar cell technology supplies Juice

Specialty semiconductor and performance materials producer 5N Plus Inc of Montreal, Québec, Canada says it has played a key role in enabling the European Space Agency's Jupiter Icy Moons Explorer (Juice) mission, with high-end triple-junction solar cell technology from subsidiary AZUR SPACE Solar Power GmbH of Heilbronn, Germany (acquired in 2021, which makes multi-junction solar cells based on III-V compound semiconductor materials).

The environment around Jupiter is characterized by low sunlight intensity and low ambient temperature (LILT) as well as harsh particle radiation, which represent extremely demanding operating conditions for solar cells. After extensive research and testing, AZUR's specific 3G28 proprietary solar cell technology was selected by ESA's engineers to cover Juice's 85m2 of solar arrays, the largest ever built for interplanetary spacecraft. The specific 3G28 solar cells, which were laid down by Leonardo in Italy and integrated by Airbus Defence and Space in the Netherlands, were considered to be the best solar cells for their unique capacity to make solar power work in Jupiter's dark and gloomy space. Accordingly, NASA's future Europa Clipper mission to Jupiter moon Europa is also employing AZUR's 3G28 solar cells.

"It continues to be a privilege for 5N Plus to work in partnership with the world's leading space agencies, such as ESA and NASA, to help, quite literally, push the boundaries of solar-powered space missions," says 5N Plus' president & CEO Gervais Jacques.

www.azurspace.com
www.5nplus.com

EDP Renewables orders 1.8GW of First Solar modules

Deliveries up to 2028 to power US projects of EDP Renewables North America

EDP Renewables of Madrid, Spain has placed a multi-year order for 1.8GW$_{DC}$ cadmium telluride (CdTe) thin-film photovoltaic (PV) modules from First Solar Inc of Tempe, AZ, USA. To be delivered up to 2028, the modules will power US projects developed by subsidiary EDP Renewables North America LLC (EDPR NA) of Houston, TX, USA.

EDP Renewables operates in 28 markets around the globe. North America is its biggest market in terms of installed capacity and production, where it operates 475MW of solar projects and has 1.6GW of solar capacity under construction. In addition, EDPR operates over 200 distributed generation solar sites throughout North America. Including both utility-scale and distributed generation, EDPR plans to add 4.8GW of solar capacity in North America in 2023–2026.

"EDP Renewables' ambitious business plan calls for more than 4GW of renewable capacity annually through 2026 with nearly half of the new clean energy generation to come from North America," says EDPR NA's CEO Sandhya Ganapathy. "Solar is an increasingly important technology in our portfolio, and we are well positioned to work with innovative and environmentally responsible partners and products that can help us meet our outlined targets."

First Solar is the only one of the world's ten largest solar manufacturers to be a member of the Responsible Business Alliance (RBA), the world's largest industry coalition dedicated to supporting the rights and well-being of workers and communities in the global supply chain, and the company says that it has zero tolerance for forced labor in its manufacturing or its supply chains. First Solar claims that its modules have the lowest carbon and water footprint of any commercially available PV module today and that it is the first PV manufacturer to have its product included in the Electronic Product Environmental Assessment Tool (EPEAT) global registry for sustainable electronics.

"We welcome EDP Renewables' decision to power its projects with our technology and look forward to supporting its growth in the US and, potentially, beyond," says First Solar's CEO Mark Widmar. "EDP Renewables joins a growing roster of large, sophisticated developers choosing long-term pricing and supply certainty, and responsibly produced solar modules by powering their projects with First Solar's technology," he adds. "This validates the value that our customers place in our differentiation, not just in technology but our way of doing business."

First Solar says that, with this strategic agreement, EDPR is de-risking its solar pipeline in the USA by securing equipment for its expected growth in the utility and distributed generation segments. Additionally, this allows EDPR to increase its commitment to local content in the USA, while also pursuing its strategy of supply chain and technology diversification. The partnership between the firms began in 2019, when EDPR acquired a 50% stake in a 278MW solar portfolio developed by First Solar.

First Solar is expanding its US manufacturing footprint, from over 5GW of annual nameplate capacity (in three operating factories in Ohio) to over 10GW by 2025 (when it completes its new $1.1bn factory in Alabama and a $185m expansion of its existing capacity in Ohio). The firm is also investing $270m in a new R&D innovation center in Ohio. Additionally, it expects to commission its first factory in India in second-half 2023, adding 3.4GW of new nameplate annual capacity. The firm expects to have more than 20GW of annual global nameplate manufacturing capacity by 2025.

www.firstsolar.com
www.edpr.com/north-america

Midsummer participating in Australian project to reach 30% efficiency in tandem solar cells

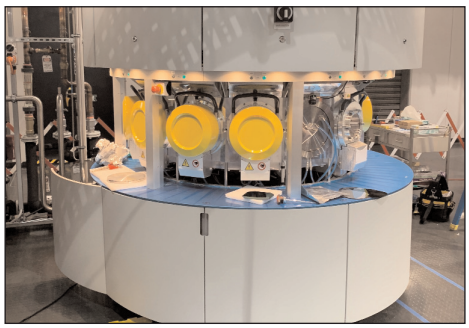
ARENA-funded project led by University of New South Wales

Midsummer AB of Järfälla, near Stockholm, Sweden — a provider of turnkey production lines as well as flexible, lightweight copper indium gallium diselenide (CIGS) thin-film solar panels for building-integrated photovoltaics (BIPV) — has been selected to be part of a research team aiming to reach 30% efficiency in silicon/CIGS tandem solar cells using already commercialized technologies.

Led by the University of New South Wales (UNSW) in Sydney, Australia, the project also includes what are said to be the world's leading solar panel makers and has been awarded funding of AUS$3.08m from the Australian Renewable Energy Agency (ARENA), as part of a total project budget of AUS$11.55m [US$8.21m; €7.55m].

A significant part of the research will be carried out on the UNO research system for the production of thin-film solar cells that the university previously purchased from Midsummer.

Existing mass-produced silicon panels have efficiencies of about 20%, and thin-film panels like CIGS (copper, indium, gallium, selenide and/or sulphur) have slightly lower efficiencies. By combining the technologies in tandem solar cells, it is theoretically possible to achieve much higher efficiency. In tandem solar cells, different semiconductor materials are combined in one device, each of which absorbs different areas of the solar spectrum. The result is more efficient solar cells.



Midsummer's UNO system at the University of New South Wales.

"By working closely with our project partners, world-leading chalcogenide and Si PV researchers and manufacturers, this project will provide next-generation, high-performance, durable and cost-effective tandem cells that can be rapidly scaled up," says professor Xiaojing Hao of the UNSW School of Photovoltaic and Renewable Energy Engineering, who heads the project.

"A tandem solar cell with silicon + chalcogenide has the best conditions for rapid commercialization as they are two mature, stable and proven technologies," says Midsummer's CEO Sven Lindström. "As Midsummer's DUO system already today uses the same solar cell size as silicon solar cells, it would be the obvious production tool choice when the world's largest solar panel manufacturers want to commercialize tandem solar cells on a large scale," he adds.

Silicon-based tandem solar cells are seen as the main track to commercialize solar panels with over 30% efficiency, says Midsummer. High-bandgap CIGS cells, which can be manufactured on the firm's machines, have demonstrated among the highest efficiencies for potential peak cells to combine with silicon and have the advantage of a very long lifetime as well as already proven scalability in mass production.

www.unsw.edu.au
www. midsummer.se

Midsummer receives €6.4m grant as first instalment of €22m from Invitalia

CIGS thin-film PV factory in Bari to start production this year

Midsummer has received a grant payment of €6.4m (SEK73.4m) from the Italian Ministry of Finance's state investment and economic development institution Invitalia for the establishment of a factory for the production of thin-film solar cells in Bari, Italy. This is a first instalment of the agreement concluded between the parties, which will give Midsummer €22m (just over SEK240m) in total in the form of grants to start production in what will be Europe's largest factory for the production of thin-film solar cells.

In February, Midsummer shipped three of its DUO machines for the production of thin-film solar cells to its subsidiary Midsummer Italia in Bari. A total of five DUO machines have now been installed in Bari, and the conditions met according to the agreement between the parties for a first payment from Invitalia.

After a recent on-site inspection at the factory, Invitalia is fully satisfied with the installations and payment of €6.4m has now been made to Midsummer Italia. In addition, a smaller establishment grant will soon be paid out from the Italian region of Puglia, of which Bari is the capital.

Production in Italy is expected to start later this year. At full operation, the factory can produce 50MW of solar cells per year.

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Indium arsenide quantum dot lasers on silicon with simple GaAs buffer

Avoiding a complex structure is expected to promote photonic integration.

Researchers in China have fabricated monolithic indium arsenide (InAs) quantum dot(QD) lasers on silicon (Si) without using dislocation filter layers of strained-layer superlattices (SLSs) in the gallium arsenide (GaAs) buffer [Yongli Wang et al, Optics Express,v31, p4862, 2023].

The team from Institute of Semiconductors, University of Chinese Academy of Sciences, and Beijing University of Posts and Telecommunications, comments: "This simple structure avoids the injection of current through the SLSs interface and the cross-hatching introduced by the SLSs. Moreover, the whole process can be further simplified, which is expected to promote the application of photonic integrated circuits."

The purpose of dislocation filters, and other complex techniques is to avoid defects that sap laser performance such as antiphase boundaries (APBs) and threading dislocations, which arise through the differences in the charge polarities of the chemicals bonds, and the large lattice mismatch, between silicon and GaAs.

The researchers add: "As the device has GaAs-only growth and has a buffer as thin as ~2.5μm, the compatibility of the device with the industry-standard fabrication process has also improved."

The team sees their approach as providing "an innovative way to prepare low-cost, CMOS-compatible silicon-based light sources, which is conducive to promoting the commercial development of silicon photonic interconnects."

The GaAs buffer was grown using metal-organic chemical vapor deposition (MOCVD). The silicon substrate was cleaned using an RCA process modified with a sulfuric acid (H_2SO_4) step to remove organic pollutants, particles, metal contaminants, and native oxide. A 735°C, 20min surface treatment with hydrogen (H_2)

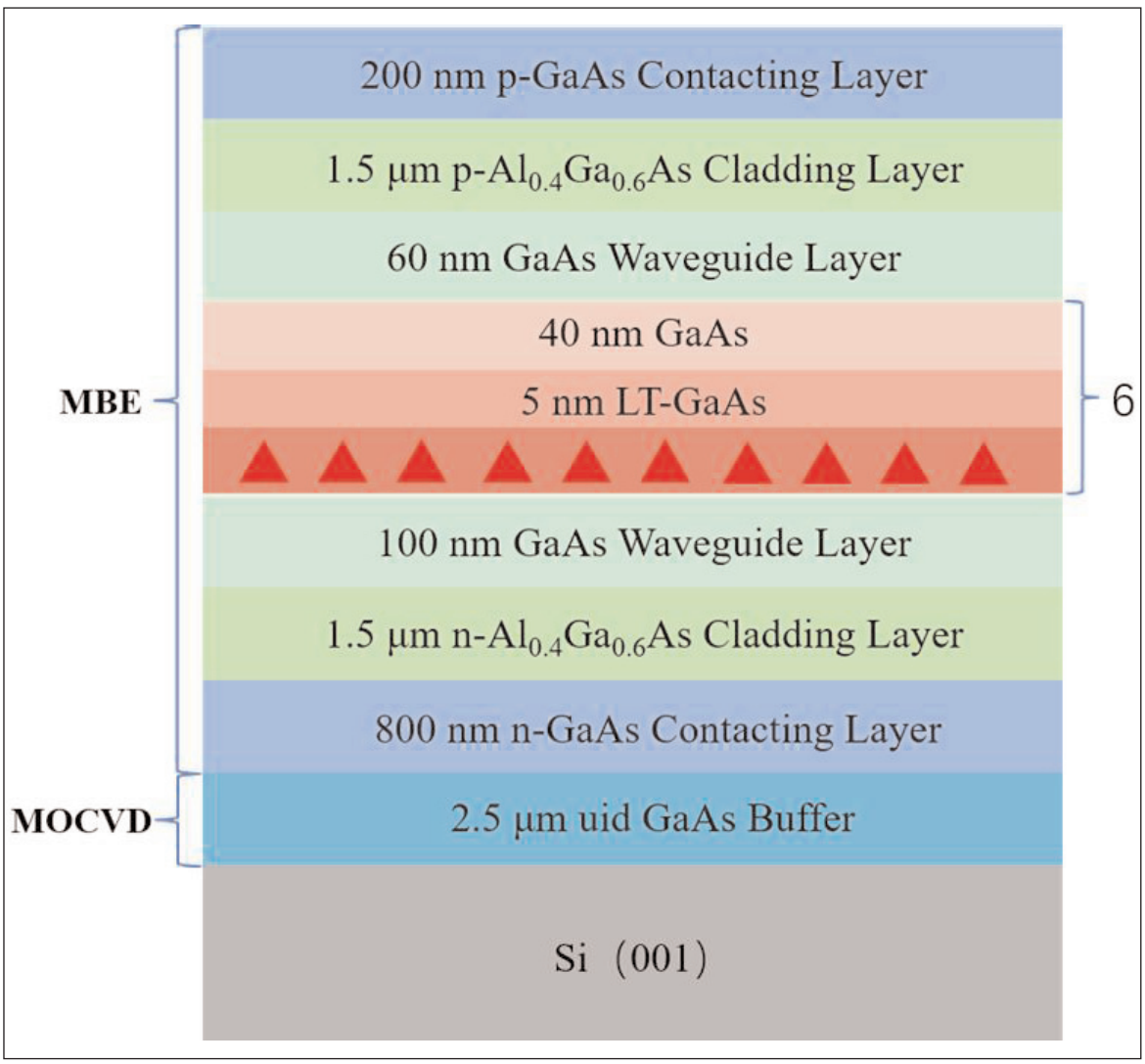

Figure 1. Schematic of InAs/GaAs QD laser material grown on on-axis Si (001).

