ISSN 1752-2935 (online)

semiconductorTODAY

COMPOUNDS & ADVANCED SILICON

Vol. 19 • Issue 5 • June/July 2024

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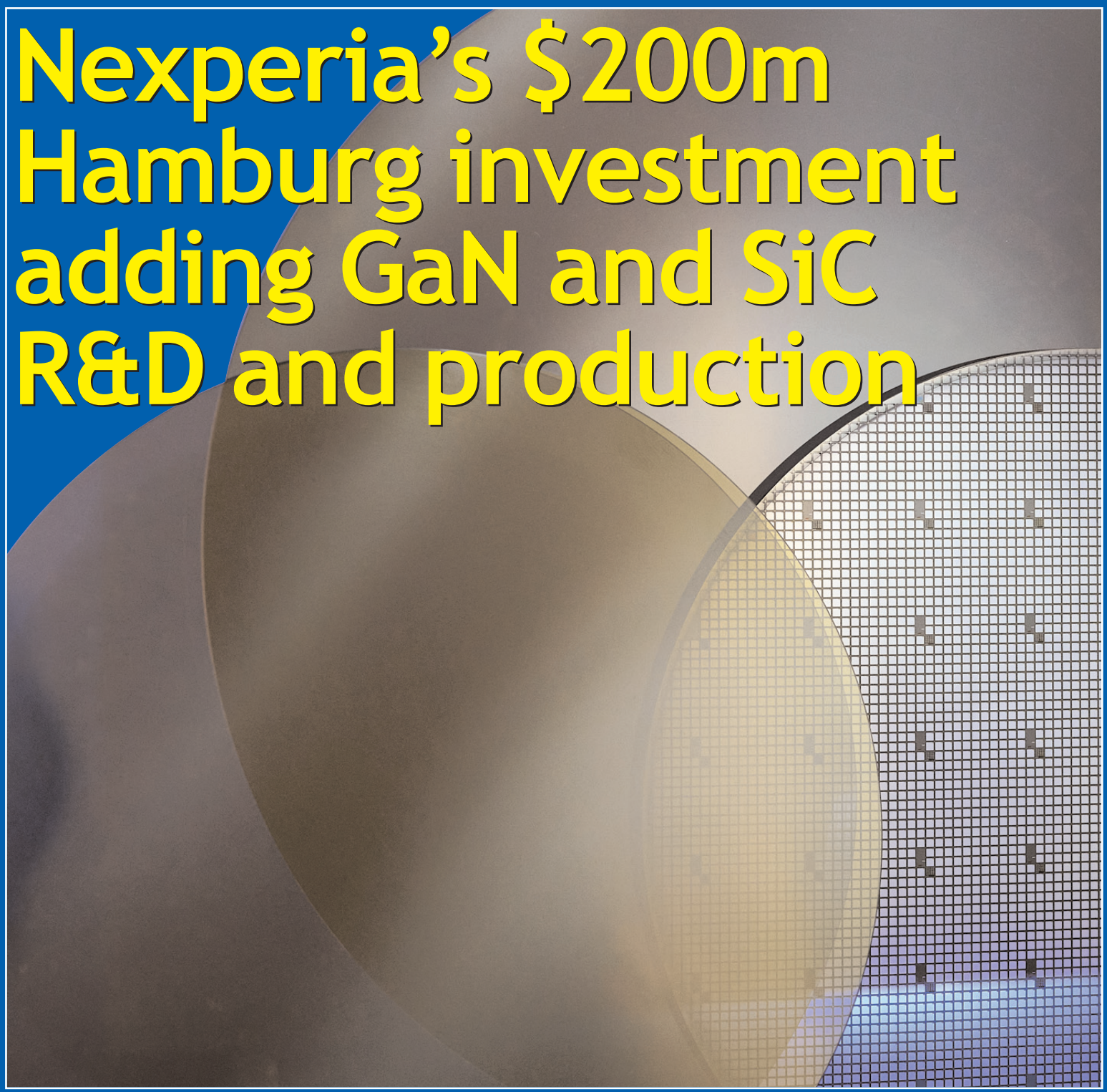
Nexperia's $200m Hamburg investment adding GaN and SiC R&D and production



ST building 200mm SiC fab in Catania • CGD and Qorvo partner
onsemi to establish $2bn Czech SiC fab • Kymera buying Fiven

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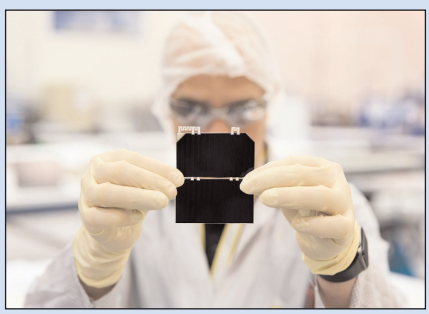
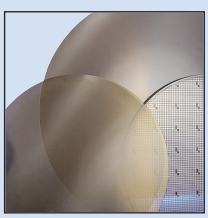
p12 ST is building a high-volume 200mm silicon carbide fab for power devices and modules, as well as test & packaging, in Catania, Italy.

p56 Cambridge spin-off Wave Photonics has received £4.5m in seed funding to be used to develop on-chip photonics designs for quantum technologies, sensors, and data-center applications.



p60 Allocated $23.9m in US CHIPS Act funding, Rocket Lab is to expand space-grade solar cell production by 50% in the next three years.



Cover image: Nexperia is investing $200m to develop wide-bandgap semiconductors such as SiC and GaN and to establish production infrastructure at its site in Hamburg, Germany, while also expanding wafer fab capacity there for silicon diodes and transistors. **p20**

editorial

Regional development versus trade

After a slump in sales in first-quarter 2024, Tesla's sales of electric vehicles rebounded by a more-than-expected 14% in Q2, despite the erosion of its market share by rapidly growing rivals such as China's BYD. Indicative of EV sales continuing to grow through penetration of the overall car market, confidence remains in the demand for silicon carbide power devices for EVs, especially as SiC's adoption further erodes silicon's market share. Collaborations and investments in SiC manufacturing hence continue, aided by funding from governments aiming to foster secure regional ecosystems.

Europe's STMicroelectronics had a leading 32.6% share of the world's SiC power device market in 2023 (see page 7). Now, supported by €2bn in Italian government funding via the European Chips Act, ST is investing €5bn to add a 200mm SiC wafer fab for manufacturing, test & packaging of power devices and module at its site in Catania, Italy, creating a fully vertically integrated 'Silicon Carbide Campus' (see page 12). The firm is targeting automotive, industrial and cloud infrastructure applications. Also, as well as signing a multi-year deal to accelerate their existing supply of SiC devices to China's Geely Auto Group, ST has also agreed to establish a joint development lab in China (see page 13). ST already has a 200mm SiC device fab joint venture with Sanan in China.

Likewise, US-based onsemi — which rose from fourth- to second-largest SiC power device maker in 2023 — is to establish a $2bn 'end-to-end' vertically integrated SiC manufacturing facility in the Czech Republic, aided by Czech government incentives via the European Chips Act (page 14).

Meanwhile, 'American-led' SMC Diode Solutions has opened its second power discrete fab in Nanjing, China, not only expanding the firm's production of silicon devices but also allowing the firm's first end-to-end production of SiC products (page 17).

China-owned Netherlands-based firm Nexperia is investing $200m to not only expand capacity for silicon diode and transistor production but also to develop and produce silicon carbide and gallium nitride wide-bandgap semiconductor devices at its site in Hamburg, Germany (page 20).

Used mainly for RF or low-power applications, GaN-on-silicon has been making inroads into higher-voltage power electronics applications, exemplified at PCIM Europe 2024 by Germany's Fraunhofer IAF presenting its development of 1200V GaN HEMT devices (page 34).

However, one factor affecting GaN is the impact of China — home to 86% of the world's primary unrefined gallium production capacity — imposing restrictions on the export of gallium (as well as germanium) in response to the USA restricting exports of key semiconductor manufacturing equipment to China. Now, China has added a new regulation (from 1 October) prohibiting anyone from unlawfully accessing or damaging rare-earth material resources such as gallium, citing the securing of national and industrial interests to effectively assert state ownership.

Trade relations are further clouded by the European Union deciding to increase tariffs on the import of Chinese-made EVs on the grounds of "unfair subsidization". Apart from the complexity that some European and US firms such as Tesla make cars in China and import them into Europe — and some Chinese firms such as Geely make cars (i.e. Volvo) in Europe — there is also the factor that European and US SiC device makers not only supply to Chinese EV makers but even have manufacturing JVs in China. So, as usual, trade barriers cut both ways.

Mark Telford, Editor

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

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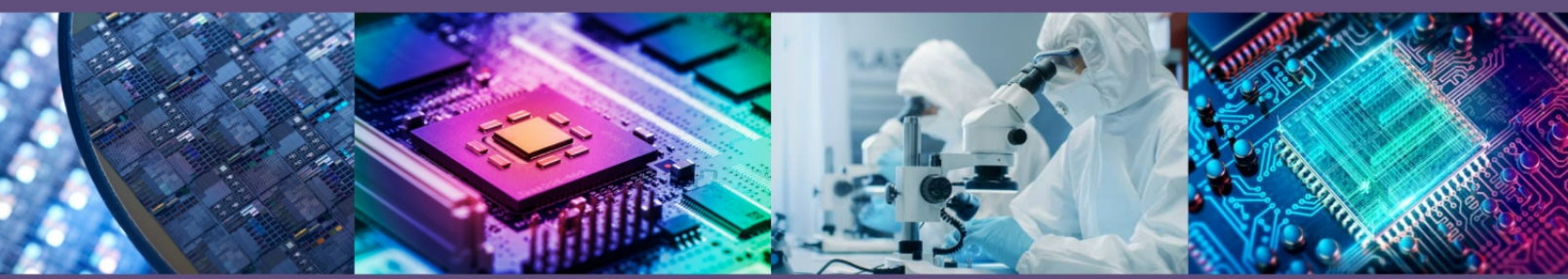

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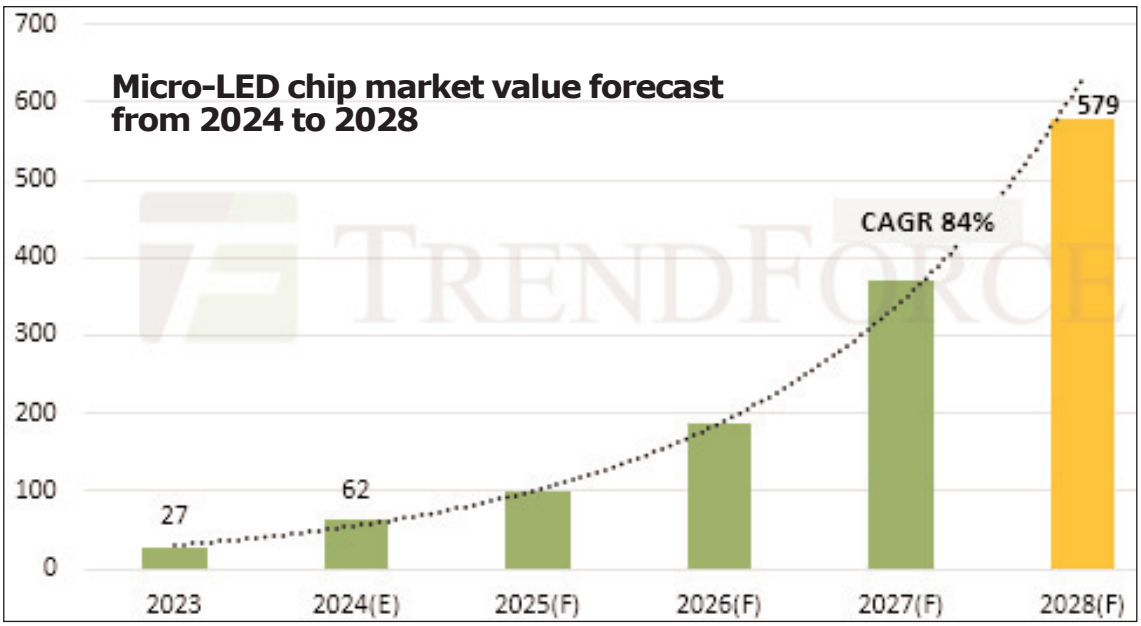
Micro-LED chip market growing at 84% CAGR to $579m by 2028

Increasing focus on head-mounted devices and automotive applications

The micro-LED chip market is rising at a compound annual growth rate (CAGR) of 84% from just $27m in 2023 to $579m by 2028, forecasts TrendForce's '2024 Micro LED Market Trend and Cost Analysis Report'.



With efforts to reduce the cost of micro-LED chips through size miniaturization ongoing, companies like LGE, BOE and Vistar continue to invest in large-display applications, while AUO has been focusing on developing smartwatch products. There is also growing demand for new display applications in head-mounted devices and for automotive uses.

Challenges in the micro-LED industry

The inability to reduce costs and technical challenges are major factors behind the cancellation of Apple's micro-LED watch. Therefore, continuous optimization of production processes remains critical for the development of the micro-LED industry. The evolution of mass transfer technology is expected to shift from a single technique to a composite technique, such as combining laser transfer with stamp transfer and potentially achieving a transfer solution with bonding capability with no stiction.

Inspection and repair processes are critical for improving yield rates and reducing micro-LED costs. Existing electrical testing methods are being upgraded, focusing on high-precision probe cards and contactless testing. These advances are not only leading the development of electrical testing but also present significant business opportunities for equipment manufacturers.

The cancellation of the Apple Watch has prompted Germany-based chip supplier ams OSRAM to consider selling its 8-inch wafer fabrication plant in Malaysia. If the buyer is a company within the existing micro-LED supply chain, this could positively impact the industry's technical development and cost structure optimization. Considering the shift in technology routes and target markets, Chinese compound semiconductor manufacturers developing 8-inch silicon carbide (SiC) power semiconductors are also potential buyers. This would allow them to expand into international markets, providing chip manufacturers with a means to increase profitability.

Opportunities in the micro-LED industry

Micro-LEDs still retain distinct advantages over competing technologies like micro-OLEDs. In augmented-reality (AR) glasses, which require light engines with high brightness and small volume, micro-LED light engines have now achieved sizes smaller than 0.2cc. With brightness levels advancing toward 350,000nits, micro-LEDs are well suited to high-brightness, all-weather and all-scene recognition. The rapid development of AI-assisted tools is also expected to drive demand for AR glasses with micro-LED displays over the next 1–2 years.

In the automotive sector, displays do not require extremely high levels of pixels per inch PPI but demand higher contrast and reliability. Due to its high brightness, contrast, wide color gamut and fast response, micro-LED technology can enhance the driving experience when integrated into smart cockpit display solutions with unique shapes, curves, flexibility and feedback. This expands the potential applications of micro-LEDs in automotive scenarios — such as AR-HUDs and P-HUDS — as well as innovative display technologies for car windows using transparent displays.

www.trendforce.com

ST remains largest silicon carbide power device maker, with 32.6% market share

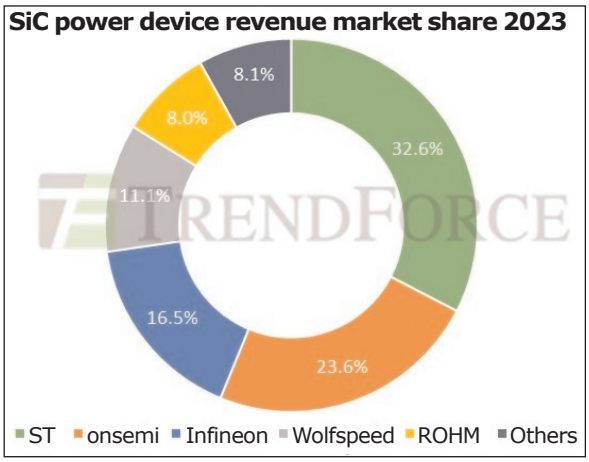
onsemi rises from fourth to second; top five comprise 91.9% of revenue

Market research firm TrendForce reports that the silicon carbide (SiC) power device industry maintained strong growth in 2023, driven by the application of battery electric vehicles (BEVs). The top five suppliers accounted for about 91.9% of total revenue: Europe-based STMicroelectronics led the pack with 32.6% market share, while US-based onsemi rose from fourth place in 2022 to second place in 2023.

The analysis indicates that demand from artificial intelligence (AI) servers and other fields will rise significantly in 2024. However, the noticeable slowdown in BEVs sales growth and weakening industrial demand are affecting the SiC supply chain. It is expected that the annual growth rate of revenue for SiC power devices will slow significantly in 2024 compared with previous years.

As a key supplier of automotive SiC MOSFETs, ST is building a full-process SiC factory in Catania, Italy, that is expected to be operational by 2026. Additionally, the 8-inch SiC joint venture factory established by ST and Sanan Optoelectronics in China is expected to be up and running by the end of 2024. This will enable ST to achieve vertical integration by combining local post-processing production lines and supporting substrate material factories provided by Sanan Optoelectronics.

onsemi's SiC business has progressed rapidly in recent years, mainly due to its automotive EliteSiC series of power devices. The firm's SiC wafer factory in Bucheon, South Korea, completed its expansion in 2023 and plans to transition to 8-inch production after completing relevant technical verification in 2025. Since acquiring SiC materials manufacturer GT Advanced Technologies Inc of Hudson, NH, USA in late 2021, onsemi's self-sufficiency rate for SiC substrate materials has exceeded 50%. With the increase in internal material production capacity, the company is moving toward achieving a gross profit margin of 50%.



Almost half of Infineon's SiC revenue is derived from the industrial market, but the main customer of its Kulim, Malaysia plant (SolarEdge) is facing difficulties, which has impacted Infineon's operations. In contrast, Infineon's automotive business is developing more robustly, as evidenced by the recent design win with the Xiaomi SU7. Interestingly, Infineon's previously lagging capacity expansion progress now positions it favorably amid market headwinds. Unlike other leading SiC integrated device manufacturers (IDMs), Infineon lacks internal production capabilities for SiC crystal materials and is actively promoting a diversified supplier system to ensure supply chain stability.

Wolfspeed's operational strategy missteps have caused it to miss market opportunities over the past two years, leading to setbacks in its power device business. However, Wolfspeed remains the world's largest supplier of SiC materials — particularly for automotive-grade MOSFET substrates — and has a first-mover advantage in the 8-inch domain.

With Wolfspeed's John Palmour Manufacturing Center for Silicon Carbide (the JP) about to start production, it is expected to significantly increase material capacity and advance the progress of the Mohawk Valley Fab (MVF) plant's commissioning. Despite this, Wolfspeed still faces enormous idle capacity and startup costs, which is putting significant pressure on its financial situation. The operational progress of the Mohawk Valley Fab and JP plants will determine whether Wolfspeed can smoothly navigate this challenging period.

ROHM recently acquired Solar Frontier's Kunitomi plant as its fourth SiC plant and plans to begin production of 8-inch SiC substrates this year, followed by the manufacturing of power devices. The firm has established long-term partnerships with automotive companies and tier-1 suppliers, such as Vitesco Technologies, Mazda and Geely, accelerating the development of the next generation of power modules to boost its market share.

TrendForce believes that, overall, the SiC industry is in a phase of rapid growth and intense competition, where economies of scale are more critical than any other factor. Leading IDM manufacturers have shifted from their previous conservative and steady strategies to actively investing in SiC expansion plans, aiming to establish a leadership position. Currently, more than 10 companies worldwide are investing in the construction of 8-inch SiC wafer plants. As the market continues to expand, competition in the SiC field is expected to become even more intense.

www.trendforce.com

EC and Italian government awards IPCEI ME/CT funding to GlobalWafers/MEMC to establish 300mm wafer production

€103m supports EC's aim to endorse research, innovation and industrial deployment of microelectronics and communication technologies across EU value chain

GlobalWafers Co Ltd of Hsinchu, Taiwan (GWC, the world's third largest supplier of semiconductor wafers) says that the Italian Ministry of Enterprises and Made in Italy (MIMIT) — following project authorization by the EU Commission (Directorate General for Competition) — issued an Assignment Decree awarding MEMC Electronic Materials S.p.A. of Novara, Italy an R&D grant of up to €103m to establish Europe's most advanced 300mm semiconductor wafer production facility. MEMC's new wafer fab is targeted at filling a critical gap in the European semiconductor supply chain that, until now, has been highly dependent on imports to supply wafers for the most advanced technology platforms.

"Our new MEMC 300mm production facility will support the creation of downstream products in all four of the high-tech Workstreams targeted by the IPCEI-ME/CT [Important Project of Common European Interest in Microelectronics and Communications Technologies] program, namely SENSE (Sensor applications), THINK (Logic applications), ACT (Power Applications), and COMMUNICATE (Communication applications)," notes president Marco Sciamanna. "We are proud to be counted among the 56 companies participating in the program and even prouder to be one of only a handful of the companies to add tangible value to all four of the targeted Workstreams," he adds.

"In this era of economic regionalization, the European Commission and the Italian Government have strategically targeted the most important investments to build resiliency in the European semiconductor and high-tech sectors. In this regard, GlobalWafers MEMC's new 300mm Novara fab perfectly fits the European Commission's definition of 'Research and Development' and 'First Industrial Deployment' of advanced technology," says GlobalWafers' chairwoman Doris Hsu. "As the newest 300mm silicon wafer production facility in Europe, MEMC S.p.A. is utilizing the industry's most cutting-edge manufacturing technology to meet our clients' ever more sophisticated requirements."

With manufacturing facilities in Novara and Merano, MEMC S.p.A. has operated in Italy for decades, producing wafers for hundreds of European and global makers. MEMC S.p.A. wafers are used to fabricate devices used across the entire European high-tech economy, ranging from cars and the industrial-Internet of Things (IOT & IIOT) to consumer electronics and medical equipment. With this expansion, MEMC is bringing 600 construction jobs to Novara, in addition to 150 new long-term company jobs. With each new job added in the semiconductor industry, 5.7 additional jobs are supported in the local economy, according to the Semiconductor Industry Association (SIA).

GlobalWafers says that, as a key ESG (environmental, social and governance) imperative, its companies across the globe practice green manufacturing and aim to improve energy efficiency, water conservation, waste management and air pollution control. When fully ramped-up, MEMC S.p.A.'s new 300mm fab will recycle up to half of its water used in production. It also plans to utilize 100% renewable energy to manufacture advanced silicon wafers.

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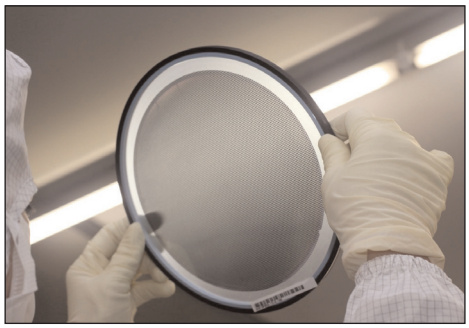
WIN Semiconductors releases moisture rugged 0.1µm GaAs pHEMT technology

PP10-29 supports amplifier designs through E-band and provides wafer-level moisture resistance for bHAST requirements in low-cost plastic packages

WIN Semiconductors Corp of Taoyuan City, Taiwan — which provides pure-play gallium arsenide (GaAs) and gallium nitride (GaN) wafer foundry services for the wireless, infrastructure and networking markets — has announced the beta release of its PP10-29 moisture rugged 0.1µm pseudomorphic high-electron-mobility transistor (pHEMT) technology.

Building on the mature and production-proven PP10 platform, the high-performance technology incorporates WIN's second-generation humidity resistance process EMRII to provide mechanical protection and moisture ruggedness at the wafer level, satisfying bHAST (biased highly accelerated stress test) requirements. To minimize added parasitic capacitance, the EMRII layers form localized air-cavities over all transistors to provide moisture resistance with minimal impact to gain, noise figure and output power.



This key feature of PP10-29 mitigates amplifier performance changes from packaging, plastic encapsulation or PCB embedding, and accelerates new product development.

The core of PP10-29 is a versatile 0.1µm-gate D-mode with f_T/f_{max} of 145GHz and 180GHz, respectively (supporting operation at E-band frequencies), and is qualified for 4V operation. Manufactured on 150mm GaAs substrates, the platform offers two interconnect metal layers, air-bridge crossovers, precision tantalum nitride (TaN) resistors, monolithic PN-junction diodes for compact on-chip ESD protection circuits and through-wafer vias for low inductance grounding. Providing a path to new packaging and assembly options, PP10-29 supports multiple DC and RF I/O configurations including standard wire-bonding, front-side Cu-bumps/RDL (copper redistribution layers), and through-chip RF and DC transitions.

PP10-29 has reached beta release and is available for early-access multi-project wafer (MPW) runs. Qualifications testing is complete and final modeling/PDK generation is expected to conclude in August, with full production release scheduled for late third-quarter 2024.

WIN showcased its compound semiconductor RF and mm-Wave solutions at the 2024 IEEE MTT-S International Microwave Symposium (IMS) in Washington DC (16–21 June).

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ST to build fully integrated 200mm silicon carbide power device and module plant in Catania

€5bn investment includes €2bn from Italy under EU Chips Act

STMicroelectronics of Geneva, Switzerland has announced a new high-volume 200mm silicon carbide (SiC) manufacturing facility for power devices and modules, as well as test & packaging, to be built in Catania, Italy. Combined with the SiC substrate manufacturing facility being readied on the same site, these facilities will form ST's Silicon Carbide Campus, realizing the firm's vision of a fully vertically integrated manufacturing facility for the mass production of SiC on one site.

The creation of the new Silicon Carbide Campus is said to be a key milestone to support customers for SiC devices across automotive, industrial and cloud infrastructure applications as they transition to electrification and seek higher efficiency.

"The fully integrated capabilities unlocked by the Silicon Carbide Campus in Catania will contribute significantly to ST's SiC technology leadership for automotive and industrial customers through the next decades," reckons president & CEO Jean-Marc Chery. "The scale and synergies offered by this project will enable us to better innovate with high-volume manufacturing capacity, to the benefit of our European and global customers as they transition to electrification and seek more energy-efficient solutions to meet their decarbonization goals."

The Silicon Carbide Campus will serve as the center of ST's global SiC ecosystem, integrating all steps in the production flow, including SiC substrate development, epitaxial growth processes, 200mm front-end wafer fabrication and module back-end assembly, as well as process R&D, product design, advanced R&D labs for dies, power systems and modules, and full packaging capabilities. This will achieve what is claimed to be a first of a kind in Europe for the mass production of 200mm SiC wafers, with each step of the process — substrate, epitaxy & front-end, and back-end — using 200mm technologies for enhanced yields and performances.

The site of ST's Silicon Carbide Campus.

Combined with the silicon carbide substrate manufacturing facility being readied on the same site, these facilities will form STMicroelectronics' Silicon Carbide Campus

The new facility is targeted to start production in 2026 and to ramp to full capacity by 2033, with up to 15,000 wafers per week at full build-out. The total investment is expected to be about €5bn, with a support of €2bn provided by the State of Italy within the framework of the EU Chips Act. Sustainable practices are said to be integral to the design, development and operation of the Silicon Carbide Campus to ensure the responsible consumption of resources including water and power.

Catania has long been a key site for innovation for ST as the home of SiC R&D and manufacturing operations. With an established ecosystem for power electronics — including a long-term collaboration between ST and the University of Catania and the CNR (Italian National Research Council), as well as a large network of suppliers — this investment is expected to strengthen Catania's role as a global competence center for SiC technology and for further growth opportunities.

ST manufactures its flagship high-volume SiC products on two 150mm wafer lines in Catania (Italy) and Ang Mo Kio (Singapore). A third hub is a joint venture with Sanan Optoelectronics, with a 200mm facility under construction in Chongqing (China), dedicated to ST to serve the Chinese market. ST's wafer production facilities are supported by automotive-qualified, high-volume assembly & test operations in Bouskoura (Morocco) and Shenzhen (China). SiC substrate R&D and industrialization is undertaken in Norrköping (Sweden) and Catania, where ST's SiC substrate manufacturing facility is ramping up production and most of ST's SiC product R&D and design staff are based.

www.st.com

Geely and ST set up joint lab and sign multi-year silicon carbide device supply deal

ST's third-generation SiC MOSFETs to boost powertrain efficiency for Geely battery electric vehicles

STMicroelectronics of Geneva, Switzerland and China-based automobile and electric vehicle (EV) maker Geely Auto Group have signed a multi-year silicon carbide supply agreement to accelerate their existing cooperation on SiC devices.

ST will provide multiple Geely Auto brands with SiC power devices for mid-to-high-end battery electric vehicles (BEVs), boosting Geely Auto's new-energy vehicle (NEV) transformation strategy with improved performance, faster charging speeds and extended driving range.

In addition, building on their long-standing cooperation across multiple automotive applications, Geely and ST have established a joint lab to exchange information and explore innovative solutions related to automotive electronics/electrical (E/E) architectures (i.e. in-vehicle infotainment, smart cockpit systems), advanced driver assistance (ADAS), and NEVs.

Geely Auto Group has adopted ST's third-generation SiC MOSFET devices in traction inverters to maximize the efficiency of the electric powertrains. The combination of advanced inverter design with high-efficiency power semiconductors like SiC is the key to superior EV performance.

"This long-term SiC supply agreement and the joint lab establishment mark a significant step forward in our long-established cooperation," says Henry Cao, executive VP of sales & marketing, China Region, at STMicroelectronics. "China is the biggest NEV market worldwide and a leading innovator. Our local competence centres and joint labs with our customers across the value chain of automotive allow ST to better support automotive innovation and transformation in China," he adds.

As China's top automotive brand, Geely Auto sold 1.68 million vehicles in 2023, with NEV sales growing by 48% year-on-year to 480,000 units (28% of total sales), demonstrating the firm's transition towards NEVs and its growing impact in the industry.

With a completely vertically integrated supply chain, ST provides SiC devices for EV applications including traction inverters, on-board chargers (OBCs), DC–DC converters, EV charging stations and e-compressor applications, significantly enhancing the performance, efficiency and range of NEVs. In June 2023, ST and China-based Sanan Optoelectronics announced the creation of a new 200mm SiC device manufacturing joint venture in Chongqing, China. This facility will better support Chinese customers as ST collaborates with more Chinese carmakers, industrial customers and solution providers in SiC, accelerating the pace of electrification in China.

www.geely.com
www.st.com

Signing ceremony for the collaboration between ST and Geely Auto.

onsemi selects Czech Republic to establish $2bn end-to-end silicon carbide production site for power semiconductors

onsemi is cooperating with Czech government on incentive package to support investment

In a strategic move addressing what it describes as unprecedented demand for power semiconductors that can optimize energy conversion and management, onsemi of Scottsdale, AZ, USA plans to establish a vertically integrated silicon carbide (SiC) manufacturing facility in the Czech Republic. The site would produce the firm's intelligent power semiconductors for improving the energy efficiency of power electronics in electric vehicles, renewable energy and artificial intelligence (AI) data centers.

onsemi's facility in Ro_nov pod Radho_t_m in the Czech Republic.

"Our brownfield investment would establish a Central European supply chain to better service our customers' rapidly increasing demand for innovative technologies that improve the energy efficiency in their applications," says president & CEO Hassane El-Khoury. "Through a close collaboration with the Czech government, the expansion would also enhance our production of intelligent power semiconductors that are essential to helping ensure the European Union is able to achieve its ambitions to significantly reduce carbon emissions and environmental impact," he adds.

"onsemi's decision to expand in Czechia is a clear confirmation of our country's attractiveness for foreign investment and will bring significant momentum for the development of our economy," believes Jozef Síkela, the Czech Republic's Minister of Industry and Trade. "This investment not only strengthens our position in the semiconductor field but can also contribute to the development of the automotive industry and help us with its adaptation to the rise of electro-mobility."

Commitment to Europe and the Czech Republic

onsemi's plan to expand SiC manufacturing with a multi-year brownfield investment of up to $2bn (CZK44bn) is part of its previously disclosed long-term capital expenditure target. This investment would build on existing operations in the Czech Republic, which include silicon crystal growth, silicon and silicon carbide wafer manufacturing (polished and epitaxy) and a silicon wafer fab. Currently, the site can produce more than 3 million wafers annually, including more than 1 billion power devices. Upon completion, the operation would contribute annually more than US$270m (CZK6bn) to the country's gross domestic product (GDP).

