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# semiconductorTODAY

COMPOUNDS & ADVANCED SILICON

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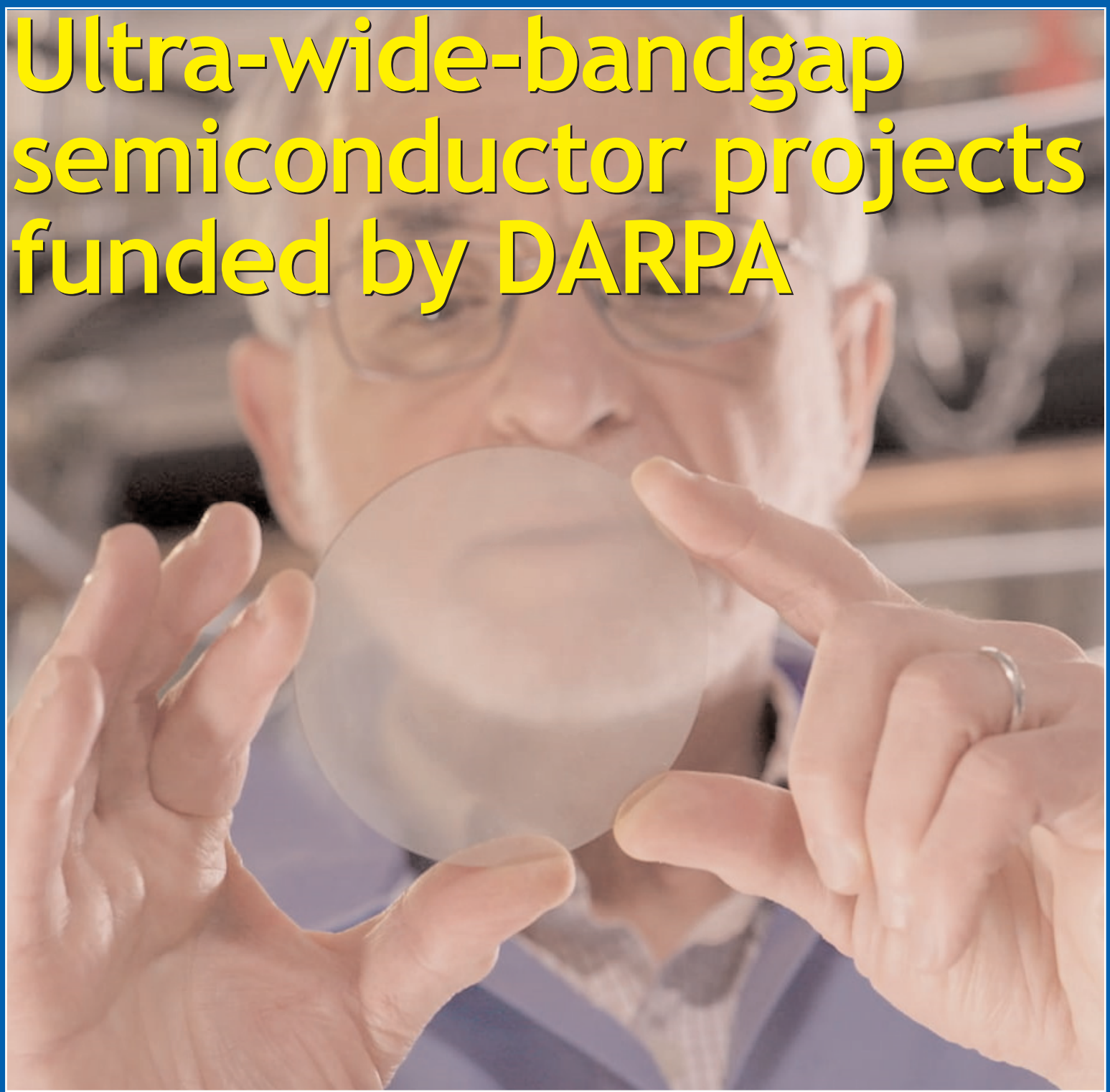
# Ultra-wide-bandgap semiconductor projects funded by DARPA