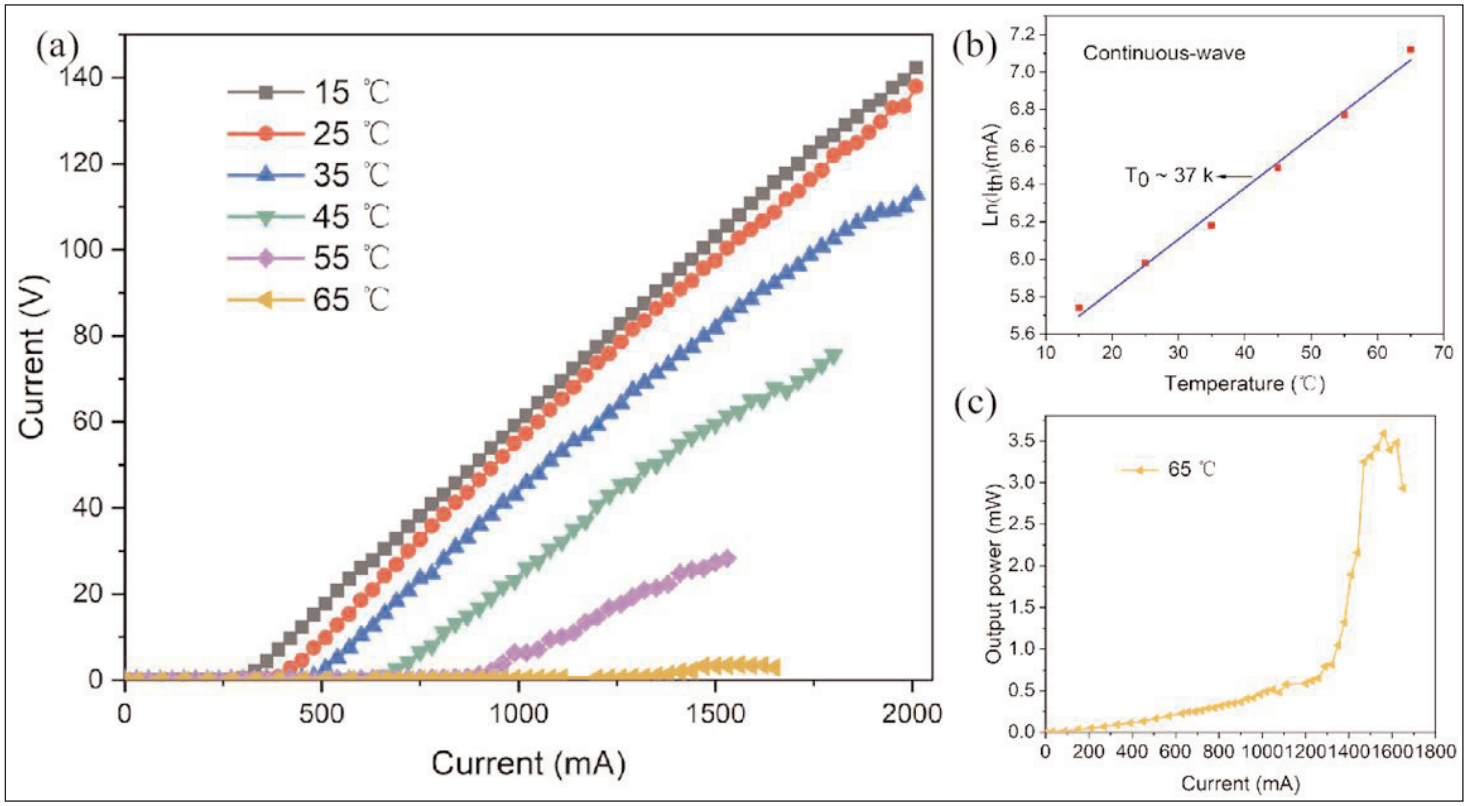

Figure 2. (a) High-temperature measurements of device showing lasing up to 65°C under CW operation. (b) Natural logarithm of threshold current versus temperature. (c) Output power versus injection current at 65°C.

and arsine (AsH_3) promoted atomic reconfiguration into double-atom steps to enable GaAs growth avoiding APB formation.

The unintentionally doped (uid) GaAs buffer itself was grown in three temperature steps — 420°C, 630°C and 700°C. The low-temperature step was critical in suppressing APBs and reducing threading dislocation density (TDD), according to the team. The researchers also used thermal cycle annealing (TCA) to encourage dislocation annihilation. The TCA consisted of two periods of three cycles of 720°C/450°C alternations.

Atomic force microscopy (AFM) gave a surface roughness of the buffer of 2.85nm. The TDD was estimated at $9.2x10^6/cm^2$ from x-ray diffraction analysis. A very similar result was found from electron channeling contrast imaging ($9.4x10^6/cm^2$). Using more complex techniques, TDDs of $1.5x10^6/cm^2$ have been achieved.

Further growth (Figure 1) was by molecular beam epitaxy (MBE). The active light-generating region consisted of six layers of InAs quantum dots (QDs) in GaAs. The QD density in each layer was around $5.2x10^{10}/cm^2$, according to AFM. A photoluminescence peak for the InAs QDs was observed at 1296nm wavelength with 34meV full-width at half maximum (FWHM). Optical confinement was provided by aluminium gallium arsenide (AlGaAs) cladding layers.

The material was fabricated into broad-area laser diodes (LDs) with silicon dioxide (SiO_2) electrical isolation. The p- and n-electrode metal sequences were titanium/platinum/gold and gold–germanium alloy/nickel/gold, respectively. The devices were thinned to about 100μm. There was no coating applied to the cleaved facets.

A laser diode with 2mmx50μm ridge had a room-temperature laser threshold current at 397mA ($397A/cm^2$ density) in continuous wave (CW) operation. The single-facet output power reached 138mW at 2A, while the slope efficiency was 0.085W/A. The power-current performance showed kinks due to mode competition.

University of California Santa Barbara (UCSB) has achieved 185mW and 175mW output power for InAs QD laser diodes with and without facet coatings, respectively, on a complex buffer.

Spontaneous emission at 300mA, below threshold, had a wavelength of 1302nm with 27nm FWHM. At increased 600mA injection, above threshold, the FWHM narrowed to 2.7nm, while the emission wavelength red-shifted somewhat.

The device continued to lase, demonstrating a maximum 3.6mW output power, when the heatsink temperature was raised to 65°C (Figure 2). The degradation of the laser threshold with increased temperature had a characteristic temperature (T_0) of 37K between 15°C and 65°C. The researchers suggest that T_0 could be increased with a p-type modulation doping, but this would have to be balanced against that technique's tendency to increase threshold current. ■

https://doi.org/10.1364/OE.475976

Author: Mike Cooke

First transverse DUV-LEDs without n-AlGaN layers

Emission intensity has been doubled over conventional device performance.

Institute of Semiconductors and Lishui Zhongke Semiconductor Material Co Ltd in China claim the first fabrication of deep-ultraviolet light-emitting diodes (DUV-LEDs) with transverse electron injection from selective-area growth (SAG) n^+-type gallium nitride (GaN) [Xingfa Gao et al, ACS Photonics (2023) vol10, issue 2, p601].

The structure was free from the thick n-type aluminium gallium nitride (n-AlGaN) layer usually used to inject electrons into the LED. The aim was to improve the overall crystal quality of the structure, in particular reducing threading dislocations generated by low-quality n-AlGaN growth that then penetrate the UV-emitting multiple quantum wells, reducing recombination into photons.

The researchers see DUV-LEDs as promising for deployment in sterilization, water purification, UV communication, and in-situ sensing roles. Unfortunately, present external quantum efficiencies (EQEs) are less than 10% for DUV wavelengths less than 300nm.

The AlGaN material was grown on sapphire through metal-organic chemical vapor deposition (MOCVD) in two stages (Figure 1). In the first stage, layers were grown without n-type doping layers: the buffer layers consisted of 3μm AlN, 120nm AlN/AlGaN, 90nm AlGaN superlattice (SL), 20nm undoped grading layer (UGL). High-quality AlN is easier to grown than high-Al-content AlGaN.

The LED layers consisted of a 50nm SL electron-blocking layer (EBL-1), a multiple quantum well (MQW) active region, 50nm EBL-2, p-AlGaN transit layer, and 300nm p-GaN for hole injection. The EBLs -1 and -2

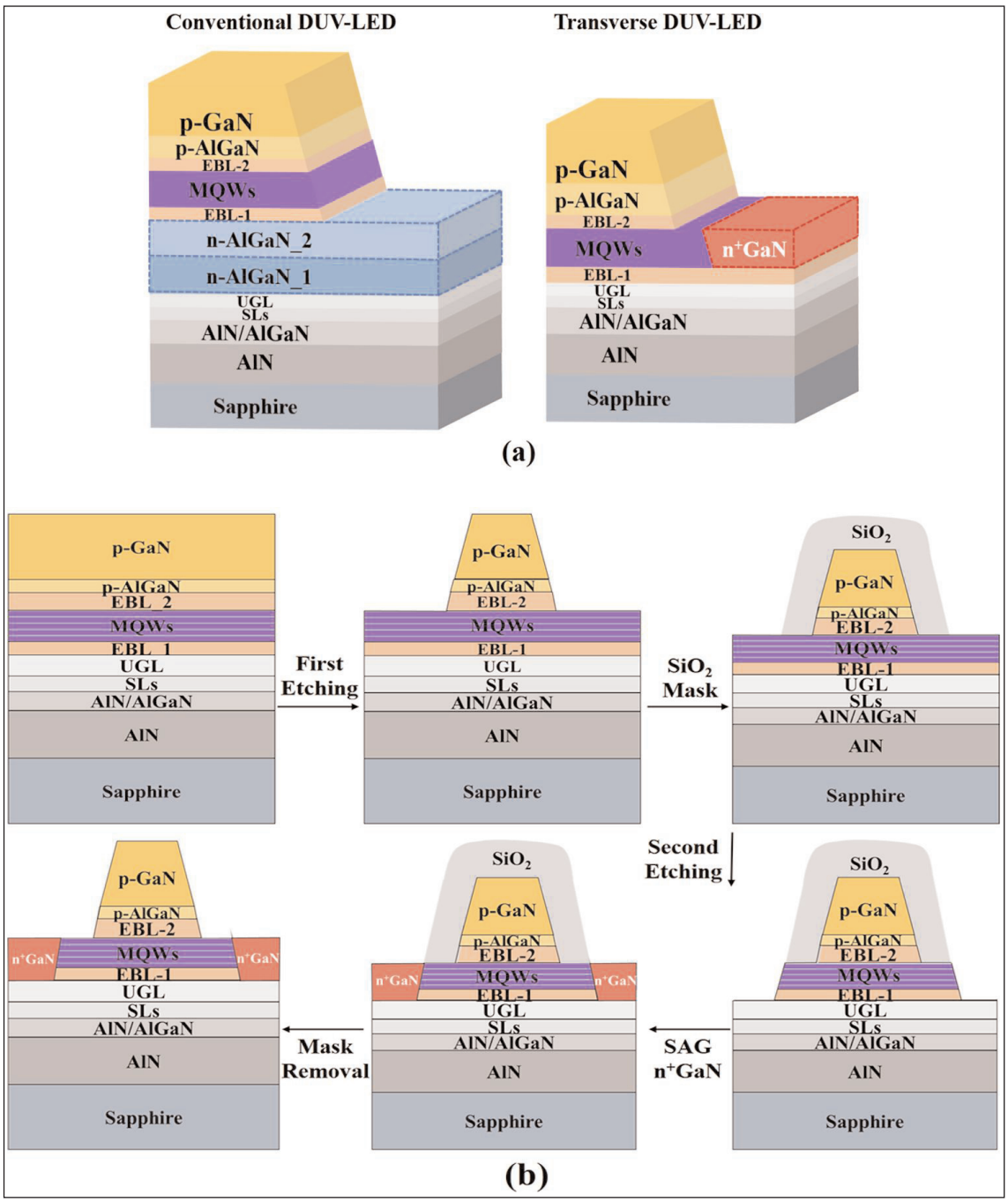

Figure 1. (a) Schematic diagrams of conventional and transverse AlGaN DUV-LED structures and (b) process flow for transverse structure.

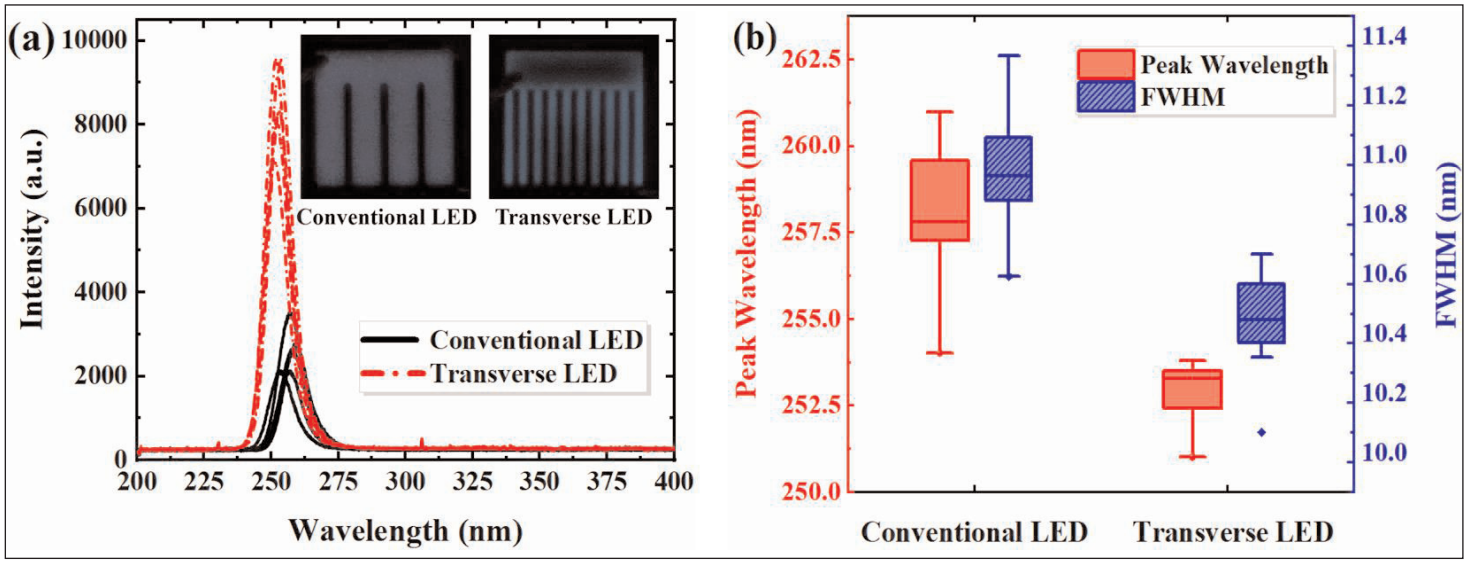

Figure 2. (a) EL spectra and optical microscope images of blue-light from p-GaN layers excited by DUV emissions from conventional and transverse LEDs under 100mA at room temperature. (b) Peak wavelength and FWHM distributions of EL spectra of LEDs.

contained layers with 78%/80% and 75%/78% Al, respectively. The MQW had four 2nm $Al_{0.64}Ga_{0.36}N$ wells separated by 15nm $Al_{0.72}Ga_{0.28}N$ barriers.