Investment would build on existing operations in the Czech Republic, which include silicon crystal growth, silicon and silicon carbide wafer manufacturing and a silicon wafer fab

Pending all final regulatory and incentive approvals (including by the government of the Czech Republic and its notification to the European Commission), this would be one of the largest private sector investments in the Czech Republic's history and would further contribute to the economic prosperity of the Zlín region. Onsemi's investment would also contribute to the strategic positioning of the region within the EU's semiconductor value chain and demonstrate that all EU countries can benefit from the European Chips Act. The announcement also reflects onsemi's strategic alignment with the overarching goals of the European Chips Act of increasing market share and technological advancement to strengthen the resilience of the EU's semiconductor supply chains in times of ever-growing demand.

www.onsemi.com

SiCSem to collaborate with Indian Institute of Technology to develop compound semi ecosystem in Bhubaneswar

First project to indigenize SiC crystal growth at IIT Bhubaneswar

Chennai-based SiCSem Private Limited (which was incorporated at the end of 2023) and the Indian Institute of Technology Bhubaneswar (IIT–BBS) has signed a memorandum of agreement to collaborate on research on compound semiconductors.

The first project to be carried out as part of the agreement aims to indigenize silicon carbide (SiC) crystal growth at IIT Bhubaneswar. Estimated to cost Rs45crore (about $5.4m), it would develop expertise in the high-volume production of 150mm and 200mm SiC wafers. Also, SiCSem plans to establish an SiC process fabrication and ATMP (assembly, test & packaging) plant in Odisha state. This should help India to become self-sufficient in power semiconductor devices for advanced technologies such as EVs, fast chargers, green energy, PV inverters, motor controls, and beyond-5G communication.

The collaboration will promote innovation and self-reliance in SiC crystal growth, and represents a "major industry-academia partnership for IIT Bhubaneswar", says its director, professor Shreepad Karmalkar. The collaboration is expected to contribute significantly to the development of the semiconductor ecosystem in Odisha as well as the nation's semiconductor industry, in line with the India Semiconductor Mission, Make in India and Atmanirbhar Bharat initiatives.

www.iitbbs.ac.in

Kymera to acquire silicon carbide materials firm Fiven

Acquisition expected to close in Q3/2024

Kymera International of Research Triangle Park, NC, USA (which develops and manufactures specialty materials and high-performance surface coatings) has signed an agreement to acquire Fiven ASA of Oslo, Norway from Los Angeles-based global private equity firm OpenGate Capital, which acquired Fiven in 2019 through a corporate carve-out from Saint-Gobain.

With production facilities in Norway, Belgium and Brazil, as well as a global distribution network, Fiven manufactures silicon carbide grains and powders for industrial end markets such as metallurgy, refractories, abrasives, filtration, and technical ceramics. Through its recent R&D initiatives, it has developed and marketed high-purity materials for power electronics industries such as semiconductors and lithium-ion batteries. Under the leadership of CEO Falk Ast, Fiven continues to drive collaborative relationships with its customers, with a strong emphasis on environmental, social & governance (ESG) issues.

"Fiven has all of the strong attributes we look for in an acquisition. They have an excellent reputation for quality and service, are aligned with Kymera's strategy of focusing on attractive end markets such as electronics, aerospace and defense, and have an outstanding management team and dedicated workforce," comments Kymera's CEO Barton White, who expects to continue growing Fiven and capitalize on the operational and commercial synergies that they have identified.

Since 2018, Kymera has been owned by affiliates of Palladium Equity Partners LLC, a middle-market private equity firm with over $3bn in assets under management. "The acquisition of Fiven will accelerate Kymera's mission to become a high-growth specialty materials and chemicals platform, and unlocks substantial organic growth opportunities for the combined business," reckons Palladium partner Adam Shebitz. "Altogether, Kymera is well on its way towards achieving Palladium's investment objectives, having more than tripled in size from our initial investment, while creating a more resilient business oriented towards the industries of tomorrow."

The acquisition of Fiven is expected to close in third-quarter 2024 following customary regulatory approvals.

www.fiven.com

Wolfspeed's Mohawk Valley 200mm SiC fab reaches 20% utilization

June quarter to see under-utilization impact from equipment incident at Durham 150mm fab

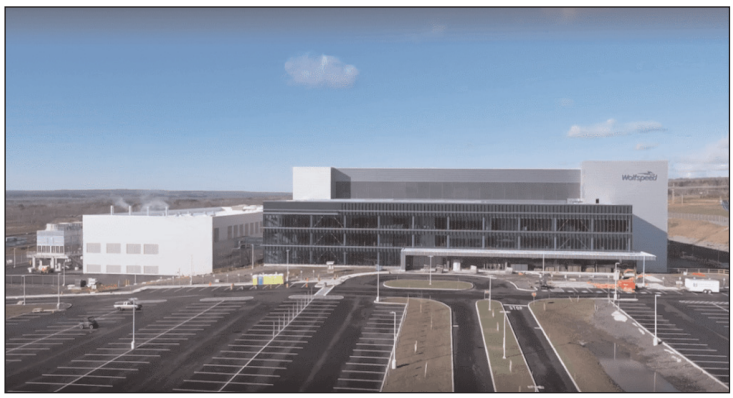
Wolfspeed Inc of Durham, NC, USA — which makes silicon carbide (SiC) materials and power semiconductor devices — says that its Mohawk Valley silicon carbide fab has reached 20% wafer start utilization, a critical step in the firm's efforts to meet the growing demand for silicon carbide power devices.

Additionally, Wolfspeed's Building 10 Materials facility has achieved its 200mm wafer production target to support about 25% wafer start utilization at the Mohawk Valley fab by the end of calendar year 2024.

The Mohawk Valley fab has also achieved LEED (Leadership in Energy and Environmental Design) Silver certification, a distinction from the world's most widely used green building framework and rating system. Wolfspeed says that the LEED Silver certification highlights its commitment to going beyond compliance, promoting environmental health and industry-leading sustainability.

The Mohawk Valley facility is reckoned to be the world's first purpose-built, fully automated 200mm silicon carbide fab and, when combined with Wolfspeed's 200mm materials production, makes Wolfspeed currently the only fully vertically integrated 200mm silicon carbide manufacturer at scale.

Also, Wolfspeed's John Palmour Manufacturing Center (the JP) in Siler City, NC, which will be the world's largest silicon carbide materials facility upon completion, has installed and recently activated initial furnaces less than one year after vertical construction began. As a result, the facility is on schedule to achieve crystal qualification by early August. The firm says that this progress reinforces its confidence that it is well positioned to ramp the JP in line with its target to deliver



wafers from the facility to the Mohawk Valley fab by summer 2025.

"Having reached our 20% utilization target at Mohawk Valley, we are well positioned to continue executing our 200mm vertical integration strategy ahead of other market participants," says president & CEO Gregg Lowe. "Further, recent advancements at the JP put Wolfspeed well on track to achieve our facility targets and significantly expand our materials capacity, driving meaningful progress towards our strategic goals."

Business outlook after equipment incident at Durham 150mm device fab

Wolfspeed says that, at its Durham 150mm device fab, it experienced an equipment incident that was quickly identified and resolved. However, this has resulted in a temporary capacity reduction while the incident was being remediated. Production has been resumed and the firm expects that the fab's capacity utilization can return to previously targeted levels by August.

As a result of the production disruption, in fiscal fourth-quarter 2024 (to end-June), Wolfspeed does not expect an impact on revenue but does expect an impact from under-utilization and other costs.

Due to the Durham 150mm device fab equipment incident, Wolfspeed is updating its fiscal fourth-quarter 2024 guidance as follows, and providing a preliminary outlook for revenue and non-GAAP gross margin for fiscal first-quarter 2025 (to end-September):

- Targeted fiscal fourth-quarter revenue from continuing operations is unchanged at $185–215m, but the firm expects a potential negative impact to fiscal first-quarter 2025 revenue of about $20m.
- Targeted fourth-quarter GAAP gross margin of (4%) to 4% and non-GAAP gross margin is 0–8%, due to an under-utilization impact realized in the fourth quarter and other costs related to the equipment incident. Also, due to under-utilization, the firm expects fiscal first-quarter 2025 non-GAAP gross margin to be in a similar range.
- Fourth-quarter GAAP net loss from continuing operations is targeted to be $204–182m ($1.61–1.44 per diluted share. Non-GAAP net loss from continuing operations is targeted to be $122–105m ($0.96–0.83 per diluted share), excluding $77–82m of estimated expenses (net of tax), primarily related to stock-based compensation expense, amortization of discount and debt issuance costs, net of capitalized interest, project, transformation and transaction costs and loss on Wafer Supply Agreement.

Wolfspeed will update the market on its next utilization milestone for Mohawk Valley during its fiscal fourth-quarter 2024 earnings call in August.

www.wolfspeed.com

SMC opens second power MOSFET & diode fab in Nanjing

Capacity quadrupled, including end-to-end production of silicon carbide products for the first time

American-led semiconductor design and manufacturing company SMC Diode Solutions (which was founded in 1997) has celebrated the opening of its second power discrete fab in Nanjing, China.

The new facility achieved volume production only 21 months after groundbreaking in September 2022, and will begin shipments to customers in fourth-quarter 2024 for high-power and high-voltage rectifiers and MOSFET 6-inch and 8-inch wafers.

As Nanjing is also home to its existing fab, resources and engineering talent, SMC says that the city was an advantageous choice for the new fab location. With its experienced management team, starting up the new fab was said to be a seamless process.

SMC says that the new fab marks a milestone in its growth as it further invests in China and the growing renewable energy sector. The 300,000ft^2 facility is set to produce 1.2 million silicon wafers and 60,000 silicon carbide wafers per year, increasing SMC's total production by over four times. SMC's existing fab in Lukou, Nanjing produces 300,000 silicon wafers per year. The RMB3bn investment in the new fab will allow SMC to handle the end-to-end production of silicon carbide products for the first time.

SMC Diode Solutions' new fab in Nanjing, China.

As well as silicon Schottky rectifier diodes, ultrafast recovery rectifier diodes, TVS diodes, and Schottky and rectifier modules, SMC's product portfolio includes silicon carbide Schottky rectifiers and MOSFETs.

"As the world moves towards using more and more renewable energy, we are thrilled to now be able to participate in the sector and be part of the solution to increase green energy usage," says SMC's chairwoman & CEO Dr Yunji Corcoran.

www.smc-diodes.com

Qorvo launches first 4mΩ SiC JFET in TOLL package

Lowest on-resistance in 650–750V class targets circuit protection

Qorvo Inc of Greensboro, NC, USA (which provides core technologies and RF solutions for mobile, infrastructure and defense applications) has launched what it claims is the industry's first 4mΩ silicon carbide (SiC) junction field-effect transistor (JFET) in a TOLL package, designed for circuit protection applications including solid-state circuit breakers, where low resistance, superior thermal performance, small size and reliability are paramount.

With an $R_{DS(on)}$ of just 4mΩ, the UJ4N075004L8S offers what is said to be the industry's lowest on-resistance in the 650–750V class of power devices in standard discrete packages. This low $R_{DS(on)}$ drives significant reductions in heat generation and, when coupled with a compact TOLL package, enables a solution size that is 40% smaller than competing devices in TO-263 packages, it is reckoned. This small solution size supports the space-limited dimensions of today's electro-mechanical circuit breakers and operates without the need for elaborate cooling systems, accelerating the transition from electro-mechanical circuit breakers to semiconductor-based solid-state circuit breakers (SSCBs).

"The SSCB market is growing rapidly, and Qorvo's newest product marks a significant milestone in the evolution of the technology," claims Ramanan Natarajan, director of product line marketing for Qorvo's SiC Power Products business.

Qorvo says that its JFETs are highly robust devices suited to meet the challenges of circuit protection, providing the ability to turn off at very high inrush currents during circuit faults. Qorvo's newest JFET can also withstand high instantaneous junction temperatures without experiencing degradation or parametric drift. The normally-on nature of the JFET lends itself to seamless integration into systems where the switch is in the on-state by default and in turn-off state under fault conditions.

The UJ4N075004L8S is available now for sampling and will enter full production in fourth-quarter 2024, accompanied by additional JFET options, including 750V with 5mΩ and 1200V with 8mΩ ratings, all in TO-247 packaging.

www.mesago.de/en/PCIM/
www.qorvo.com/products/power-solutions

ROHM adds 2-in-1 silicon carbide molded modules to TRCDRIVE pack series

Blurb: Integrating fourth-generation SiC MOSFETs achieves 1.5 times higher power density, shrinking xEV inverters

As part of its TRCDRIVE pack series, Japan-based ROHM has developed four models with 2-in-1 silicon carbide (SiC) molded modules (two 750V-rated: BSTxxxD08P4A1x4, two 1200V-rated: BSTxxxD12P4A1x1) optimized for xEV (electric vehicles) traction inverters. The TRCDRIVE pack supports up to 300kW and has high power density and a unique terminal configuration, helping to solve key challenges of traction inverters in terms of miniaturization, higher efficiency, and fewer person-hours.

As the electrification of cars advances, progress is being made in the development of electric powertrain systems that are more efficient, compact, and lightweight. However, for SiC power devices that are attracting attention as key components, achieving low loss in a small size has been a difficult challenge. ROHM claims to have solved these issues inside powertrains with its TRCDRIVE pack.

A trademark brand for ROHM SiC molded type modules developed specifically for traction inverter drive applications, the TRCDRIVE pack reduces size by utilizing a unique structure that maximizes heat dissipation area. In addition, ROHM's fourth-generation SiC MOSFETs with low ON-resistance are built in, resulting in what is claimed to be an industry-leading power density 1.5 times higher than that of general SiC molded modules while greatly contributing to the miniaturization of inverters for xEVs.

The modules are also equipped with control signal terminals using press-fit pins enabling easy connection by simply pushing the gate driver board from the top, reducing installation time considerably. In addition, low inductance (5.7nH) is achieved by maximizing the current path and utilizing a two-layer bus-bar structure for the main wiring, contributing to lower losses during switching.

Despite developing modules, ROHM has established a mass-production system similar to discrete products, making it possible to increase production capacity by 30 times compared with conventional SiC case-type modules, it is reckoned.

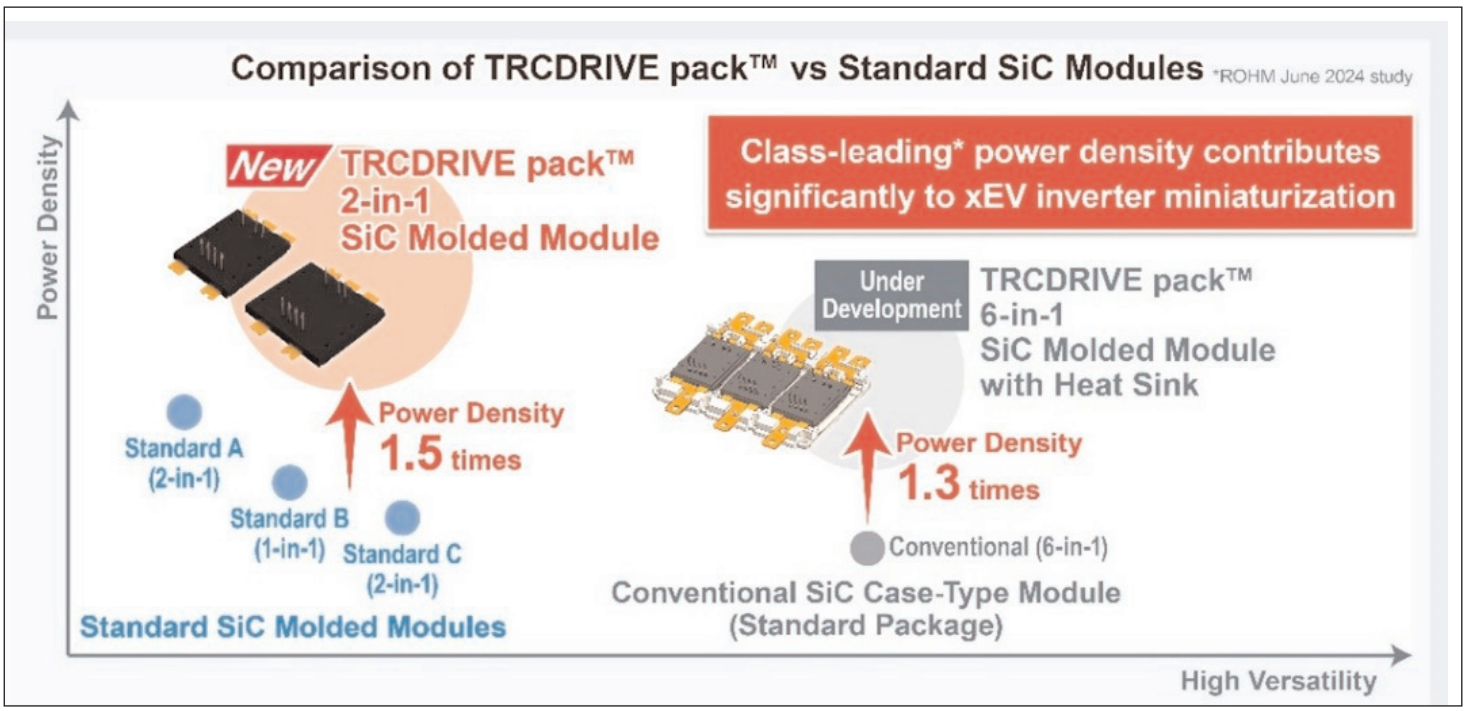
Product lineup

TRCDRIVE pack is due to be launched by March 2025 with a lineup of 12 models in different package sizes (small/large) and mounting patterns (TIM: heat dissipation sheet/Ag sinter). In addition, ROHM is developing a 6-in-1 product with a built-in heat sink to facilitate rapid traction inverter design and model rollout tailored to a variety of design specifications.

Application-level support

ROHM says that it is committed to providing application-level support, including the use of in-house motor testing equipment. Supporting materials are also offered, such as simulations and thermal designs that enable quick evaluation and adoption of TRCDRIVE pack products. Two evaluation kits are also available — one for double-pulse testing and the other for 3-phase full-bridge applications — enabling evaluation in similar conditions as practical inverter circuits.

www.rohm.com



SemiQ launches 1700V SiC Schottky discretes and dual diode modules

Compact and robust low-loss diode technologies enable designs for solar inverters, SMPS, DC/DC converters and EV charging

SemiQ Inc of Lake Forest, CA, USA — which designs, develops and manufactures silicon carbide (SiC) power semiconductors and 150mm SiC epitaxial wafers for high-voltage applications — has added 1700V SiC Schottky discrete diodes and dual diode packs to its QSiC product line.

The new devices meet the size and power demands of a wide range of demanding applications including switched-mode power supplies (SMPS), uninterruptible power supplies (UPS), induction heaters, welding equipment, DC/DC converters, solar inverters and electric vehicle (EV) charging stations.

Featuring zero reverse recovery current and near-zero switching loss, SemiQ's 1700V SiC Schottky diode technologies are said to offer enhanced thermal management that reduces the need for cooling. As a result, engineers can implement highly efficient, high-performance designs that minimize system heat dissipation, allow the use of smaller heat-sinks, and lead to cost and space savings. All of the new products support fast switching across operating junction temperatures (T_j) of −55°C to +175°C.

The GP3D050B170X (bare die) and GP3D050B170B (TO-247-2L package) discrete diode is rated for respective maximum forward currents of 110A and 151A. Device design supports easy parallel configurations, enhancing flexibility and scalability for various power applications.

The GHXS050B170S-D3 and GHXS100B170S-D3 dual diode packs are rugged modules supplied in a SOT-227 package. Maximum respective forward currents are 110A and 214A and each combine what is said to be outstanding performance at high frequencies with low-loss and low-EMI operation, ensuring energy efficiency and reliability by minimizing interference. Key features include low stray inductance, high junction temperature operation, rugged and easy mounting, and an internally isolated package (AlN), which provides optimal insulation and thermal conductivity. Low junction-to-case thermal resistance enables efficient heat dissipation, ensuring stability under high-power conditions. The modules can be easily connected in parallel due to the positive temperature coefficient (T_c) of the forward voltage (V_f).

"Our new 1700V SiC diodes represent a leap forward in power efficiency and reliability," claims president Dr Timothy Han. "With their compact and flexible design, low-loss operation and superior thermal management, our QSiC diodes will enable our customers to create innovative, high-performance solutions while reducing costs and improving overall system efficiency."

All parts have been tested at voltages exceeding 1870V and have undergone avalanche testing up to 1250mJ.

www.semiq.com

ROHM launches EcoSiC brand for products using silicon carbide

EcoSiC joins EcoGaN as part of Power Eco Family

Japan-based power semiconductor device maker ROHM Co Ltd has launched its EcoSiC brand as a trademark for products using silicon carbide (SiC).

The launch of the EcoSiC brand pursues several strategic objectives:

- *Improved performance*: SiC devices enable higher switching frequencies and lower losses, leading to more efficient and compact systems.
- *Sustainability*: Promoting eco-friendly products — such as carbon-neutral silicon carbide technologies — significantly reduces energy consumption in applications such as electric vehicles (EV) and renewable energy systems.
- *Technological innovation*: Positioning ROHM as a leading company in the development and manufacture of SiC products. ROHM is investing in R&D to improve the performance of silicon carbide components.

Also, ROHM is expanding its production capacities to meet the increasing demand for silicon carbide components.

The EcoSiC logo is part of ROHM's 'Power Eco Family' branding concept, which aims to maximize the efficiency and compactness of electronic applications while making a positive contribution to the environment.

The EcoGaN brand has already been in use since 2022, supporting ROHM's growing portfolio of power devices using gallium nitride and its properties in terms of switching speed. ROHM will also add high-performance silicon products to the Eco family in the future.

www.rohm.com

Nexperia investing $200m in Hamburg site to add wide-bandgap semiconductors

R&D and production of GaN and SiC to be added to expansion of silicon production to 200mm wafers

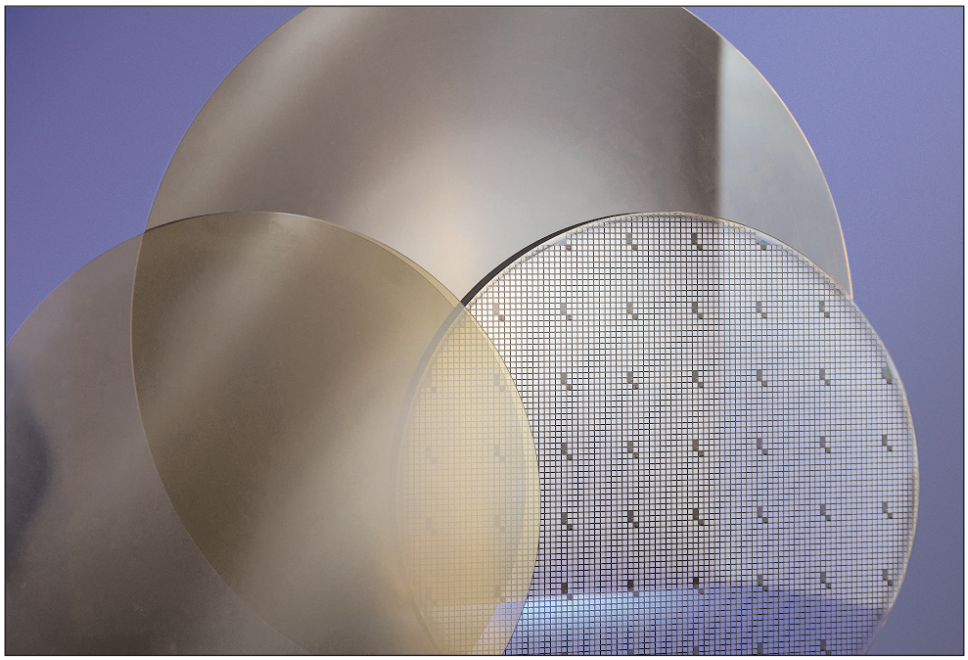
Discrete device designer and manufacturer Nexperia B.V. of Nijmegen, The Netherlands (a subsidiary of Wingtech Technology Co Ltd) plans to invest $200m (€184m) to develop wide-bandgap semiconductors (WBG) such as silicon carbide (SiC) and gallium nitride (GaN), and to establish production infrastructure at its site in Hamburg-Lokstedt, Germany. At the same time, wafer fab capacity for silicon (Si) diodes and transistors will be increased. The investments were jointly announced with Hamburg's Minister for Economic Affairs Dr Melanie Leonhard on the occasion of the 100-year anniversary of the production site.

To meet the growing long-term demand for efficient power semiconductors, all three technologies (SiC, GaN, and Si) will be developed and produced in Germany, starting from June.

"This investment strengthens our position as a leading supplier of energy-efficient semiconductors and enables us to utilize available electrical energy more responsibly," says Achim Kempe, chief operating officer & managing director at Nexperia Germany.

"In the future, our Hamburg fab will cover the complete range of WBG semiconductors while still being the largest factory for small-signal diodes and transistors. We remain committed to our strategy of producing high-quality, cost-efficient semiconductors for standard applications and power-intensive applications, while addressing one of the greatest challenges of our generation: meeting the growing demand for energy and while reducing the environmental footprint."

The first production lines for high-voltage GaN D-mode transistors and SiC diodes started up in June.



Silicon carbide epi and wafer.

The next milestone will be cost-efficient 200mm production lines for SiC MOSFETs and GaN HEMTs, established at the Hamburg factory over the next two years.

At the same time, the investment will help to further automate the existing infrastructure at the Hamburg site and expand silicon production capacity by systematically converting to 200mm wafers. Following expansion of the cleanroom areas, new R&D laboratories are being built to ensure a seamless transition from research to production in the future.

In addition to advancing technology, Nexperia expects the initiative to stimulate local economic development, helping to secure and create jobs, while enhancing the European Union's semiconductor self-sufficiency. Nexperia says that it works closely with universities and research institutes to benefit from each other's expertise and promote highly qualified employee training, relying on a robust R&D ecosystem in Hamburg and throughout Europe. Development partnerships and co-operations — e.g. in GaN technology as part of the Industrial Affiliation Program (IIAP) of the nanoelectronics research center imec in Leuven, Belgium — play a crucial role.

"The planned investment enables us to bring WBG chip design and production to Hamburg. However, SiC and GaN are by no means new territory for Nexperia. GaN FETs have been part of our portfolio since 2019, and in 2023 we expanded our range of products to include SiC diodes and SiC MOSFETs, the latter in collaboration with Mitsubishi Electric," says Stefan Tilger, chief financial officer & managing director at Nexperia Germany. "Nexperia is one of the few suppliers to offer a comprehensive range of semiconductor technologies, including Si, SiC and GaN in both E-mode and D-mode. This means we offer our customers a one-stop shop for all their semiconductor needs."

www.nexperia.com

Nexperia's 650V SiC Schottky diodes now automotive-qualified and available in R2P DPAK packaging

Portfolio also extended to 6A, 16A and 20A devices in TO-220-2, TO-247-2 and D2PAK-2 packaging for industrial applications

Nexperia says that its 650V, 10A silicon carbide (SiC) Schottky diode is now automotive qualified (PSC1065H-Q) and available in real-two-pin (R2P) DPAK (TO-252-2) packaging, making it suitable for applications in electric vehicles (EVs) and other automobiles.

Additionally, in a further extension to its portfolio of SiC diodes, Nexperia is now also offering industrial-grade devices with current ratings of 6A, 16A and 20A in TO-220-2, TO-247-2 and D2PAK-2 packaging to facilitate greater design flexibility. These diodes address the challenges of demanding high-voltage and high-current applications including switched-mode power supplies (SMPS), AC–DC and DC–DC converters, battery-charging infrastructure, motor drives, uninterruptible power supplies (UPS) as well as photovoltaic inverters for sustainable energy production.

The merged PiN Schottky (MPS) structure of these devices is said to provide additional advantages over similar competing SiC diodes,

including outstanding robustness against surge currents. This eliminates the need for additional protection circuitry, significantly reducing system complexity and enabling hardware designers to achieve higher efficiency with smaller form factors in rugged high-power applications. Nexperia says that its consistent quality across various semiconductor technologies provides designers with confidence in the reliability of these diodes.

In addition, Nexperia's 'thin SiC' technology delivers a thinner substrate (one-third of its original thickness), which dramatically reduces the thermal resistance from the junction to the back-side metal. This results in lower operating temperature, higher reliability and device lifetime, higher surge current capability, and lower forward voltage drop.

"We've seen an excellent market response to the initial release of our SiC diodes. They have proven themselves in design-ins, with one notable example in power supplies for industrial applications, where customers have achieved especially good results," says Katrin Feurle, senior director & head of product group SiC Diodes & FETs at Nexperia.

"The superior reverse recovery of these diodes translates to high efficiency in real-world use," she adds. "This is our first automotive-qualified product, and it is already recognized by major automotive players for its performance and reliability."

www.nexperia.com/sic diodes

Mitsubishi Electric ships lower-power 3.3kV SBD-embedded SiC-MOSFET modules

Existing 800A version joined by 400A and 200A versions for auxiliary power supplies in railcars and small-capacity drive systems

Tokyo-based Mitsubishi Electric Corp has begun shipping low-current 3.3kV/400A and 3.3kV/200A versions of a Schottky barrier diode (SBD) embedded silicon carbide (SiC) metal-oxide-semiconductor field-effect transistor (MOSFET) module.

Together with the existing 3.3kV/800A version launched on 29 March, the newly named Unifull series comprises three modules to meet the growing demand for inverters capable of increasing power output and power conversion efficiency in large industrial equipment.

Mitsubishi Electric's SBD-embedded SiC-MOSFET modules feature an optimized package structure to reduce switching loss and improve SiC performance. Compared with existing power modules, Unifull modules are claimed to significantly reduce switching loss and contribute to higher power output and power conversion efficiency in the inverters of large industrial equipment.

The new low-current modules are specifically suitable for the auxiliary power supplies in railcar rolling stock as well as drive systems with relatively small capacities, expanding the range of applications.

www.mitsubishielectric.com/semiconductors/powerdevices

Infineon adds Thin-TOLL 8x8 and TOLT packaged families to CoolSiC MOSFET discretes 650V portfolio

New packages increase system power density for high and medium SMPS applications

Infineon Technologies AG of Munich, Germany is expanding its portfolio of CoolSiC MOSFET discretes 650V by introducing two new product families housed in the Thin-TOLL 8x8 and TOLT packages, enabling maximum utilization of the PCB mainboard and daughter cards while also taking the system's thermal requirements and space restrictions into account.

The new product families are based on the CoolSiC Generation 2 (G2) technology, offering significantly improved figures-of-merit, reliability and ease of use. Both product families specifically target high and medium switching-mode power supplies (SMPS), including artificial intelligence (AI) servers, renewable energy, electric vehicle (EV) chargers, and large home appliances.

The Thin-TOLL package has a form factor of 8mm x 8mm and offers what is said to be the best-in-class thermal cycling on board (TCoB) capability on the market. The TOLT package is a top-side-cooled (TSC) enclosure with a similar form factor to TOLL.

Both package types are said to offer developers several benefits: Using them in AI and server power supply units (PSUs), for example, reduces the thickness and length of the daughter cards and allows for a flat heat sink. When used in micro-inverters, 5G PSU, TV PSU and SMPS, the Thin-TOLL 8x8 package allows for a minimization of the PCB area occupied by the power supply devices on the mainboard, while TOLT keeps the junction temperature of the devices under control, given that these applications typically use convection cooling. In addition, TOLT devices complete Infineon's top-side-cooled CoolSiC industrial portfolio, namely CoolSiC 750V in Q-DPAK. They enable developers to reduce the PCB footprint occupied by SiC MOSFETs when the power to be delivered to the devices does not require a Q-DPAK package.

Infineon's new CoolSiC MOSFET 650V G2 product families.

The CoolSiC MOSFETs 650V G2 in ThinTOLL 8x8 and TOLT are now available with on-resistances $R_{DS(on)}$ of 20mΩ, 40mΩ, 50mΩ and 60mΩ. Additionally, the TOLT variant is also available with an $R_{DS(on)}$ of 15mΩ. The product family will be expanded by a more granular portfolio by the end of 2024.