First 300mm power GaN piloted on high-volume silicon line • UK buys Coherent's Newton Aycliffe fab • News from ECOC 2024

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# contents




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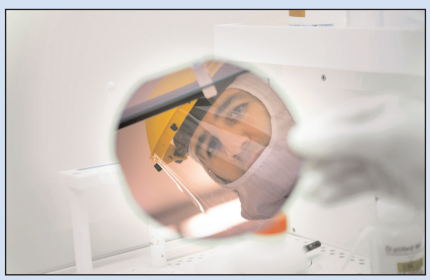
Vol. 19 • Issue 7 • September/October 2024

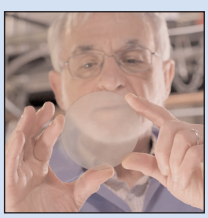


**p10** The UK Department of Defence has bought the Newton Aycliffe fab of Coherent (formerly II-VI Inc).

**p27** Infineon has piloted the first 300mm power GaN wafer technology on an existing large-scale 300mm silicon line.



**p47** Swedish atomic layer etching firm AlixLabs is expanding into photonics due to a research grant from imec-led and EU-supported PhotonHub Europe.



Cover image: US-based Raytheon has been awarded a three-year, two-phase contract from the DARPA to develop foundational ultra-wide-bandgap semiconductors, based on diamond and aluminium nitride technology. **p36**

# editorial

## National security driving development

The UK government's Department of Defence is spending £20m to buy the fab in Newton Aycliffe, UK of US-based Coherent, which — after axing over 100 staff last year — had been due to close it as part of a restructuring, especially after orders from customers including Apple had dried up.

The new UK government — which took power in July — intervened to secure for the country's Armed Forces what it describes as "critical to the defence supply chain and major military programs and exports", as it is "the only secure facility in the UK with the skills and capability to manufacture gallium arsenide (GaAs) semiconductors" (see page 10).

This contrasts with the prior government's belated order in March last year requiring that Netherlands-based Nexperia (a subsidiary of China-based Wingtech Technology) sell South Wales-based Newport Wafer Fab (which it had acquired in July 2021) on grounds of national security, relating to "technology and know-how that could result from a potential reintroduction of compound semiconductor activities at the Newport site" and the "links between the site and the South Wales-based compound semiconductor cluster". Consequently, this March, Newport Wafer Fab was bought from Nexperia by US-based Vishay Intertechnology, which aimed to "accelerate SiC and GaN production and technology development", on the proviso that Vishay gives the UK government prior notice of selling, transferring, leasing or licencing any part of Newport to a third party.

The UK's purchase of the Newton Aycliffe fab tallies with the National Semiconductor Strategy (launched in 2023), which is being supported by Innovate UK funding 16 projects to boost semiconductor manufacturing and supply chains, including developing onshore capabilities in key technologies such as GaN and SiC power devices and packaging (see pages 8–9).

The much greater funds made available through both the US CHIPS Act and the EU Chips Act likewise aim to secure onshore semiconductor manufacturing and supply chains. For example, US-based SiC materials and device maker Wolfspeed is "down to negotiating the final terms and conditions" concerning capital grants under the US CHIPS Act, as it seeks to defray the capital expenditure costs of expanding to 200mm-diameter wafer processing at its Mohawk Valley Fab (leading it to now consider closing its 150mm-wafer device fab in Durham, NC) — see pages 16–18.