By not having to grow the n-AlGaN layers, the total growth time was reduced by 3 hours.

The transverse device fabrication consisted of etching a mesa down to the MQW. The mesa was then covered with plasma-enhanced CVD (PECVD) silicon dioxide (SiO_2) as a mask for the second-stage MOCVD: selective-area growth (SAG) of n^+-GaN. The SAG region was opened with more etching through the MQW and EBL-1.

The two-stage etch process was designed to avoid short-circuiting between the electron and hole injection regions, ensuring current flow through the MQW for the emission of UV light.

After deposition of the n-AlGaN, the SiO_2 was removed from the mesa through buffered oxide etching (BOE). The n- and p-type electrodes consisted of annealed titanium/aluminium/titanium/gold and nickel/gold, respectively. The structure was finally passivated with SiO_2 and aluminium/titanium/gold deposited for contact pads and a mirror to direct the generated UV through the sapphire backside for collection.

The researchers performed a range of analyses showing reduced dislocations in the transverse LED structure, relative to a more conventional one with n-AlGaN grown before/underneath the MQW and p-type layers. The conventional n-AlGaN was grown in two steps to reduce dislocation generation: 870nm with 78% Al-content, and then 990nm 70% Al. As one indication of reduced dislocation density in the transverse structure, surface roughness was reduced to 0.5nm, compared with 1.28nm for the conventional structure, according to atomic force microscopy (AFM).

Photoluminescence (PL) measurements indicated an internal quantum efficiency (IQE) of 95% for the transverse structure, compared with 48% for the conventional set up. The p-GaN layer was removed for the PL measurements since it strongly absorbs deep UV light. The emission wavelength peaks from the MQWs were 250nm (transverse) and 255nm (conventional) with full-widths at half-maximum (FWHM) of 7.37nm and 8.53nm, respectively.

The two devices had similar current–voltage behavior under forward bias, but leakage was much reduced, and relatively flat, in the transverse structure under reverse bias. The turn-on voltage was around 5V.

The electroluminescence from the devices (Figure 2) was much higher in the transverse LED, more than twice that of the conventional structure. The operating voltages were 6.1V and 9.5V for the transverse and conventional LEDs, respectively. A lower operating voltage to supply a given injection current indicates more efficient operation.

The researchers comment: "The absolute EQE and wall-plug efficiency (WPE) values of packaged conventional LEDs operating at 100mA are about 3.2% and 2.6%, respectively."

Although the LEDs were unpackaged, the team infers from the intensity measurements much higher EQE of the transverse LEDs, adding: "The WPE of the transverse LEDs may be slightly higher than that of the conventional LEDs due to the compromise between EQE and voltage."

The researchers give two main reasons for the improved performance of the transverse structure: reduced dislocations and reduced DUV absorption due to the absence of underlying n-AlGaN layers.The longer wavelength and broader peaks of the conventional LEDs was suggested to be due to "compositional inhomogeneity and/or compositional fluctuations". ■

https://doi.org/10.1021/acsphotonics.2c01558

Author: Mike Cooke

MOVPE core–shell AlGaN nanorods for UV emission

A hybrid top-down/bottom-up process improves lattice matching.

Researchers based in the UK and Germany report progress in improving the optoelectronic behavior of core–shell aluminium gallium nitride (AlGaN) nanorods as a basis for ultraviolet (UV) light-emitting devices [Douglas Cameron et al, Nano Letters, v23, p1451, 2023].

The team from University of Strathclyde, University of Bath and University of Cambridge in the UK and Technische Universität Berlin in Germany comment: "Our 'GaN-free' designs upon sapphire substrates prevent self-absorption from lower-bandgap materials. These effectively transparent device structures could additionally allow for backside light extraction, simplifying future contacting schemes in a commercial device."

In planar devices, UV-absorbing GaN layers are used in p-type layers because of poor doping effectiveness of magnesium in AlGaN. It is hoped that, by using the three-dimensional structuring of nanorods, UV devices will benefit from enhanced doping, reduced dislocation density, and improved light-extraction efficiency.

Also, nanorods tend to be more strain-relaxed, reducing charge-polarization-induced electric fields, and hence the impact of the quantum-confined Stark effect (QCSE) on carrier recombination into photons. Further, the radial deposition of shell layers tends to result in non-polar and semi-polar facets, with reduced or zero electric fields, and thus reduced QCSE.

The researchers used a commercially scalable hybrid top-down/bottom-up method to create a simple single quantum well shell, using metal-organic vapor phase epitaxy (M0VPE) rather than the more laborious molecular beam epitaxy (MBE). The team comments: "As techniques mature, we envisage the addition of electron-blocking layers, multi-quantum well (MQW) structures, and other advancements found to improve conventional LED performance. We expect that the nano-structuring of AlGaN-based LEDs will be key to overcoming the current barriers to efficient deep UV emission in solid-state devices."

Potential applications for efficient compact UV emitters include water purification, skin-safe disinfection, and resin curing.

The nanorod cores were wet etched out of a 3μm n-$Al_{0.76}Ga_{0.24}N$ layer on AlN/sapphire template, grown by M0VPE.

The team previously reported a similar shell-core structure with the core consisting of AlN, but that attempt suffered from low n-type conductivity due to poor silicon doping. The new AlGaN core demonstrated a doping level of $2x10^{19}/cm^3$ and a resistivity of 0.04Ω-cm.

The lithography of the metal dot mask for the nanorods used the diffraction-based Talbot effect. The resulting rods were 210nm diameter, and 1.7μm high.

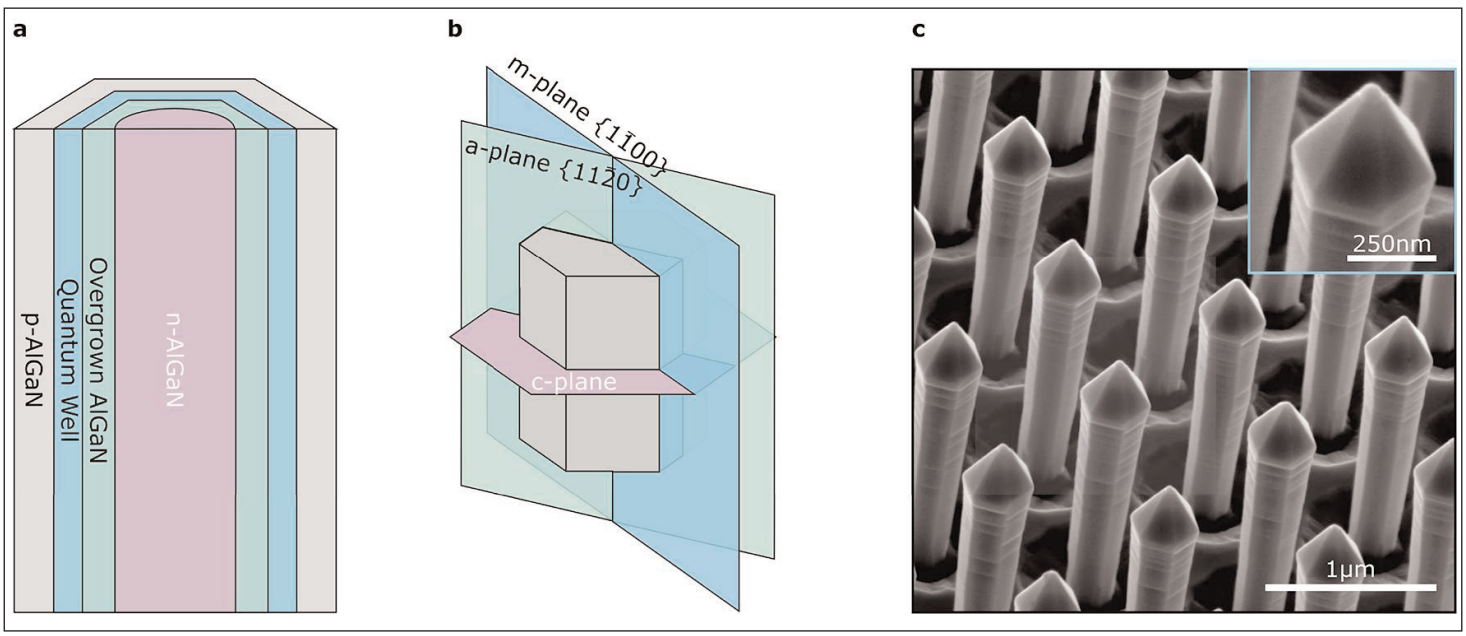

Figure 1. (a) Schematic of core_shell structures (not to scale). (b) Important crystal planes relating to rods. (c) Scanning electron micrograph (SEM) of nanorod array with higher-magnification inset.

The shell layers (Figure 1) were also grown by MOVPE: AlGaN to give semi-polar and non-polar facets, and to recover from etch surface damage; a thick quantum well; and p-AlGaN hole injection layer. The quantum well was designed to have a narrower bandgap energy relative to other materials in the LEDs, avoiding absorption of the generated UV light.

Material studies found significant compositional variations, which the team attributes to knock-on effects of the nanorod n-AlGaN core etch.

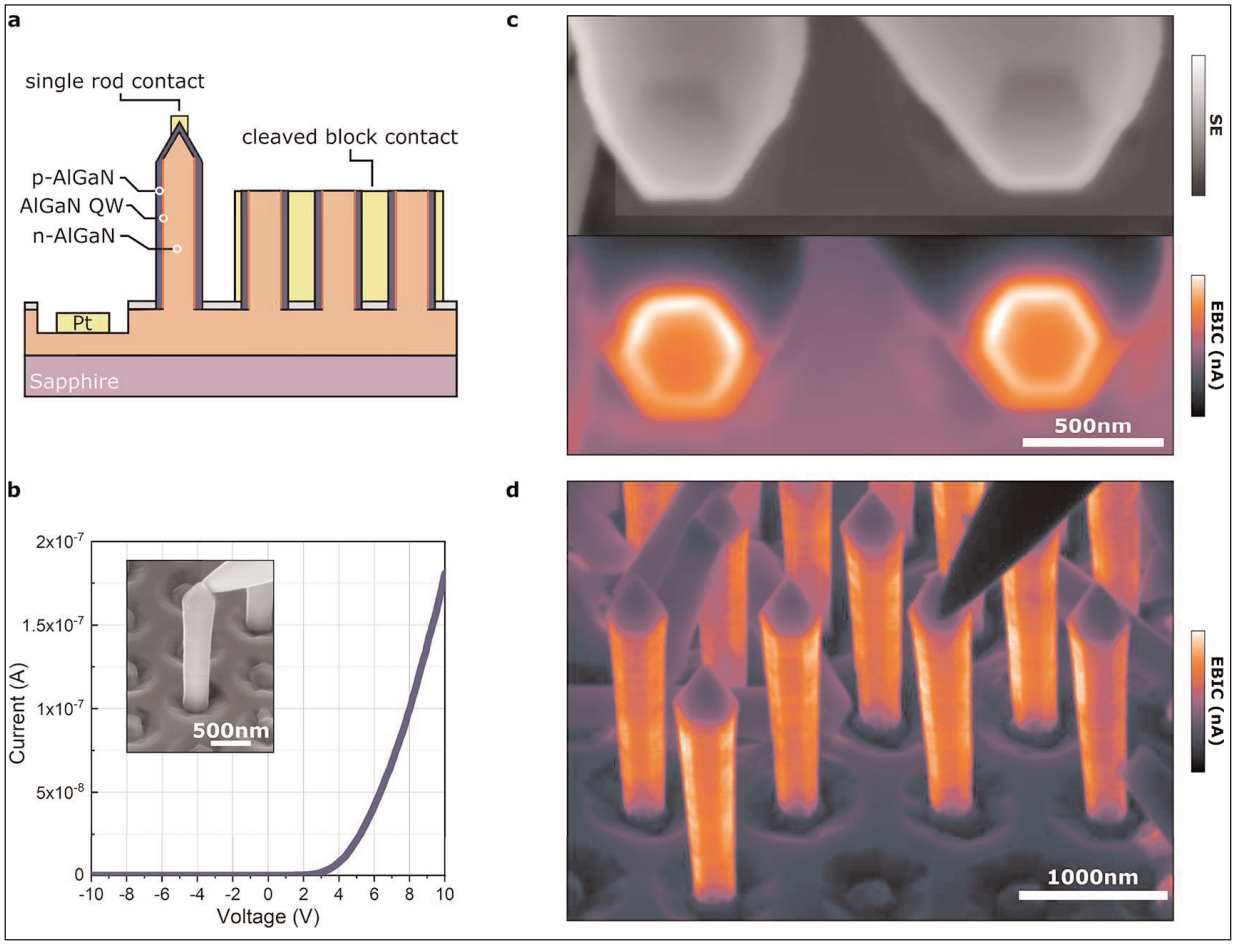

Figure 2. (a) Schematic of nanorod electrical testing architecture. (b) Example current–voltage curve for single rod contacted with nanoprobe as inset. (c) SEM (grayscale) and electron-beam-induced current (EBIC) images of cleaved block contact viewed above. (d) EBIC image of single-rod contact, with nanoprobe contacting above.

The structures were subjected to electron-beam excitation to spectrally analyze the cathodoluminescence (CL) at cryogenic temperatures.

The bare etched cores had a main peak at 243nm, and a "very low" longer-wavelength bump centered at 392nm. The short wavelength was attributed to band-edge emissions, while the longer wavelength was associated with defects.

The team comments: "The optical quality of this core is a significant improvement over the AlN core previously employed to create AlN/AlGaN core–shell structures."