Infineon's CoolSiC MOSFET 650V Generation 2 devices were showcased at Power, Control and Intelligent Motion (PCIM) Europe 2024 in Nuremberg, Germany (11–13 June). Company representatives also gave several presentations at the accompanying PCIM Conference and Forums, followed by discussions with the speakers.

www.mesago.de/en/PCIM/
www.infineon.com/coolsic-gen2

Infineon unveils CoolSiC MOSFET 400V family

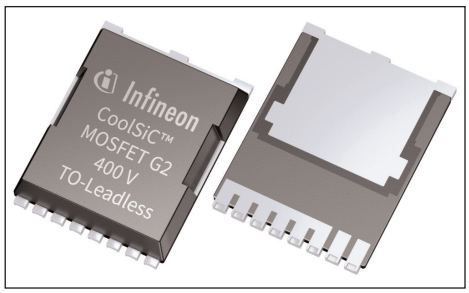
Extending silicon carbide MOSFETs below 650V targets AC/DC stage of AI server power supplies

With the increasing power requirements of artificial intelligence (AI) processors, server power supplies (PSUs) must deliver more and more power without exceeding the defined dimensions of the server racks. This is driven by a surge in energy demand of high-level GPUs, which could consume 2kW and more per chip by the end of the decade.

Infineon Technologies AG Munich, Germany says that these needs, as well as the emergence of increasingly demanding applications and the associated specific customer requirements, have prompted it to extend the development of SiC MOSFETs to voltages below 650V. The firm is now launching the new CoolSiC MOSFET 400V family, which is based on the second-generation (G2) CoolSiC technology introduced in early March.

The new MOSFET portfolio was specially developed for use in the AC/DC stage of AI servers, complementing Infineon's PSU roadmap unveiled this May. The devices are also suitable for solar and energy storage systems (ESS), inverter motor control, industrial and auxiliary power supplies (SMPS) as well as solid-state circuit breakers for residential buildings.

"Infineon offers an extensive portfolio of high-performance MOSFETs and GaN transistors to meet the demanding design and space requirements of AI server power supplies," says Richard Kuncic, head of the Power Systems business line. "We are committed to supporting our customers with advanced products such as the CoolSiC MOSFETs 400V G2 to drive highest energy efficiency in advanced AI applications."



Infineon's CoolSiC 400V MOSFETs, developed for the AC/DC stage of AI server power supplies.

The new family features ultra-low conduction and switching losses compared with existing 650V SiC and silicon MOSFETs. Implemented in a multi-level PFC, the AC/DC stage of the AI server PSU can attain a power density of more than 100W/in^3 and is proven to reach 99.5% efficiency. This is an improvement of 0.3 percentage points over solutions using 650V SiC MOSFETs. In addition, the system solution for AI server PSUs is completed by implementing CoolGaN transistors in the DC/DC stage. With this combination of high-performance MOSFETs and transistors, the power supply can deliver more than 8kW with an increase in power density by a factor of more than 3 compared with existing solutions.

The new MOSFET portfolio comprises a total of 10 products: five $R_{DS(on)}$ classes from 11mΩ to 45mΩ in Kelvin-source TOLL and D^{2}PAK-7 packages with .XT package interconnect technology. The drain–source breakdown voltage of 400V at T_{vj} = 25°C makes them suitable for use in 2- and 3-level converters and for synchronous rectification. The components offer high robustness under harsh switching conditions and are 100% avalanche tested. The highly robust CoolSiC technology, in combination with the .XT interconnect technology, enables the devices to cope with power peaks and transients caused by sudden changes in the power requirements of the AI processor. Both the connection technology and a low and positive $R_{DS(on)}$ temperature coefficient enable excellent performance under operating conditions with higher junction temperatures.

Engineering samples of the CoolSiC MOSFET 400V portfolio are now available and will enter series production from October onwards. The latest generation of Infineon's CoolSiC MOSFETs was showcased at Power, Control and Intelligent Motion (PCIM) Europe 2024 in Nuremberg, Germany (11–13 June).

www.mesago.de/en/PCIM/
www.infineon.com/AI-PSU

CoolGaN 700V G4 power transistor family launched

Infineon Technologies AG of Munich, Germany has launched the CoolGaN Transistor 700V G4 product family, which is said to be highly efficient for power conversion in the voltage range up to 700V.

In contrast to other GaN products on the market, the input and output figures-of-merit provide 20% better performance, it is claimed, resulting in increased efficiency, reduced power losses, and more cost-effective solutions. The combination of electrical characteristics and packaging ensures maximum performance in applications such as consumer chargers and notebook adapters, data-center power supplies, renewable energy inverters, and battery storage, adds the firm.

The product series comprises 13 devices with a voltage rating of 700V and on-resistance range from 20mΩ to 315mΩ. The increased granularity in device specification, combined with a wide range of industry-standard package options including PDFN, TOLL and TOLT, allow R_{DS} resistance and packages to be selected according to application requirements. As a result, both electrical and thermal system performance can be optimized and implemented in the most cost-effective solution, says Infineon.

The devices are characterized by a fast turn-on and turn-off speed and minimal switching losses. The on-resistance range enables power systems from 20W to 25,000W. In addition, the 700V E-mode with what is claimed to be the industry's highest transient voltage of 850V boosts the reliability of the overall system as it offers greater robustness against anomalies in the user environment such as voltage peaks.

The CoolGaN Transistor 700V G4 products in TOLL, PDFN 5x6 and 8x8 packages are available now. More variety in $R_{DS(on)}$ as well as the TOLT package follow later this year.

www.infineon.com/cms/en/product/power/gan-hemt-gallium-nitride-

CoolGaN gains bidirectional switch & Smart Sense products

Infineon has announced two new CoolGaN product technologies: CoolGaN bidirectional switch (BDS) and CoolGaN Smart Sense.

CoolGaN BDS provides soft- and hard-switching behavior, with bidirectional switches available at 40V, 650V and 850V. Target applications include mobile device USB ports, battery management systems, inverters, and rectifiers. The CoolGaN Smart Sense products feature lossless current sensing, simplifying design and further reducing power losses, as well as transistor switch functions integrated into one package. They are suitable for usage in consumer USB-C chargers and adapters.

The CoolGaN BDS high voltage will be available at 650V and 850V and feature a true normally-off monolithic bi-directional switch with four modes of operation. Based on the gate injection transistor (GIT) technology, the devices have two separate gates with substrate terminal and independent isolated control. They utilize the same drift region to block voltages in both directions with what is claimed to be outstanding performance under repetitive short-circuit conditions. Applications can benefit by using one BDS instead of four conventional transistors, resulting in higher efficiency, density and reliability. Furthermore, significant cost savings are achieved.

The devices optimize performance in the replacement of back-to-back switches in single-phase H4 PFC and HERIC inverters and three-phase Vienna rectifiers. Additional implementations include single-stage AC power conversion in AC/DC or DC/AC topologies.

The CoolGaN BDS 40V is a normally-off, monolithic bi-directional switch based on Infineon's in-house Schottky gate GaN technology. It can block voltages in both directions and, through a single-gate and common-source design, it is optimized to replace back-to-back MOSFETs used as disconnect switches in battery-powered consumer products. The first 40V CoolGaN BDS product has a 6mΩ $R_{DS(on)}$, with a range of products to follow. Benefits of using 40V GaN BDS versus back-to-back silicon FETs include 50–75% PCB area savings and a reduction in power losses by more than 50%, all at a lower cost.

The CoolGaN Smart Sense products feature 2kV electrostatic discharge withstand and can connect to controller current sense for peak current control and overcurrent protection. The current sense response time is ~200ns, which is equal or less than common controller blanking time for ultimate compatibility.

Implementing the devices results in increased efficiency and cost savings. At a higher $R_{DS(on)}$ of for example 350mΩ, the CoolGaN Smart Sense products offer similar efficiency and thermal performance at lower cost compared with traditional 150mΩ GaN transistors. Moreover, the devices are footprint compatible to Infineon's transistor-only CoolGaN package, eliminating the need for layout rework and PCB re-spin, and further facilitating design with Infineon's GaN devices.

Engineering samples of the CoolGaN BDS 40V are available now for 6mΩ, and will follow in third-quarter 2024 for 4mΩ and 9mΩ. Samples of the CoolGaN BDS 650V will be available in fourth-quarter 2024, and 850V will follow in early 2025. CoolGaN Smart Sense samples will be available in August 2024.

www.infineon.com/pcim

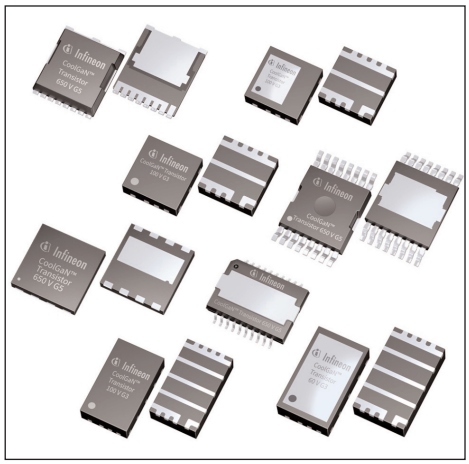
Infineon launches CoolGaN transistor families built on 8-inch foundry processes

Spanning 40V to 700V, medium-voltage G3 and high-voltage G5 families to be available in Q3 and Q4/2024

Infineon Technologies AG of Munich, Germany has announced two new generations of high-voltage (HV) and medium-voltage (MV) CoolGaN devices that now enable customers to use gallium nitride (GaN) in voltage classes from 40V to 700V in a broader array of applications that help to drive digitalization and decarbonization.

The two new product families are manufactured on high-performance 8-inch in-house foundry processes in Kulim (Malaysia) and Villach (Austria). Infineon says that it is hence expanding its CoolGaN advantages and capacity to ensure a robust supply chain in the GaN device market, which is forecastted to grow at an average annual growth rate (CAGR) of 46% over the next five years, according to Yole Group.

The announcement follows Infineon's acquisition of GaN Systems in October 2023. "The new generations of our Infineon CoolGaN family in high- and medium-voltage demonstrate our product advantages and are manufactured entirely on 8 inch, demonstrating the fast scalability of GaN to larger wafer diameters," says Adam White, division president of Power & Sensor Systems at Infineon.



Infineon's two new generations of high-voltage (HV) and medium-voltage (MV) CoolGaN devices for voltage classes from 40V to 700V in a broader array of applications.

The new 650V G5 family addresses applications in consumer, data center, industrial and solar. These products are the next generation of Infineon's gate injection transistor (GIT)-based high-voltage products. The second new family manufactured on the 8-inch process is the medium-voltage G3 devices, which include CoolGaN transistor voltage classes 60V, 80V, 100V and 120V; and 40V bidirectional switch (BDS) devices. The medium-voltage G3 products are targeted at motor drive, telecom, data-center, solar and consumer applications.

The CoolGaN 650V G5 will be available in fourth-quarter 2024 and the medium-voltage CoolGaN G3 will be available in third-quarter 2024. Samples are available now.

www.infineon.com

BAE and GlobalFoundries collaborate on supply of essential semiconductors for US national security programs

Focus on US chip manufacturing and joint R&D for advanced chip technologies including GaN-on-Si

BAE Systems Inc — which develops and services electric propulsion technology at its facilities in Endicott, NY, USA and Rochester, UK — and New York-headquartered GlobalFoundries (GF) are collaborating to strengthen the supply of critical semiconductors for US national security programs. Under the strategic agreement, the firms will align technology roadmaps and collaborate on long-term strategies for increasing US semiconductor innovation and manufacturing, with the joint goal of advancing the ecosystem for domestic fabrication and packaging of secure chips and solutions for use in aerospace and defense systems.

Together, the companies will engage in long-term planning for emerging technologies and collaborate on R&D in areas including advanced semiconductor packaging and integration, gallium nitride on silicon (GaN-on-Si) chips, silicon photonics and advanced technology process development.

The new non-exclusive collaboration builds on the longtime relationship between BAE Systems and GF, and further brings together BAE Systems' expertise in microelectronics for critical defense systems with GF's expertise as a high-volume semiconductor manufacturer and a supplier of secure, essential chips to the US Department of Defense (DoD).

Both BAE Systems and GF were recently named as recipients of planned direct funding from the US government as part of the CHIPS and Science Act.

"Our leadership in microelectronics for critical defense systems is predicated on a reliable and secure supply chain and the availability of trusted, uncompromised semiconductors," says Terry Crimmins, president of BAE Systems' Electronic Systems sector. "This new collaboration with GlobalFoundries, with its expertise in secure chip manufacturing, is imperative for BAE Systems to advance the overmatch thresholds of technologies, stay ahead of the increasingly complex defense environment, and enable creative solutions to mitigate the growing challenges to both the integrity of microelectronics and their associated supply chains," he adds.

"GF is committed to strengthening the semiconductor supply chain for national security and innovating to meet the future needs of the aerospace and defense sector," says GF's president & CEO Dr Thomas Caulfield. "We are proud to deepen our strategic relationship with BAE Systems, and further strengthen supply chain resiliency. Together, we will accelerate the research and development of a new generation of essential technologies and securely manufacture essential chips for a diverse range of critical defense applications."

A recent example of collaboration between the two companies involved BAE Systems leveraging GF's 12LP and 12S0 technology platforms for custom radiation-hardened by design semiconductor solutions for sensitive space applications. These highly differentiated US-made chips enable electronic systems to withstand the harsh environment of space, while offering power efficiency, area benefits, and a robust design ecosystem to enable cost-efficient and quick-turn prototyping. These chips deliver the performance, reliability and yield of GF's high-volume commercial sector offerings, tailored to the needs of the aerospace and defense industry by BAE Systems, and manufactured by GF with the right level of security — up to the DoD's highest security level, Trusted Supplier Category 1A.

GF's US manufacturing facilities have Trusted Foundry accreditation from the US government to securely manufacture chips in partnership with the DoD Defense Microelectronics Activity (DMEA) for use in some of the nation's sensitive national security and critical infrastructure systems on land, air, sea and in space. In 2023, the DoD awarded GF a new $3.1bn, 10-year contract for a supply of securely manufactured, US-made semiconductors for use across a wide range of critical aerospace and defense applications. The new contract was the third sequential 10-year contract of its kind between the DoD and the Trusted Foundry business team at GF.

www.gf.com
www.baesystems.com

GlobalFoundries acquires Tagore's GaN IP portfolio

Technology acquisition expands GF's power management solutions and accelerates roadmap

GlobalFoundries (GF) of Malta, NY, USA has acquired the proprietary and production-proven power gallium nitride (GaN) IP portfolio of Chicago-based fabless firm Tagore Technology Inc, which was founded in 2011 and has design centers in Arlington Heights, IL, USA and Kolkata, India developing gallium nitride-on-silicon (GaN-on-Si) and gallium nitride-on-silicon carbide (GaN-on-SiC) technology for RF and power management applications.

The power GaN IP portfolio is a high-power-density solution designed to boost efficiency and performance in automotive, Internet of Things (IoT) and artificial intelligence (AI) data-center applications.

GF says that the acquisition reinforces its commitment to large-scale manufacturing of GaN technology that can help data centers meet increasing power demands while maintaining or improving power efficiency, reducing costs and managing heat generation. It also expands GF's power IP portfolio and broadens access to GaN IP that can enable its customers to quickly bring differentiated products to market. As a part of the acquisition, a team of experienced engineers from Tagore, dedicated to the development of GaN technology, will be joining GF.

"The accelerating demand for more power-efficient semiconductors is dramatically increasing, and Tagore has been at the forefront of developing disruptive solutions using GaN technology for a wide range of power devices," says Tagore's co-founder & chief operating officer Amitava Das. "The team and I are excited to join GlobalFoundries to increase our focus on market-leading IP that will help address power design challenges and support the continued evolution of automotive, industrial and AI data-center power delivery systems."

In February, GF was awarded $1.5bn in direct funding under the US CHIPS and Science Act, partly targeted at enabling the high-volume manufacturing of critical technologies including GaN to securely produce more essential chips.

Combining this manufacturing capacity with the technical expertise of the Tagore team, GF aims to transform AI system efficiency, especially in edge or IoT devices, where reduced power consumption is critical.

"With Tagore Technology joining the GF India team, we will further enhance our tech capabilities, particularly in emerging areas like GaN," says Jitendra Chaddah, VP & India country head at GF.

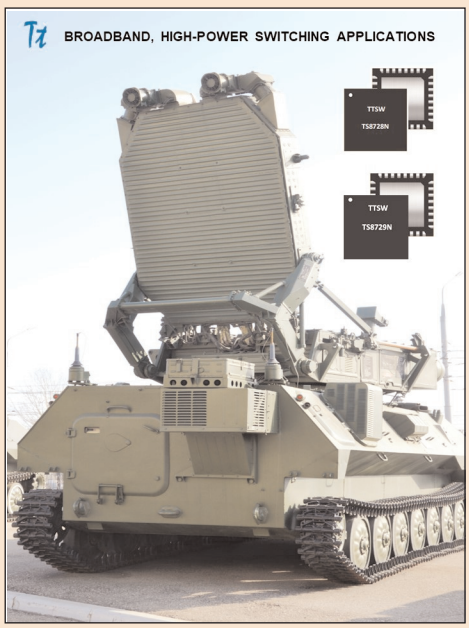
www.gf.com
www.tagoretech.com

Tagore launches GaN SPDTs for broadband switching

Up to 550W peak power handling for radar & cellular infrastructure

Tagore has introduced the TS8728N and TS8729N asymmetrical reflective single-pole double-throw (SPDT) switches designed for broadband, high-power switching applications. The new feature-rich switches offer what is claimed to be best-in-class insertion loss, power handling, high linearity, and high isolation performance and are well suited for L- and S-band radar and cellular infrastructure applications.

The TS8728N and TS8729N operate with a single +5V supply and switch with a single control voltage (0V to 3V). They can be tuned to specific RF bands within the range of 0.3–5.0GHz by modifying select external SMT components.



The new devices are compact, integrated high-power SPDT switches with on-board driver circuits.

TS8729N can cover 500MHz to 2.0GHz and provide very high RF power handling and high linearity within a small package size. The TS8728N covers 0.5–5.0GHz and has been optimized for switching speed.

"The TS8728N and TS8729N feature low TX and RX insertion loss, high isolation with very low DC power consumption and require minimal external components, enabling a smaller PCB footprint" says chief sales & marketing officer Klaus Buehring.

The TS8728N and TS8729N are packaged in a compact quad flat no-lead (QFN) 5mm x 5mm 32-lead plastic package.

www.tagoretech.com

Renesas completes acquisition of Transphorm

Renesas Electronics Corp of Tokyo, Japan has completed its acquisition of Transphorm Inc of Goleta, CA, USA.

Spun off from University of California at Santa Barbara (UCSB) in 2007, Transphorm designs JEDEC- and AEC-Q101-qualified gallium nitride (GaN) field-effect transistors (FETs) for high-voltage power conversion, and has manufacturing operations in Goleta and in Aizu, Japan.

Renesas is hence now offering GaN-based power products and related reference designs to meet the rising demand for wide-bandgap (WBG) semiconductor products.

Since WBG materials like GaN and silicon carbide (SiC) have superior power efficiency, higher switching frequencies and small footprints versus conventional silicon-based devices, the markets for both GaN- and SiC-based products are expected to grow rapidly over the next decade, driven by demand from electric vehicles, inverters, data-center servers, artificial intelligence, renewable energy, industrial power conversion, consumer applications etc.

"Customers instantly benefit from the new GaN products through turnkey reference designs, which integrate technologies from both companies," says Chris Allexandre, senior VP & general manager of Power at Renesas. "Adding GaN into our portfolio also reinforces our commitment to develop products and technology that make people's lives easier," he adds. "Providing robust and sustainable power solutions that save energy, reduce cost and minimize environmental impacts does just that."

Investing in the power business is an important part of Renesas' strategy for achieving sustainable, long-term growth. Other recent moves that Renesas has made to bolster this market segment include: the opening of the Kofu Factory (a dedicated 300mm wafer fab for power products); ramping up a new SiC production line at the Takasaki Factory; and forging an agreement with Wolfspeed to secure a steady supply of SiC wafers over the next 10 years. With GaN technology now part of its portfolio, Renesas reckons that it is poised to offer more comprehensive power solutions to support the evolving needs of customers across a broad range of applications.

Also, Renesas has rolled out 15 new market-ready reference designs that combine the new GaN products with Renesas' embedded processing, power, connectivity and analog portfolios. These include the designs of Transphorm's automotive-grade GaN technology integrated for on-board battery chargers as well as 3-in-1 powertrain solutions for EVs.

Some examples are:

- 500W on-board battery charger for 2-wheeler EV;
- 3-in-1 EV unit: inverter, on-board charger, DC/DC converter;
- 240W 48V extended power range AC/DC adapter;
- 3.6kW bi-directional digital power DAB system.

www.transphormusa.com
www.renesas.com/power

Transphorm adds Farnell as global distributor

Farnell Global (which trades as Farnell in Europe, Newark in North America and element14 in Asia Pacific) has announced a new global distribution partnership with Transphorm.

"Onboarding Transphorm as a new supplier supports our commitment to deliver high-quality products to customers while giving them the ability to choose preferred manufacturers as well as the best GaN device package and performance to meet their design needs," says Jose Lok, Farnell product category director — Passives & Semiconductors.

Transphorm's GaN innovations are claimed to have led to several industry firsts, such as the 1200V GaN-on-sapphire device slated for commercial availability in mid-2024; short-circuit withstand times of 5µs; and a GaN four-quadrant switch with true voltage and current bidirectionality control.

"The primary advantage of SuperGaN is the use of GaN in its native d-mode form. By doing this, the 2DEG channel that is spontaneously created between the undoped GaN and AlGaN layers is left untouched. This yields a simple-to-manufacture solution that harnesses all the 2DEG's inherent advantages, maximizing the device's electron mobility and charge while minimizing temperature effects," says Lok. "The result is the highest-performing solution spanning the widest power spectrum versus other silicon and WBG [wide-bandgap] technologies. These are just some of the many reasons we are now delighted to offer them, with rapid ordering and delivery options, to our customers," he adds.

"The power electronics market across all industries is radically changing as power conversion technologies like our SuperGaN platform drive major design and performance advantages," says Vipin Bothra, Transphorm's VP of sales for North America and Europe. "Our GaN devices are currently being adopted into a global consumer, industrial and automotive markets. We feel it is critical to enable our customers to access our devices however they prefer. Partnering with well-respected global distributors like Farnell is a necessary step to meeting that objective," he adds. "We look forward to a strong, mutually beneficial relationship that helps revolutionize power systems in everything from adapters and PCs to renewable energy systems and electric vehicles."

https://uk.farnell.com/b/transphorm

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hofer powertrain and ETH Zurich initiate GaN multi-level traction inverter development project

Adaptive gate drivers to improve switching controllability and reduce energy losses

Automotive technology company hofer powertrain of Nürtingen, Baden-Württemberg, Germany has begun a research project in collaboration with the Swiss Federal Institute of Technology in Zurich (ETH Zürich). Supported by funding from INNOSUISSE (the Swiss Agency of Innovation Promotion, which advances science-based innovations in the interest of the economy and society in Switzerland), the core objective of the project is to rapidly develop an advanced multi-level traction inverter integrating gallium nitride (GaN) switches.

hofer powertrain says that over the last four years it has made significant strides in developing multi-level power electronics utilizing GaN chip technology, resulting in enhanced efficiency and power density compared with silicon-based systems. Their latest 800V GaN inverters have showcased remarkable performance in tests, it is claimed. The collaborative project with ETH Zürich builds on that experience to realize an inverter that aims to leverage a novel modulation scheme, operate at very high switching frequencies, and incorporate a wide array of additional pioneering features that the firm has been working on in recent years.

The Innosuisse funding underscores the project's potential impact in the country and the DACH (Germany, Austria and Switzerland) region. The financial support will facilitate the design of a new, optimized and highly efficient three-level GaN power inverter, featuring adaptive gate drivers to improve switching controllability and further reduce energy losses. The outcome is expected to significantly enhance the performance and efficiency of powertrain systems for electric vehicles.

ETH Zürich has appointed a PhD candidate to lead the research effort. The project will be supervised by power electronics expert professor Johann Biela of ETH Zürich and Dr Lukasz Roslaniec, the division lead of power electronics at hofer powertrain, who has extensive industry experience and has been working on these technologies proactively.

ETH Zürich is "renowned for its groundbreaking work in Power Electronics and Electric Drives," notes Roslaniec. "Our partnership will yield solutions that are not only technologically advanced and unparalleled but also financially accessible, thereby pushing the adoption of electric vehicles and environmental sustainability in the region and beyond."

www.hoferpowertrain.com
www.ethz.ch/en.html
www.iqe.phys.ethz.ch

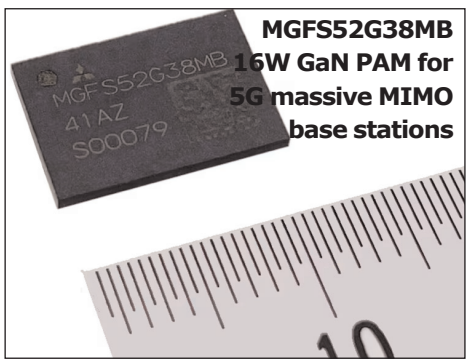
Mitsubishi Electric sampling 16W GaN power amplifier module for 5G massive MIMO base stations

Deployment in 32T32 massive MIMO antennas to lower production costs and reduce base-station power consumption

Tokyo-based Mitsubishi Electric Corp is shipping samples of a new 16W-average-power gallium nitride (GaN) power amplifier module (PAM) for 5G massive MIMO (mMIMO) base stations.

PAMs, which can be used in 32T32R mMIMO antennas (with 32 transmitters and receivers) to cut the manufacturing cost and power consumption of 5G mMIMO base stations, are expected to be increasingly deployed as 5G networks expand from urban centers to regional areas.

In September 2023, Mitsubishi Electric began providing samples of



MGFS52G38MB 16W GaN PAM for 5G massive MIMO base stations

a GaN PAM that achieves an average output power of 8W (39dBm) over a wide frequency range of 3.4–3.8GHz, suitable for 64T64R mMIMO antennas (64 transmitters and receivers) in 5G base stations. The new 16W (42dBm) GaN PAM achieves even higher average output power over a wide frequency range of 3.3–3.8GHz and is suitable for 32T32R mMIMO antennas, extending the communication range of 5G mMIMO base stations and lowering their manufacturing cost by reducing the required number of PAMs.

Mitsubishi Electric exhibited its new 16W GaN PAM at IEEE MTT-S International Microwave Symposium (IMS) 2024 in Washington DC, USA (18–20 June).

www.mitsubishielectric.com

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TI and Delta collaborating on EV on-board charging

Joint innovation lab to enable Delta to leverage TI's digital control and gallium nitride technology to enhance power density and performance of electric vehicle power systems

Dallas-based Texas Instruments Inc (TI) has announced a long-term collaboration with global power and energy management manufacturer Delta Electronics to create next-generation electric vehicle (EV) on-board charging and power solutions. This will leverage both companies' R&D capabilities in power management and power delivery in a joint innovation laboratory in Pingzhen, Taiwan. Together, TI and Delta aim to optimize power density, performance and size to accelerate the realization of safer, faster-charging and more affordable EVs.

"The transition to electric vehicles is key to helping achieve a more sustainable future, and through years of collaboration with Delta Electronics, we have a solid foundation to build upon," says Amichai Ron, senior VP for Embedded Processing at TI. "Together with Delta, we will use TI semiconductors to develop EV power systems like on-board chargers and DC/DC converters that are smaller, more efficient and more reliable, increasing vehicle driving range and encouraging more widespread adoption of electric vehicles," he adds.

"Delta has been developing high-efficiency automotive power products, systems and solutions since 2008 to help reduce transportation-related carbon emissions," says James Tang, executive VP of Mobility and head of the Electric Vehicle Solutions business group at Delta. "Through the establishment of this joint innovation laboratory with TI, Delta intends to leverage TI's abundant experience and advanced technology in digital control and GaN [gallium nitride] to enhance the power density and performance of our EV power systems. With more leading-edge product development and design capabilities, we aim to achieve closer technology exchange and collaboration to accelerate product development and improve product safety and quality."

Left to right: Delta Electronics' James Tang and Texas Instruments' Amichai Ron.

We will use TI semiconductors to develop EV power systems like on-board chargers and DC/DC converters that are smaller, more efficient and more reliable

The firms cite three phases of development for next-generation automotive power solutions :

- Phase one focuses on Delta's development of a lighter-weight, cost-effective 11kW on-board charger, using TI's latest C2000 real-time microcontrollers (MCUs) and TI's proprietary active electromagnetic interference (EMI) filter products. The companies are working together using TI's products to reduce the charger's size by 30% while achieving up to 95% power conversion efficiency.
- In phase two, TI and Delta will leverage the latest C2000 real-time MCUs for automotive applications to enable auto-makers to achieve automotive safety integrity levels (ASILs) up to ASIL D, which represents the strictest automotive safety requirements. Highly integrated automotive isolated gate drivers will further enhance the power density of on-board chargers, while also minimizing overall solution size.
- In phase three, the two companies will collaborate to develop the next generation of automotive power solutions, capitalizing on TI's more than 10 years of experience in developing and manufacturing products with GaN technology.

"The rapid growth of electronics in automotive applications has enabled more feature-rich, efficient and safer vehicles. However, technical challenges remain," notes Luke Lee, president of Taiwan, Japan, Korea and South Asia at TI. "Having been in Taiwan for 55 years, coupled with decades of experience in automotive power management, TI has built a strong connection with the local automotive industry. Establishing this collaboration and joint innovation laboratory with Delta is just one more way TI is driving vehicle electrification forward."

www.ti.com/power-management

TI unveils first 650V three-phase GaN intelligent power module for 250W motor drive applications

Elimination of external heat-sink cuts solution size by up to 55%

Dallas-based Texas Instruments (TI) introduced what it claims is the first 650V three-phase gallium nitride (GaN) intelligent power module (IPM) for 250W motor drive applications, on display at the Power Electronics, Intelligent Motion, Renewable Energy and Energy Management (PCIM) conference in Nuremberg, Germany (11–13 June).

The new GaN IPM addresses many of the design and performance compromises that engineers typically face when designing major home appliances and heating, ventilation and air-conditioning (HVAC) systems. Specifically, the DRV7308 GaN IPM enables more than 99% inverter efficiency, optimized acoustic performance, reduced solution size and lower system costs.

"Designers of high-voltage home appliances and HVAC systems are striving to meet higher energy-efficiency standards to support environmental sustainability goals around the world. They are also addressing consumer demand for systems that are reliable, quiet and compact," notes Nicole Navinsky, Motor Drives business unit manager at TI. "With TI's new GaN IPM, engineers can design motor driver systems that deliver all of these expectations and operates at peak efficiency."

Worldwide efficiency standards for appliances and HVAC systems such as SEER, MEPS, Energy Star and Top Runner are becoming increasingly stringent. The DRV7308 helps engineers meet these standards, leveraging GaN technology to deliver more than 99% efficiency and improve thermal performance, with 50% reduced power losses compared with existing solutions, claims TI.

In addition, the DRV7308 achieves what is claimed to be industry-low dead-time and low propagation delay, both less than 200ns, enabling higher pulse-width modulation (PWM) switching frequencies that reduce audible noise and system vibration. These advantages, plus the higher power efficiency and integrated features of the DRV7308, also reduce motor heating, which can improve reliability and extend the lifetime of the system.

New DRV7308 enables more than 99% inverter efficiency for appliances and HVAC systems by integrating TI's GaN technology.

Advanced integration and high power density reduce solution size and costs

Supporting the trend to more compact home appliances, the DRV7308 helps engineers to develop smaller motor drive systems, says TI. Enabled by GaN technology, the new IPM delivers high power density in a 12mm x 12mm 60-pin quad flat no-lead (QFN) package, making it the industry's smallest IPM for 150–250W motor-drive applications, it is claimed. Because of its high efficiency, the DRV7308 eliminates the need for an external heat-sink, resulting in motor drive inverter printed circuit board (PCB) size reduction of up to 55% compared with competing IPM solutions. The integration of a current sense amplifier, protection features and inverter stage further reduces solution size and cost.

Pre- production quantities of the DRV7308 three-phase, 650V integrated GaN IPM are available for purchase now. Pricing starts at $5.50 in 1000-unit quantities. The DRV7308EVM evaluation module is also available at $250.