Meanwhile, with future defense-related needs in mind, the USA's DARPA has awarded contracts under its Ultra-Wide Bandgap Semiconductors (UWBGS) program, primarily to Raytheon to develop aluminium nitride and diamond films for electronic devices and their optimizing on larger-diameter wafers for sensor applications. Correspondingly, Hexatech and Element Six have also been awarded UWBGS contracts to develop 100mm-diameter AlN and diamond substrates, respectively (pages 36–37). Applications include radar and communication systems with extended capability and range, including cooperative sensing, electronic warfare, directed energy, and circuitry in high-speed weapon systems such as hypersonics.

However, such national security initiatives are not restricted to national boundaries, as evidenced by the USA recently announcing a collaboration to establish a fab in India focused on advanced sensing, communications and power electronics for national security, next-generation telecoms, and green energy applications that spans infrared, GaN and SiC materials, supported by the India Semiconductor Mission plus a strategic technology partnership between Bharat Semi, 3rdiTech, and the US Space Force.

**Mark Telford, Editor**

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

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- conference reports;
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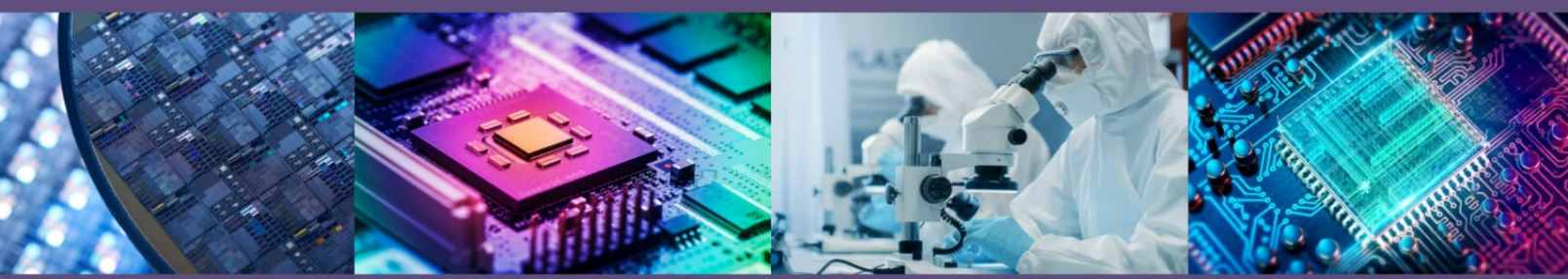

CSconnected is home to the world's first regional ecosystem based on the manufacture of compound semiconductor enabled hardware, located in south Wales

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# CSA Catapult and UK Electronics Skills Foundation coordinating Welsh Sparc bursaries

## Innovate UK-funded 'Spark their imagination; power their future' project aims to support early careers in electronics

As part of the 'Spark their imagination; power their future' project funded by Innovate UK and run by Compound Semiconductor Applications (CSA) Catapult and the UK Electronics Skills Foundation (UKESF), a total of 24 Year 13 students from across Wales have been awarded bursaries to provide support while they complete electronics-related degrees and help them start careers in technology.

The bursary program offers students financial support while at university, access to professional mentoring and learning and development opportunities.

The Welsh Sparc bursary provides £1000 to Year 13 pupils who have accepted a place to study electronics-related degrees. A one-off bursary of £1500 will also be awarded for personal and professional development after the first year of study.

Between 2012 and 2021, the number of Welsh students studying an Electronics and Electrical Engineering (EEE) degree fell by a third, from 180 to 120. "Going on to further study can be daunting. Financial pressure can cause added stress and be a huge deterrent," notes Alex Leadley, Skills Academy manager at CSA Catapult. "Our sector is facing a workforce shortage. We need many engineers with a variety of skills and capabilities from all backgrounds, so schemes and interventions like ours which encourage students are incredibly important," he adds.

The Welsh Sparc bursary aims to encourage more young people in Wales to consider a career in electronics. Electrical engineers are in high demand as technology plays an increasingly important role in areas such as smartphone technologies, aerospace, robotics and artificial intelligence.

"This program is designed to create a pipeline of future talent into our sector from Wales," says UKESF's CEO Stewart Edmondson.