Faceting significantly increased the luminescence in the long-wavelength 360–470nm region, indicating the generation of large numbers of point defects. "These defect bands are ascribed to cation vacancy complexes and are commonly seen in AlGaN alloys," the researchers comment. This layer didn't seem to add any extra band-emission peak, probably "due to the close compositional match to the core, combined with the increased defect population".

The full core–shell structure did have an extra peak from the quantum well around 300nm, varying by about 10nm. The team comments: "Shorter-wavelength emission should be possible using our methods by modifying the quantum well compositions and/or thicknesses."

Time-resolved CL at 80K gave a very short 19ps lifetime for the carriers in the quantum wells in the m-plane regions. The researchers explain: "Such short lifetimes can only be explained by the absence of or significant reduction in the internal electric fields." They add: "These short lifetimes are desirable for fast-switching devices and may also help to reduce the influence of droop by keeping carrier densities tolerable, allowing for higher optical powers to be extracted."

Two schemes were set up for studying the optoelectronic behavior (Figure 2), differing in the nature of the p-contact: a single rod contact of electron-beam-deposited platinum (Pt) on the tip; and, a cleaved block contact, where the space between a small array of rods was filled with Pt from Ga-beam deposition and cut by focused ion-beam (FIB) in the c-plane below the pyramid tip. The n-contact was formed by FIB milling into the n-AlGaN and depositing platinum.

The turn-on voltage of the p–n junctions was around 4.5V, "indicating high doping efficiency". The rectifying ratio between +5 and –5V was 10^5. ■

https://doi.org/10.1021/acs.nanolett.2c04826

Author: Mike Cooke

Green exciton emission from nanowire micro-LEDs

Devices demonstrate record EQEs up to 25%.

University of Michigan in the USA reports high-efficiency green emission from micron-scale light-emitting diodes using bottom-up growth of nanowires, allowing strain and quantum engineering [Ayush Pandey et al, Nano Letters, published online 2 February 2023].

The researchers claim record peak external quantum efficiency (EQE) and wall-plug efficiency (WPE), compared with devices with a similar active region area. Such devices are being developed for next-generation displays, virtual/augmented reality, and ultrahigh-speed optical interconnects.

The Michigan researchers believe that the higher efficiencies are due to excitonic, rather than free electron–hole, recombination.

The team explains: "In an excitonic LED, electroluminescence emission originates from a bound state of an electron and hole, instead of recombination from free charge carriers. Due to the strong Coulombic interaction between electrons and holes, the negative impact of Shockley–Read–Hall recombination on the performance of an excitonic LED is significantly reduced."

In conventional indium gallium nitride (InGaN) LEDs excitonic recombination is hindered by the presence of strong electric fields arising from strain-dependent and spontaneous charge-polarization contrasts of InGaN and GaN. The electric fields tend to tear apart electron–hole excitons, and further even reduce the ability of free holes and electrons to recombine into photons. These behaviors are referred to as the quantum-confined Stark effect (QCSE).

Further optimization may be possible in terms of the strain state, composition and thickness of the InGaN active region in the nanowires along with the dimensions of the nanowires themselves. The team suggests that "micro-LEDs with emission across the entire visible spectrum could be grown, with efficiencies approaching to, or better than, commercial broad-area LEDs."

To grow the nanowires, the Michigan researchers first patterned a titanium mask on an N-polar GaN-on-sapphire template using electron-beam lithography. The titanium was opened to expose the underlying GaN by reactive-ion etching. Before nanowire growth, the mask surface was nitrided with nitrogen plasma exposure.

Comprising n-GaN, active region, and p-GaN (Figure 1), the nanowires were grown via molecular beam epitaxy (MBE). The active region was grown at lower temperature than the two contact layers. Also, the researchers targeted green emission from the InGaN layers of the active region with an In/Ga flux ratio of 0.6. The active region consisted of 6 pairs of InGaN/GaN multiple quantum disks (MQDs).

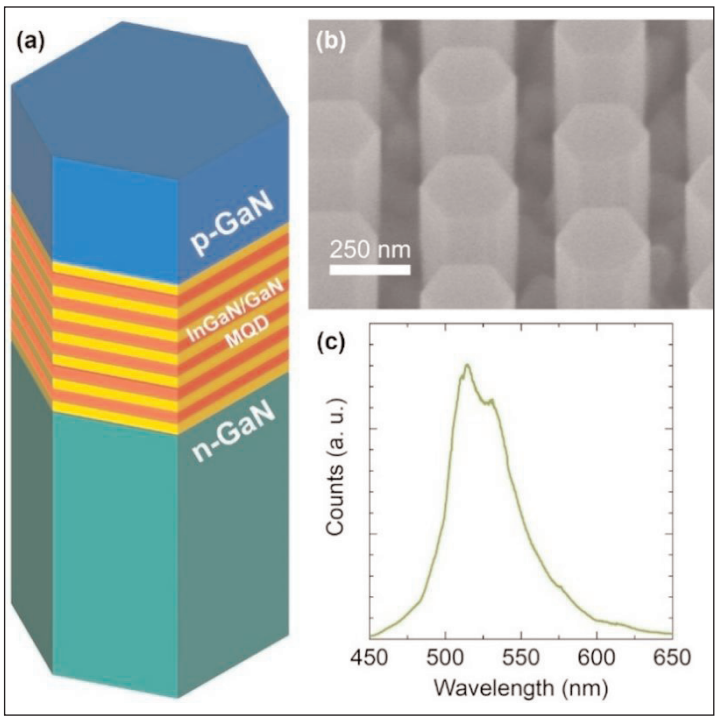

Figure 1. (a) Schematic of N-polar InGaN/GaN nanowire excitonic LED heterostructure. (b) Representative scanning electron microscope (SEM) image of nanowire array. (c) Photoluminescence (PL) spectrum of nanowire array.

The growth resulted in hexagonal vertical nanowires with flat tops, which are desired for the fabrication of high-efficiency devices. Ga-polar nanowire growth tends to result in tapered structures. Also, the growth of nanowires from the bottom up avoids the sidewall damage of top-down methods where the nanowires are formed from etching standard materials.

The photoluminescence from the material peaked in the green region of the spectrum. The peak was quite broad with some shoulders, which the researchers attribute to "Fabry–Perot modes formed with the substrate".

The team comments: "The luminescence spectrum is relatively broad, due to variations in indium composition of the quantum disks".

Analysis using scanning transmission electron microscopy and x-ray energy-dispersive element mapping

suggested 'faceting' near the sidewalls of the nanowires. This refers to preferred growth of the layer parallel to semi-polar planes rather than the c-plane. One result was higher indium incorporation near the sidewall. Also, it is to be expected that there is reduced strain in the semi-polar faceted regions, resulting in reduced QCSE and hence tighter exciton binding. Faceting was more prominent in smaller-diameter nanowires, around 125nm (array/device A) compared with 165nm (B).

Micro-LEDs were fabricated by atomic layer deposition (ALD) of 65nm aluminium oxide coating the nanowires; etching back to expose the p-GaN contact layer; plasma-enhanced chemical vapor deposition (PECVD) of 500nm silicon dioxide insulation; and etching of vias for deposition of the metal n- and p-type electrodes.

The n-electrodes were titanium/gold, while p-electrodes were nickel/gold/indium tin oxide (ITO). The light emission was arranged through the sapphire backside by coating the top side with a mirror consisting of silver/titanium/aluminium/nickel/gold.

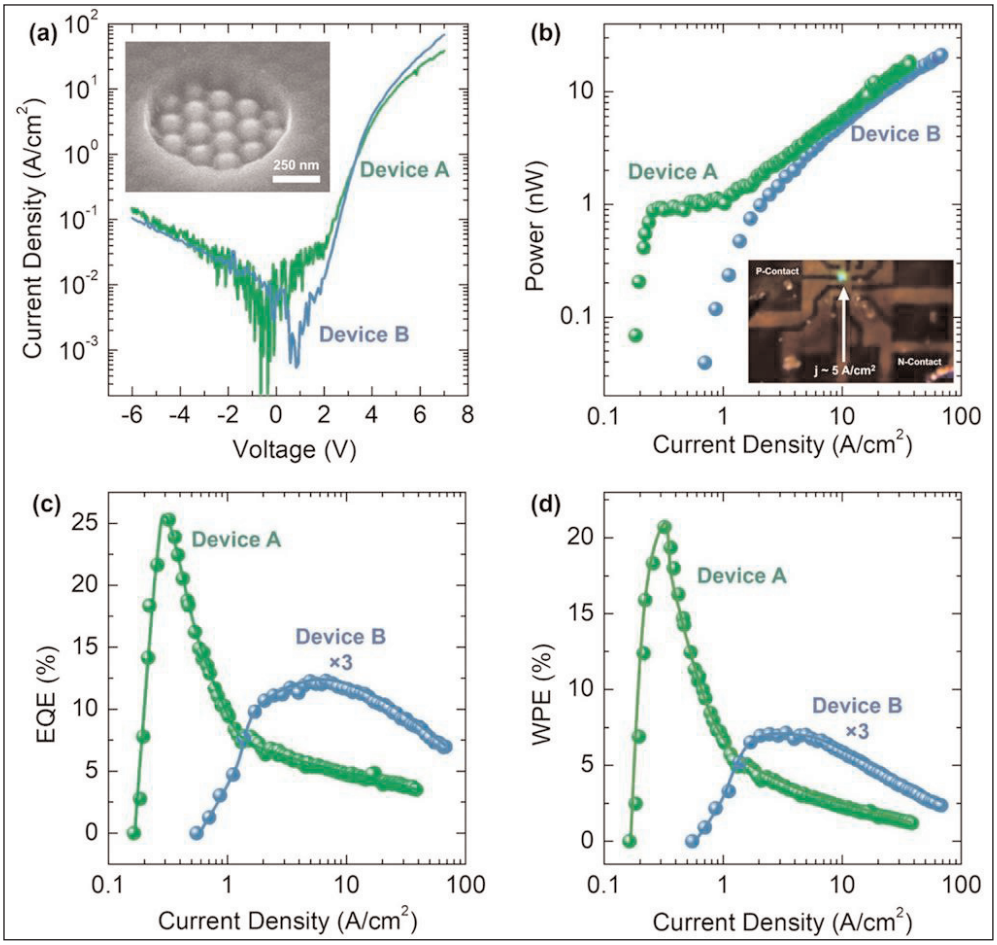

Figure 2. (a) Current density versus voltage. Inset: SEM image of representative injection opening. (b) Light output power versus current density. Inset: image of strong green emission from submicron device. (c) External quantum efficiency and (d) wall-plug efficiency versus current density.

Micro-LED devices were prepared for testing by thinning the sapphire backside, and dicing into small pieces. The current injection area was about 750nmx750nm.

Device A with narrower nanowires exhibits better performance overall (Figure 2). The peak in the efficiencies comes sooner (around 0.3A/cm^2) however, before fall off at higher current injection. The peak EQE and WPE for device A were 25.2% and 20.7%, respectively. The researchers comment that these efficiencies are "significantly higher than conventional quantum well micro-LEDs of similar dimensions". The high WPE also indicates excellent carrier conduction in the device, particularly with respect to hole injection into the active region.

The team points out: "While the efficiency peak occurs at low current, corresponding to low absolute output power, the small size of an individual device allows several of them to be arranged in larger arrays, greatly boosting their total power for applications that demand it."

The 4.1% EQE peak for device B came at 5A/cm^2. The researchers suggest that the efficiency droop at higher injection could be reduced by including an electron-blocking layer between the active and p-contact regions.

The power output of device A has a fast rise at low current, then the power saturates before rising again more slowly, in line with the performance of device B with wider nanowires. The researchers attribute this behavior to indium-rich clusters in the faceted region of the quantum disks dominating the emissions at low injection, "due to their higher indium compositions and proximity to the highly doped nanowire sidewalls".

At higher injection, the clusters are saturated and emission increases of the MQDs must come from the more central c-plane portions with free electron–hole recombination, instead of excitons.

These behaviors were also clarified by spectral analyses: at low current there was a dominant 'green' peak in device A, around 515nm wavelength. As current injection increased, higher-energy emissions from shorter, bluer wavelengths in the 475–490nm range came to dominance. Device B's spectral behavior showed only dominance of emission from free electron–hole recombination. Device B, and device A with injection above a few A/cm^2, show operation corresponding to conventional quantum well LEDs, according to the researchers. ■

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Author: Mike Cooke

GaN on silicon through surface-activated bonding

Annealing of bonded materials allows tuning of the interface structure.

Researchers from UK, China and Japan have been exploring the potential of surface-activated bonding (SAB) as a means to create high-quality gallium nitride (GaN) on silicon (Si) with a view to low-cost, large-scale and multi-functional GaN/Si device applications [Yan Zhou et al, Appl. Phys. Lett., v122, p082103, 2023].

The technique avoids thick aluminium gallium nitride (AlGaN) heterostructures of direct GaN growth on silicon. Such layers are needed to bridge the large 17% lattice mismatch between GaN and silicon generating performance-sapping dislocations and other defects. The main attraction of using GaN/Si — rather than better matched silicon carbide, diamond or free-standing GaN substrates — is cost.

The drawback for applications — particularly ones involving heat generation such as for high-power/voltage management, for which there is much interest in GaN-based devices — is that these layers tend to be thermally resistive. This makes thermal management much more difficult.

The team — from University of Bristol in the UK; State Key Laboratory of Superlattices and Microstructures, University of Science and Technology of China, Center for High Pressure Science and Technology of Advanced Research, and Harbin Institute of Technology, Beijing University of Technology in China; and Osaka City University and Osaka Metropolitan University in Japan — also found that annealing could convert the relatively thick amorphous layer of the bond formed at room temperature to a much thinner crystalline layer.

The epitaxial GaN was grown on 4-inch n-Si(111) wafers using metal-organic chemical vapor deposition (MOCVD) with trimethyl-Ga/Al and ammonia (NH_3) precursors. The 1.2μm 1000°C GaN layer was grown on 200nm 1060°C AlN buffer.

The surface activation (Figure 1) for the bonding consisted of fast argon atom beam irradiation of both the target n-Si(111) wafer and the epitaxial GaN/Si wafer. The bonding was carried out at room temperature in $7x10^7$Pa vacuum with 1GPa external load for a minute.