TI's high-voltage technology at PCIM 2024

In addition to the DRV7308 GaN IPM, TI's highlights at PCIM included:

- Next-generation EV propulsion system: TI is demonstrating a new 800V, 750kW silicon carbide (SiC)-based scalable traction inverter system for EV six-phase motors, in collaboration with EMPEL Systems. The demonstration features high power density and efficiency using TI's high-performance isolated gate drivers, isolated DC/DC power modules and ARM Cortex-R MCUs.
- TI's manager of high-voltage power systems applications, Sheng-Yang Yu, participated in the Markt & Technik panel discussion 'Will SiC ultimately Hold its Own against GaN?'.
- TI's manager of renewable energy systems Harald Parzhuber participated in Bodo Power Systems' panel discussion 'GaN Wide Bandgap Design, the Future of Power'.

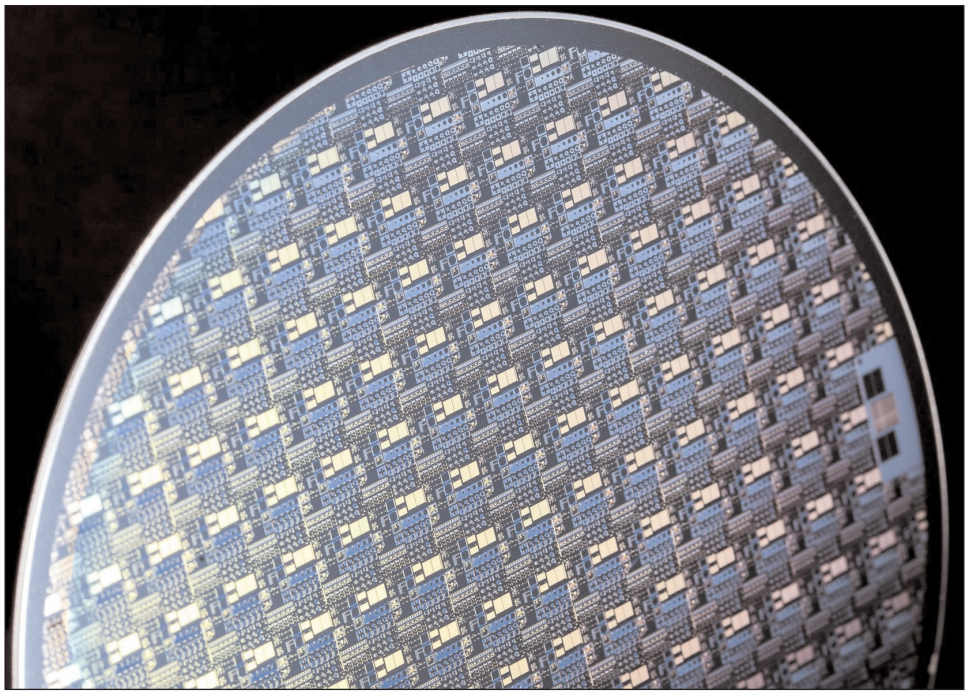
www.mesago.de/en/PCIM/
www.ti.com/power-management/gan/overview.html

Fraunhofer IAF presents 1200V GaN HEMTs at PCIM

Lateral GaN-on-Si HEMTs achieve static blocking voltages over 1200V

At Power, Control and Intelligent Motion (PCIM) Europe 2024 in Nuremberg (11–13 June), Fraunhofer Institute for Applied Solid State Physics (IAF) of Freiburg, Germany presented the current state of its development of novel technologies for lateral and vertical gallium nitride (GaN) transistors with blocking voltages above 1200V.

The Institute is currently working on realizing GaN-based HEMT technologies with blocking voltages up to and above 1200V, which can be used for numerous CO_2 reduction measures as part of the energy transition, such as bidirectional charging of electric vehicles. GaN HEMTs are intended to provide an alternative to already available silicon carbide (SiC) metal–oxide–semiconductor field-effect transistors (MOSFETs), which are very cost-intensive and therefore not suitable for widespread use. Fraunhofer IAF is pursuing several approaches for this purpose: the processing of GaN HEMTs on silicon substrates (GaN-on-Si HEMTs), the use of highly insulating carrier substrates such as sapphire, SiC or also GaN (GaN-on-insulator HEMTs) and the development of vertical GaN technologies.



GaN-on-Si wafer comprising vertical components, developed by Fraunhofer IAF,

GaN-on-Si, GaN-on-insulator and vertical GaN HEMTs for high-voltage applications

All approaches enable high-performance, efficient and cost-effective high-voltage GaN components with great application potential in key technological areas of the energy transition.

Lateral GaN-on-Si HEMTs are already commercially available, but are limited to a blocking voltage of 650V due to limited GaN layer thicknesses. By continuously optimizing the material and its processing (epitaxy, processing, structuring), researchers at Fraunhofer IAF have been able to demonstrate GaN-on-Si HEMTs with static blocking voltages of over 1200V. In addition, the power components were switched up to 1100V in an application-oriented measuring stand (double-pulse measurements).

In the second approach, the researchers replace the conductive silicon with highly insulating carrier substrates such as sapphire, SiC or GaN, which virtually eliminates the voltage limit.

Lateral GaN-on-sapphire HEMTs can be manufactured cost-effectively based on relevant preliminary work for light-emitting diode applications and can be produced in existing production lines.

Lateral GaN-on-sapphire HEMTs can be manufactured cost-effectively based on relevant preliminary work for light-emitting diode applications and can be produced in existing production lines

Vertical GaN technologies, in which the current flow runs vertically through the material layers, enable even greater performance with higher efficiency and integration capability at the same time. Within the next decade, the researchers at Fraunhofer IAF want to make vertical GaN power ICs suitable for industrial use. The aim is also to help to shape the next technological leap in the transformation towards a climate-neutral society.

More about 1200V GaN HEMTs at PCIM Europe

At PCIM Europe, Dr Richard Reiner provided an overview of the development of lateral and vertical GaN power ICs in his presentation 'Lateral and Vertical GaN Power ICs: Status and Future'.

In the 'Device Concepts' session, Reiner provided an insight into the various lateral 1200V GaN technologies in his presentation 'More than 1200V Breakdown and Low Area-Specific On-State Resistances by Progress in Lateral GaN-on-Si and GaN-on-Insulator Technologies'.

Also, in the session 'GaN Converters', Fraunhofer IAF's Dr Stefan Mönch gave a presentation 'Over 99.7% Efficient GaN-Based 6-Level Capacitive-Load Power Converter'.

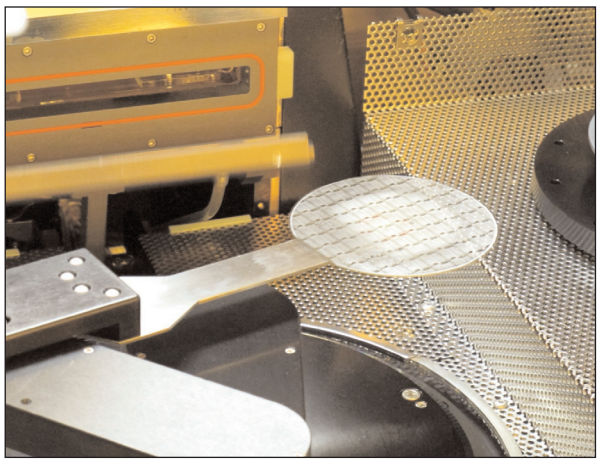
www.mesago.de/en/PCIM/
www.iaf.fraunhofer.de

WIN announces beta release of NP12-0B millimeter-wave RF GaN-on-SiC technology

0.12μm-gate RF GaN HEMTs enable development of compact saturated power amplifiers operating at 50GHz

WIN Semiconductors Corp of Taoyuan City, Taiwan — which provides pure-play gallium arsenide (GaAs) and gallium nitride (GaN) wafer foundry services for the wireless, infrastructure and networking markets — has expanded its portfolio of RF GaN technologies with the beta release of its highly robust NP12-0B millimeter-wave (mmWave) gallium nitride on silicon carbide (GaN-on-SiC) technology.

Core to this platform is a 0.12μm-gate RF GaN HEMT technology incorporating multiple refinements to enhance DC and RF ruggedness and add die-level moisture resistance. NP12-0B integrates multiple transistor improvements providing high ruggedness when operated in deep-saturation/high-compression pulsed and continuous-wave (CW) conditions. This new rugged technology is said to eliminate the pulse droop behavior seen in GaN HEMT power amplifiers, improving the range and sensitivity of pulsed-mode radar systems. Additionally,



The NP12-0B platform provides rugged RF, DC performance with added moisture resistance, enabling the use of plastic packages for high-performance power applications.

NP12-0B is available with the Enhanced Moisture Ruggedness option and provides what is claimed to be excellent humidity resistance when used in plastic packages.

Supporting full MMICs, the NP12-0B platform allows customers to develop compact pulsed or CW saturated power amplifiers for applications through 50GHz. This process is qualified for 28V operation, and in the 29GHz band generates saturated output power of 4.5W/mm with 12dB linear gain and over 40% power-added efficiency (PAE). The NP12-0B technology is suitable for rugged pulsed-mode high-power amplifiers used in advanced radar systems.

NP12-0B has reached beta release and is available for early-access multi-project wafer (MPW) runs. Qualification testing is complete and final modeling/PDK (process design kit) generation is expected to conclude in August, with full production release scheduled for late third-quarter 2024.

WIN showcased its compound semiconductor RF and mm-Wave solutions at the 2024 IEEE MTT-S International Microwave Symposium (IMS) in Washington DC (16–21 June).

www.winfoundry.com

VisIC presenting new Gen 1+ 650V/6mΩ and Gen 2 650V/5mΩ GaN HEMTs at PCIM

New power modules with over 650V/500A_{rms} targeted at BEVs, AI data centers and renewable energy

At Power, Control and Intelligent Motion (PCIM) Europe 2024 in Nuremberg, Germany (11–13 June), VisIC Technologies Ltd of Ness Ziona, Israel — a fabless supplier of power conversion devices based on gallium nitride (GaN) transistors — presented its new Gen 1+ 650V/6mΩ and Gen 2 650V/5mΩ GaN HEMT power devices as well as a new range of power modules with over 650V/500A_{rms} current for battery electric vehicles, AI data-center and renewable energy applications.

VisIC says that the market is moving quickly from silicon to silicon carbide (SiC) and nowadays to the next megatrend of GaN-on-silicon to reduce the CO_2 footprint in power conversion applications. Utilizing its economic scale of 8" (200mm) silicon-based wafers and future 12" (300mm) wafers means that there is no concern about supply risk and future cost reduction, the firm adds.

At PCIM, VisIC showcased its D^3GaN products, including a D^3GaN Inverter Demonstrator on a motor dyno testing with over 130kW and WLTP results.

Also at PCIM 2024, in Bodo Power Systems' panel discussion 'GaN Wide Bandgap Design, the Future of Power', VisIC's founder & CEO Tamara Baksht talked about 'D3GaN for EV Inverter'.

www.mesago.de/en/PCIM/
www.visic-tech.com

Navitas launches Gen-3 Fast 650V and 1200V SiC MOSFETs

Switching speed, efficiency and power density optimized for AI data-center power supplies, on-board chargers, EV roadside super-chargers and solar/energy-storage systems

Gallium nitride (GaN) power IC and silicon carbide (SiC) technology firm Navitas Semiconductor Corp of Torrance, CA, USA has announced its new portfolio of Gen-3 'Fast' (G3F) 650V and 1200V SiC MOSFETs optimized for fastest switching speed, highest efficiency, and increased power density for applications such as AI data-center power supplies, on-board chargers (OBCs), fast electric vehicle (EV) roadside super-chargers, and solar/energy-storage systems (ESS). The broad portfolio spans industry-standard packages from D2PAK-7 to TO-247-4, designed for demanding, high-power, high-reliability applications.

The G3F family is optimized for high-speed switching performance, resulting in a 40% improvement to hard-switching figures-of-merits (FOMs) compared with competition in CCM TP PFC systems. This can enable an increase in the wattage of next-generation AI power supply units (PSUs) up to 10kW, and an increase in power per rack from 30kW to 100–120kW.

The G3F GeneSiC MOSFETs are developed using a proprietary 'trench-assisted planar' technology and are said to offer better-than-trench MOSFET performance while also providing superior robustness, manufacturability and cost than competition. G3F MOSFETs deliver high-efficiency with high-speed performance, enabling up to 25°C lower case temperature, and up to 3x longer life than SiC products from other vendors, it is claimed.

The 'trench-assisted planar' technology enables an extremely low $R_{DS(ON)}$ increase versus temperature, which results in the lowest power losses across the complete operating range and offers up to 20% lower $R_{DS(ON)}$ under real-life operation at high temperatures compared with competition, it is reckoned.

Additionally, all GeneSiC MOSFETs have what is claimed to be the highest-published 100%-tested avalanche capability, 30% longer short-circuit withstand time, and tight threshold voltage distributions for easy paralleling. GeneSiC MOSFETs are hence suitable for high-power, fast-time-to-market applications.

Navitas' 4.5kW high-power-density AI server PSU reference design in CRPS185 form factor showcases the 650V-rated, 40mΩ G3F FETs for an interleaved CCM TP PFC topology. Alongside the GaNSafe power ICs in the LLC stage, a power density of 138W/inch^3 and peak efficiency above 97% is realized, which comfortably achieves 'Titanium Plus' efficiency standards, now mandatory in Europe.

For the EV market, 1200V/34mΩ (G3F34MT12K) G3F FETs enable Navitas' 22kW, 800V bi-directional OBC and 3kW DC–DC converter to achieve a power density of 3.5kW/L and a peak efficiency of 95.5%.

"G3F sets a new standard for efficient, cool-running SiC performance, coupled with high reliability and robustness for high-power, high-stress systems," says Dr Sid Sundaresan, senior VP of SiC technology & operations. "We're pushing the boundaries of SiC, with up to 600kHz switching speeds, and hard-switching figures-of-merit up to 40% better than competition."

www.navitassemi.com
www.mesago.de/en/PCIM/

CEO & co-founder Gene Sheridan a finalist in EY's Entrepreneur Of The Year 2024 Greater Los Angeles

Navitas' CEO & co-founder Gene Sheridan was a finalist in the Entrepreneur Of The Year 2024 Greater Los Angeles Award of Ernst & Young LLP (EY US).

'Entrepreneur Of The Year' was founded in 1986 as a competitive business award for "leaders who disrupt markets, revolutionize sectors and have a transformational impact on lives".

Sheridan was selected as a finalist by an independent panel of judges, and evaluated on the basis of building long-term value through entrepreneurial spirit, purpose, growth and impact, among other core contributions and attributes.

"We are at a pivotal time in our planet's energy transformation, and this recognition from EY highlights the importance of Navitas' mission to 'Electrify Our World' and exploit a $1.3tr opportunity as we accelerate the transition from fossil fuels to renewable energy," says Sheridan. "GaN and SiC power semiconductors enable fast, efficient and sustainable ultra-fast charging and power delivery in AI data centers, advanced EVs, mobile, solar and industrial applications," he adds.

Entrepreneur Of The Year honors business leaders for their ingenuity, courage and entrepreneurial spirit. e.g. original founders who bootstrapped their business from inception or who raised outside capital to grow their company; transformational CEOs who infused innovation into an existing organization to catapult its trajectory; and multi-generational family business leaders who reimagined a legacy business model to fortify it for the future.

SK keyfoundry's 650V GaN HEMTs due by end-2024

Portfolio to extend to GaN and SiC power semiconductors

South Korea-based SK keyfoundry — which provides specialty analog and mixed-signal foundry services on 8-inch wafers for consumer, communications, computing, automotive and industrial applications — says that, after recently achieving key device characteristics, it is intensifying its efforts to develop 650V gallium nitride (GaN) high-electron-mobility transistors (HEMTs) as it aims to complete development by the end of this year.

Spun off from Magnachip Semiconductor as Key Foundry in September 2020, the firm became a subsidiary of SK hynix in August 2022, after which a dedicated team was formed to drive GaN process development. Key Foundry was renamed SK keyfoundry this January.

As 650V GaN HEMTs have high power efficiency, they reduce the cost of heat sinks compared with silicon-based products, notes the firm. This results in a less significant difference in price for end-customers' systems. The company expects that — for fabless customers in markets such as fast-charging adapters, LED lighting, data centers and energy-storage systems (ESS), and solar micro-inverters — the GaN 650V product will provide an advantage in developing premium products. In addition to securing new customers, SK keyfoundry plans to actively promote its 650V GaN HEMTs to existing power semiconductor process-using customers who have expressed interest in the technology.

Due to its high-speed switching and low ON-resistance characteristics (enabling lower loss, higher efficiency, and miniaturization than silicon-based semiconductors), the GaN power semiconductor market is expected to increasing at a compound annual growth rate (CAGR) of 33% from $500m in 2023 to $6.4bn in 2032, reckons market research firm Omdia, used primarily in power supplies, hybrid and electric vehicles, and solar power inverters.

SK keyfoundry says that, based on the 650V GaN HEMT, it plans to build a GaN portforlio that can offer a wide range of voltages for GaN HEMTs and GaN ICs.

"We are preparing for the next generation of power semiconductors in addition to our competitive high-voltage BCDs [bipolar–CMOS–DMOS]," says CEO Derek D. Lee. "We will also expand our power semiconductor portfolio to include not only GaN but also SiC [silicon carbide] in the future to establish ourselves as a specialized power semiconductor foundry."

www.skkeyfoundry.com

CGD and Qorvo partner to develop reference design and evaluation kit showcasing GaN for motor control

Cambridge GaN Devices Ltd (CGD) — which was spun out of the University of Cambridge in 2016 to design, develop and commercialize power transistors and ICs that use GaN-on-silicon substrates — is partnering with Qorvo Inc of Greensboro, NC, USA (which provides core technologies and RF solutions for mobile, infrastructure and defense applications) to develop a reference design and evaluation kit (EVK) that showcases GaN for motor control applications. CGD aims to speed the use of GaN power ICs in BLDC (brushless DC) and PMSM (permanent-magnet synchronous motor) applications, resulting in higher-power, highly efficient, compact and reliable systems. Qorvo is building an EVK for its PAC5556A motor/control IC that is powered by CGD's ICeGaN (IC-enhanced GaN) technology.

"Because ICeGaN — unlike other GaN implementations from other companies — integrates the interface circuitry but not the controller together with the GaN HEMT, it is simple to combine with highly integrated motor controller and drive ICs such as Qorvo's PAC5556A 600V high-performance BLDC/PMSM motor controller and driver," says CEO Dr Giorgia Longobardi. "We are delighted to partner with Qorvo to enable motor controller and driver applications to enjoy the benefits of GaN power," she adds.

"Wide-bandgap semiconductors such as GaN [gallium nitride] and SiC [silicon carbide] are being actively considered in various motor control applications for the power density and efficiency benefits they bring," notes Jeff Strang, general manager of Qorvo's Power Management business unit. "CGD's ICeGaN technology offers ease of use and reliability, two crucial factors for motor control and drive designers."

GaN's benefits primarily include lower losses, which results in higher efficiency, leading to increased power availability and less heat. This reduces the need for complex, bulky and costly thermal management solutions, resulting in smaller, more powerful systems that have a longer life. GaN also delivers higher torque at low speeds and, therefore, more accurate control. Also, GaN allows high-speed switching, which can reduce audible noise, which is especially valued for domestic items such as ceiling fans, heat pumps, and refrigerators.

In addition to being easy to use, ICeGaN is said to offer other benefits over other GaN devices. The gate drive voltage of ICeGaN is compatible with IGBTs. Because ICeGaN integrates the Miller clamp within the GaN IC, a negative turn-off voltage is not required, and low-cost current drivers can be used. Finally, ICeGaN includes a useful current sense function, simplifying circuit design and reducing the bill of materials (BOM).

The reference design is available now, and the EVK RD5556GaN is available for purchase in third-quarter 2024.

www.camgandevices.com
www.qorvo.com/products/p/PAC5556A

CGD demos new ICeGaN 650V GaN ICs at PCIM Europe

Portfolio addressing higher-power applications such as motor drives, inverters and data centers, as well as lower-power, ultra-compact smart portable device adapters and chargers

At Power, Control and Intelligent Motion (PCIM) Europe 2024 in Nuremberg, Germany (11–13 June), CGD demonstrated how its product portfolio is developing to address higher-power applications such as motor drives, inverters and data centers, as well as lower-power, ultra-compact smart portable device adapters and chargers.

As well as introducing a new product family, CGD gave the following presentations:

- CEO Dr Giorgia Longobardi formally launched the latest ICeGaN 650V family of GaN ICs, targeting applications in the 1–5kW range;
- CTO professor Florin Udrea took part in a panel discussion hosted by Markt & Technik editor Engelbert Hopf;
- Udrea was part of a panel discussion hosted by Bodo's Power Systems, 'GaN Wide Bandgap Design, the Future of Power';
- Di Chen, director of business development & technical marketing at CGD, and José Quiñones staff applications engineer at Qorvo, gave a joint presentation 'GaN Power ICs and Power Application Controller Optimize Performance in BLDC and PMSM Motor Drives'.

"With its inherent ruggedness and reliability, our ICeGaN GaN ICs are perfectly suited to meet the needs of higher-power applications such as data centers and inverters," believes chief commercial officer Andrea Bricconi. "Our presentations and demos and the new devices which we are launching at the show will illustrate our capabilities for these markets.

www.mesago.de/en/PCIM

Cambridge GaN Devices signs MoU with ITRI covering GaN-based power supply development

First target is 140–240W USB-PD adaptor exceeding 30W/in³

Cambridge GaN Devices Ltd (CGD) — which was spun out of the University of Cambridge in 2016 to design, develop and commercialize power transistors and ICs that use GaN-on-silicon substrates — has signed a memorandum of understanding (MoU) with Taiwan's Industrial Technology Research Institute (ITRI) to solidify a partnership in developing high-performance GaN solutions for USB-PD adaptors. The MoU also covers the sharing of domestic and international market information, joint visits to potential customers, and promotion.

"We are excited to partner with ITRI, an organization with a power solution research team that is very experienced in developing power solutions and holds many patents," comments CGD's chief commercial officer Andrea Bricconi. "We will be demonstrating some of their board designs at our booth at the upcoming PCIM [Power, Control and Intelligent Motion] show in Nuremberg in June. These products utilize CGD's unique IC chip architecture and ITRI's patented designs to achieve product size reduction, high efficiency and power density, and cost competitiveness," he adds.

"CGD's IC-enhanced GaN — ICeGaN — is a novel platform that improves ease-of-use, facilitates smart temperature control and enhances gate reliability," says Wen-Tien Tsai, leader of the Commercial Power Design team at ITRI's Green Energy & Environment Research Laboratories (GEL). "We are excited to include these benefits in our new power designs."

According to market analyst firm Yole Group, the GaN market is expected to exceed $1bn, with key growth in the applications of comms power supplies, and automotive DC/DC converters and on-board chargers. However, the first commercialized product in the market to adopt GaN devices has been USB-PD adaptors, and it is this market that the first designs from the partnership will address. Specifically, the agreement covers the development of power solutions in the 140–240W range with power densities exceeding 30W/in^3 for e-mobility, power tools, notebook and cell-phone applications.

www.camgandevices.com

CGD launches P2 series ICeGaN power ICs

CGD has launched its lowest ever on-resistance ($R_{DS(on)}$) parts, which have been engineered with a new die and new packages to deliver the benefits of gallium nitride to high-power applications such as data centers, inverters, motor drives and other industrial power supplies. New ICeGaN P2 series ICs feature $R_{DS(on)}$ levels down to 25mΩ, supporting multi-kW power levels with the highest efficiency.

"The explosive growth of AI is leading to a significant increase in energy consumption, prompting data-center systems designers to prioritize the use of GaN for high-power, efficient power solutions," says chief commercial officer Andrea Bricconi. "This new series of power GaN ICs is a stepping stone for CGD to support our customers and partners by achieving and exceeding 100kW/rack power density in data centers, required by most recent TDP (thermal design power) trends for high-density computing. Turning to motor control inverters, developers are looking to GaN to reduce heat for smaller, longer-lasting system power. These are just two examples of markets that CGD is now aggressively targeting with these new high-power ICeGaN ICs," he adds. "Simplified gate driver design and reduced system costs, combined with advanced high-performance packaging, make P2 series ICs an excellent choice for these applications."

Incorporating an on-chip Miller clamp to eliminate shoot-through losses during fast switching and implementing 0V turn-off to minimize reverse conduction losses, ICeGaN ICs outperform discrete e-mode GaN and other incumbent technologies, it is claimed. The new packages offer improved thermal resistance performance as low as 0.28K/W — again, equivalent or better than anything else currently available on the market, CGD claims — and the dual-gate pinout of the dual-side DHDFN-9-1 (Dual Heat-spreader DFN) package facilitates optimal PCB layout and simple paralleling for scalability, enabling cu stomers to address multi-kW applications with ease. The new packages have also been engineered to improve productivity, with wettable flanks to simplify optical inspection.

New P2 series ICeGaN power ICs are sampling now. The family includes four devices with $R_{DS(on)}$ levels of 25mΩ and 55mΩ, rated at 60A and 27A, in 10mm x 10mm-footprint DHDFN-9-1 and BHDFN-9-1 (Bottom Heat-spreader DFN) packages. In common with all CGD ICeGaN products, the P2 series can be driven using any standard MOSFET or IGBT driver.

Two demo boards feature the new P2 devices: a single leg of a 3-phase automotive inverter demo board (developed in partnership with the French public R&I institute IFP Energies nouvelles) and a 3kW totem-pole power factor correction (PFC) demo board.

Diamond Quanta announces findings on diamond fabrication & doping techniques

Founder & CEO Adam Khan and senior engineer Tae Sung Kim presenting papers at IMRC 2024

Diamond Quanta of Palo Alto, CA, USA (which was founded in January by CEO Adam Khan) says that on 20 and 21 August at the 32nd International Materials Research Congress (IMRC 2024) in Cancun, Mexico, it is announcing breakthroughs around its proprietary, novel diamond semiconductor fabrication and doping techniques. With publications pending in two upcoming white papers (co-authored by Khan and senior engineer Tae Sung Kim), the results illustrate new strength and efficiency capabilities for diamond-based semiconductors, the firm says.

In the first symposium Materials Science & Quantum Technology, the paper 'Advanced Co-Doping Techniques for Enhanced Charge Transport in Diamond-Based Quantum Devices' presents the assumptions, formalisms and predictions of the firm's Unified Diamond Framework in the context of the experimental findings, contrasting with other approaches and their limited results. The technique is shown to optimize the electronic structure for enhanced charge transport with improved crystalline quality and fewer defects in the novel co-doped diamond system, contrasting with traditional methods where increased disorder is observed post-doping. The findings are correlated and supported with the enhanced electronic properties reported, such as high carrier mobility, demonstrating that the novel doping techniques effectively manage crystalline anisotropy and charge transport dynamics inherent to the diamond system. Further discussed, the high carrier mobility and low defect densities in diamond semiconductors enable the creation of reliable and efficient quantum gates, essential components for quantum computers.

In the second symposium Advanced Defense Materials, Diamond Quanta's contribution focuses on the application of the technology in high-power, high-temperature operating environments, specifically contrasting the findings of the US Army DEVCOM's recent report 'Development of Diamond-Based Materials Systems for High-Power RF Electronics: Third-Year Report' to show the increased performance of Diamond Quanta's novel co-doping ion beam method, which has been designed to directly address the mechanisms promoting vacancy-defect formation. This technique optimizes the electronic structure for enhanced charge transport where, by impeding extended vacancy motion, co-dopants facilitated the integration of dopants as substituent donors. This minimizes the formation of deep gap states and promotes higher-mobility electronic states near the conduction band.
The direct comparison shows substantially increased performance compared with the costly and commercially impractical method of 'stacking' diamond with other semiconducting materials in heterostructures (e.g. boron nitride, gallium nitride etc), with fewer restrictions on initial materials defect density to achieve said performance, resulting in a more cost-efficient diamond solution.

"Advancements in the AI, automotive, aerospace industries and more require stronger, more efficient technology to confidently handle their growing power demands," says Khan. "Our team's novel diamond fabrication and doping techniques will allow diamond semiconductors the ability to enhance the reliability and longevity of data-center components by preventing overheating; decrease energy expenditures on cooling systems, leading to more sustainable and cost-effective operations; and operate at higher power densities, compared to traditional silicon-based semiconductors," he adds. "These capabilities are crucial for AI data centers that require substantial computational power, as they increase processing capabilities for intensive AI computations, which enable faster data processing and more complex AI models. They also allow for more compact chip designs, leading to reduced space requirements and potentially more processing units per server."

www.mrs-mexico.org.mx/imrc2024
www.diamondquanta.com/technology

Element Six and Orbray partner to deliver high-quality wafer-scale single-crystal synthetic diamond

Applications include 6G wireless components, advanced power & RF electronics, sensing, thermal management, and quantum devices

CVD-based synthetic diamond materials firm Element Six of Oxford, UK (E6, part of the De Beers Group) and Tokyo-based Orbray Co Ltd (which makes precision jewel parts, DC coreless motors, fiber-optic components, and medical devices) have announced a strategic collaboration to deliver high-quality wafer-scale single-crystal (SC) synthetic diamond.

Future industrial applications across telecoms, defense and artificial intelligence (AI) will place unprecedented demands on power and energy efficiency, and enabling these technologies to reach their full potential requires novel material solutions, say the firms. Due to properties including high breakdown field and high thermal conductivity, synthetic diamond promises to be the go-to material platform in the future. However, unlocking these industrial opportunities can only be realised if a reliable supply of wafer-scale SC diamond is available.

Element Six was the first company to build and develop a chemical vapor deposition (CVD) platform consistent with large-area, uniform polycrystalline diamond growth up to 150mm in diameter and, later, pioneering electronic-grade SC diamond development and production, commercializing its first SC product range in the 2000s. Recently, E6 opened a CVD facility in Gresham, Oregon, USA, enabling sustainable, scale production of high-quality SC synthetic diamond products.

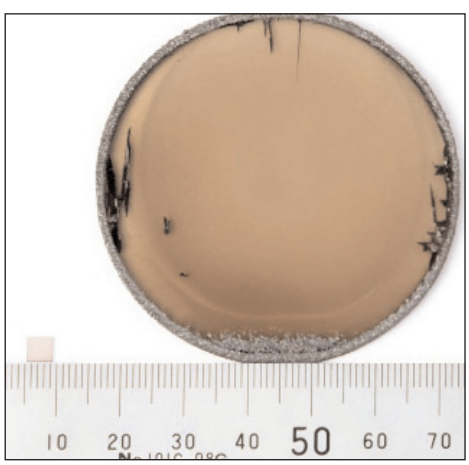
In parallel, Orbray pioneered the development of a unique heteroepitaxial process to grow SC diamond on cost-efficient sapphire substrates, demonstrating milestone results of SC deposition up to 55mm diameter.

The partnership between the firms will combine Orbray's approach to scaling SC CVD diamond with E6's large-area deposition system and expertise in making high-purity SC diamond, to deliver a reliable supply of high-quality, wafer-scale, single-crystal diamond for key applications, including 6G wireless components, advanced power and RF electronics, sensing, thermal management, and quantum devices.

From left to right: Orbray's executive VP Osamu Wada, Orbray's president & CEO Riyako Namiki, Element Six's CEO Siobhán Duffy, and Element Six's chief technologist Daniel Twitchen.

Through this strategic collaboration, Orbray and Element Six will work together to produce wafer-scale high-quality SC diamond, expanding their core competency in diamond technology ahead of anticipated industrial opportunities.

Element Six's patented technology and expertise in high-quality SC CVD diamond and large-area synthesis technology is already being exploited in atomic particle detection and researched in novel applications such as RF transistors, quantum sensing and quantum-secure communication. Orbray's heteroepitaxial sapphire substrate approach is advancing the R&D of larger SC wafer-scale diamond substrates and, simultaneously, production of heteroepitaxial SC CVD diamond for novel industrial applications. As a result, by combining these unique capabilities, it is reckoned that the partnership is poised to deliver SC diamond wafer technology at sizes and levels of quality beyond what is possible currently.



"The strategic collaboration between Element Six and Orbray represents the next milestone to unlock a new era of single-crystal diamond applications, delivering unprecedented competitive advantage and new heights of performance to an ever-growing range of global customers," says Orbray's president & CEO Ms Riyako Namiki. "Element Six has already accelerated key advances in a wide range of novel applications, enabling significant milestones such as the identification of Higg's boson and the advancement of optics technology for metrology in the pharmaceutical industry," she adds.