The silicon epitaxial growth wafer was removed by chemical polishing and wet etching. The target wafer was protected from the etching by RF-sputtered silicon dioxide (SiO_2). Epitaxial growth produced

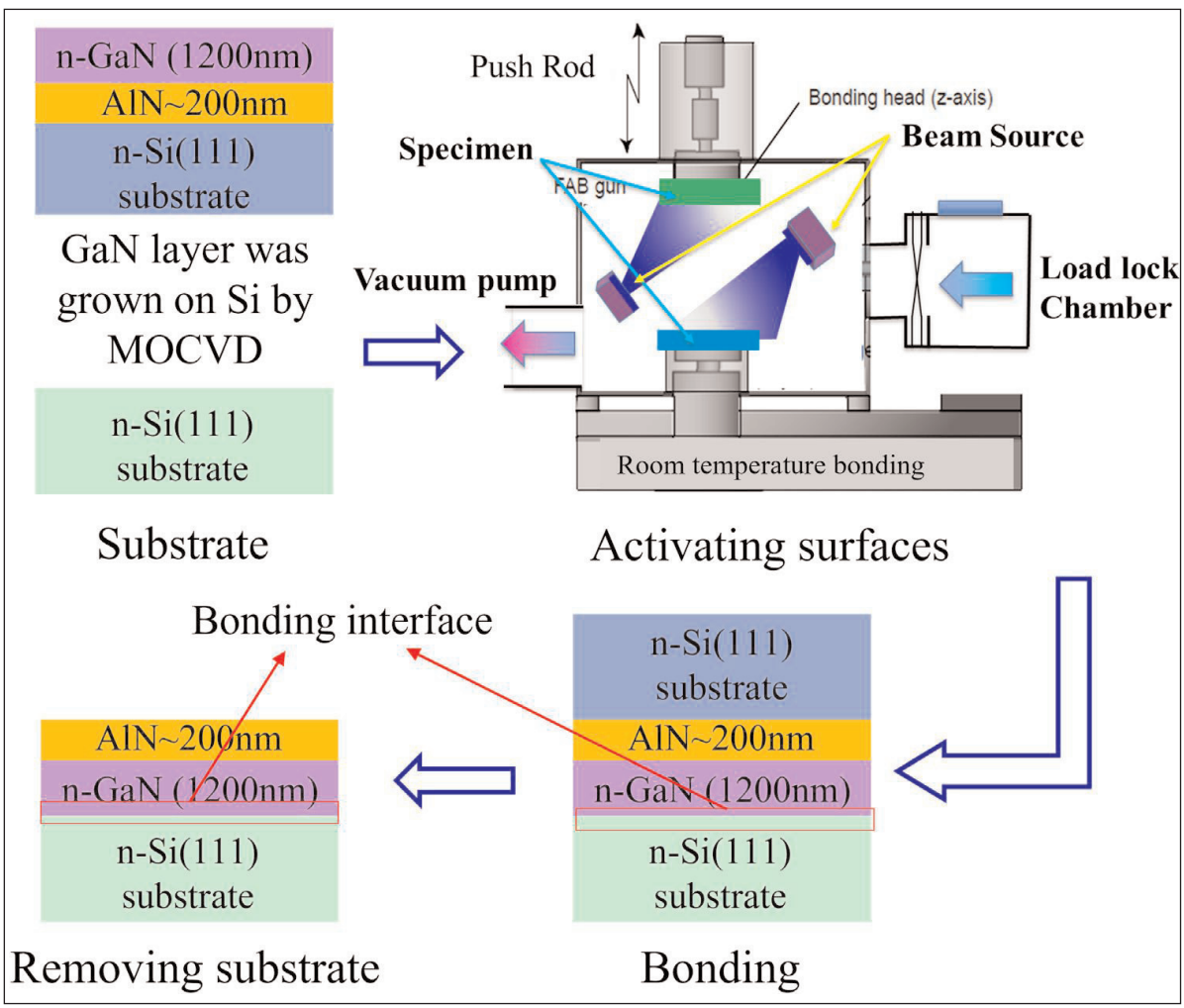


Figure 1. Schematic SAB process to fabricate GaN/Si heterostructure.

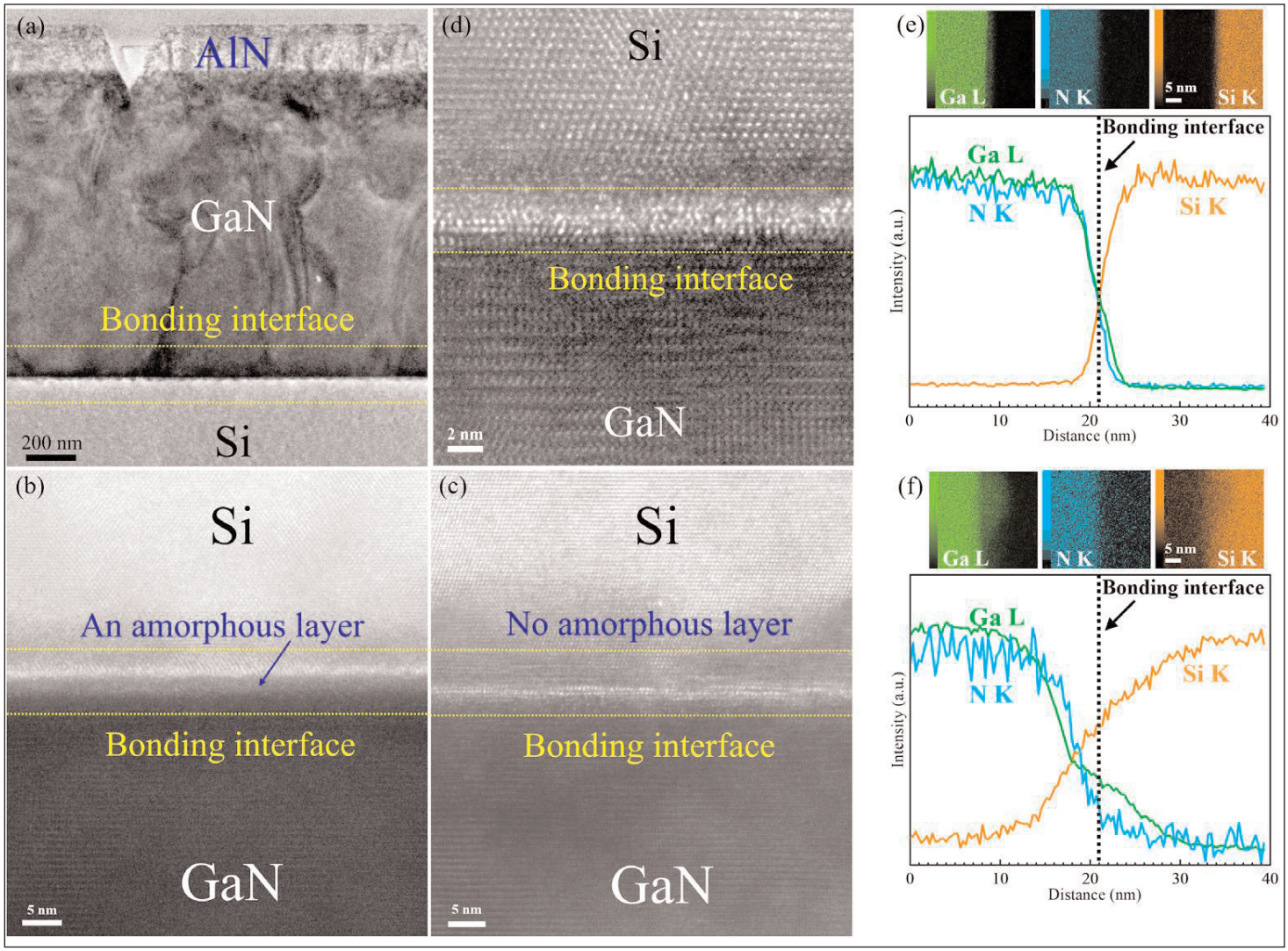


Figure 2. Low (a) and high-magnification (b) cross-sectional TEM images of GaN/Si bonding interface fabricated by SAB without annealing. High-magnification (c) and high-resolution (d) cross-sectional TEM images of bonding interface after annealing at 1000°C. EDS mapping of bonded interface region (e) without annealing and (f) after annealing at 1000°C.

Ga-polar GaN, and therefore the GaN/Si target wafer-bonded material was N-polar.

The stress state of the GaN/Si was studied using Raman spectroscopy. The researchers estimated a residual stress of 0±005GPa by comparing the E_2^{high} Raman peak shift relative to free-standing GaN grown by hydride vapor phase epitaxy (HVPE), assumed stress-free. This compares with MOCVD GaN/Si-grown samples, which had typical values of –0.05±0.09GaP (compressive) stress.

The team also studied the stress after annealing the SAB samples at 400°C, 700°C or 1000°C for 300s in nitrogen atmosphere. At the highest annealing temperature, a tensile stress of 0.16GPa developed, but at the lower temperatures the stress was negligible.

Transmission electron microscope (TEM) examination of the interface before and after 1000°C annealing showed the effect of the thermal process to be the transformation of an amorphous layer into a thin crystallized interlayer (Figure 2). The amorphous bond layer was of the order of tens of nanometers, while the crystallized interlayer was only a few nanometers. The inspection also found that "no structural defects, such as cracks, were observed at the interface whether without or with annealing."

According to energy-dispersive x-ray spectroscopy (EDS) mapping, the crystallized interlayer consisted of Ga, N and Si. There was also some diffusion of these elements into the neighboring GaN/Si materials.

The researchers attribute the amorphous layer of the unannealed samples to the effect of the surface activation in the bonding process, creating a cushion and allowing the GaN to relax over the silicon target wafer, despite the 17% lattice mismatch.

The researchers suggest that their study indicates that "it is possible to obtain stress-free GaN epitaxial layers through SAB technique at room temperature and tune the interlayer structure and residual stress through appropriate temperature annealing." ■

https://doi.org/10.1063/5.0135138

Author: Mike Cooke

Commercialization of 800V for EVs to play crucial role in growth strategy of OEMs

Substrates & epi comprise nearly 70% of the SiC value chain, says Research In China.

As new energy vehicles and battery technology boom, charging and battery swapping in the industry chain have become weak links for the development of new energy vehicles. Inconvenient charging and short cruising range have become sore points that plague every consumer buying electric vehicles.

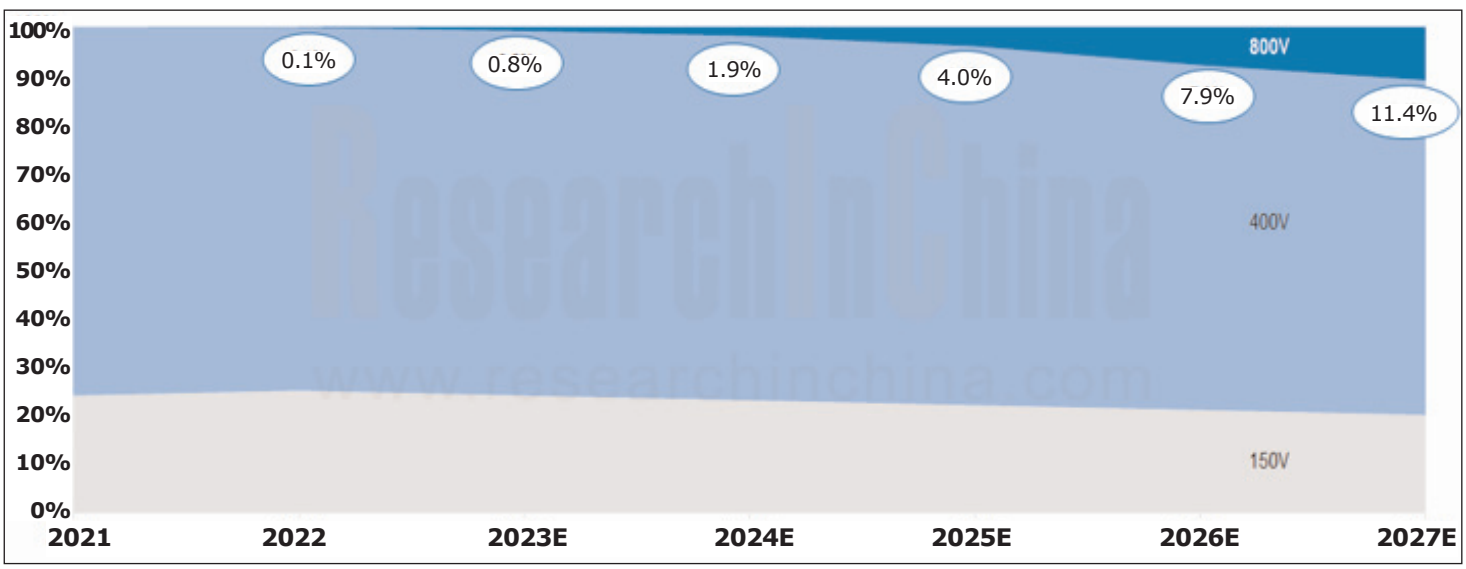
In this context, 800V high-voltage charging for new energy vehicles has been a spotlight, notes the '800V High Voltage Platform Research Report, 2023' by Research In China. 2022 was the first year for the development of 800V high-voltage platforms in China. In particular, a large number of 800V high-voltage platform models will go on sale during 2023–2024.

In the current stage, 800V platforms are still facing a situation of "loud thunder but small raindrops". Insurance data show that insured vehicles with 800V platforms in China were still fewer than 10,000 units in 2022. The low cost performance and poor ultrafast charging experience offered by 800V models are the major flaws criticized by consumers.

The industry boom still requires lower cost of upstream materials and systems, and the gradual deployment of downstream 480kW/500kW ultrafast-charging piles to cover key use scenarios, so that 800V models can be pulled into the market explosion node that is expected to come in about 2024, according to the plans of large auto makers.

Deployment of 800V ultra-fast charging:

- **Xpeng**: for the top ten cities by orders for G9, concentrate on building S4 ultrafast charging stations. In 2023, S4 stations will be used to provide energy replenishment in key cities and along key highways; it is estimated that in 2025, in addition to the current self-operated 1000 charging stations, Xpeng will build another 2000 ultrafast charging stations.
- **GAC**: in 2021, GAC introduced a fast-charging pile with maximum charging power up to 480kW. It is predicted that, in 2025, 2000 supercharging stations will be built in 300 cities across China.
- **NIO**: in December 2022, NIO officially released a 500kW ultrafast charging pile with maximum current of 660A supporting high-power charging. The fastest charging time for 400V models is only 20 minutes; for 800V models, the fastest charge from 10% to 80% takes 12 minutes.
- **Li Auto**: in 2023 Li Auto has started the construction of 800V high-voltage supercharging piles in Guangdong, and its goal is to build 3000 supercharging stations in 2025.
- **Huawei**: in March 2023, the 600kW supercharging



Penetration of 800V high-voltage platforms in new energy passenger cars in China, 2022–2027 (estimated).

pile exclusively for AITO came out in Huawei Base in Bantian Street, Shenzhen. This charging pile, named FusionCharge DC Supercharging Terminal, adopts single-pile single-gun design. The manufacturer is Huawei Digital Power Technologies Co Ltd. Its external dimensions are 295mm (L) x 340mm (W) x 1700mm (H) and the product model is DT600L1-CNA1. The charging pile has an output voltage range of 200–1000V, maximum output current of 600A, maximum output power of 600kW, and liquid cooling.

Due to the high construction cost of 480kW ultrafast-charging piles, generally speaking, an ultrafast-charging station is equipped with just one or two 480kW supercharging piles and several 240kW fast-charging piles, and supports dynamic power distribution. Overall, according to the plans of auto makers, it is conceivable that in late 2027 ownership of 800V high-voltage platform models will reach 3 million units; the number of 800V supercharging stations will be 15,000–20,000; the number of 480/500kW supercharging piles will exceed 30,000.

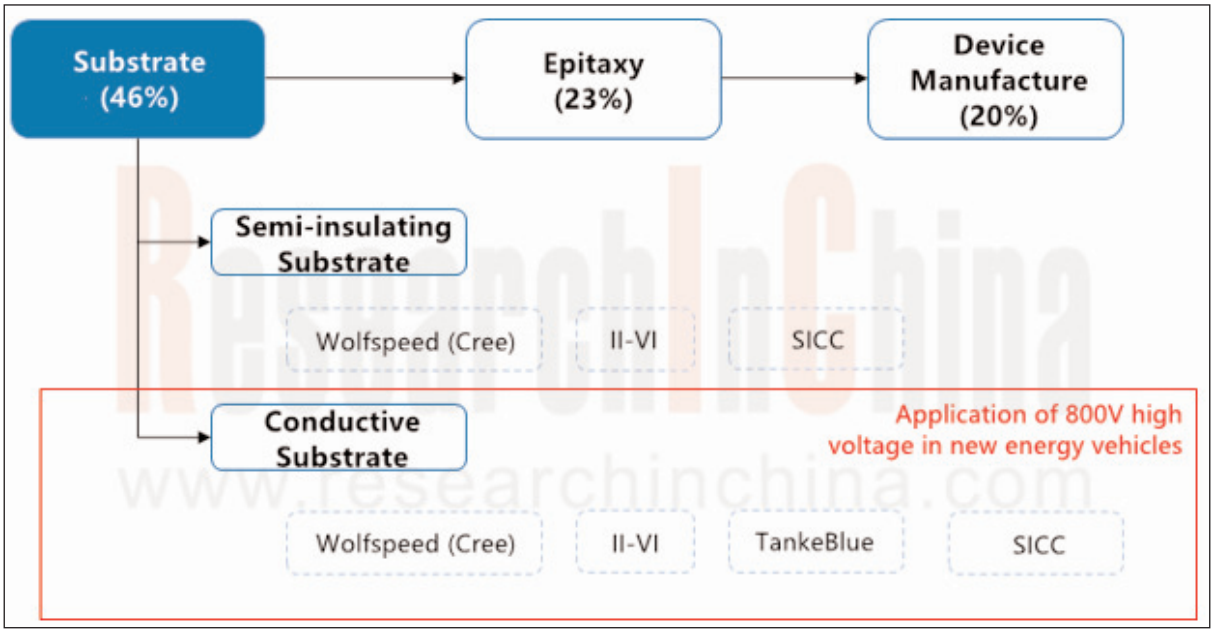
As well as charging piles, in the evolution of architecture from 400V to 800V, the implementation of vehicle engineering also remains very complicated. It requires simultaneous introduction of an entire system spanning semiconductor devices and battery modules to electric vehicles, charging piles, and charging networks, and poses higher demands on reliability, size and electrical performance of connectors. It also requires technology improvements in mechanical, electrical and environmental performance.

Tier-1 suppliers race to unveil 800V component products. Most new products to be available during 2023–2024

Leadrive Technology: in 2022, the first silicon carbide (SiC)-based `three-in-one` electric drive system jointly developed by Leadrive Technology and SAIC Volkswagen went into trial production and made a debut at the Volkswagen IVET Innovation Technology Forum. Tested by SAIC Volkswagen, this 'three-in-one' system equipped with Leadrive Technology's silicon carbide ECU can increase the cruising range of the ID.4X model by at least 4.5%. Additionally, Leadrive and Schaeffler will co-develop electric drive assembly products including an 800V SiC electric axle.

SOP Plans of Major Global Silicon Carbide (SiC) Device Companies

Self-built Production Line		
Company	**Product Layout**	**Product Development Stage**
BYD	Started self-developing IGBT in 2005 and SiC in 2020	IGBT has iterated to 5.0, and SiC power modules are used in Han EV
BIO	A SiC power module process experiment line	Designed annual capacity of 5000 sets of modules
BorgWarner	IGBT module and SiC Mosfet module	3 Viper packaging and testing lines for the Phase II of Suzhou factory project
UAES	IGBT power module	Bosch produces SiC chips
Vitesco Technologies	IGBT and SiC modules	Packaging line in Tianjin factory
Denso	SiC power module	Applied to Toyota fuel cell vehicle Miral
Leadrive Technology	IGBT and SiC power modules	Plan to self-build production lines
Equity Cooperation		
Company	**Product Layout**	**Product Development Stage**
SAIC	IGBT module	Established joint venture SAIC Infineon Automotive Power Modules (Shanghai) Co, Ltd. together with Infineon
	Automotive chip	Initiated the establishment of the Shanghai Automotive Chip Engineering Center together with the Shanghai Industrial µTechnology Research Institute; to build an automotive chip pilot test line and a production line
Geely	SiC chip	Established joint venture AscenPower together with AccoPower among others
Dongfeng Motor	IGBT module	Established joint venture Zhixin Semiconductor together with CRRC Times
FAW	IGBT and SiC modules	FAW Fund as the leading investor established a joint venture together with eMotor Advance, and founded wholly-owned subsidiary eMotor Semiconductor in Suxiang Cooperation Zone
Li Auto	SiC chip, module	Established a joint venture with Sanan Semiconductor
GAC	IGBT module	Established joint venture Guangzhou Qinglan Semiconductor Co., Ltd. together with CRRC Times
Zhenghai Group	SiC module	Established joint venture HAIMOSIC together with ROHM Semiconductor



- **Vitesco Technologies**: the highly integrated electric drive system product EMR4 is projected to be mass produced in China and supplied to global customers in 2023. EMR4 will be spawned at Vitesco's factory in Tianjin Economic-Technological Development Area and delivered to auto-makers both inside and outside China.

BorgWarner: the new 800V SiC inverter adopts Viper's patented power module technology. The application of SiC power modules to 800V platforms reduces the use of semiconductors and SiC materials. This product will be mass produced and installed on vehicles between 2023 and 2024.

800V still in ascendance, but battle for SiC production capacity has begun

In new 800V architectures, the key to electric drive technology is the use of 'third-generation' SiC/GaN semiconductor devices. While bringing technical benefits to new energy vehicles, technology iterations also pose many challenges to automotive semiconductors and the entire supply chain. In the future, 800V high-voltage systems with SiC/GaN as the core will usher in a period of large-scale development in automotive electric drive systems, electronic control systems, on-board chargers (OBCs), DC–DC, and off-board charging piles.

In particular, silicon carbide is at the core of the high-voltage platform strategy of OEMs. Although 800V is still growing at present, the war for SiC production capacity has already started. OEMs and tier-1 suppliers are competing to form strategic partnerships with suppliers of SiC chips and modules or to set up joint ventures with them for the production of SiC modules in order to lock in SiC chip capacity.

On the other hand, the campaign for SiC cost reduction has also been launched. At present, SiC power devices are extremely expensive. In Tesla's case, the value of SiC-based MOSFET per vehicle is about $1300; at its recent annual investor day, Tesla announced progress in the development of its second-generation power chip platform, mentioning a reduction of 75% in silicon carbide device usage, which attracted a lot of attention in the market.

Tesla's confidence lies in the fact that the auto-maker has independently developed a TPAK SiC MOSFET module and is deeply involved in the chip definition and design. Each bare die in the TPAK can be purchased from different chip vendors to establish a multi-supplier system (ST, ON Semiconductor, etc). TPAK also allows for the application of cross-material platforms, e.g. mixed use of IGBT/SiC MOSFETs/GaN HEMTs.

(1) China has built a SiC industry chain, but with a technology level slightly below the international level

Power devices based on SiC offer the benefits of high frequency, high efficiency and small volume (70% or 80% smaller than IGBT power devices), and have been seen in the Tesla Model 3.

From the perspective of the value chain, substrates comprise more than 45% of the cost of silicon carbide devices, and its quality also directly affects the performance of epitaxy and the final product. The substrate and epitaxy comprise almost 70% of the value, so cutting their cost will be the main development direction of the SiC industry. The silicon carbide required for high voltage (800V) for new energy vehicles is mainly conductive substrate SiC crystal. The existing major manufacturers include Wolfspeed (formerly Cree), II–VI, TankeBlue Semiconductor and SICC.

In terms of global SiC technology development, the SiC device market is monopolized by large vendors such as STMicroelectronics, Infineon, Wolfspeed and ROHM. Chinese vendors already have large-scale production capacity, and are on a par with international developments. Their capacity planning and production timescale are almost equal to their foreign peers.

Regarding the SiC substrate development level, 6-inch substrates currently prevail in the SiC market, and the 8-inch SiC substrate is a development priority globally. At present, only Wolfspeed has achieved the mass pro-

	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015	2015-2020	2020-2025
Wolfspeed	1991: first substrate 1993: commercialization of 30mm substrate	1995: 50mm 1999: 4 inches		2009: 6-inch substrate		2015: 8-inch substrate	2022: fully spawned the 8-inch
II-VI			2004: produced the 3-inch		2012: displayed the 6-inch 2013: produced the 6-inch	2015: 8-inch conductive type 2019: 8-inch semi-insulating	2024: to spawned the 8-inch
ROHM			2000-2002: fundamental research on devices	2009: acquired SiCrystal	2011: spawned the 4-inch 2014: spawned the 6-inch		2021: 8-inch substrate 2025: to spawn the 8-inch
ST						2019: acquired Norstel AB for 6-inch substrate capacity	2021: delivered 8-inch wafers
ON Semiconductor						2021: acquired GTAT	2021: launched the 8-inch 2025: to spawn the 8-inch
TANKEBLUE 天科合达				2006: 2 inches 2008: 3 inches	2012: successfully developed the 4-inch	2017: spawned the 4-inch 2018: developed the 6-inch semi-insulating	2020: spawned the 6-inch 2023: to spawn the 8-inch
SICC					2012: spawned the 2-inch 2013: spawned the 3-inch	2015: spawned the 4-inch semi-insulating 2017: spawned the 6-inch conductive type 2019: spawned the 6-inch semi-insulating	
SEMISiC 烁科晶体				2009: SiC research		2020: spawned the 4 to 6-inch 2020: displayed the 8-inch	2021: produced 8-inch crystals 2022: produced 8-inch wafers
JSG							2022: displayed the 8-inch 2023: to spawn the 8-inch

duction of 8-inch SiC. The Chinese company SEMISiC has produced 8-inch N-type SiC polished wafers on a small scale in January 2022. Most international companies plan the production of 8-inch SiC substrates during 2023.

(2) GaN is still at an early stage of application in automotive, and the layout pace of related manufacturers is quickening

Gallium nitride (GaN) is largely used in consumer electronics fields such as tablet PCs, TWS earbuds and notebook computer fast charging (PD). Yet, as new energy vehicles thrive, electric vehicles become a potential application market for GaN. In electric vehicles, GaN field-effect transistors (FETs) are very applicable to AC–DC OBCs, high-voltage (HV) to low-voltage (LV) DC–DC converters, and low-voltage DC–DC converters.

In the field of electric vehicles, GaN and SiC technologies complement each other and cover different voltage ranges. GaN devices are suitable for tens of volts to hundreds of volts, and in medium- and low-voltage applications (less than 1200V); their switching loss is three times less than SiC in 650V application. SiC is more applicable to high voltages (several thousand volts). Currently, the application of SiC devices in a 650V environment is mostly to enable 1200V or higher voltage in electric vehicles.

China still has a big gap with foreign counterparts in development of Ga_2O_3, and has yet to achieve mass production

By virtue of having a large energy bandgap, high breakdown field strength and strong radiation resistance, gallium oxide (Ga_2O_3) is expected to dominate in the field of power electronics in the future. Compared with common wide-bandgap SiC/GaN semiconductors, Ga_2O_3 boasts a higher Baliga figure-of-merit and lower expected growth cost, and has more potential in application to high-voltage, high-power, high-efficiency and small-size electronic devices.

In policy's term, China is also paying ever more attention to Ga_2O_3. As early as 2018, China began exploring and studying ultra-wide-bandgap semiconductor materials including Ga_2O_3, diamond and boron nitride. In 2022, China's Ministry of Science and Technology brought Ga_2O_3 into the National Key R&D Program during the '14th Five-Year Plan' period.

On 12 August 2022, the US Department of Commerce's Bureau of Industry and Security (BIS) issued an interim final rule that establishes new export controls on four technologies that meet the criteria for emerging and foundational technologies, including: gate-all-around (GAA) technology, electronic design automation (EDA) software, pressure gain combustion (PGC) technology, and the two ultra-wide-bandgap semiconductor substrates, gallium oxide and diamond. The two export controls came into effect on 15 August. Ga_2O_3 has drawn more attention from the global scientific research and industrial circles.