The collaboration follows Element Six's selection for a United States Defense Advanced Research Projects Agency (DARPA) program LADDIS (Large Area Device-quality Diamond Substrates) aimed at developing new ways of fabricating device-quality diamond substrates for use in military applications.

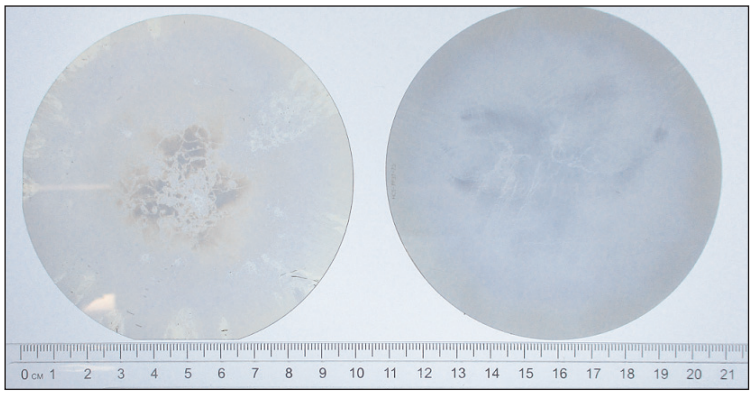
www.orbray.com/en
www.e6.com/en/products/thermal-management

Crystal IS achieves 99% usable area on 100mm bulk AlN

Sale to key partners to begin this year amid expansion beyond UVC LEDs

Crystal IS Inc of Green Island, NY, USA — a subsidiary of Tokyo-based Asahi Kasei that makes proprietary ultraviolet light-emitting diodes (UVC LEDs) — has announced serial production of 100mm-diameter single-crystal aluminium nitride (AlN) substrates with 99% usable area, based on current requirements for UVC LEDs, with manufacturing to take place in the USA. The ultra-wide bandgap and high thermal conductivity of AlN help to improve device reliability and performance in UVC LEDs and other next-generation RF and power devices.

"The improvement of our large-diameter substrate quality over the last nine months showcases the expertise of our team in Crystal Growth," says president & CEO Eoin Connolly. "The inherent thermal benefits of aluminium nitride can enable higher-performing RF and power devices in mission-critical and telecom applications."



Comparison of Crystal IS 100mm bulk AlN substrate from Q1/2024 (left) with 90% usable area and Q2/2024 (right) with 99.3% usable area.

This achievement follows the company's announcement of the first-ever recorded 100mm diameter in August 2023.

Crystal IS manufactures bulk single-crystal aluminium nitride substrates, and began selling 2-inch diameter substrates for R&D in RF and power devices in late 2023. The 100mm-diameter milestone accelerates the development of new applications on AlN substrates as it integrates into existing fabrication lines for RF and power devices using alternative materials. The firm plans to offer 100mm-diameter substrates, which will be exclusively manufactured in its US facility, to key partners this year as they continue to expand beyond UVC LEDs.

www.cisuvc.com/products/klaran
www.asahi-kasei.com/sustainability

Axus secures $12.5m in funding from IntrinSiC

Funds to be used for expansion of CMP products for silicon carbide device manufacturing

Axus Technology of Chandler, AZ, USA — a provider of chemical-mechanical polishing/planarization (CMP), wafer thinning and surface-processing solutions — has received $12.5m in capital funding from IntrinSiC Investment LLC of Palo Alto, CA, USA, a private equity firm that invests in suppliers of key enabling technology for silicon carbide (SiC). In addition, the firm has secured a significant revolving and term line of credit from a leading national bank.

Axus says that, as an established equipment manufacturer with a strong installed base and a focus on silicon carbide semiconductor processing, it has developed a core understanding of technologies related to CMP – specifically wafer polishing, thinning and cleaning. It hence reckons that is well positioned to drive toward volume sales of, and enter new markets with, its Capstone CMP and Aquarius wafer cleaning platforms. The firm will use the equity funds to further these efforts, aiming to leverage its strong capitalization to pursue and fulfill high-volume orders from semiconductor and compound semiconductor manufacturers worldwide.

"With this additional funding, we are strongly positioned to support our rapidly growing installed base of high-performance Capstone CMP systems, particularly with our leading-edge, high-volume customers," believes CEO Dan Trojan. "In addition to strengthening our balance sheet, we expect to significantly benefit from the interaction, support and contribution of IntrinSiC's principals, whose skill and experience in the semiconductor industry and impressive track record will greatly benefit Axus Technology's continued growth and evolution," he reckons.

"We have been engaged in the compound semiconductor ecosystem for more than a decade. Over the past two years, we have made strategic investments in companies with a strong focus on SiC, as well as gallium nitride," says IntrinSiC Investment's general partner Johannes Froehling. "Our approach is to seek recommendations from leading chipmakers for companies with a solid, technically differentiated product portfolio that are well positioned to move to high-volume manufacturing once capitalized," he adds. "Axus Technology was cited across the board as a company that met or exceeded these characteristics."

www.axustech.com

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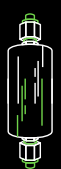
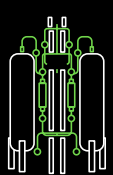
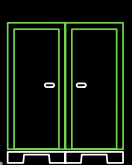


Point-of-Use Purifiers



Frame-Mounted Purifiers



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University of Sheffield to partner with other universities to form Compound Semiconductor Manufacturing Hub

Funded by UK Research and Innovation (UKRI) and the Engineering and Physical Sciences Research Council (EPSRC), five new hubs, led by universities across the UK, have been announced. Each hub will receive £11m as part of ESPRC's Manufacturing Research Hubs for a Sustainable Future program. Partner contributions (cash and in-kind) takes total support committed to the new hubs to £99.3m.

The hubs aim to address wide-ranging challenges in commercializing early-stage research in various manufacturing sectors by reducing waste, finding alternatives to costly or environmentally damaging materials, and speeding up processes.

The University of Sheffield will be a key partner on the Compound Semiconductor Manufacturing Hub, led by Cardiff University, with the Management School's professor Lenny Koh being the lead for Sheffield. Other partners include UCL, University of Cambridge, University of Manchester and industry concerns.

The hub aims to capitalize on the huge opportunity of compound semiconductor manufacturing, as identified in the UK's national semiconductor strategy. The researchers will develop energy-efficient optoelectronics for use in key emerging technologies such as quantum, the 6G network, sensors for autonomous vehicles, the Internet of Things and satellite communications. They will expand on the environmental benefits of compound semiconductors by creating new devices such as mercury-free 'night vision' mid-infrared detector arrays and devices that both communicate and illuminate based on integrated transistors and LEDs.

Professor Fraser McLeay, Dean at Sheffield University Management School commented, "Professor Koh will lead on advancing the research and innovation of the environmental sustainability and supply chain resilience of compound semiconductor manufacturing. Advances in environmental sustainability across manufacturing processes are also a focus of the hubs, which hope to bolster the economy through efficiencies such as reducing waste, emissions and pollution, and lowering production costs. Working with industry partners, the researchers will also explore different pathways to manufacture, including production scale-up and integration within the wider industrial system. This new exciting initiative is closely linked with our mission to foster socially responsible work practices and our new cross-cutting research theme Pathways to Sustainable Consumption, Production and Finance."

www.sheffield.ac.uk
www.ukri.org

JST and EPSRC announce Japan–UK joint funding opportunity

Up to three research projects to be awarded total of £3.99m from EPSRC and ¥234m from JST

The UK's Engineering and Physical Sciences Research Council (EPSRC) and the Japan Science and Technology Agency (JST) have announced an international joint funding opportunity — with a closing date of 18 July — to support up to three research projects lasting 41 months (from an anticipated fixed start date of 1 November 2024 until 31 March 2028).

Based on the implementation principles of the ALCA-Next program in Japan and the International Science Partnerships Fund (ISPF) in the UK, the partnership program aims to support internationally competitive collaborative research projects between Japan and the UK focusing on semiconductor research.

Applications must involve researchers from Japan and the UK. UK applicants must be based at a UK research organization eligible for EPSRC funding. Japanese applicants must be eligible for JST funding.

Applicants may request up to:

- £1.33m (80% of the full economic cost (FEC)) for the UK component;
- ¥234m (including 30% overhead expenses) for the Japanese component.

Scope

Research projects should address one or more of the following four priority areas of joint interest for both Japan and the UK:

- Low-power hardware for artificial intelligence (AI) systems, including:
- low-power design technologies and methods;
- innovative architectures for improving energy efficiency;
- hardware or software systems approach to low-power devices;
- search or generation of algorithm or architecture design space for energy efficiency;
- 3D or 2.5D integrated circuit processes, circuits, and architectures for emerging materials and new computing paradigms;
- compatibility of AI algorithms with semiconductor hardware;
- photonics to address any of these points above, for example low power or low heat or more energy-efficient parallel processing.
- Power devices or radiofrequency devices, including:
- materials, silicon carbide (SiC)-related material processes, evaluation and calculation;
- compound semiconductors more broadly, including GaN, Ga_2O_3, GaAs, InP, AlN, BN;
- applications in power electronics, radio transmission, materials for photonics;
- active electronics or thermal management, for example diamond.
- Security by design, including:
- trusted electronics;
- security architectures at the design stage so that they are intrinsically part of integrated circuits;
- discrete designs to enable security as part of a package or board;
- approaches for secured-by-design system-on-chip (SoC), for example capability architectures such as Morello and across SoC;
- a focus on hardware and manufacture.
- Semiconductor photonics, including:
- exploring materials for heterogenous integration, for example as a route to low-power electronics, for example photonics, silicon, compound semiconductors, nano-electro-mechanical systems (NEMS), micro-electro-mechanical systems (MEMS);
- materials platforms for photonic integrated circuits, for example silicon photonics, compound semiconductors, emerging materials platforms;
- photonic logic;
- photonic integrated circuits (PICs);
- photonic communication across chip and inter-chip (inter package);
- novel devices, for example low-power modulators, efficient coupling to or from PICs, specific reconfigurable devices for AI.

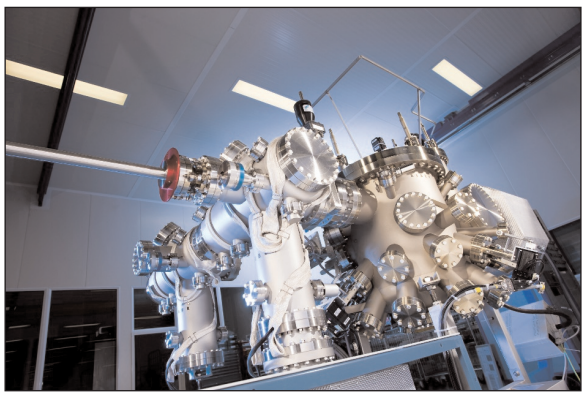
www.ukri.org/opportunity/japan-uk-joint-opportunity-in-semiconductor-research-jst-epsrc
www.ukri.org/councils/epsrc

Riber receives order from IEMN for double Compact 21 research MBE system

System to be used for developing hetero- and nanostructures, high-temperature surface treatment and research on new materials

Molecular beam epitaxy (MBE) system maker Riber S.A. of Bezons, France says that long-standing customer the Institut d'Électronique de Microélectronique et de Nanotechnologie (IEMN-CNRS) research institute in Villeneuve-d'Ascq, France, has ordered a double Compact 21 research system (for delivery in 2025) for the development of hetero- and nanostructures, high-temperature surface treatment and exploratory research into new materials.

Equipped with a fleet of Riber machines since the mid-1980s, IEMN is enhancing its versatility by



adding the ultra-modern double Compact 21 system to its existing lines. The acquisition will enable IEMN to step up its research to meet the challenges of next-generation 6G wireless communication, with its objectives of ultra-high data rates, low latency, low energy consumption and integration on CMOS components.

The new Compact 21 platform will provide IEMN with enhanced safety, reliability and ease of use by incorporating a range of instruments including the EZ CURVE in-situ control device and Crystal XE process control software.

www.iemn.fr
www.riber.com

Riber receives order for MBE 49 production system

Asia-based customer to boost production capacity of GaAs photodiodes and optical amplifiers based on quantum dot lasers

An industrial customer in Asia has ordered a Riber MBE 49 production system — for delivery in 2025 — to enhance its production capacity for gallium arsenide (GaAs) photodiode devices and optical amplifiers based on quantum dot lasers.

Riber notes that GaAs photonic and radio-frequency components are gaining significant importance in the MBE market, especially with the rise of high-volume applications in 3D detection, leading to a shift in the supply chain towards 6-inch substrates.

The MBE 49 production system offers compatibility with the 6-inch substrate manufacturing process and features what are said to be optimized, uniform and stable effusion cells along with efficient cracking cells for the manufacture of photonic and electronic components from III-V elements.

The MBE 49 is a fully automated system with a proven track record of more than 30 years, benefiting from customized control through Crystal XE software developed by Riber.

MBE 49 system ordered for GaN opto production

An industrial customer in Asia has ordered a Riber MBE 49 production system — for delivery in 2025 — to boost production capacity for gallium nitride (GaN) optoelectronic components used in consumer applications such as fast chargers, on-board chargers, power supplies and converters, as well as for research into new applications in the automotive industry.

Characterized by their high switching speed and exceptional efficiency, GaN-based devices are attracting a much interest in power applications, where the industry is seeking to reduce the size and weight of systems while increasing their efficiency.

The MBE 49 GaN machine is specifically designed for the gallium nitride fabrication process, providing a specific pumping configuration as well as highly stable, uniform and repeatable effusion cells for the development of III–nitride optoelectronic devices.

The developments and technical improvements made to the MBE 49 GaN platform are the result of a collaborative program between Riber and the CNRS–CRHEA (Centre de Recherche sur L'Hétéro-Epitaxie et ses Applications — Centre National de la Recherche Scientifique) in Sophia Antipolis, France, which specializes in epitaxial growth of wide-bandgap semiconductor materials.

www.crhea.cnrs.fr
www.riber.com

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Aixtron acquires Italian production site near Turin

Expansion in Europe to prepare for further growth in unit shipments

Deposition equipment maker Aixtron SE is expanding its manufacturing presence in Europe with the acquisition of a production site near Turin, in the Piedmont region of Italy. The firm is hence expanding its production capacities to be prepared for further growth in unit shipments in the coming years. Furthermore, the new location allows Aixtron to establish a link to the strong university and supplier ecosystem in the Piedmont region. Aixtron's exiting locations in Herzogenrath, Germany (headquarters, R&D, production) and Cambridge, UK (R&D, production) are expected to benefit from the strengthened European footprint.

"Within 2–3 years, we envision a significant share of Aixtron volume to be shipped from this location," says Aixtron's CEO & president Dr Felix Grawert at a media event with representatives of the regional Italian government. "We were able to secure the rare opportunity to purchase an existing production facility at very attractive commercial terms, which provides almost all of the specialized operations and test infrastructure for the manufacturing of our equipment," he adds. "We will be located in the heart of the manufacturing ecosystem of northern Italy, being close to many strong suppliers and world-class universities. We are proud to join this ecosystem and expect strong benefits for all parties, also for our exiting sites in Germany and in the UK."

From right to left: regional minister for Productive Activities Andrea Tronzano, Piedmont Region president Alberto Cirio, Aixtron's CEO Dr Felix Grawert, and Confindustria Piemonte president Marco Gay.

In a speech via video at the event, Adolfo Urso (National Minister for Enterprises and Made in Italy) emphasized the importance of the semiconductor industry for Italy and the region, and vice versa. "With these investments announced for 2024, Italy is on its way to become one of the leading chip and semiconductor manufacturers in Europe."

"Investment by Aixtron in Piedmont for a new production site comes a few weeks after the launch in Turin of the Foundation for the National Center for Artificial Intelligence," emphasized Piedmont Region president Alberto Cirio, together with the regional ministers Andrea Tronzano (Productive Activities), Elena Chiorino (Training and Work) and Fabrizio Ricca (Internationalization). "An already excellent supply chain is therefore enriched and becomes increasingly competitive. "Piedmont aspires to have a leading role [in the semiconductor sector], as demonstrated by the decision to join the Alliance of European Regions for Semiconductors, a body of which we will assume the presidency in 2025," they add.

"The contact with Aixtron was born exactly one year ago during a mission together with the president Cirio in Düsseldorf to consolidate our relations with the State of North Rhine-Westphalia, with which we have many points of contact," says Tronzano. "This is an important result, achieved thanks to the work of our Attraction Team, created precisely to attract, accompany and consolidate investments in our territory. Piedmont, as also certified by the Financial Times, is confirmed as one of the most attractive European regions from a production and industrial point of view."

www.aixtron.com

Lit Thinking selects Nippon Sanso MOCVD platform

TNSC SR2000HT-RR system to be used for far-UVC-LED R&D

Taiyo Nippon Sanso Corp (TNSC) of Tokyo, Japan (part of Nippon Sanso Holdings Group) says Lit Thinking of Orlando, FL, USA is purchasing a TNSC SR2000HT-RR metal-organic chemical vapor deposition (MOCVD) reactor for its research and development on far- UVC-LEDs, aided by support and expertise from TNSC.

"Taiyo Nippon Sanso is very proud to establish a relationship with Lit Thinking for development and commercialization of UV-LED technology and products," says TNSC's senior corporate officer Kunihiro Kobayashi. "Taiyo Nippon Sanso is looking forward to working with John Rajchert, Dr Leo Schowalter and the entire Lit Thinking team," he adds.

"The integration of the TNSC SR2000HT-RR MOCVD system marks a pivotal advancement for us, equipping our team with unparalleled materials growth capabilities," comments Lit Thinking's CEO John Rajchert. "This collaboration not only accelerates our journey towards ground-breaking UV-LED technologies but also enhances our ability to develop commercial products that promise to redefine safe indoor environments," he adds. "We are eager to leverage this technology to push the boundaries of what's possible in UV-LED applications."

As applications for UV-LEDs expand, TNSC expects its HT (high-temperature) MOCVD platforms to be the platforms of choice for advanced aluminium gallium nitride (AlGaN) device fabrication.

www.litthinking.com
www.MOCVD.jp

AlixLabs gains SEK2.5m grant from Sweden's Vinnova

Firm to continue commercialization of ALE processes and equipment

AlixLabs AB of Stockholm, Sweden — which was spun off from Lund University in 2019 and has developed Atomic Layer Etching (ALE) Pitch Splitting technology (APS) — has been granted SEK2.5m (equivalent to about €220,000) by Sweden's innovation agency Vinnova, for continuous R&D of its semiconductor products, starting September 2024 through August 2026. The funding is part of a SEK4m (about €350,000) grant from the strategic innovation program Electronic Components and Systems and its Research and Innovation Projects 2024, with SEK1.5m going to Halmstad University.

The funding allows AlixLabs to continue commercializing its ALE processes and associated equipment which enables semiconductor manufacturers to streamline production workflows, cutting down the number of manufacturing steps required to turn silicon into chips.

"We are proud to be recognized as an important innovator in Sweden, despite the Swedish semiconductor cluster being of modest size on a global scale," says CEO & co-founder Jonas Sundqvist. "With the help of Vinnova and by extension all of Sweden, we are closing in on our goal, which is to make advanced semiconductor production more energy efficient and sustainable."

APS can be used, for example, to split a 40nm-wide nanostructure into two that measure 10nm across — etching with never-before seen precision rather than relying on expensive EUV (extreme ultraviolet) lithography equipment.

"Our products will offer semiconductor giants such as TSMC, Samsung and Intel ways to streamline their future production workflows," says Sundqvist. "The same products also enable those who are not necessarily at the bleeding edge of semiconductor production, such as UMC, GlobalFoundries and Tower Semiconductor, to advance manufacturing in a cost-effective manner."

www.alixlabs.com

Laser Thermal awarded DoD Phase I STTR contract

Phase I to develop metrology of high-thermal-conductivity materials and interfaces

Laser Thermal of Charlottesville, VA, USA (which was spun off from University of Virginia in 2020 and designs and makes metrology equipment and provides services for thermal property measurement down to nanometer scales) says that the US Department of Defense (DoD) Office of the Secretary of Defense – Basic Research Office (OSD-BRO) has awarded it a Phase I Small Business Technology Transfer (STTR) contract to develop advanced thermal metrology technology for use with high-thermal-conductivity materials and interfaces. The Phase I program period of performance is six months, with an additional six-month option extending until February 2025.

Wide-bandgap (WBG) and ultra-wide-bandgap (UWBG) materials and devices include high-thermal-conductivity materials and interfaces with pertinent resistances spanning nano- to sub-millimeter length scales. Characterization of these materials with a single platform is challenging and there are limited available commercial options, says Laser Thermal. Most methods require a high degree of user knowledge in advanced optics and physics, for both instrumentation and analysis, and are traditionally only found in academic institutions and national labs. Laser Thermal says that the current and next generation of horizontal and vertical high-power devices and packages will benefit from commercially viable measurement systems to characterize:

- high-thermal-conductivity materials;
- thermal interface resistances;
- sub-surface films, interfaces, heat-sinks etc;
- temperature-dependent properties;
- spatially varying thermal resistances with areal length scales on the order of contacts and depth resolution on order of device layers;
- measurements in operando.

The results of the OSD-BRO Small Business Technology Transfer program will enable the design and manufacture of a high-power-density steady-state thermoreflectance (SSTR) tool for high-thermal-conductivity materials such as isotopically pure diamond. It will have integrated temperature testing and electrical probing for temperature-dependent property measurement and testing of devices in operando.

The new high-power SSTR system will enable variable depth sensitivity, spatial mapping and automated thermal property fitting across these temperature and applied external field capabilities.

The new tool is expected to dramatically increase ease of use for both data acquisition and, particularly, data analysis, allowing users to understand the most important use cases for temperature testing, electrical biasing, and thermal mapping.

www.laserthermal.com

CrayoNano announces volume delivery to key water disinfection customer

CrayoLED H-Series UV-C LED shipments mark revenue generation

CrayoNano AS of Trondheim, Norway — which develops and manufactures semiconductor components based on patented and proprietary nanomaterials technology — has announced the high-volume delivery of its CrayoLED H-Series (CLH-N3S) UV-C LED components to a key customer, described as a global leader in the development, manufacturing and sales of UV-C LEDs systems and disinfection products for water, air and surface applications.

CrayoNano says that the milestone highlights its qualification by an "industry-leading" customer. The "significant" shipment marks second-quarter 2024 revenue generation for CrayoNano, reinforcing its commercial momentum.

"Our key customer, renowned for its expertise and innovation in UV-C LED water purification solutions, has integrated CrayoNano's UV-C LEDs into its commercial and consumer point-of-use (POU) and point-of-entry (POE) water disinfection systems, ensuring safe and clean drinking water," says global sales director Stefan Stockbauer. "We are thrilled to witness our UV-C LED components being actively utilized in the field, marking a significant milestone as we deliver our UV-C LEDs in high volume to one of the leading global players in the UV-C LED water purification industry," he adds. "This achievement not only validates our technology but also solidifies CrayoNano's market position as a high-performing and reliable supplier for drinking water disinfection."

CrayoNano reckons that the customer shipment marks the beginning of an acceleration in the adoption of UV-C LEDs in the water disinfection market, as the customer's products showcase the proven performance, reliability and efficiency of its UV-C LEDs, meeting the standards and qualifications required for real-world applications. "Together, we pave the way for future advancements in automated disinfection, reduction in the use of harmful chemicals, facilitating a future where clean water is more accessible, and contribute to a cleaner environment," says Stockbauer.

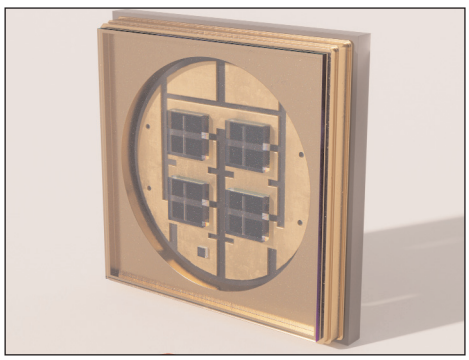
www.crayonano.com

Silanna UV launches 235nm Quad High-Power far-UVC LED at ICFUST

Compact 6.8mm package with ESD protection offers 125° viewing angle and 3mW output at 30mA

Silanna UV of Brisbane, Australia — which provides far-UVC light sources for water quality sensors, gas sensors, disinfection, and HPLC (high-performance liquid chromatography) applications — launched a new 235nm Quad High-Power far-UVC LED at the International Congress on Far-UVC Science and Technology 2024 (ICFUST) at the University of St Andrews in Scotland, UK (19–21 June). As a sponsor of the event, Silanna UV showcased its latest deep-UVC and far-UVC LED innovations.

The SF1-3M1FWL1 is a high-power, far-UVC emitting device, with a peak wavelength of 235nm in a compact LED package, enabling a variety of new applications and potential markets. Protected by a US patent and offering a typical viewing angle of 125° and a typical output power of over 3mW at 30mA, the 235nm UV LED is effective for surface disinfection, air purification, medical device sterilization, home appliance sterilization, and liquid chromatography.



Unlike UV lamps still used in many high-value critical applications and legacy situations, Silanna UV's easy-to-implement LED replacements are said to have superior energy efficiency and cooler operation. Free of mercury, the LEDs are claimed to offer significant environmental and regulatory advantages, while their robustness reduces maintenance and replacement costs.

The surface-mount (SMD) SF1-3M1FWL1 UV LED component provides flexibility for application design and assembly. Electrostatic discharge (ESD) protection is integrated into the UV LED's small-footprint 6.8mm x 6.8mm package. Standard tape-and-reel or Gel-Pak packing options are available for manufacturers and users, while Silanna UV also offers pre-solder on a starboard for an eco-friendly evaluation.

www.eventsforce.net/standrews/frontend/reg/thome.csp
www.silannauv.com/products/quad-highpower

CrayoNano adds Turkish design-in partner

CrayoNano AS of Trondheim, Norway — which develops and makes semiconductor components based on patented and proprietary nano-materials technology — has expanded its European footprint with a new design-in partnership agreement with Turkey-based Gesan Aydınlatma VE Elektronik Ltd _ti, which designs, makes and sells LED lighting systems and solutions for water and surface disinfection for agriculture and horticulture, under its brand DEM_RLED. Gesan Aydınlatma has designed CrayoNano's UV-C LEDs into its products and systems for the disinfection of fungi, bacteria and other micro-organisms that are harmful to plants.

The collaboration is said to mark a milestone for CrayoNano as it continues to expand across new regions and agritech (agriculture technology), aquaculture and smart farming applications for its UV-C LEDs components and technology.

The utilization of UV-C LEDs for disinfection in food production and packaging can positively impact agritech and horticulture by enhancing food safety and extending food shelf and transportation life, says CrayoNano. UV-C LEDs effectively eliminate pathogens (including bacteria and viruses) on food surfaces and packaging materials, reducing the risk of contamination and spoilage. This technology supports sustainable agriculture practices by minimizing the need for chemical disinfectants, which can have harmful environmental and human health impacts. By ensuring safer and longer-lasting food products, UV-C LED disinfection can contribute to food security and reduce food waste, addressing critical aspects of the UN's Sustainable Development Goal 2. It can be integrated into various stages of food production, from farm to fork, ensuring that agricultural produce maintains its nutritional value and safety throughout the supply chain. In horticulture, UV-C LEDs can be used to disinfect water and surfaces in greenhouses, promoting healthier plant growth and higher yields. The adoption of UV-C LED disinfection systems offers a powerful solution to enhance food safety, reduce waste and support sustainable agricultural practices, playing a vital role in achieving global food security and improved nutrition, says CrayoNano.

Gesan Aydınlatma and its brand DEM_RLED have decades of experience in agriculture and horticulture, providing LED lighting systems that enhance plant growth and food production in Turkey, Eastern Europe and Middle East. Its DEM_RLED UV LED lamp won first prize in the plant protection category at the ATSO Antalya Growtech 2022 international fair.

The new partnership followed successful testing of CrayoLEDs by Gesan's general manager Sıtkı Mehmet Bozbiyik with his customers. "CrayoNano's LEDs are very efficient and powerful. Our tests demonstrated the performance superiority and efficacy of CrayoNano's products," he notes, adding that they will be incorporated in all Gesan's products and ongoing and future projects. "This collaboration will enable us to offer even more effective and efficient solutions to our customers, enhancing crop yields and sustainability."

"The expertise and market innovation Gesan Aydınlatma has in LED lighting systems and technologies, especially in the agricultural and horticulture sector, align perfectly with our mission to deliver high-quality, innovative UV-C LED components into systems to support sustainable agriculture technology that contribute to improving global health and bringing food security to all," says CrayoNano's global sales director Stefan Stockbauer. "Together, we aim to drive advancements in plant growth technologies and promote sustainable agricultural practices."

The CrayoNano–Gesan partnership promises to bring advances in UV-C LED applications, offering enhanced plant growth and treatment solutions and contributing to the future of sustainable agriculture.

www.demirled.com
www.crayonano.com

Seoul Viosys files patent lawsuit against Feit

Ultraviolet LED product maker Seoul Viosys Co Ltd (SVC, a subsidiary of South Korean LED maker Seoul Semiconductor Co Ltd) has filed a patent infringement lawsuit in the US District Court for the Central District of California against California-based home lighting firm Feit Electronic Company Inc.

The complaint asserts that the LED lighting products manufactured and sold by Feit infringe six patented technologies jointly developed by Seoul Semiconductor and Seoul Viosys, including proprietary omnidirectional filament LED technology. Currently, about half of general household light bulbs are filament-type products.

Seoul Semiconductor has also successfully pursued lawsuits against filament LED patent infringers in Europe. In 2020, based on a finding of infringement of Seoul's patent, the German District Court of Düsseldorf issued two orders for permanent injunctions, recalls and destructions of filament LED products manufactured and sold by the affiliate of Philips brand lighting. Also, due to the establishment of the Unified Patent Court in Europe in 2023, Seoul Semiconductor's filament LED patented technology will be enforced in 18 European countries, including Germany, France, the Netherlands and Italy.

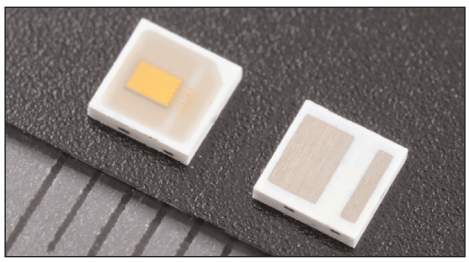
www.feit.com
www.seoulviosys.com

ROHM develops VCSELED infrared light source

Low temperature dependence plus wide-angle emission and uniform output aid ADAS

ROHM has established VCSELED as a new infrared light source technology that encapsulates a VCSEL (vertical-cavity surface-emitting laser) chip in a resin optical diffusion material for laser light. ROHM is now developing this technology for commercialization as a light source for improving vehicle driver monitoring systems (DMS) and in-cabin monitoring systems (IMS).

To further enhance automotive safety, driver monitoring systems are increasingly being installed in vehicles equipped with advanced driver assistance systems (ADAS) to detect drowsiness, sleepiness and distracted driving. In Japan, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has created guidelines that define the design and functions of the system, and in the European Union (EU) there are plans to make installation mandatory in all new vehicles sold in Europe from July onwards. Auto-makers and suppliers are also developing in-vehicle monitoring systems to detect occupants other than the driver, and there is a growing awareness of the need for high-performance light sources that enable detection systems to function with greater precision.



ROHM's 3.0mm x 3.0mm x 0.5mm VCSELED IR light source package.

In response, ROHM has developed VCSELED technology to achieve high-accuracy sensing. Minimal wavelength temperature variation combined with a wide emission beam angle mean not only that it is suitable for in-vehicle monitoring systems but also that it contributes to improving the accuracy and performance of inspection systems for robots and industrial equipment as well as spatial recognition and ranging systems.

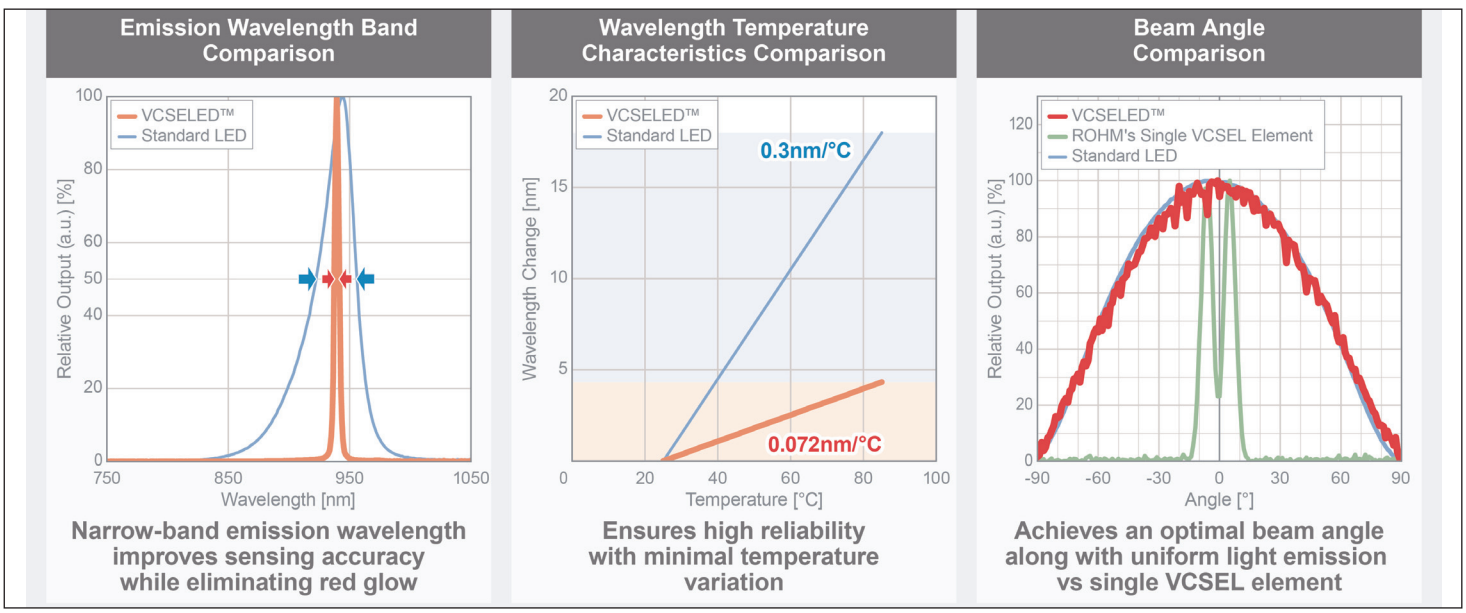
Similarly to LEDs, VCSELED extends the beam (irradiation) angle by combining a high-performance VCSEL chip and light diffusion material to enable sensing over a wider area with higher accuracy than VCSELs. Also, the light-emitting chip and light diffuser are integrated into a compact package, contributing to smaller, thinner applications.

The VCSEL chip used in VCSELED features a narrow emission wavelength bandwidth of 4nm, which is one-seventh that of LEDs. This characteristic improves resolution performance on the receiving side while eliminating the red glow that is often associated with LEDs. At the same time, a wavelength temperature variation of 0.072nm/°C — less than a quarter that of LEDs (0.3nm/°C) — allows high-accuracy sensing, unaffected by temperature changes. Furthermore, the response time when emitting light is 2ns, which is about 7.5 times faster than LEDs, contributing to higher performance in time-of-flight (ToF) applications that use infrared light to measure distance.

ROHM is working on commercializing VCSELED as a new technology brand for infrared light source components. Prototype samples are available for purchase now, with mass-production samples scheduled for release in October 2024 for consumer applications and in 2025 for automotive applications, respectively.

ROHM adds that, going forward, it will continue to develop laser light source technology for in-vehicle monitoring and other systems.

www.rohm.com



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NYSE American to begin delisting NUBURU

NUBURU trading on OTC Market while appealing NYSE delisting

NYSE American LLC says that the staff of NYSE Regulation has begun delisting the common stock of high-power industrial blue laser maker NUBURU Inc of Centennial, CO, USA (which was founded in 2015) from the NYSE American stock exchange. Trading in the firm's common stock has been suspended.

NYSE Regulation says that, pursuant to Section 1003(f)(v) of the NYSE American Company Guide, NUBURU is no longer suitable for listing due to the selling price of the common stock falling below $0.10.

NYSE American will apply to the US Securities and Exchange Commission (SEC) to delist the common stock upon completion of all applicable procedures.

In the meantime, NUBURU plans to appeal the delisting to the Listings Qualifications Panel of the Committee for Review of the exchange's board of directors.

In the interim, FINRA's Department of Market Operations has assigned the symbol 'BURU' for quotation and trading of NUBURU's stock in the over-the-counter market (OTC Markets).

"It is unfortunate that NUBURU is having to contend with this at a time when it is successfully reducing debt, raising capital, taking on new orders, and receiving prestigious recognitions in our industry," comments NUBURU's CEO Brian Knaley. "We continue to believe the company has a bright future and the actions of NYSE will in no way deter our commitment to strengthen our relationships with our shareholders, key financing partners, employees, customers, and vendors in order to advance the company's business plan and increase shareholder value."

www.nuburu.net

Japan Laser installs BL250 BlueScan in Osaka office

System to be used to demonstrate micro-welding and wire stripping to electronic and medical device customers

NUBURU says that distributor Japan Laser Company (JLC) has installed a BL250 BlueScan system in the JLC Osaka office, to be used to demonstrate micro-welding and wire stripping to strategic electronic and medical device customers in the Japanese market.

NUBURU's BL250 BlueScan system optimizes beam quality through innovative engineering. By minimizing the beam parameter product (BPP), it achieves maximum brightness, which is essential for efficient laser performance. Its unique approach involves actively aligned micro-optics to circularize and collimate the output of individual diodes, preserving the BPP and creating a high-power beam. This design contrasts with linear diode arrays, which suffer from increased BPP and reduced brightness, it is claimed. NUBURU says its technology ensures higher power density, resulting in faster processing speeds and deeper weld penetration, enhancing overall performance in industrial applications.

"The ability to deliver the blue wavelength beam through a scan head is unique and enables many micro-welding and wire stripping applications," says Akira Morohashi, JLC's general manager, Sales. "Japan Laser Company has already installed NUBURU's BL250 BlueScan system and intends to demonstrate the technology to many customers over the next few months."

Japan's electronic and medical device market is experiencing significant growth, driven by technical advances and increasing demand for innovative healthcare solutions. The Japanese medical device market is estimated to be rising at a compound annual growth rate (CAGR) of 6.34% from 2022 to about $282.11bn by 2027, fuelled by the increasing prevalence of chronic diseases, the aging population and the growing emphasis on early diagnosis and treatment. In 2023, the Japanese market for medical devices was worth about $29.7bn and is expected to continue growing as the adoption of digital health technologies and AI-enabled devices increases.

NUBURU claims its blue lasers offer the highest brightness available, enabling effective use with galvo scanners and delivering superior results in welding, soldering and additive manufacturing of metals including copper, gold, aluminium, nickel and stainless steel, as well as joining dissimilar metals. The all-semiconductor construction and proprietary chip-based design are said to ensure greater stability, reliability and operating efficiency than other laser types.

"NUBURU's first BL installation at the Osaka office of Japan Laser Company could open up numerous opportunities in Japan's electronics, medical device and general manufacturing industries," reckons NUBURU's CEO Brain Knaley. "As JLC demonstrates the unique benefits of higher yields and greater uptime and reliability when welding copper and aluminium and stripping wire with blue wavelength to its customers, we expect numerous additional opportunities to unfold in the Japanese market," he adds. "NUBURU's presence in Japan could facilitate closer collaboration with JLC's customers, potentially leading to improvements in cost-efficiency, technology and supply chain logistics."

www.japanlaser.co.jp/en

Vector Photonics gains £1.667m in equity investment and £1.27m in research funding

Funding for continued commercialization of Surface Coupling Lasers

Vector Photonics Ltd (which was spun off from Scotland's University of Glasgow in 2020, based on research led by professor Richard Hogg) has received £1.667m in equity investment and £1.27m in additional research funding for the continued commercialization of its unique Surface Coupling Laser (SCL) technology, which is claimed to enhance performance in applications as diverse as next-generation data centers, co-located optics, artificial intelligence (AI), metal and plastic printing, LiDAR, and optical sensing.

The £1.667m equity investment comes from four companies, each a next-generation technology and early-stage investment specialist that has invested in Vector Photonics previously.

- Foresight WAE Technology (FWT) Funds invests in high-growth-potential companies with innovative and transformational technologies;
- UK Innovation & Science Seed Fund (UKI2S) is a specialist deep-tech seed fund focused on spin outs from the UK's research base;
- Equity Gap is an angel investment syndicate, investing at an early stage in new technology businesses throughout Scotland; and
- Scottish Enterprise is Scotland's national economic development agency and works to transform the Scottish economy by helping businesses innovate and scale.

The new research funding comprises two development projects:

- FRONTIERS is a £670,000 revenue-generating development project for free-space optics, funded by the Small Business Research Initiative (SBRI).
- GRAPHICS is a £600,000 Innovate UK-funded grant, in collaboration with the University of Glasgow, developing gallium nitride (GaN) material processing expertise. This could lead to blue and green lasers that consume 70% less power than equivalent LEDs, it is reckoned.

The new funds take Vector's current funding total to nearly £3m. "This provides a strong, financial base to continue the development and commercialization of the company's unique and revolutionary surface-emitting laser technologies," says Neil Martin.

www.vectorphotonics.co.uk

Cambridge start-up Wave Photonics raises £4.5m in seed funding

Funds to be used to develop on-chip photonics designs for quantum technologies, sensors, and data-center applications

Wave Photonics of Cambridge, UK (which was founded in May 2021) has received £4.5m ($5.8m) in a seed investment round co-led by the UK Innovation & Science Seed Fund (UKI2S) and Cambridge Enterprise Ventures, with participation from the Redstone and QAI Ventures' Quantum Fund, Kyra Ventures, and Deep Tech Labs. This was complemented by non-dilutive funding in grants from the Horizon Europe European Innovation Council (EIC) Fund and UK Government agency Innovate UK (which provides funding and support for business innovation as part of UK Research and Innovation). The company's total funding to date is now £5.4m ($6.9m).

The new funds will be used to develop on-chip photonics designs for quantum technologies, sensors, and data-center applications.

Integrated photonics can be used as the platform for energy-efficient communications, wearable healthcare sensors, rapid diagnostic tools, optical sensor processors, on-chip LiDAR, quantum computing and communications. But, in contrast to mature semiconductor chip processes, taking a photonic integrated circuit (PIC) from a concept to mass production is long and often prohibitively expensive, says the firm.

Wave Photonics was founded by two University of Cambridge quantum photonics PhDs James Lee and Matthew Anderson along with chief technology officer Mateusz Kubica (a former quantitative finance VP with 10 years' experience in mathematical and computational modelling). The firm has since built and validated its core computational photonics design technology to reduce photonic product development time. It aims to use this to unlock what it describes as the transformative potential of integrated photonics.

The Wave Photonics team.

The firm's mission is to help unlock valuable photonics markets by reshaping the inefficient and fragmented productization cycle into an integrated and rapid process, analogous to the development of modern semiconductors.

The new investment will enable it to take its technology from a research manufacturing line to a commercial foundry, with a particular focus on solutions for frontier applications such as quantum technologies and biosensing.

"The team has spent the past few years building and experimentally validating our design technology — it's exciting to have the resources to begin deploying it to solve real industry problems," says CEO James Lee.

"When we first met Jamie and his partners, we were very impressed by both the vision and the promise of the very innovative approach taken to design for the next generation of integrated photonics," comments UKI2S investment director Mark White.

"Cambridge Enterprise Ventures is pleased to follow our initial pre-seed investment and co-lead Wave Photonics' seed round with UKI2S," says Dr Christine Martin, head of ventures at Cambridge Enterprise. "Integrated photonics is poised to disrupt high-value industries ranging from quantum computing to bio-sensing, and Wave Photonics' team and technologies are in a great position to enable and accelerate the adoption of next-generation integrated photonics products," she reckons.

"Integrated photonics is an expanding field with strong impact on quantum technologies, as well as diverse applications touching our everyday life," notes Chiara Decaroli of Redstone. "We believe Wave Photonics' products will play a significant role in shaping PICs design in the future."

www.wavephotonics.com

NASA awards $750,000 EPSCoR grant for project using UV light for space communications

III–nitride wide- and ultra-wide-bandgap materials target high-data-rate communications with satellites and deep-space probes

Under the 'Established Program to Stimulate Competitive Research' (EPSCoR), the US National Aeronautics and Space Administration (NASA) has awarded a grant worth $750,000 to the project 'III–Nitride Ultraviolet Laser Diodes for Harsh Environments, Space-Based Communications, and Remote Sensing', which focuses on enhancing high-data-rate communications between satellites and Earth, particularly for deep-space missions.

Morgan Ware, an associate professor in the Department of Electrical Engineering and Computer Science at the University of Arkansas (U of A), serves as the lead scientific investigator for the project. With co-investigator Robert 'Drew' Fleming at Arkansas State University, the project is administered through the Arkansas Space Grant Consortium by the principal investigator Constance Meadors. In addition, Paul Minor joins the team as an industrial adviser from Ozark Integrated Circuits Inc.

"The primary goal of the project is to facilitate the transformation of space-based information transfer from radio to optical wavelengths, while looking towards future deep-space relays using ultraviolet light," Ware says. "There is an effort at NASA to move from very traditional radio-based communications to communications based on the modulation of light. Current efforts use lasers like those used in fiber-optic communications, which make up nearly all terrestrial communication backbones. This would make possible a thousand to million or more times improvement in data transfer rates. However, these optical signals must transmit through the air or, in the case of satellite-to-satellite communication, through space."

The project's lead scientific investigator Morgan Ware, associate professor in the University of Arkansas' Department of Electrical Engineering and Computer Science.

"To achieve this, we will make semiconductor laser diodes using various alloys of the nitride family of semiconductors including aluminium nitride, gallium nitride and indium nitride. This amazing group of materials spans from the so-called ultra-wide-bandgap aluminium nitride providing structural rigidity, optical transparency and harsh-environment tolerance to the so-called narrow-bandgap indium nitride providing optical wavelength tunability and electrical conductivity. Using different combinations of these materials we will monolithically build each component of a vertical-cavity surface-emitting laser (VCSEL)," Ware adds.

While the long-term focus is on advancing communications technology, the project is rooted in semiconductor research that spans multiple scientific disciplines and industries, underscoring the potential growth and importance of wide- and ultra-wide-bandgap materials in technological development, U of A says.

If successful, the technology could greatly speed up satellite-to-satellite or deep-space communications.

"There is a growing need for high data transfer rates from very distant systems," says Ware. "Having the capability to watch pseudo-live video feed from the Mars rovers, for example, would make future explorations there significantly more productive."

The next steps for the project involve simulating and testing the semiconductor alloys and nanostructures to ensure that they can emit the desired wavelength of light, while remaining unstrained to prevent cracking and future degradation. In addition: "We want to ensure the lasers and other optical components can operate effectively in the harsh environments of space," Ware says.

It is reckoned that the results of this and similar research efforts have the potential to fundamentally change space exploration as satellites and other space probes travel further from Earth. The development of semiconductor-based UV lasers will not only significantly increase data transmission rates, enabling faster communication between Earth, satellites and distant space missions, they also provide a platform for satellite-based remote sensing using laser excitation, to probe the more complicated chemistries of other planets' atmospheres, the U of A concludes.

Ware is a member of the Institute for Nanoscience and Engineering at the U of A, which houses the graduate program in materials science and engineering, and is where most of the research will be performed. He is also a member of the Arkansas Power Group, which is currently deeply invested in wide- and ultra-wide-bandgap semiconductor research.

www.research.uark.edu

Nokia to acquire Infinera for $2.3bn, boosting in-house optical technology and vertical integration

Nokia aims to strengthen position in optical sector, specifically in North America

Infinera Corp of San Jose, CA, USA — a vertically integrated manufacturer of open optical networking systems and optical semiconductors — has agreed to be acquired by Finland's Nokia for $6.65 per share (an enterprise value of $2.3bn), representing a premium of 28% to Infinera's share price at the close of 26 June and a 37% premium to the trailing 180-day volume-weighted average price (VWAP).

At least 70% will be paid in cash and Infinera's shareholders can elect to receive up to 30% in the form of Nokia American Depositary Shares (ADSs) at 1.7896 Nokia shares per Infinera share. Each shareholder can alternatively choose a combination of $4.66 in cash and 0.5355 Nokia shares for each Infinera share.

Also, to mitigate any dilution from the equity component of the acquisition, Nokia's board of directors has committed to increase and accelerate Nokia's on-going €600m share buyback program. At or around the time of closing of the transaction Nokia will repurchase Infinera's outstanding convertible notes for an estimated $760m (including change of control costs), which is already considered in the $2.3bn enterprise value.

Nokia and Infinera see a significant opportunity in merging to improve scale and profitability, enabling the combined business to accelerate the development of new products and solutions. The transaction aligns with Nokia's strategy, as it is expected to strengthen its optical technology and increase exposure to webscale customers (the fastest-growing segment of the market).

The combination with Infinera is projected to accelerate Nokia's progress to double-digit operating margin in its Optical Networks business. Assuming that the transaction closes during first-half 2025, Nokia aims to achieve €200m of net comparable operating profit synergies by 2027 (about one third from cost of sales due to supply chain efficiencies, and the remainder from operating expenses due to portfolio optimization and integration along with reduced product engineering costs and standalone entity costs). Nokia expects one-time integration costs of about €200m.

Along with its recently announced sale of Submarine Networks, Nokia says that the acquisition of Infinera will create a reshaped Network Infrastructure built on the three pillars of Fixed Networks, IP Networks and Optical Networks. Nokia targets mid-single-digit organic growth for the overall Network Infrastructure business and to improve its operating margin to the mid-to-high teens level.

The transaction is also expected to be accretive to Nokia's comparable EPS in the first year post-close and to deliver over 10% comparable EPS accretion by 2027, with a return on invested capital (RoIC) comfortably above Nokia's weighted average cost of capital (WACC).

"In 2021 we increased our organic investment in Optical Networks with a view to improving our competitiveness. That decision has paid off and has delivered improved customer recognition, strong sales growth and increased profitability," says Nokia's president & CEO Pekka Lundmark. Now is the right time to take a compelling inorganic step to further expand Nokia's scale in optical networks. The combined businesses have a strong strategic fit, given their highly complementary customer, geographic and technology profiles," he adds.

"Network Infrastructure offers a unique portfolio across the fixed access, optical and IP networks domains built on leading technology innovation and a strong customer focus. This acquisition will further strengthen the optical pillar of our business, expand our growth opportunities across all our target customer segments and improve our operating margin," believes Federico Guillén, president of Network Infrastructure at Nokia.

"Together we will have greater scale and deeper resources to set the pace of innovation and address rapidly changing customer needs at a time when optics are more important than ever – across telecom networks, inter-data-center applications, and now inside the data center," says Infinera's CEO David Heard. "This combination will further leverage our vertically integrated optical semiconductor technologies. Furthermore, our stakeholders will have the opportunity to participate in the upside of a global leader in optical networking solutions."

Nokia lists strategic benefits of the acquisition as follows:

- Improving global scale and product roadmap: The combination will increase the scale of Nokia's Optical Networks business by 75%, enabling it to accelerate its product roadmap timeline and breadth.
- In-house capabilities will include an expanded digital signal processor (DSP) development team, expertise across silicon photonics and indium phosphide (InP)-based semiconductor materials, and deeper competency in photonic integrated circuit (PIC) technology.
- Gaining scale in North America optical market: The two companies have limited customer overlap, putting the combined business in a strong position in all regions

(excluding China), it is reckoned. The North America optical market comprises ~60% of Infinera's sales, which will improve Nokia's optical scale in the region and complement Nokia's strong positions in APAC, EMEA and Latin America.

- Building on Nokia's commitment to investment in US-based manufacturing and advanced testing and packaging capabilities.
- Accelerating Nokia's expansion into enterprise and particularly webscale: Combination of the two businesses is also expected to accelerate Nokia's strategic goal of diversifying its customer base and growing in enterprise.

Internet content providers (ICP, or webscale in Nokia's terminology) comprise over 30% of Infinera's sales. With recent wins in line systems and pluggables, Infinera is well established in this fast-growing market. Infinera has also recently been developing high-speed and low-power optical components for use in intra-data-center (ICE-D) applications, which are particularly suited to AI workloads which can become a very attractive long-term growth opportunity. Overall, Nokia reckons that the acquisition offers an opportunity for a step change in its penetration into webscale customers.

The acquisition has been unanimously approved by the board of directors of both Nokia and Infinera. It is targeted to close during first-half 2025, subject to approval by Infinera's shareholders, regulatory approvals including anti-trust, CFIUS (Committee on Foreign Investment in the United States) and other foreign direct investment approvals and other customary closing conditions.

Oaktree Optical Holdings L.P., which owned about 11% of Infinera's common stock as of 27 June, has agreed to vote their shares in favor of the transaction.

www.nokia.com
www.infinera.com

Coherent appoints Jim Anderson as CEO as Mattera retires

Former Lattice president & CEO also joins board

The board of directors of materials, networking and laser technology firm Coherent Corp of Saxonburg, PA, USA has appointed Jim Anderson, an established industry executive with a proven track record of driving innovation and leading business transformations, as CEO. Anderson also joins the board. He succeeds Dr Vincent D. (Chuck) Mattera Jr, who is retiring as chair & CEO.

Anderson joins Coherent from Lattice Semiconductors, where he was president, CEO & board member. As CEO, he was responsible for driving Lattice's corporate strategy and strengthening its product roadmap, achieving record operating profits and gross margins.

"Jim's business acumen and technical capability, coupled with his extensive experience transforming complex global businesses to deliver above-market growth and profitability, make him the ideal leader to steer Coherent through its next chapter amidst a rapidly changing market," believes board chair Enrico DiGirolamo. "Coherent will benefit from Jim's operational expertise, innovation-first approach and in-depth knowledge of our market and platform, as we capitalize on the strong market demand we


Jim Anderson

see across our AI-related datacom portfolio and improving industrial market, while leveraging our diversification strategy that continues to serve us well," he adds.

"With cutting-edge innovation, an industry-leading platform, and an intense focus on the customer, Coherent is exceptionally well positioned to build on its existing momentum and deliver enhanced profitable growth over the long term," comments Anderson.

"Chuck Mattera has been in and around this industry for almost half a century, conceptualizing and directing the acquisition and business development strategy that made Coherent the multi-billion-dollar global entity it is today," says DiGirolamo. "Chuck thoughtfully forged meaningful relationships with employees, customers, suppliers, government officials, key partners and shareholders that established a values-based foundation." he adds, "I have the privilege of thanking Chuck for his many years of visionary leadership, tireless execution and energetic commitment to redefining the possibilities of our industry."

Prior to joining Lattice in 2018, Anderson was senior VP & general manager of Advanced Micro Devices' Computing and Graphics business group. He previously held leadership positions in general management, engineering, sales, marketing and strategy at companies including Intel, Broadcom (formerly Avago Technologies) and LSI Corp.

Anderson serves on the board of directors of Entegris, EdgeQ and Lumotive, as well as on the board of directors of the Semiconductor Industry Association, the MIT Sloan Americas Executive Board, the Electrical and Computer Engineering Advisory Board at Purdue University, and the Dean's Advisory Board for the University of MinnesotaCollege of Science and Engineering. Previously, he was a director at Sierra Wireless.

Anderson holds an MBA and Master of Science in electrical engineering and computer science from the Massachusetts Institute of Technology, a Master of Science in electrical engineering from Purdue University, and a Bachelor's degree in electrical engineering from the University of Minnesota.

www.Coherent.com

Rocket Lab allocated $23.9m US CHIPS Act funding

Expansion of space-grade solar cell production by 50% in next three years to create 100 jobs in New Mexico

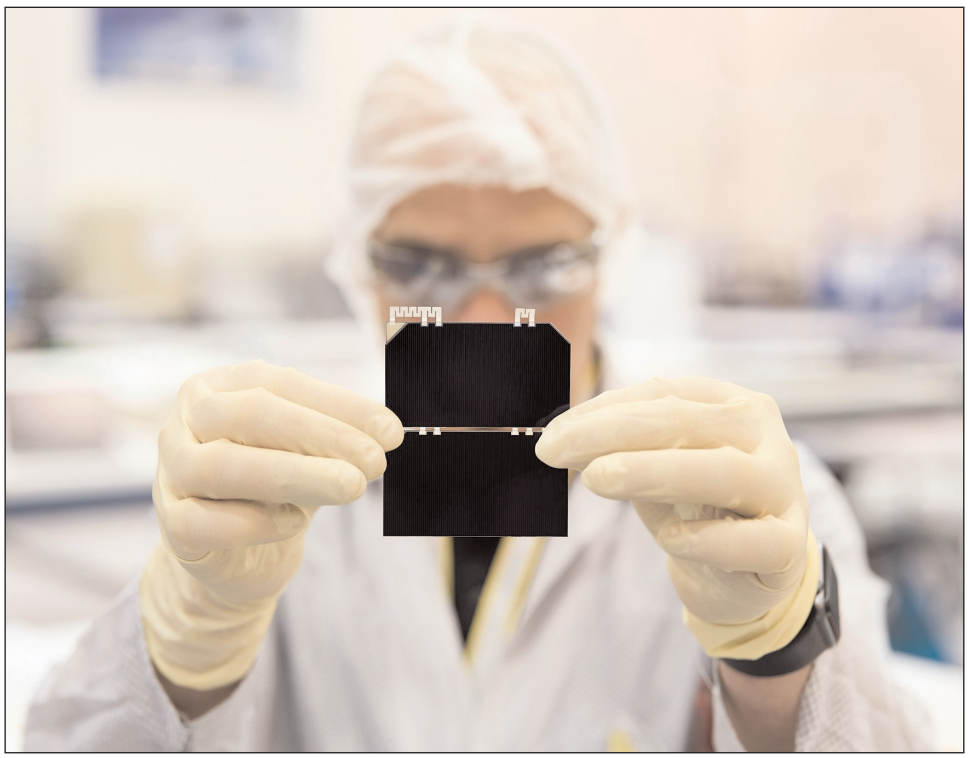
Launch services and space systems provider Rocket Lab USA Inc has signed a non-binding preliminary memorandum of terms (PMT) with the Department of Commerce that would see Rocket Lab receive up to $23.9m in direct funding under the CHIPS and Science Act.

The proposed investment would enable Rocket Lab to increase its production of compound semiconductors for spacecraft and satellites, as part of an expansion and modernization of its facility in Albuquerque, New Mexico.

Rocket Lab acquired SolAero Technologies Inc in 2022, making Rocket Lab one of only two companies in the USA — and three companies outside of Russia and China — that specializes in the production of highly efficient and radiation-resistant compound semiconductor-based space-grade solar cells. The space-grade solar cells produced in Albuquerque power critical space programs such as missile awareness systems and exploratory science missions including the James Webb Space Telescope, NASA's Artemis lunar explorations, Ingenuity Mars Helicopter, and the Mars Insight Lander. Rocket Lab's technology also serves a booming commercial satellite market, such as powering the OneWeb broadband internet satellite constellation.

The proposed CHIPS investment would help create a more robust and resilient supply of space-grade solar cells. The modernization and expansion project would also increase Rocket Lab's compound semiconductor production by 50% within the next three years, helping to domestically meet the growing national security and consumer demand for these solar cells.

In addition to these proposed federal incentives, the State of New Mexico has also committed to provide financial assistance and



incentives worth $25.5m to Rocket Lab in support of this effort.

"For more than two decades the SolAero team, now part of Rocket Lab, has played a crucial role in the domestic production of semiconductors," says Rocket Lab founder & CEO Sir Peter Beck. "This program is a continuation of our commitment to ensuring resilient US supply chains and creating highly productive local jobs," he adds.

"Rocket Lab has called New Mexico home for 25 years, first as SolAero Technologies and now as a thriving modern company manufacturing space solar cell technology," commented Governor Michelle Lujan Grisham. "Rocket Lab's expansion will bring more than 100 new jobs to New Mexico. This is just the latest example of how the CHIPS and Science Act is fueling new technology and high-wage jobs," she adds.

"With this funding, our satellites won't be dependent on foreign sources for solar power, and instead use American-manufactured solar cells made from compound semiconductors," notes Congresswoman Teresa Leger Fernández.

Rocket Lab plans to claim the Department of the Treasury's Investment Tax Credit, which is expected to be up to 25% of qualified capital expenditures. As explained in its first Notice of Funding Opportunity, the Department may offer applicants a PMT on a non-binding basis after satisfactory completion of the merit review of a full application. The PMT outlines key terms for a potential CHIPS incentives award, including the amount and form of the award. The award amounts are subject to due diligence and negotiation of award documents and are conditional on the achievement of certain milestones. After the PMT is signed, the Department begins a comprehensive due diligence process on the proposed projects and continues negotiating or refining certain terms with the applicant. The terms contained in any final award documents may differ from the terms of the PMT announced.

www.chips.gov
www.rocketlabusa.com/

5N Plus renews and increases CdTe materials supply agreement with First Solar

Deal represents 50% increase in volume over next two years

Specialty semiconductor and performance materials producer 5N Plus Inc of Montreal, Québec, Canada has renewed its supply agreement with First Solar Inc of Tempe, AZ, USA.

5N+ will increase its supply of cadmium telluride (CdTe) semiconductor materials to First Solar for the manufacturing of thin-film photovoltaic (PV) solar modules. 5N+'s materials are embedded in First Solar's Series 6 and 7 PV modules in a specialty semiconductor stack. This is aligned with 5N+'s announced plans to increase capacity to serve high-value, high-growth end markets.

"We are pleased to have once again successfully extended our long-standing partnership under favourable terms," says president & CEO Gervais Jacques. "We are committed to partnering with strategic customers operating in critical industries as a strong, reliable and trusted provider of advanced specialty semiconductors," he adds.

"This agreement with First Solar represents a 50% increase in volume over the next two calendar years compared to our previous agreement, an increase which we will meet as a result of the investments made over the last few years in Montréal and Eisenhüttenstadt, Germany, to increase our semiconductor compound production capacity and recycling capabilities. This will also allow us to expand our semiconductor product portfolio in support of First Solar," Jacques continues.

"With its semiconductor material production facilities in Canada and Germany, 5N+ is a key part of our supply chain," says First Solar's chief supply chain officer Mike Koralewski. "We are pleased to extend our longstanding partnership with 5N+ as we continue our journey to growth and expand our global manufacturing footprint to reach an expected 25GW of nameplate capacity by 2026."

As part of the agreement, 5N+ and First Solar also continue to collaborate on the development and supply of other renewable energy products to support the growth and improvement of CdTe thin-film technology.

www.5nplus.com

First Solar is PV industry's first EPEAT Climate+ Champion

Cadmium telluride (CdTe) thin-film photovoltaic (PV) module maker First Solar Inc of Tempe, AZ, USA says that its Series 6 Plus and Series 7 TR1 products are the world's first PV solar modules to achieve the EPEAT Climate+ designation, establishing a new benchmark for the solar technology and manufacturing industry.

EPEAT (Electronic Product Environmental Assessment Tool) is a globally recognized ecolabel that includes independent validation and allows for the easy identification of environmentally preferable products from socially responsible companies. It addresses the whole product life-cycle, including managing substances in the product, manufacturing energy and water use, product packaging, end-of-life recycling, corporate responsibility, and human rights.

EPEAT Climate+ makes EPEAT the only global ecolabel to address greenhouse gas (GHG) emissions during the different stages of solar module production, and products receiving the designation must meet the ultra-low-carbon threshold of ≤400kg CO_2e/kWp. EPEAT Climate+ helps purchasers to quickly identify technology products designed and manufactured with climate change mitigation in mind, allowing them to reduce scope 3 emissions of solar installations.

"EPEAT Climate+ helps ensure that purchasers and investors are able to prioritize ultra-low-carbon solar technologies that meaningfully support decarbonization efforts," says Bob Mitchell, CEO of the Global Electronics Council (GEC). "This is a simple, yet effective tool to mitigate life-cycle carbon impacts of solar modules, while enabling a market for responsibly manufactured technologies that embody sustainability."

First Solar's thin-film PV modules are claimed to already set industry benchmarks for quality, durability, reliability, design and environmental performance, adding that its Series 7 modules have the lowest carbon and water footprint of any commercially available PV module.

"With EPEAT Climate+, our customers now benefit from a global standard that allows them to confidently procure solar modules that lower their scope 3 emissions and are responsibly made," says Samantha Sloan, VP of policy, sustainability & marketing, First Solar. "We encourage other manufacturers to embrace this global validation standard and contribute to the effort to reinforce our industry's license to operate."