Although gallium oxide is still at the initial stage of R&D, China has made several breakthroughs within 15 months since the start of 2022. Its gallium oxide preparation technologies — from 2-inches to 6-inches in 2022, and then to 8-inches most recently — are maturing. Chinese Ga_2O_3 material research units include: China Electronics Technology Group Corporation No.46 Research Institute (CETC46), Evolusia Semiconductor, Shanghai Institute of Optics and Fine Mechanics (SIOM), Gallium Family Technology, Beijing MIG Semiconductor, and Fujia Gallium Industry; listed companies like Xinhu Zhongbao, Sinopack Electronic Technology, Jiangsu Nata Opto-Electronic Material and San'an Optoelectronics; plus dozens of colleges and universities. ■

www.researchinchina.com/Htmls/Report/2023/72874.html

CSA Catapult celebrates fifth anniversary

Highlights of CSA Catapult's first five years include delivering £14m of collaborative R&D projects; leveraging £177m of direct investment; and creating or safeguarding over 5000 jobs across the UK.

Compound Semiconductor Applications (CSA) Catapult is celebrating its five-year anniversary with the publication of an overview of its impact and achievements to date.

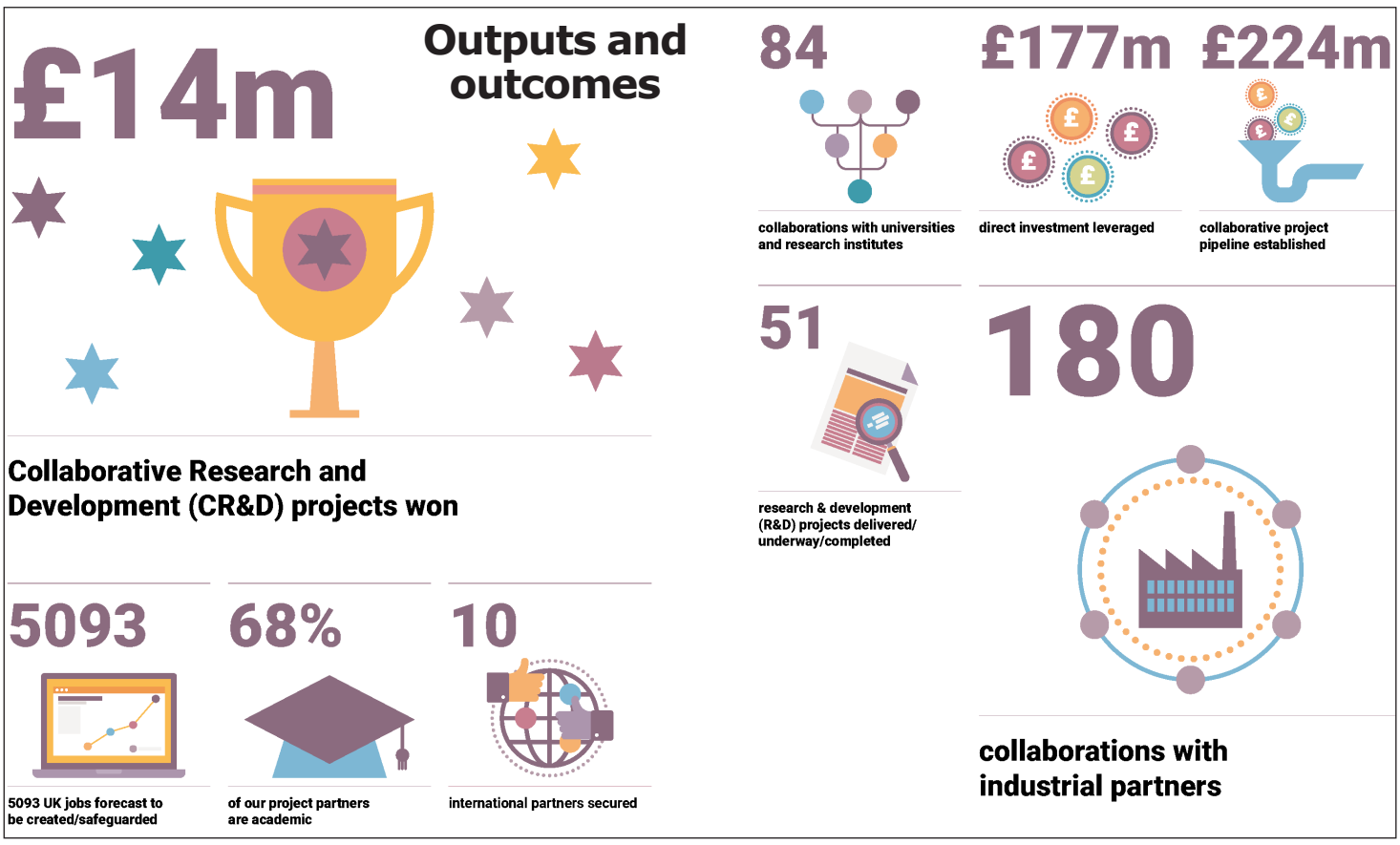
Established in 2017 by UK Government agency Innovate UK (which provides funding and support for business innovation as part of UK Research and Innovation), CSA Catapult is a not-for-profit organization focused on accelerating the adoption of compound semiconductors for three key areas (the road to Net Zero, future telecoms and intelligent sensing). Headquartered in South Wales, it works across the UK in a range of industry sectors, from automotive to medical, and from digital communications to aerospace.

The new document details the journey of CSA Catapult from 2018 to 2022, highlighting achievements that have included: delivering over £14m of collaborative R&D projects; leveraging over £177m of direct investment; and creating/safeguarding over 5000 jobs across the UK.

CSA Catapult's function in the UK's compound semiconductor ecosystem is helping companies to fully embrace the power of compound semiconductor technology and bring their innovations to market.

During the last five years, CSA Catapult has focussed on leveraging research, eliminating barriers, minimizing risk, accelerating routes to market, and attracting investment for collaborators in industries ranging from vehicle electrification and future telecoms to smart energy grids.

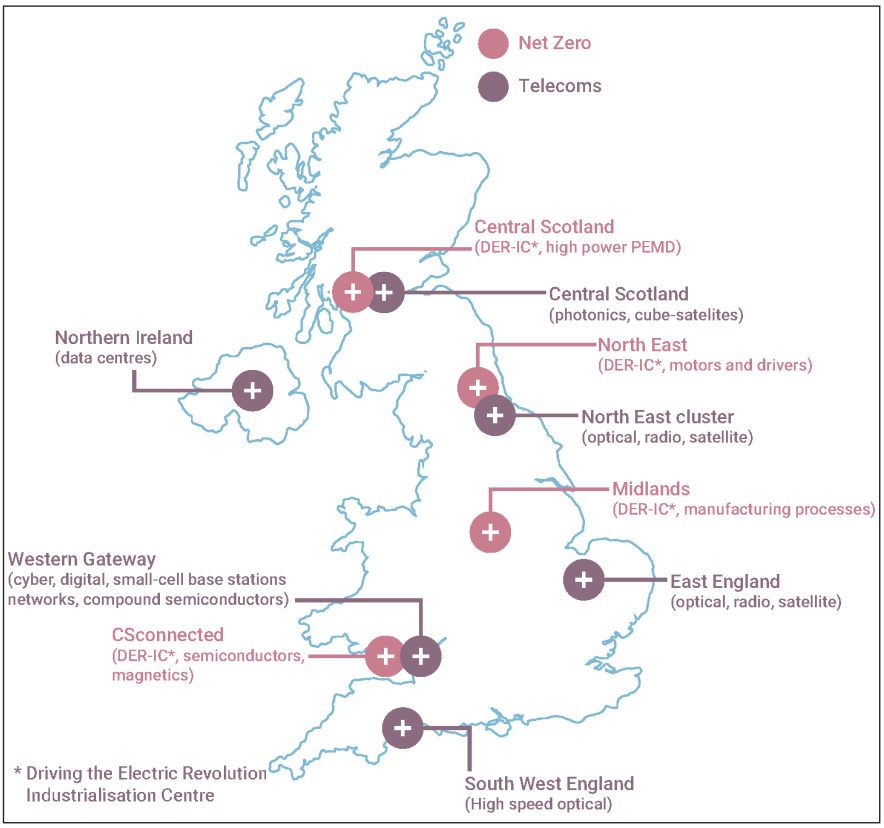
In 2018, CSA Catapult set up an Innovation Centre in Newport, South Wales, offering innovation as a service and providing knowledge and expertise across four areas: power electronics; photonics; RF (radio frequency) and microwave; and advanced packaging. This has led to 180 collaborations with industrial partners, including BMW and McLaren Applied.



In 2022, CSA Catapult entered a partnership with Siemens to deliver joint projects that accelerate the development of leading-edge power electronics, machines and drives technology, capability, skills and jobs across the UK. The Siemens Power Electronics Innovation Hub is now permanently located in CSA Catapult's Innovation Centre in Newport.

Throughout the first five years of its existence, CSA Catapult has also developed a wide-ranging skills program, starting in schools, and extending through to post-graduate-level and the workplace. Through its dedicated Skills Academy, it is developing initiatives to help create the workforce of the future that will develop the next generation of compound semiconductor technologies.

In the next five years, CSA Catapult aims to grow technology clusters and local supply chains across the UK, creating a network of regional support hubs in areas of significant national strength and importance, including quantum sensing, healthcare, defence and space.



CSA Catapult also aims to create more prototypes, building on experience in automotive power electronics technologies to address new market opportunities.

CSA Catapult's plays a "central convening role in building growth of supply chains working with industry," says interim chair Rob Bryan. "The Catapult must continue to grow academic collaborations; create new opportunities to work with industry; accelerate commercial scale-up; safeguard intellectual property; identify new international partners to address new and emerging markets. Upskilling a new generation is critical and I am particularly proud of our Skills Academy," he adds.

"I would like to take this opportunity to thank my predecessor, our first chair, Kevin Crofton, for his inspirational leadership during the Catapult's first years. He led us from start-up to become the leading neutral convener as well as the major commercial partner in the UK research and development ecosystem," continues Bryan.

"CSA Catapult is at the heart of the flourishing UK compound semiconductor ecosystem. We work with academia and industry to accelerate increasing product development, testing and evaluation," says CEO Martin McHugh. "We will identify significant new domestic and international markets and end-to-end supply chains," he adds. "In the next five years, we will support industry and supply chains and clusters, extending our footprint and contributing to the UK Government's levelling up agenda."

Key achievements include:

- £14m of collaborative research and development (CR&D) projects won;
- £177m direct investment leveraged;
- £224m collaborative project pipeline established;
- 84 collaborations with universities and research institutes;
- 51 R&D projects delivered/underway/completed;
- 180 collaborations with industrial partners;
- 5093 UK jobs forecast to be created/safeguarded;
- 68% of project partners are academic;
- 10 international partners secured.

In Summer 2022, CSA Catapult surveyed its customers to understand its impact, with the following key findings:

- 93% said they would work with CSA Catapult again;
- 56% would not have been able to progress on new developments, or it would have taken longer or cost more, if they had not worked with the CSA Catapult (according to those who answered the question);
- 100% have been able to develop new partnerships;
- 20% agreed they have stronger international links;
- 30% agreed they have been able to target new markets because of working with the CSA Catapult.

Analysis of public and private funding

In addition, internal analysis shows that 44% of the companies that had worked with CSA Catapult have secured public sector funding because of their direct or indirect engagement with the company. Companies that the Catapult has worked with are more than twice as likely to get private investment (36% versus 16%) and the average private investment raised by companies that work with it (per company per year) has also more than doubled, it is reckoned. ■

www.csa.catapult.org.uk

suppliers' directory

Index

To have your company listed in this directory, e-mail details (including categories) to mark@semiconductor-today.com
Note: advertisers receive a free listing. For all other companies, a charge is applicable.

1 Bulk crystal source materials

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68 Huacheng Avenue,
Tianhe District,
Guangzhou, Guangdong,
China 510623
Tel: +86 020-83511906
Fax: +86 020-83511907
E-mail: Sales@vitalchem.com
www.vitalchem.com
Vital Materials is the world's leading producer of rare metals as well as the first Chinese manufacturer to deliver G11 rotary ITO target. Vital is also one of the world's three major supplier of infrared materials, a key supplier of compound semiconductor substrates, and a strategic partner of the world's largest thin film solar manufacturer.

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Lyndhurst, NJ 07071, USA
Tel: +1 201 507 3300
Fax: +1 201 507 1506
www.umccorp.com

2 Bulk crystal growth equipment

Cyberstar
109 Rue Hilaire de Chardonnet — Technisud,
38100 Grenoble,
France
Tel: +33 (0)4 76 49 65 60
E-mail: cyberstar@cyberstar.fr
www.cyberstar.fr

3 Substrates

AXT Inc
4281 Technology Drive,
Fremont,
CA 94538, USA
Tel: +1 510 438 4700
Fax: +1 510 683 5901
www.axt.com

Crystal IS Inc
70 Cohoes Avenue,
Green Island,
NY 12183,
USA
Tel: +1 518 271 7375
Fax: +1 518 271 7394
www.crystal-is.com

CS Microelectronics Co Ltd (Vital Materials subsidiary)
Gaofeng Park,
Wanzhou Economic-Technological Development Area,
Chongqing,
China 404040
Tel: +86 023-58879888
E-mail: csm_sales@vitalchem.com
www.cs-micro.com
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Germany
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Fax: +49 3731 280 106
www.fcm-germany.com

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Fax: +1 919 789 8881
www.kymatech.com

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Owariasahi, Aichi 488-0044, Japan
Tel: +81 572 52 2317
www.maruwa-g.com/e/products/ceramic

sp3 Diamond Technologies
2220 Martin Avenue,
Santa Clara, CA 95050, USA
Tel: +1 877 773 9940
Fax: +1 408 492 0633
www.sp3inc.com

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Fax: +1 503 693 8275
www.sesmi.com

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Quebec H9R 6A8, Canada
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Fax: +1 514 630 0227
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Germany
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Fax: +49 8728 911 156
www.35reclaim.de

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Santa Clara, CA 95054 , USA
Tel: +1 408 748 0100
Fax: +1 408 748 0111
Contact Person: Cathy W. Hung
E-mail: sales@tecdia.com
www.tecdia.com

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Fax: +1-561-842-2677
www.waferworld.com

4 Epiwafer foundry

Albemarle Cambridge Chemical Ltd
Unit 5 Chesterton Mills,
French's Road, Cambridge CB4 3NP,
UK
Tel: +44 (0)1223 352244
Fax: +44 (0)1223 352444
www.camchem.co.uk

Intelligent Epitaxy Technology Inc
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Richardson, TX 75081-2401,
USA
Tel: +1 972 234 0068
Fax: +1 972 234 0069
www.intelliepi.com

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200 Voyageur Drive, Montreal,
Quebec H9R 6A8, Canada
Tel: +1 925 980 5645
Fax: +1 514 630 0227
www.thefoxgroupinc.com

5 Deposition materials

Materion Advanced Materials Group
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Buffalo, NY 14214,
USA
Tel: +1 716 837 1000
Fax: +1 716 833 2926
www.williams-adv.com

Matheson Tri-Gas
6775 Central Avenue,
Newark, CA 94560,
USA
Tel: +1 510 793 2559
Fax: +1 510 790 6241
www.mathesontrigas.com

Nouryon Functional Chemicals B.V.
Zutphenseweg 10, 7418 AJ
Deventer,
The Netherlands
Tel. +31 652 478554
https://hpmo.nouryon.com

Praxair Electronics
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Orangeburg, NY 10962,
USA
Tel: +1 845 398 8242
Fax: +1 845 398 8304
www.praxair.com/electronics

Vital Thin Film Materials (Guangdong) Co Ltd (Vital Materials subsidiary)
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Nanshan District,
Shenzhen, Guangdong, China 518067
Tel: (+86) 0755-21651348
sales@vitaltfm.com

www.vitaltfm.com
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6 Deposition equipment

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Germany
Tel: +49 2407 9030 0
Fax: +49 2407 9030 40
www.aixtron.com

ETC (LPE subsidiary)
Via Falzarego, 820021 Baranzate (Mi),
Italy
Tel: +39 02 383 41 51
Fax: +39 02 383 06 118
www.lpe-epi.com

Evatec AG
Hauptstrasse 1a,
CH-9477 Trübbach,
Switzerland
Tel: +41 81 403 8000
Fax: +41 81 403 8001
www.evatecnet.com

FHR Anlagenbau Gmbh
(Vital Materials subsidiary)
Am Hügel 2, D-01458
Ottendorf-Okrilla,
Germany
Tel: +49 35205 520-0
E-mail: sales@fhr.de
E-mail: sales@vitalchem.com
www.fhr.biz
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LPE S.p.A.
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20021 Baranzate (Mi), Italy
Tel: +39 02 383 41 51
Fax: +39 02 383 06 118
www.lpe-epi.com

PLANSEE High Performance Materials
6600 Reutte,
Austria
Tel: +43 5672 600 2422
info@plansee.com
www.plansee.com

Plasma-Therm LLC
10050 16th Street North,
St. Petersburg, FL 33716,
USA
Tel: +1 727 577 4999
Fax: +1 727 577 7035
www.plasmatherm.com

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95873 Bezons Cedex,
France
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Fax: +33 (0) 1 39 47 45 62
www.riber.com

SVT Associates Inc
7620 Executive Drive,
Eden Prairie, MN 55344,
USA
Tel: +1 952 934 2100
Fax: +1 952 934 2737
www.svta.com

Temescal, a division of Ferrotec
4569-C Las Positas Rd,
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USA
Tel: +1 925 245 5817
Fax: +1 925 449-4096
www.temescal.net

Veeco Instruments Inc
100 Sunnyside Blvd.,
Woodbury, NY 11797,
USA
Tel: +1 516 677 0200
Fax: +1 516 714 1231
www.veeco.com

7 Wafer processing materials

Kayaku Advanced Materials Inc
200 Flanders Road,
Westborough, MA 01581,
USA
Tel: +1 617 965 5511
www.kayakuam.com

Praxair Electronics
(see section 5 for full contact details)

Versum Materials
8555 S. River Parkway,
Tempe, AZ 85284,
USA
Tel: +1 602 282 1000
www.versummaterials.com

8 Wafer processing equipment

Evatec AG
Hauptstrasse 1a,
CH-9477 Trübbach,
Switzerland
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Fax: +41 81 403 8001
www.evatecnet.com

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Tel: +44 (0) 1389 875 444
Fax: +44 (0) 1389 879 042
www.logitech.uk.com

Plasma-Therm LLC
(see section 6 for full contact details)

SAMCO International Inc
532 Weddell Drive,
Sunnyvale, CA, USA
Tel: +1 408 734 0459
Fax: +1 408 734 0961
www.samcointl.com

SPTS Technology Ltd
Ringland Way, Newport NP18 2TA,
Wales, UK
Tel: +44 (0)1633 414000
Fax: +44 (0)1633 414141
www.spts.com

SUSS MicroTec AG
Schleißheimer Strasse 90,
85748 Garching, Germany
Tel: +49 89 32007 0
Fax: +49 89 32007 162
www.suss.com

Synova SA
Ch. de la Dent d'Oche,
1024 Ecublens,
Switzerland
Tel +41 21 694 35 00
Fax +41 21 694 35 01
www.synova.ch

TECDIA Inc
2700 Augustine Drive, Suite 110,
Santa Clara, CA 95054 ,
USA
Tel: +1-408-748-0100
Fax: +1-408-748-0111
Contact Person: Cathy W. Hung
Email: sales@tecdia.com
www.tecdia.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

PLANSEE High Performance Materials
6600 Reutte,
Austria
Tel: +43 5672 600 2422
info@plansee.com
www.plansee.com

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2700 Augustine Drive, Suite 110,
Santa Clara, CA 95054,
USA
Tel: +1 408 748 0100
Fax: +1 408 748 0111
www.tecdia.com

10 Gas and liquid handling equipment

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 SOLUTIONS AG
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Ismaning, 85737,
Germany
Tel: +49 89 96 24000
Fax: +49 89 96 2400122
www.csclean.com

Entegris Inc
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Tel: +1 978 436 6500
Fax: +1 978 436 6735
www.entegris.com

IEM Technologies Ltd
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Tel: +44 (0)1278 420555
Fax: +44 (0)1278 420666
www.iemtec.com

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11 Process monitoring and control

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USA
Tel: +1 800 223 2389
Tel: +1 716 684 4500
www.conaxtechnologies.com

k-Space Associates Inc
2182 Bishop Circle
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USA
Tel: +1 734 426 7977
Fax: +1 734 426 7955
www.k-space.com

KLA-Tencor
One Technology Dr,
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CA 95035, USA
Tel: +1 408 875 3000
Fax: +1 408 875 4144
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D-78120 Furtwangen im Schwarzwald,
Germany
Tel: +49 7723 9197 0
Fax: +49 7723 9197 22
www.wepcontrol.com

12 Inspection equipment

Bruker
Oestliche Rheinbrueckenstrasse 49,
Karlsruhe, 76187, Germany
Tel: +49 (0)721 595 2888
Fax: +49 (0)721 595 4587
www.bruker.com

KLA–Tencor
160 Rio Robles, Suite 103D,
San Jose, CA 94538-7306,
USA
Tel: +1 408 875-3000
Fax: +1 510 456-2498
www.kla-tencor.com

13 Characterization equipment

J.A. Woollam Co. Inc.
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Lincoln, NE 68508, USA
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Fax: +1 402 477 8214
www.jawoollam.com

Lake Shore Cryotronics Inc
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Westerville, OH 43082, USA
Tel: +1 614 891 2244
Fax: +1 614 818 1600
www.lakeshore.com

14 Chip test equipment

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Tel: +1 203-272-4899
Fax: +1 203-250-7389
www.riff-co.com

Tektronix Inc
14150 SW Karl Braun Drive,
P.O.Box 500, OR 97077, USA
www.tek.com

15 Assembly/packaging materials

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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

Wafer World Inc
(see section 3 for full contact details)

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Fax: +1 716 833 2926
www.williams-adv.com

16 Assembly/packaging equipment

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Hamilton International
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Fort Washington,
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USA
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Fax: +1 215 784 6001
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USA
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www.PalomarTechnologies.com

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Fax: +1 508-832-0506
www.pi.ws
www.pi-usa.us

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USA
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Fax: +1 408 748 0111
www.tecdia.com

17 Assembly/packaging foundry

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18 Chip foundry

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UK
Tel: +44 (0) 1698 722072
www.cstglobal.uk

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BP46, Orsay, 91401,
France
Tel: +33 1 69 33 04 72
Fax: +33 169 33 02 92
www.ums-gaas.com

19 Facility equipment

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USA
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Fax: +1 410 506 8749
www.gore.com

21 Computer hardware & software

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Burnaby, BC, V5C 6P8,
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Fax: +1 604 320 1734
www.crosslight.com

Semiconductor Technology Research Inc
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VA 23238,
USA
Tel: +1 804 740 8314
Fax: +1 804 740 3814
www.semitech.us

22 Used equipment

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Fax: +1 770 808 8308
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23 Services

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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

7–12 May 2023
2023 Conference on Lasers & Electro-Optics (CLEO)
San Jose Convention Center, San Jose, CA, USA
E-mail: CLEO@compusystems.com
www.cleoconference.org

9–11 May 2023
PCIM (Power Conversion and Intelligent Motion) Europe 2023
Nuremberg, Germany
E-mail: pcim_visitors@mesago.com
https://pcim.mesago.com/nuernberg/en.html

15–18 May 2023
International Conference on Compound Semiconductor Manufacturing Technology (CS MANTECH 2023)
Hyatt Regency Grand Cypress, next to Disney Springs, Orlando, FL, USA
E-mail: registration@csmantech.org
www.csmantech.org

21–25 May 2023
LightFair 2023
Javits Center, New York, USA
E-mail: michellem@lightfair.com
www.lightfair.com

23–25 May 2023
SEMICON Southeast Asia (SEMICON SEA 2023)
Setia SPICE Convention Centre & Arena, Penang, Malaysia
E-mail: semiconsea@semi.org
www.semiconsea.org

24–26 May 2023
PowerUP Asia 2023
virtual conference and exhibition
https://ve.eetasia.com/powerup2023

29 May–2 June 2023
Compound Semiconductor Week (CSW 2023), joint venue for:
49th International Symposium on Compound Semiconductors (ISCS)
and
34th International Conference on Indium Phosphide and Related Materials (IPRM)
Ramada Plaza Hotel Jeju,
Jeju, South Korea
E-mail: csw2023@csw2023.org
www.csw2023.org

Microwave Week

11–13 June 2023
2023 IEEE Radio Frequency Integrated Circuits Symposium (RFIC 2023)
San Diego Convention Center,
San Diego, CA, USA
E-mail: support@mtt.org
www.rfic-ieee.org

11–16 June 2023
2023 IEEE/MTT-S International Microwave Symposium (IMS 2023)
San Diego Convention Center,
San Diego, CA, USA
E-mail: exhibits@horizonhouse.com
www.ims-ieee.org/ims2023

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11–16 June 2023
43rd Symposium on VLSI Technology & Circuits
Rihga Royal Hotel, Kyoto, Japan
E-mail: vlsisymp@jtbcom.co.jp (Asia and Japan) or vlsi@vlsisymposium.org (North America and Europe)
www.vlsisymposium.org

13–16 June 2023
Intersolar Europe 2023
Messe München, Munich, Germany
E-mail: info@intersolar.de
www.intersolar.de

25–29 June 2023
World of PHOTONICS CONGRESS — International Congress on Photonics in Europe
ICM — Internationales Congress Center München, Munich, Germany
E-mail: info@photonics-congress.com
www.photonics-congress.com/en

29 June – 1 July 2023
SEMICON China
Shanghai New International Expo Centre (SNIEC), China
E-mail: semichina@semi.org
www.semiconchina.org

11–13 July 2023
SEMICON West 2023
Moscone Center, San Francisco, CA, USA
E-mail: semiconwest@semi.org
www.semiconwest.org

23–26 July 2023
AVS 23rd International Conference on Atomic Layer Deposition (ALD 2023), featuring the 10th International Atomic Layer Etching Workshop (ALE 2023)
Hyatt Regency Bellevue in Bellevue, Washington (East Seattle), WA, USA
E-mail: della@avs.org
www.ald2023.avs.org

6–8 September 2023
CIOE 2023 (The 24th China International Optoelectronic Exposition)
Shenzhen World Exhibition & Convention Center, China
E-mail: cioe@cioe.cn
www.cioe.cn/en

6–8 September 2023
SEMICON Taiwan 2023
TaiNEX 1&2, Taipei, Taiwan
E-mail: semicontaiwan@semi.org
www.semicontaiwan.org

17–22 September 2023
International Conference on Silicon Carbide and Related Materials (ICSCRM 2023)
Hilton Sorrento Palace Conference Centre, Sorrento, Italy
E-mail: info@icscrm-2023.org
www.icscrm-2023.org

17–22 September 2023
26th European Microwave Week (EuMW 2023)
Berlin Messe, Germany
E-mail: eumwreg@itnint.com
www.eumweek.com

1–5 October 2023
European Conference on Optical Communication (ECOC 2023)
Glasgow, Scotland, UK
E-mail: postmaster@theiet.org
https://ecoc2023.theiet.org

14–18 October 2023
2023 IEEE BiCMOS and Compound Semiconductor Integrated Circuits and Technology Symposium (BCICTS)
Monterey, CA, USA
E-mail: cs@cshawevent.com
www.bcicts.org

14–17 November 2023
SEMICON Europa 2023
Messe München, Munich, Germany
E-mail: semiconeuropa@semi.org
www.semiconeuropa.org

13–15 December 2023
SEMICON Japan 2023
Tokyo Big Sight, Tokyo, Japan
E-mail: semicon@sakurain.co.jp
www.semiconjapan.org

18–22 February 2024
2024 IEEE International Solid- State Circuits Conference (ISSCC 2024)
San Francisco, CA USA
E-mail: Isscinfo@yesevents.com
www.isscc.org

12–23 June 2024
2024 IEEE Symposium on VLSI Technology and Circuits
Hilton Hawaiian Village Waikiki Beach Resort, Honolulu, HI, USA
E-mail: vlsi@vlsisymposium.org
www.vlsisymposium.org

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