First Solar's Series 6 Plus and Series 7 TR1 became the first solar modules to be included in a list of nearly 1500 products produced by leading electronics brands known as EPEAT Climate+ Champions. The firm intends to validate the environmental footprint of its Series 7 FT1 module, which is manufactured in India, with the goal of achieving an EPEAT Climate+ designation.

www.firstsolar.com

PCSEL emits at more than 300mW CW at 1550nm wavelength

Potential applications include communications and eye-safe LiDAR.

Sumitomo Electric Industries Ltd and Kyoto University in Japan have claimed a record continuous wave (CW) output power exceeding 300mW for a 1550nm-wavelength photonic-crystal surface-emitting laser (PCSEL) on an indium phosphide (InP) platform [Takeshi Aoki et al Appl. Phys. Express, p17, p042004, 2024].

The researchers note: "While single-mode lasing at a peak output power of up to 100mW under pulsed conditions has been reported using 1550nm-wavelength InP-based PCSELs, CW operation of these PCSELs at output powers of hundreds of milliwatts has not been achieved, in contrast to GaAs-based and GaN-based ones." The mentioned gallium arsenide (GaAs) and gallium nitride (GaN) PCSELs, of course, emit shorter-wavelength laser light than 1550nm.

The team sees such InP-based PCSELs as promising light sources for optical communications and LiDAR (light detection and ranging) that depend on high-power and single-mode characteristics. The 1550nm wavelength range is particularly suitable for applications where eye safety is a concern, since this wavelength is mostly absorbed in the crystalline eye lens before reaching the retina.

PCSELs use a two-dimensional (2D) photonic crystal as an optical cavity coupled to a nearby active layer. The team explains: "Lasing oscillation is achieved in the form of a broad-area 2D standing wave at a singularity point (typically Γ) in the photonic band structure."

The PC was prepared before the epitaxy of the active layers of the laser diode by patterning and dry etching of an n-InP substrate (Figure 1). The PC structure was then encapsulated by overgrowing an InP spacer layer before the indium gallium arsenide phosphide (InGaAsP) multiple quantum well (MQW) photon-generating layer.

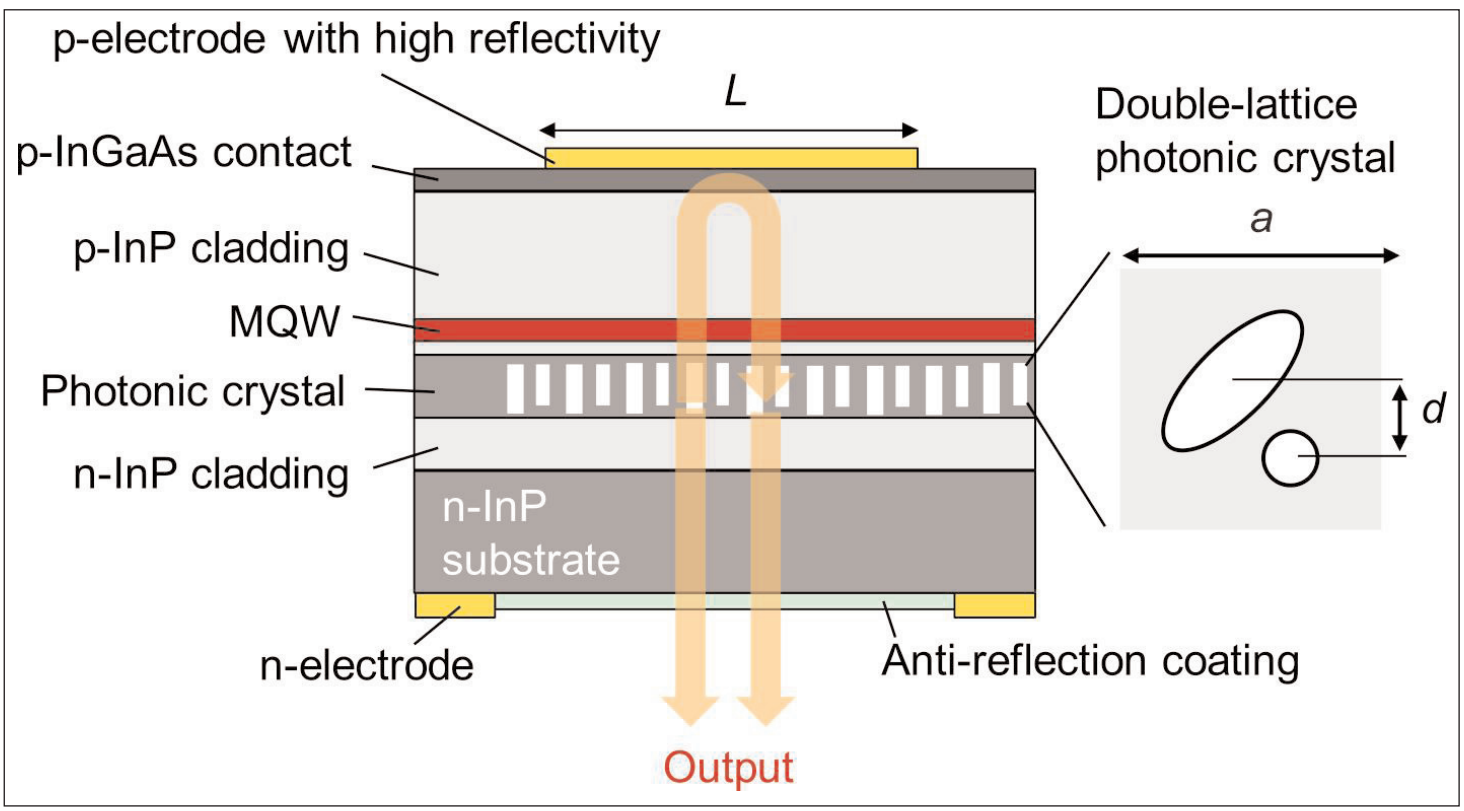


Figure 1. Schematic of 1550nm-wavelength PCSEL with double-lattice photonic crystal structure consisting of large elliptical and small circular air holes.

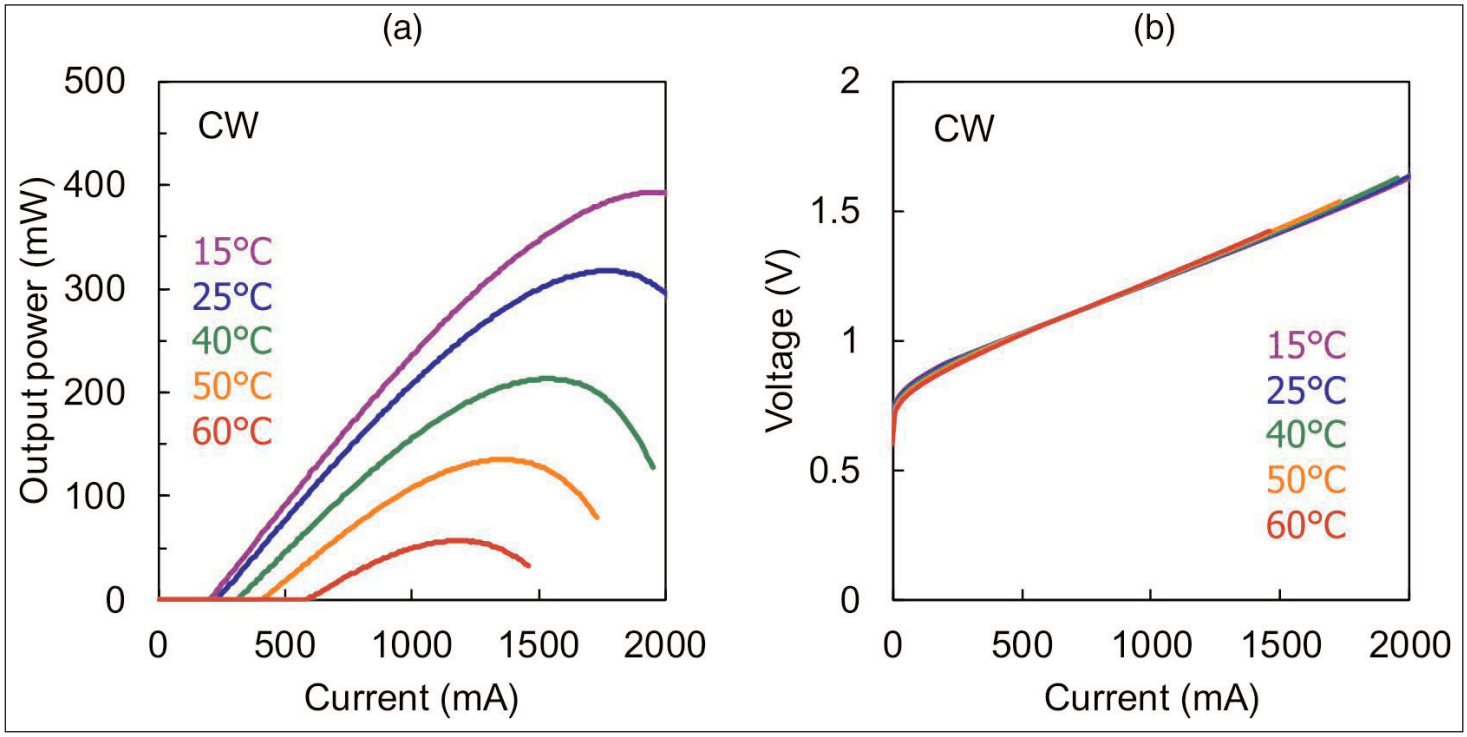


Figure 2. (a) Light output power-current (L–I) and (b) voltage–current (V–I) characteristics of fabricated 200μm-diameter PCSEL under CW conditions from 15°C to 60°C.

The researchers note: "The advantage of this fabrication process is that, by growing the active layer atop the PC layer after the dry-etching step, the risk of damaging the active layer through dry etching of the deep air holes is avoided, enabling the PC structure to be closer to the active layer."

The laser diode was designed to have a reflective p-contact with the laser beam output emerging from a 200μm circular window on the flipped n-side of the device. The PC consisted of elliptical and circular holes in a 480nm square unit cell. The size of the cell was suitable for 1550nm-wavelength oscillations.

"While single-mode lasing at a peak output power of up to 100mW under pulsed conditions has been reported using 1550nm-wavelength InP-based PCSELs, CW operation of these PCSELs at output powers of hundreds of milliwatts has not been achieved, in contrast to GaAs-based and GaN-based ones." The mentioned GaAs and GaN PCSELs, of course, emit shorter-wavelength laser light than 1550nm

The device achieved 318mW peak output power at 25°C under CW operation (Figure 2). The researchers believe that this is the highest reported output power for PCSELs in the 1550nm wavelength range. The wall-plug efficiency was 17.3%.

The J_{th} at 25°C (Table b) was comparable to the 0.67kA/cm^2 of a 1300nm PCSEL previously reported by the researchers. The team comments: "The slight difference of J_{th} is attributed to larger intrinsic loss and Auger recombination at the longer wavelength."

At 1770mA injection at 25°C, the main peak at 1546.43nm had a full-width at half maximum (FWHM) less than the 0.2nm resolution limit of the analyzer. The side-mode suppression ratio (SMSR) exceeded 60dB for currents up to 2A, and operating temperatures up to 60°C.

The researchers did observed a slight decrease in the SMSR with increasing current or temperature due to a small increase in intensity of emission from one of the side modes (labeled C). The divergence angle of the far-field pattern was less than 1° at 800mA, 25°C (1/e^2 width).

The researchers comment: "The temperature at the center of the current injection area becomes higher than that at the periphery, resulting in the concomitant emergence of a downward-convex-shaped in-plane band-edge frequency distribution caused by a temperature-borne change of refractive index." ■

https://doi.org/10.35848/1882-0786/ad3cb4

Author: Mike Cooke

Table 1. CW performance characteristics at 25°C and 60°C.

Characteristic	25°C	60°C
Threshold current	230mA	590mA
Threshold current density (J_{th})	0.73kA/cm^2	1.9kA/cm^2
Slope efficiency (η_{SE})	0.29W/A	0.15W/A

InP-on-insulator substrates for 2.1µm lasers on silicon

Ion-slicing technique could enable lower-cost production of optoelectronics.

Researchers based in China report on 2.1µm lasers produced on indium phosphide on insulator (InPOI) on silicon (Si) substrates, using ion-slicing and molecular beam epitaxy [Jiajie Lin et al, Optics Express, v32, p19655, 2024].

The team from Jiaxing University, Shanghai Institute of Microsystem and Information Technology, China Electronics Technology Group Corporation, and Shanghai Institute of Technical Physics, attribute improved high-temperature laser performance to the relatively high thermal conductivity of silicon.

The researchers see opportunities for next-generation optical networks in super- and cloud-computing from increased integration of electronics and photonics.

The team comments: "The 2–3µm wavelength spectral range is critical in military, spectroscopic sensing, medical and industrial applications as this wavelength band encompasses transparent atmospheric windows and spans the absorption bands of numerous chemical molecules."

Direct epitaxy of InP on Si tends to result in high defect levels due to large differences in lattice (8%) and thermal expansion (73%) coefficients, and other factors.

The InPOI substrates were prepared using ion-slicing (Figure 1). Ion-slicing raises the prospect of reusing the source InP substrate, avoiding the usual wastage of destructive substrate removal processes in conventional wafer-bonding scenarios.

The slices were achieved with co-implantation of hydrogen and helium ions into monocrystalline InP. The InP was transferred and hydrophilically bonded to a silicon dioxide (SiO_2) layer on Si substrate. The separation of the ion-weakened layer from the bulk InP was achieved with 400°C annealing in nitrogen for half an hour.

Ion implantation surface damage was removed with chemical mechanical polishing (CMP). The researchers report that their laser yield suffered from a poor post-CMP wash process, which left particles on the surface. The final InP thickness was 473nm. They hope that this process can be improved in future work.

The multiple quantum well (MQW) laser epitaxial structure was grown through gas-source molecular

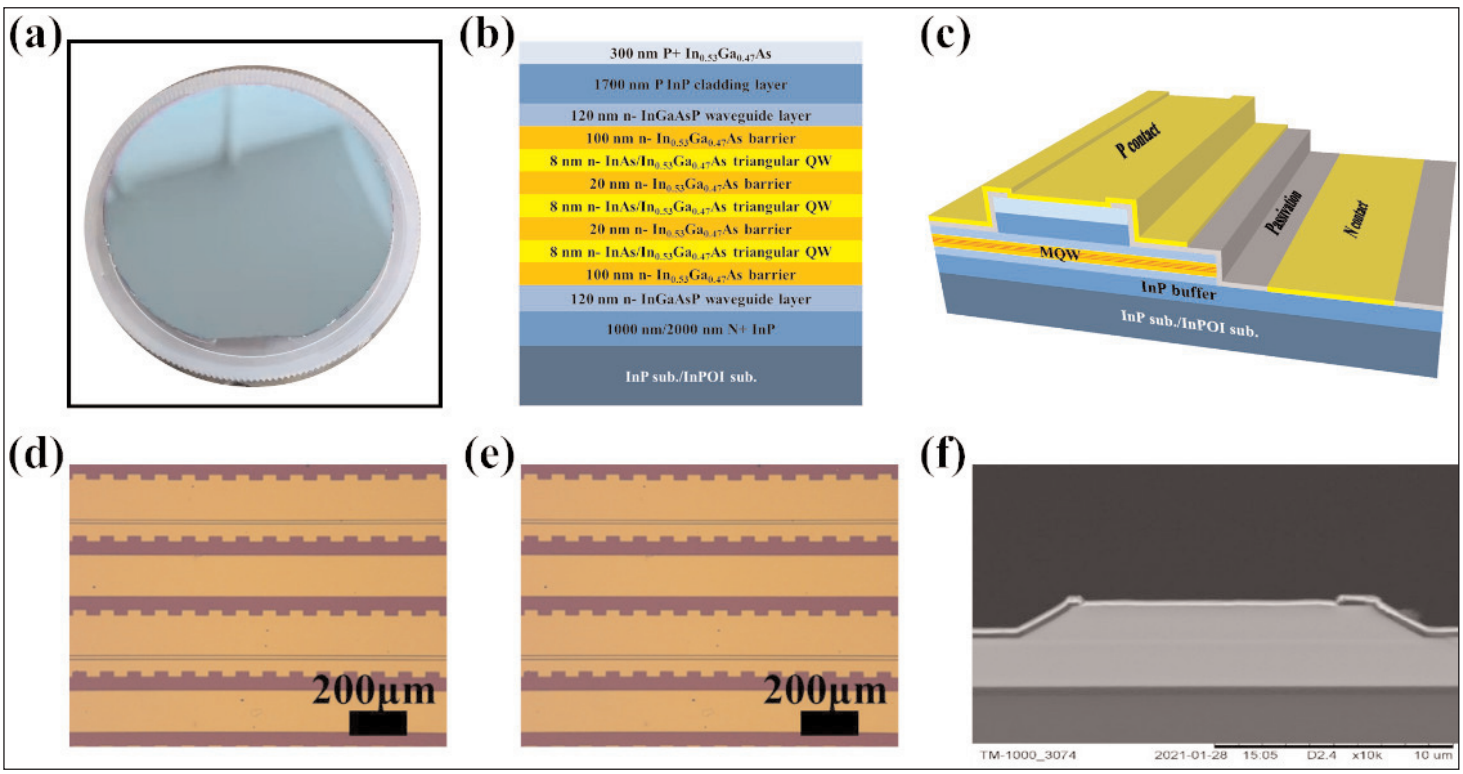


Figure 1. (a) As-prepared InPOI substrate; (b) epitaxial laser structure on InP or InPOI; (c) schematic 3D diagram of lasers; optical microscopy images of as-fabricated laser bars on (d) InP and (e) InPOI; (f) cross-section scanning electron microscope (SEM) image of as-cleaved laser on InPOI.

beam epitaxy (GSMBE). The three triangular QWs consisted of indium gallium arsenide graded with a digital alloy growth technique from 53% to 100% to 53% indium on average. The separating barriers were indium gallium arsenide ($In_{0.53}Ga_{0.47}As$).

The GSMBE process used parameters standardized for bulk InP and not taking into consideration thermal conductivity/expansion differences between InP and Si. Photoluminescence measurements showed QW peak wavelength dependence on the substrate: 2140nm on InPOI and 2090nm on InP. The difference is attributed mainly to residual strain variation. A secondary effect could be a slight difference in growth temperature resulting in compositional variation. The different temperature is expected due to thermal conductivity differences of the substrates.

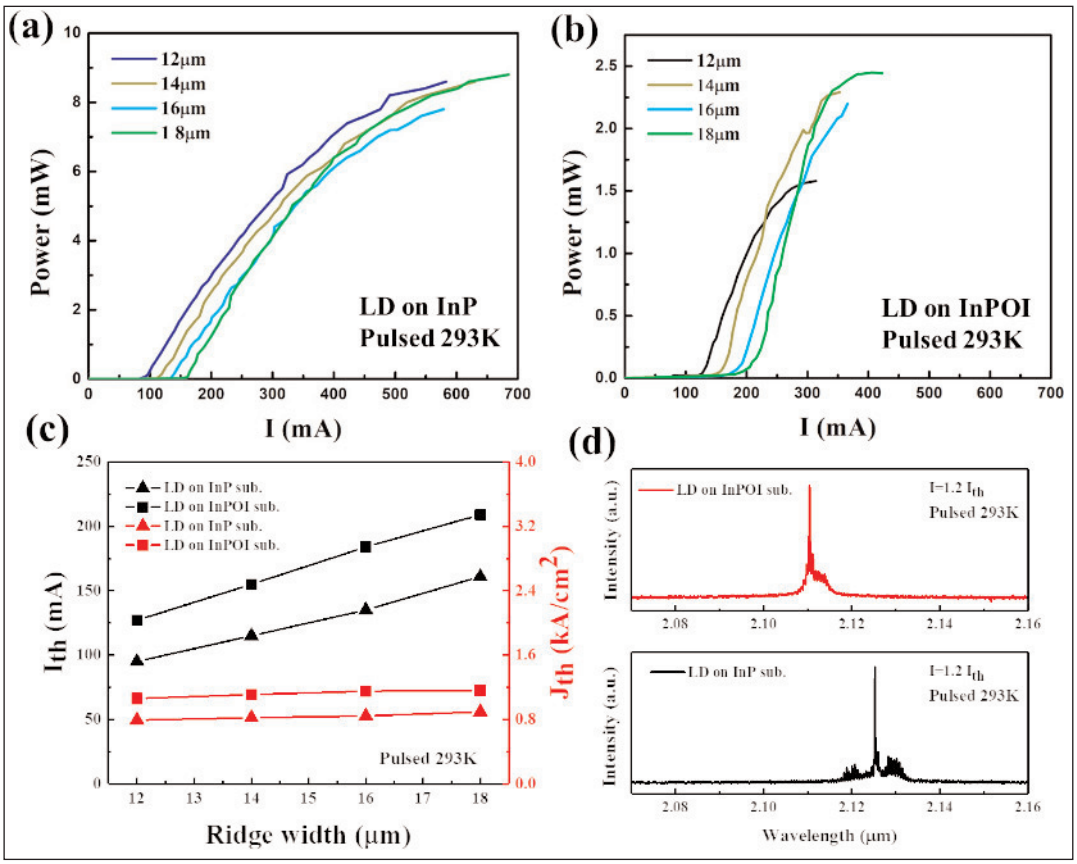


Figure 2. Lasing properties at 293K with different ridge widths on (a) InP and (b) InPOI under 5% duty cycle, 2kHz pulsed mode; (c) threshold current/current density versus ridge width; (d) lasing spectra for 14μmx1mm ridges.

The waveguide layers consisted of indium gallium arsenide phosphide (InGaAsP). Lasers produced on bulk InP used a thinner 1μm N^+-InP buffer layer. The thicker 2μm buffer on InPOI was designed to reduce series resistance caused by the heterogeneous substrate.

The surface roughness was 2.7nm on InPOI and 0.138nm on InP, according to atomic force microscopy (AFM) over a 5μm square. The deviation on InPOI over the laser wafer reached 15nm due to the presence of particles from the CMP process.

The researchers comment: "It is expected that epitaxial layers with lower RMS roughness values can be achieved under well optimized CMP conditions for the InPOI heterogeneous substrate."

The team fabricated ridge lasers using photolithography and wet etching. Plasma-enhanced chemical vapor deposition silicon nitride, 300nm thick, was used for passivation. The p-electrode consisted of titanium/platinum/gold, and the n-electrode germanium/gold/nickel/gold.

The material was cleaved into 1mm-long laser bars.

The threshold current density of the ridge laser at room temperature (20°C) was approximately constant: 0.79kA/cm^2 on InP and 1.06kA/cm^2 on InPOI (Figure 2). As with the photoluminescence, the substrate structure affected the laser peak wavelength: 2.125μm and 2.11μm for 14μm-wide ridges on InP and InPOI, respectively. The team's explanation carries over from the photoluminescence observations.

Temperature-dependent continuous wave (CW) laser measurements were carried out from 78K up to 283K and 313K for 14μm-wide ridge devices on InPOI and InP, respectively. The CW laser threshold at 283K (10°C) was 1.3kA/cm^2 on InPOI, compared with 0.76kA/cm^2 on InP. The maximum single-facet laser powers reached were 11.5mW and 3.1mW on InP and InPOI, respectively. Pulsing the drive current reduced the thresholds to 0.65kA/cm^2 and 1.03kA/cm^2 for InP and InPOI, respectively at 283K.

The team also studied the temperature dependence of the laser wavelength at 1.2 times the threshold current injection into 14μm-wide ridge devices. In CW mode, the wavelength (red-)shift rates were 0.89nm/K and 0.91nm/K for InPOI and InP substrates, respectively.

The researchers comment: "During operation, the high thermal conductivity of silicon reduces the influence of thermal effects in the active area on the red-shift caused by self-heating."

For pulsed mode operation, the shift rate was reduced to 0.87nm/K for lasers on both substrate types. ■

https://doi.org/10.1364/OE.519297

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Reversing size effects in cyan–green micro-LEDs

QD LEDs with M-plane sidewalls with much reduced surface damage.

Researchers based in China report progress in eliminating size effects in micron-scale cyan–green light-emitting diodes (LEDs) [Peng Zhang et al, ACS Photonics, v11, p2045, 2024]. In fact, the smaller 10μm devices fabricated by the team from the Suzhou Institute of Nano-Tech and Nano-Bionics (SINANO) and the University of Science and Technology of China showed higher efficiency than larger devices (15μm and 20μm).

Size effects in micro-LEDs are usually the result of non-radiative sidewall recombination, which becomes increasingly significant as devices shrink. The researchers used a wet chemical treatment on the sidewalls oriented to the 'M' planes of the gallium nitride (GaN) hexagonal crystal structure. The chemical etch preferentially smoothed the surfaces to pure M planes, from the rough alignment provided by a previous plasma etch.

In theory, devices with M-plane sidewalls could be arranged as arrays of triangles, but hexagons should provide much better current-spreading performance. The researchers see micro-LEDs as driving future display developments, particularly for augmented reality and virtual reality applications.

The epitaxial structure for the LEDs was grown by plasma-assisted molecular beam epitaxy on 2μm-thick GaN-on-sapphire templates prepared by metal-organic chemical vapor deposition. The active region consisted of multiple layers (5x) of self-assembled indium gallium nitride (InGaN) quantum dots (MQDs) in GaN. The dot layers were 3nm spaced by 11nm GaN barriers. The structure also included a 13nm aluminium gallium nitride (AlGaN) electron-blocking layer (EBL) between the active region and the hole-injecting 150nm top p-GaN layer. The electron-injection layer was 630n n-GaN between the template and active region.

The epitaxial material was etched into hexagonal micro LEDs in two steps (Figure 1): using inductively coupled plasma (ICP) to a depth of 550nm, followed by wet chemical treatment with tetramethylammonium hydroxide (TMAH) solution at 85°C for 2 hours to remove sidewall defects and etch damage (Figure 2). The etching produced arrays of 77 hexagonal micro-LEDs with the sides aligned with the M-plane family ({10$\bar{1}$0}) of the hexagonal wurtzite GaN crystal structure.

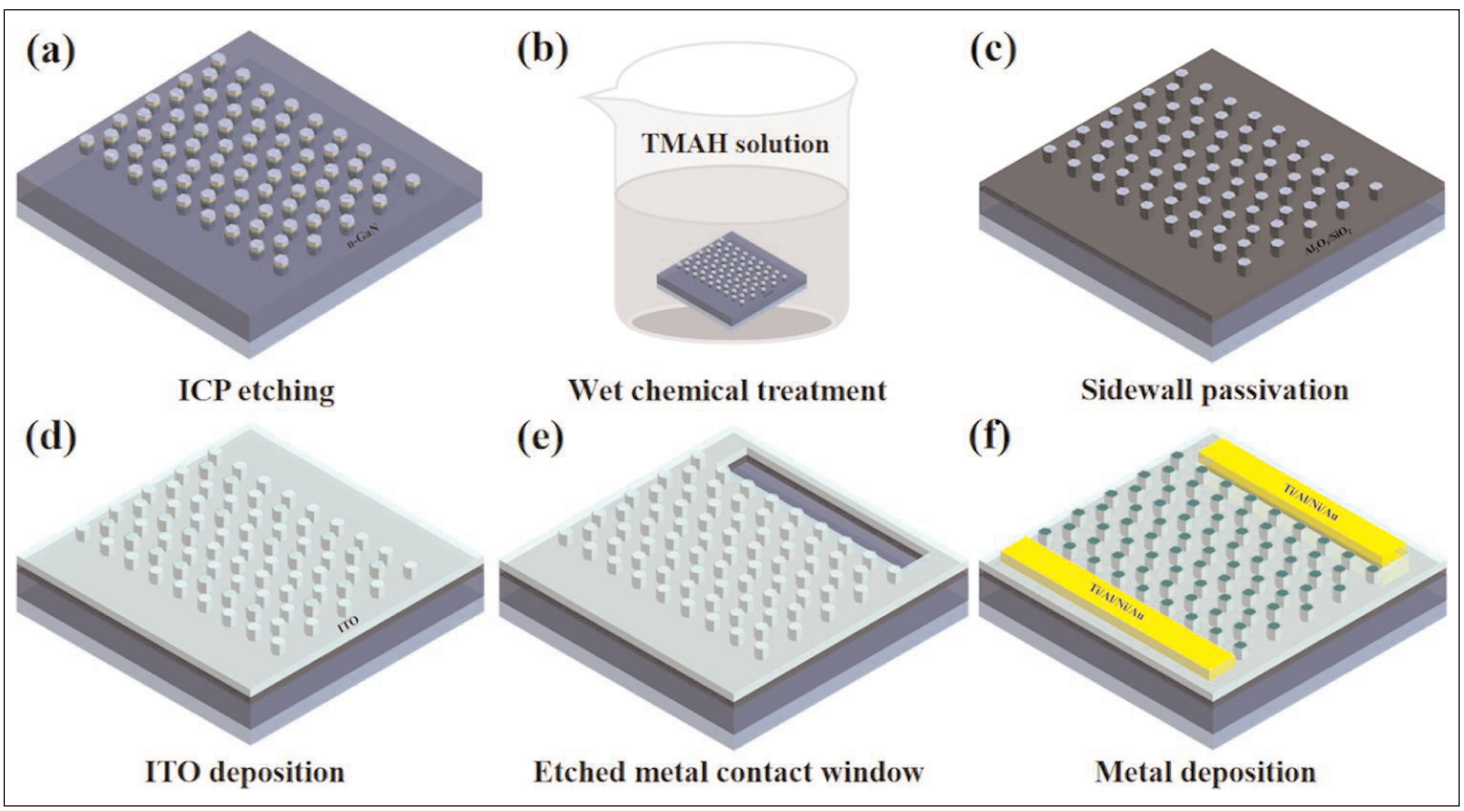

Figure 1. Process flow of cyan-green GaN-based QD micro-LED array: (a) ICP etching, (b) wet chemical treatment, (c) sidewall passivation, (d) ITO deposition, (e) etched metal contact window, and (f) metal deposition..

The TMAH treatment transformed the sidewalls from a roughly 45° bevel angle to near vertical, along with reducing the surface roughness and, presumably, defects.

The sidewall passivation consisted of 20nm atomic layer deposition aluminium oxide (Al_2O_3) and 200nm plasma-enhanced chemical vapor deposition silicon dioxide (SiO_2).

The p-contact electrode was 130nm indium tin oxide (ITO). After etching down to the n-GaN layer, titanium/aluminium/nickel/gold metal contacts were applied to the p- and n-sides of the device.

The power density and efficiency dependence went against the usual expectation of reduced performance of the smaller devices due to surface-related non-radiative recombination (Figure 3). In fact, the smaller 10μm-side devices achieved a higher light output power density, and higher efficiency than the larger 15μm and 20μm LEDs.

The researchers suggest that the increased performance was a combination of the TMAH treatment effectively tackling the size effect in terms of surface repair, and the smaller size allowing better current spreading and higher light extraction efficiency (LEE) to be realized.

The peak EQEs were 0.47%, 0.68% and 0.83% for the 20μm, 15μm and 10μm devices, respectively. Also, the peaks occurred around the same injection current density. The researchers comment: "The peak EQE of conventional micro-LEDs tends to shift toward higher current densities due to non-radiative recombination caused by sidewall defects." The team suggests that this indicates that the rate of non-radiative recombination is not increased in the smaller micro-LED array.

The low EQE compared with conventional quantum well (QW) devices was attributed to at least two factors:

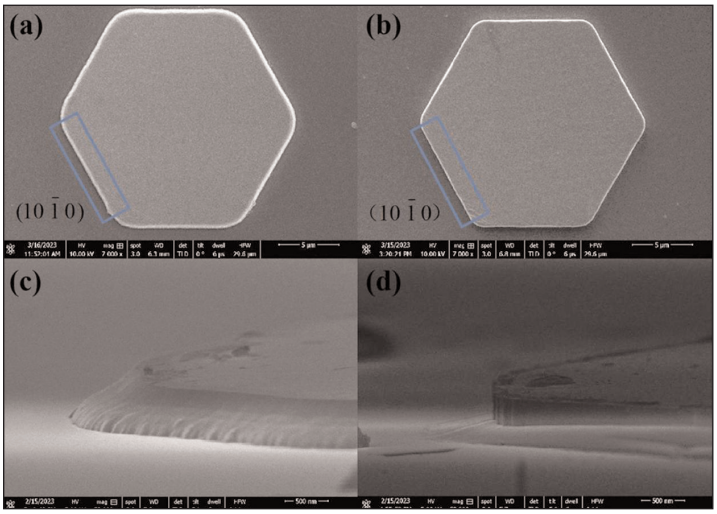

Figure 2. Scanning electron microscope (SEM) images of 10μm hexagonal QD LED. Top views (a) before and (b) after TMAH treatment. Bird's-eye views of the sidewall before (c) and after (d) treatment.

1. Low-temperature growth of the GaN quantum barrier layer. The low temperature results in lower-quality material, but is used to avoid damage of the underlying InGaN QD layers: indium tends to desorb at higher temperatures.
2. Low electron capture cross-section of QDs versus QWs. This could be improved by increasing the area density of QDs, it is hoped.

The emission wavelength of the devices at low current density (1A/cm^2) was around 503nm. When the injection reached 100A/cm^2, the wavelengths had blue-shifted by 12nm, 7.7nm and 7.6nm for the 10μm, 15μm and 20μm LED arrays, respectively. ■

https://doi.org/10.1021/acsphotonics.4c00211

Author: Mike Cooke

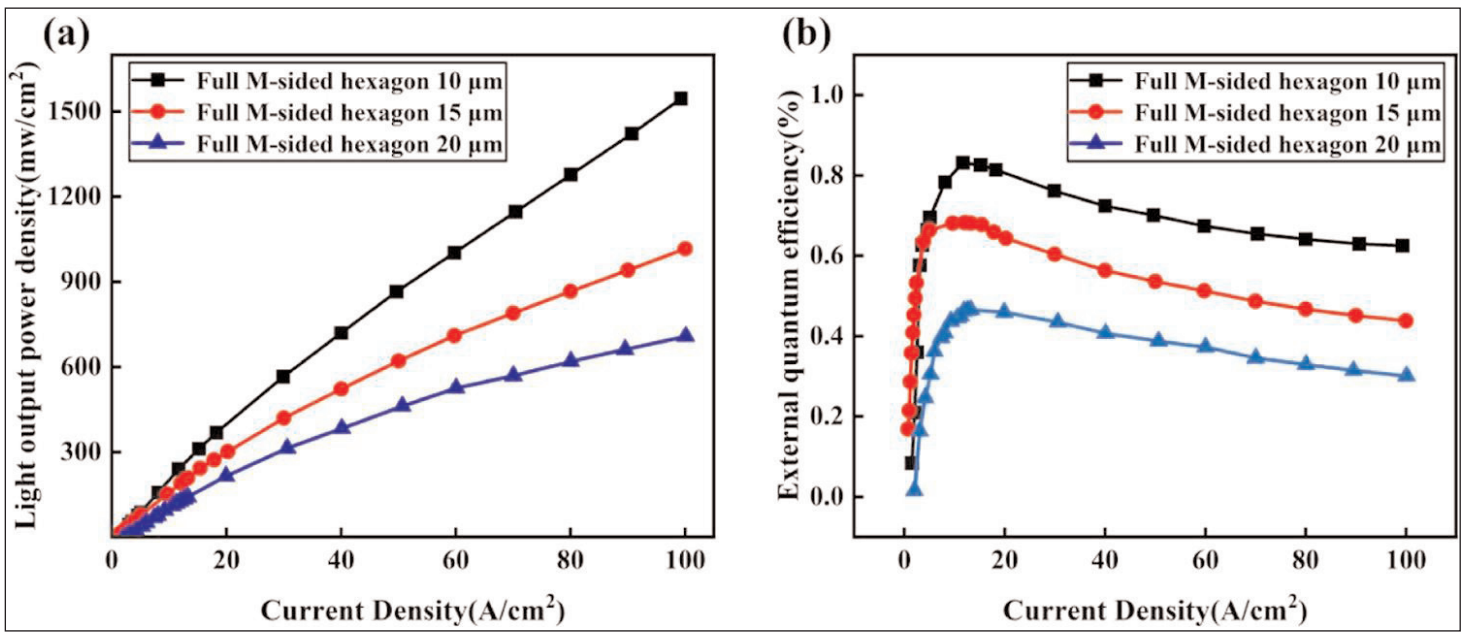

Figure 3. (a) Light output power (LOP) density and (b) external quantum efficiency (EQE) versus current density for different-sized micro-LED arrays.

Sumitomo presents pore-assisted free-standing GaN

Researchers hope the technique will enable larger substrates beyond 100mm.

Sumitomo Chemical Co Ltd in Japan has developed a pore-assisted separation (PAS) method for the fabrication of free-standing gallium nitride (GaN) substrates [Masafumi Yokoyama et al Appl. Phys. Express, v17, p055502, 2024].

The researchers comment: "We expect that the proposed method will open a path to realizing larger free-standing GaN substrates with good productivity."

Sumitomo sees improved power conversion efficiency of electrical systems as being one of the key contributors to tackling the bad effects of human activity on the global climate. GaN-based devices are being developed with this end in view, since the wide-bandgap material is capable of handling larger voltages and power densities than more traditional electronic materials such as silicon.

The researchers comment: "In fact, vertical-type GaN power devices fabricated homoepitaxially on free-standing GaN substrates have exhibited superior voltage-blocking capability and low on-resistance, as expected on the basis of GaN's nature."

Free-standing GaN has been produced by a wide variety of methods. The key steps are growing a thick layer of GaN on a suitable substrate, such as sapphire, and then separating the GaN from the initial substrate.

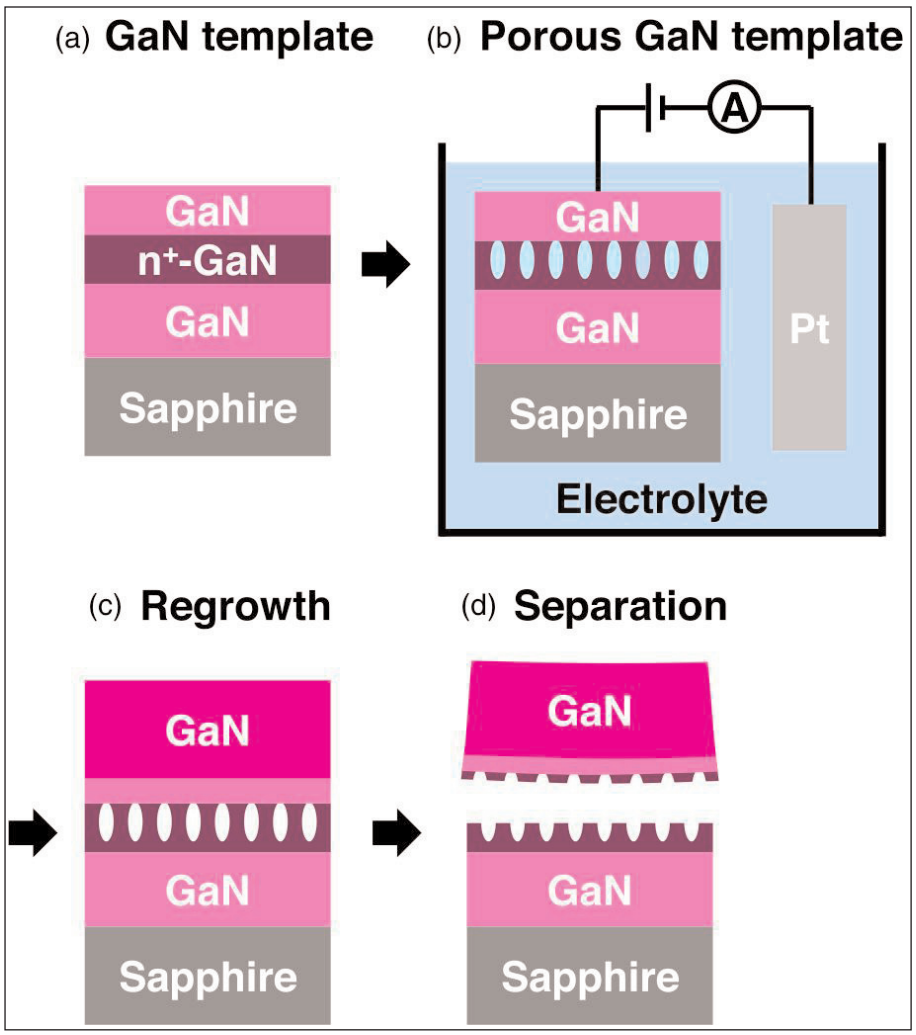

Figure 1. Process flow: (a) GaN template, (b) porosification by electrochemical etching, (c) regrowth of thick GaN layer by HVPE and (d) separation of free-standing GaN substrate from during cooling after HVPE growth.

Presently, Sumitomo uses a void-assisted separation (VAS) hydride vapor phase epitaxy (HVPE) growth process to produce commercial 2–4-inch free-standing GaN substrates. Sumitomo believes that its VAS method produces superior substrates. "However, if the GaN substrate size is further scaled beyond 4-inches (100mm) using the VAS method, process non-uniformities of void formation might become severe," the researchers worry.

In particular, the VAS method has a high-temperature anneal step, which requires a higher degree of uniformity than can be realized for wafer diameters greater than 100mm. The team has thus developed a PAS method, which creates pores at room temperature.

The researchers first prepared templates for the free-standing GaN material (Figure 1), using metal-organic vapor phase epitaxy (MOVPE) or HVPE. The researchers comment: "There was no significant difference in MOVPE and HVPE GaN templates for fabrication of the porous GaN templates."

The template consisted of an undoped base (1µm or more), heavily-doped n^+-GaN (1–3µm), and lightly doped n^--GaN layers (100–200nm). The carrier densities in the outer GaN layers were in the lower half or less than $10^{18}/cm^3$ range, while the n^+-GaN was in

the upper half 10^{18}/cm^3 range or higher.

The middle n^+-GaN layer was porosified in an electro-chemical etch process at room temperature. The electrolyte consisted of oxalic acid. The positive and negative electrodes were the thin GaN cover layer and platinum (Pt), respectively.

The team reports: "Although the as-grown GaN template before porosification showed a mirror-like surface with high transparency, the porous GaN template appeared translucent, with the mirror surface kept as it was, indicating the successful formation of a porous structure inside the GaN layer."

The region around the positive electrode on the GaN template needed an additional etch step to porosify. The surface roughness was only increased slightly from 0.36nm to 0.45nm, according to atomic force microscopy (AFM) over a 5μmx5μm field. The height and width of the average pore could be controlled by the applied voltage.

The pore formation was explained as being due to oxidation by hole injection through Zener and/or avalanche breakdown. The researchers used applied voltages in the 10–20V range, insufficient to induce breakdown for the n^--GaN layer, but high enough to induce breakdown in dislocation cores, forming pipes to the n^+-GaN for Zener and/or avalanche breakdown and pore formation in that layer.

The pores of higher-voltage electrochemical etch were larger. The variation was approximately linear between 10V and 20V with widths in the range 50–150nm, and the height in the range 50–200nm.

The materials for the free-standing GaN substrate was through HVPE regrowth at ~1000°C and atmospheric pressure. Separation of the free-standing material occurred during cooling due to the difference in thermal expansion coefficients of GaN and sapphire creating stress in the porous layer that broke the regrown material away.

HVPE growth on 20V porous material with large pores resulted in complete separation of the free-standing substrate from the template (Figure 2). The researchers report: "In contrast, the porous GaN template with small-sized pores resulted in the porous GaN template breaking as well as the sapphire substrate and without separation of the GaN layer."

The team notes that there were Ga residues on the back-side of the free-standing wafer, showing up as gray regions on photographs. "At this initial stage of development, we were not concerned with suppressing attachment of the GaN wafer to the wafer tray during deposition of the thick GaN layer," the researchers comment.

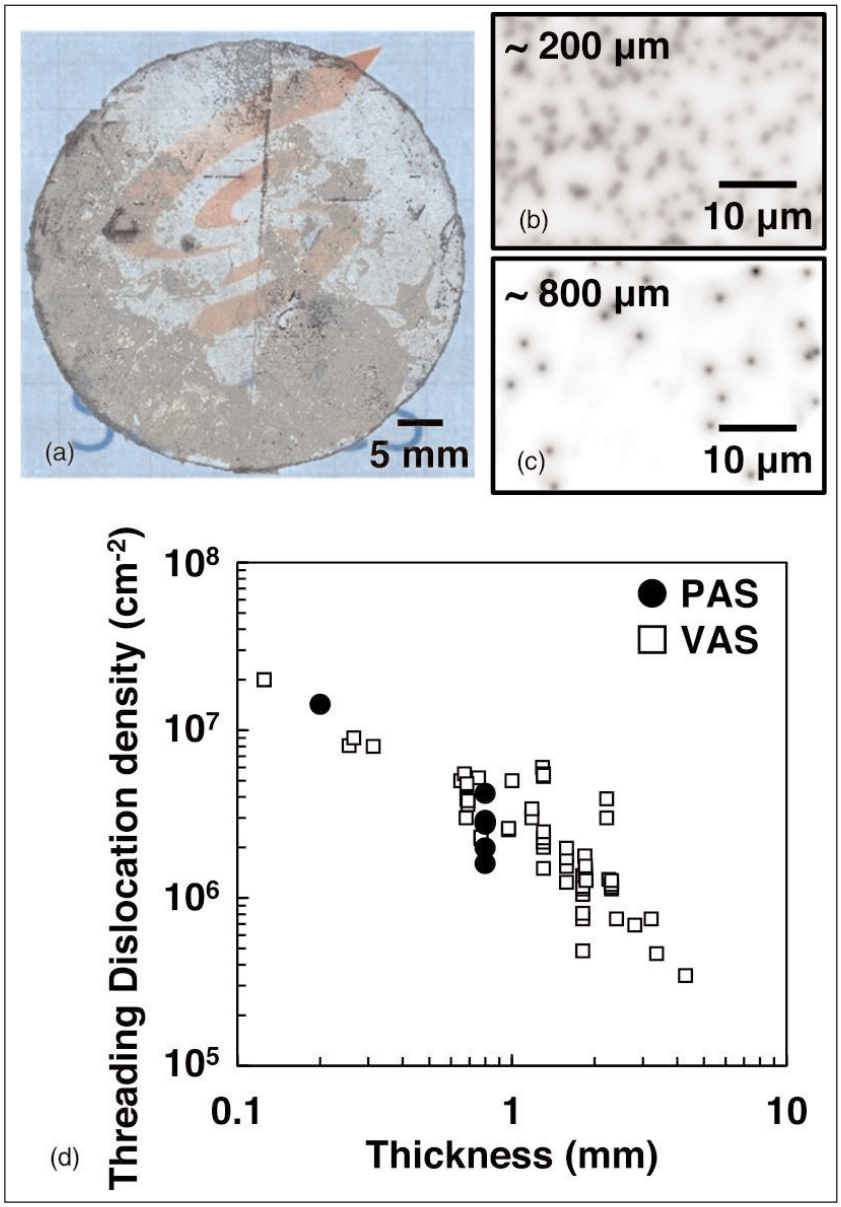

Figure 2. (a) Photograph of 800μm-thick GaN layer grown on porous GaN template. Plan-view CL images of (b) 200 μm- and (c) 800μm-thick GaN grown on 20V porous GaN templates. (d) Layer thickness versus TDD values, comparing PAS and VAS separation.

The threading dislocation density (TDD) for 200μm and 800μm free-standing substrates were measured by cathodoluminescence (CL) at 1.4x10^7/cm^2 and 2.7x10^7/cm^2, respectively. This was similar in character to the results achieved with VAS.

The researchers attempted to apply the PAS method to producing a 3-inch GaN free-standing substrate. The team were "nearly" successful in the effort "although cracks caused by crystal fixing at irregular portions remained." The researchers hope that improvements in the HVPE wafer tray design will prevent such attachments in future work. ■

https://doi.org/10.35848/1882-0786/ad3a2f

Author: Mike Cooke

Poly-MoS_2 FETs integrated on 200mm substrate

Researchers report performance comparable to single-crystal devices.

Samsung Advanced Institute of Technology (SAIT) and Seoul National University in South Korea, and Massachusetts Institute of Technology in the USA, have reported 200mm-wafer-scale integration of polycrystalline molybdenum disulfide (MoS_2) transistors [Kwon, Junyoung et al, Nature Electronics, published online 24 April 2024].

MoS_2, a transition-metal dichalcogenide (TMD) material, consists of layers held together with relatively weak van der Waals forces. Current flows in such materials are confined to two-dimensional planes. The researchers comment: "Two-dimensional semiconductors are an attractive material for making thin-film transistors due to their scalability, transferability, atomic thickness and relatively high carrier mobility. There is, however, a gap in performance between single-device demonstrations, which typically use single-crystalline two-dimensional films, and devices that can be integrated on a large scale using industrial methods."

The team redesigned the process for creating MoS_2 FETs to enable use of polycrystalline materials to achieve comparable performance to single-crystal devices created on small flakes of material under laboratory conditions. In particular, the contact resistance of the source/drain contacts was reduced by using pre-patterned bottom contacts, rather than the more usual contacts deposited on top.

The researchers comment: "These capabilities are attributed to suppressing metal-induced gap states (MIGS) and pinning the Fermi level near the conduction band, thereby reducing the Schottky barrier to zero and reducing the contact resistance."

Devices based on 2D TMD structures could be deployed at thin-film transistors (TFTs) for consumer electronic and optoelectronic products. TFTs are key components of display backplanes, and the scaling potential of 2D TMD structures would enable higher resolutions. SAIT et al see poly-TMD transistors as having better prospects than other technologies such as amorphous and polycrystalline silicon, oxide and organic semiconductors, and carbon nanotubes (CNTs). The thickness of devices being on the atomic scale raises prospects for flexible, wearable and conformable electronics.

The fabrication began with metal-organic chemical vapor deposition (MOCVD) of monolayer MoS_2 on a 200mm-diameter silicon dioxide on silicon (SiO_2/Si) substrate (Figure 1). The SiO_2 layer was 100nm thick.

The researchers used a high-throughput, cold-wall, showerhead MOCVD system. The precursors were molybdenum hexacarbonyl ($Mo(CO)_6$) and diethyl disulfide ($(C_2H_5)_2S_2$). The growth process took place at 800°C at 5Torr. The growth time was 12 minutes, consisting of five cycles of precursor co-injection and purging.

The MoS_2 layer was peeled off the growth substrate using poly(methyl methacrylate) (PMMA) and thermal release tape (TRT).

The researchers comment: "The low adhesion energy between the as-grown MoS_2 and SiO_2 originates from

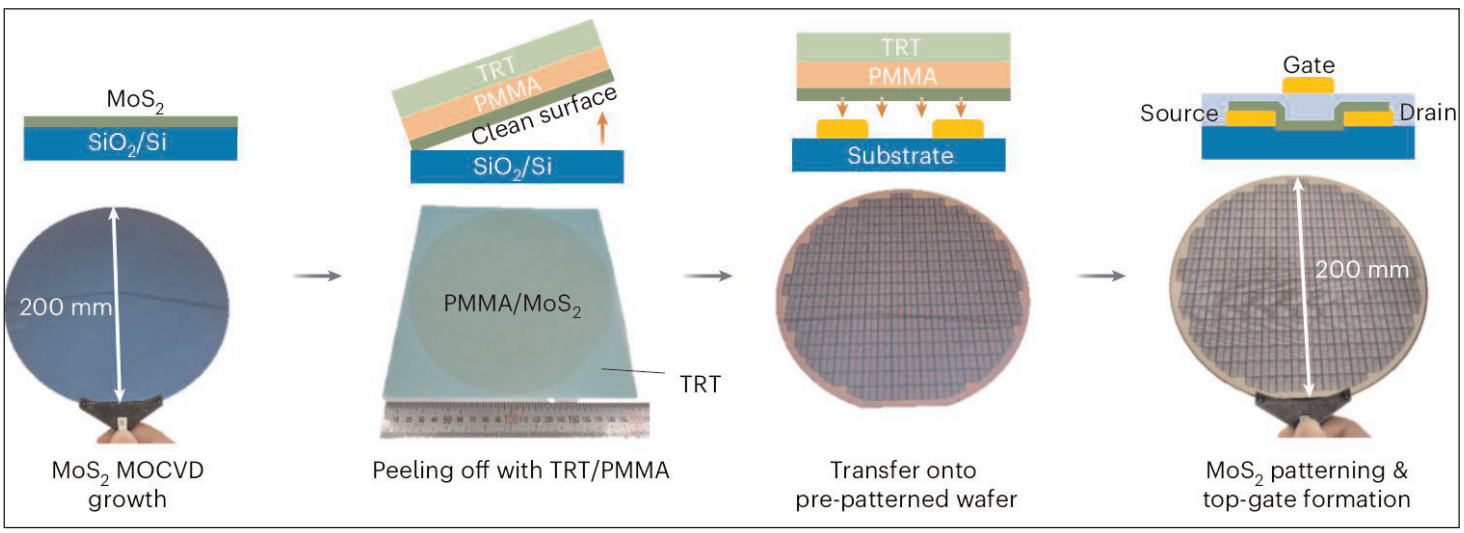

Figure 1. Simplified 200mm-wafer-scale fabrication process for bottom-contact FET.

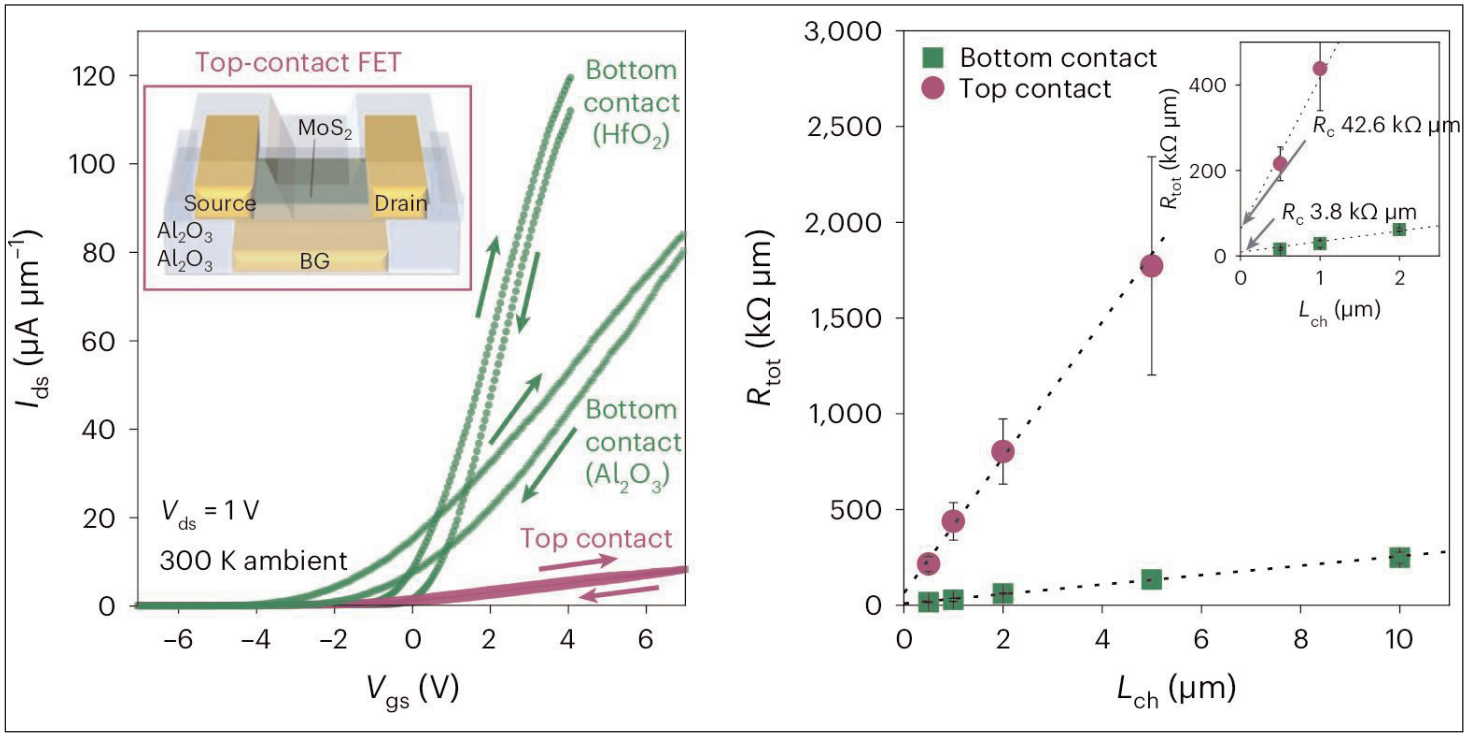

Figure 2. Left: Linear-scale transfer curves (I_{ds}–V_{gs}) for 500nm-channel-length transistors with the source/drain contacts on the bottom or top. Inset: Top-contact FET schematic. Right: Specific contact resistances extracted using transfer length method.

the residual strain and the use of an automatic transfer machine substrate, as well as additional strain that arises from PMMA curing, enabling a 100% exfoliation yield."

The MoS_2 layer was transferred onto the 200mm silicon host substrate. The researchers took particular care to maintain clean surfaces of both the MoS_2 and Au to ensure uniform, high-yield performance of the fabricated devices.

The host substrate was prepared with atomic layer deposition (ALD) hafnium dioxide (HfO_2) etch stop layer and pre-patterned titanium/gold (Ti/Au) source/drain contacts. The team comments: "HfO_2 was chosen because it provides stronger adhesion to MoS_2 than other oxides."

The researchers comment: "Two-dimensional semiconductors are an attractive material for making thin-film transistors due to their scalability, transferability, atomic thickness and relatively high carrier mobility. There is, however, a gap in performance between single-device demonstrations, which typically use single-crystalline two-dimensional films, and devices that can be integrated on a large scale using industrial methods."

The height of the metal contacts was critical — higher contacts resulted in lower mobility and yields. The contacts used finally were 30nm high. Further, sulfur and gold form tight bonds, preventing peeling of the monolayer during further processing.

The top gate stack consisted of 20nm aluminium oxide (Al_2O_3) or 10nm HfO_2 dielectric with 30nm Au electrode. The dielectrics were applied by ALD.

The fabrication, apart from the semi-automatic layer transfer, was performed at SAIT's 200mm facility.

The researchers compared the performance of their bottom-contact devices with reference FETs with the structure inverted resulting in a top-contact (Figure 2). The team comments: "When comparing devices with the same Al_2O_3 dielectric, bottom-contact FETs consistently exhibit performance approximately one order of magnitude higher than top-contact FETs."

The 1V-bias on-current of the bottom-contact devices reached 84μA/μm and the field-effect mobility (μ_{FE}) was 18cm^2/V-s. With the high-k HfO_2 dielectric, these values reached 120μA/μm and 21cm^2/V-s, respectively.

The researchers comment: "The device performance in terms of field-effect mobility and ON-current of the bottom-contact FET based on poly-MoS_2 is on par with that of a conventional top-contact device with single-crystal MoS_2. Therefore, good contact engineering can help to overcome differences in the qualities of channel materials."

The team also reports a 99.97% yield on the basis of only one device failure out of 2,976 on a 200mm wafer. ■

https://doi.org/10.1038/s41928-024-01158-4

Author: Mike Cooke

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4th European School on Crystal Growth (ESCG4)
Jachranka near Warsaw, Poland
E-mail: escg4@unipress.waw.pl
https://eccg8.syskonf.pl/escg-4-about

21–25 July 2024
8th European Conference on Crystal Growth (ECCG-8)
Warsaw, Poland
E-mail: info@eccg8.pl
https://eccg8.syskonf.pl

22–24 July 2024
38th North American Conference on Molecular Beam Epitaxy (NAMBE 2024)
Tufts University, Boston, MA, USA
E-mail: della@avs.org
www.nambe2024.avs.org

23–26 July 2024
5th International Congress on Advanced Materials Sciences and Engineering (AMSE-2024)
University of Rijeka, Opatija, Croatia
E-mail: eve@istci.org
www.istci.org/amse2024

18–23 August 2024
32nd International Materials Research Congress (IMRC 2024)
JW Marriott Cancun Resort & Spa, Cancun, Mexico
E-mail: webmaster@mrs-mexico.org.mx
www.mrs-mexico.org.mx/imrc2024

28–30 August 2024
PCIM Asia 2024
(Power Electronics, Intelligent Motion)
Shenzhen World Exhibition & Convention Center, China
E-mail: pcimasia@china.messefrankfurt.com
www.pcimasia-expo.com

4–6 September 2024
SEMICON Taiwan 2024
TaiNEX 1&2, Taipei, Taiwan
E-mail: semicontaiwan@semi.org
www.semicontaiwan.org

11–13 September 2024
25th China International Optoelectronic Exposition (CIOE 2024)
Shenzhen World Exhibition & Convention Center, China
E-mail: cioe@cioe.cn
www.cioe.cn/en

16–18 September 2024
2nd Bi-annual IEEE Workshop on Wide Bandgap Power Devices & Applications in Europe (WiPDA-Europe 2024)
Royal Welsh College of Music and Drama, Cardiff, UK
E-mail: admin@wipda-europe.org
www.wipda-europe.org

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ECOC 2024: European Conference on Optical Communication
Frankfurt am Main, Germany
E-mail: michelle.dampier@nexusmediaevents.com
www.ecocexhibition.com/future-dates

22–27 September 2024
27th European Microwave Week (EuMW 2024)
Paris Expo, Porte de Versailles, Paris, France
E-mail: eumwreg@itnint.com
www.eumweek.com

29 September – 4 October 2024
2024 International Conference on Silicon Carbide and Related Materials (ICSCRM)
Raleigh Convention Center, 500 S Salisbury St, Raleigh, NC 27601, USA
E-mail: registration@icscrm-2024.org
www.icscrm-2024.org

14–18 October 2024
2024 IEEE BiCMOS and Compound Semiconductor Integrated Circuits and Technology Symposium (BCICTS)
Fort Lauderdale, FL, USA
E-mail: cs@cshawevent.com
www.bcicts.org

23–25 October 2024
OPTO Taiwan 2024: 33rd International Optoelectronics Exposition
TWTC Nangang Exhibition Hall 1, Taipei City, Taiwan
E-mail: exhibit@mail.pida.org.tw
www.pida.org.tw/main2

3–8 November 2024
12th International Workshop on Nitride Semiconductors (IWN 2024)
Hilton Hawaiian Village Waikiki Beach Report, Honolulu, O'ahu, Hawaii, USA
E-mail: info@iwn2024.org
www.iwn2024.org

12–15 November 2024
SEMICON Europa 2024
Messe München, Munich, Germany
E-mail: semiconeuropa@semi.org
www.semiconeuropa.org

1–6 December 2024
2024 Materials Research Society (MRS) Fall Meeting & Exhibit
Hynes Convention Center, Boston, MA, USA
www.mrs.org/meetings-events/fall-meetings-exhibits/2024-mrs-fall-meeting

7–11 December 2024
70th annual IEEE International Electron Devices Meeting (IEDM 2024)
Hilton San Francisco Union Square Hotel, CA, USA
E-mail: iedm-info@ieee.org
www.ieee-iedm.org

16–20 February 2025
ISSCC 2025: IEEE International Solid— State Circuits Conference
San Francisco, CA, USA
E-mail: isscinfo@yesevents.com
www.isscc.org

19–21 February 2025
SEMICON Korea 2025
Korea World Trade Tower, Seoul, South Korea
E-mail: semiconkorea@semi.org
www.semiconkorea.org/en

5–7 March 2025
Asia Photonics Expo (APE 2025)
Level 1, Sands Expo & Convention Centre (Marina Bay Sands), Singapore
E-mail: visitors-ape@informa.com
www.asiaphotonicsexpo.com

16–20 March 2025
IEEE Applied Power Electronics Conference (APEC 2025)
Atlanta, GA, USA
E-mail: apec@apec-conf.org
www.apec-conf.org

30 March – 3 April 2025
Optical Fiber Communication Conference and Exhibition (OFC 2025)
Moscone Convention Center, San Francisco, CA, USA
E-mail: custserv@optica.org
www.ofcconference.org

4–8 May 2025
LightFair 2025
Las Vegas Convention Center, Las Vegas, NV, USA
E-mail: info@lightfair.com
www.lightfair.com

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