The inaugural 2024/25 Welsh Sparc Award winners attended a celebration event at CSA Catapult's Innovation Centre in South Wales to learn more about the support that their bursaries offer and the career opportunities ahead of them. The Welsh Sparc Award winners received advice from UKESF alumni, spoke to engineers working at CSA Catapult, and toured labs developing technology for real-world applications like EVs, clean energy and 5G communications.

'Spark their imagination; power their future' is one of many interventions that CSA Catapult's Skills Academy develops, to bring together education providers, industry, government, charities and parents to inspire and develop the next generation of scientists and engineers.

**www.csa.catapult.org.uk**


**Celebration event for Welsh Sparc award winners.**

# UK can capitalize on data-center boom, reckons CSA Catapult's CEO

## Business, academia and government needs to engage with tier-1 organizations to build new relationships

There is a significant opportunity for the UK to play a leading role in developing future technologies for data centers, according to Martin McHugh, CEO of the Compound Semiconductor Applications (CSA) Catapult in Newport, South Wales.

Established in 2018 by UK Government agency Innovate UK (which provides funding and support for business innovation as part of UK Research and Innovation), CSA Catapult is a center of excellence that specializes in the measurement, characterization, integration and validation of compound semiconductor technology across four areas: power electronics, advanced packaging, radio frequency (RF) and microwave, and photonics. As a not-for-profit organization, it is focused on accelerating the adoption of compound semiconductors. It works across the UK in a range of industry sectors, from automotive to medical, and from digital communications to aerospace.

In a blog post, McHugh says that compound semiconductors — developed widely across South Wales — will help to improve the energy efficiency of data centers and that the UK has the potential to lead the world in this technology.

There are currently 514 data centers in the UK — the third highest number in the world behind the USA and Germany. Close to CSA Catapult's Innovation Centre in Newport is Vantage, one of the largest data centers in Europe. Also, in early July, Newport Council granted permission for Microsoft to build its own hyperscale data center just across the road from CSA Catapult on Celtic Way.

Although data centers are essential for handling data and coping with the rising demands of artificial intelligence (AI), they are very energy intensive. It is estimated that data centers currently consume 1–1.5% of global electricity use. Google recently said that its greenhouse gas emissions were 48% higher in 2023 compared with 2019, driven by the increasing amounts of energy needed by its data centers to cope with the explosive growth of AI. Improving the energy efficiency of data centers is hence key to meeting net-zero targets.

McHugh says that efficiencies can be made by using compound semiconductors to improve the distribution of power across data centers. Power supply units (PSUs) are critical for converting power alternating current (AC) into direct current (DC) before it is delivered to server racks. Silicon carbide (SiC) has been used in PSUs since 2001, enabling devices to be smaller, more efficient and produce less heat — a significant benefit considering the amount of cooling required in a data centers.

McHugh also notes that compound semiconductor-based photonic devices can help to replace the traditional copper interconnects between server racks, enabling faster speeds, higher bandwidths and improved energy efficiency.

South Wales is home to the world's first compound semiconductor cluster CSconnected. To capitalize on these strengths and opportunities, McHugh calls on UK business, academia and government to engage with tier-1 organizations and big data centers to build new relationships and fully understand their future technology requirements.

He adds that stock must be taken of the UK's supply chain and areas identified where the most value can be added to the data-center market. If this supply chain exists, then it must be brought together through publicly funded R&D programs to replicate the success that the UK has had with the electric vehicle market, he argues.

# CSA Catapult's CEO McHugh stepping down in March

CSA Catapult is seeking a new CEO to lead all strategic and operational activities, as its current CEO Martin McHugh plans to retire at the end of March.

McHugh joined CSA Catapult in 2019, initially as chief technology officer. He became CEO in 2020 and was responsible for leading the organization through the COVID-19 pandemic, growing from 68 to about 100 people now. He has played a leading role in the South Wales compound semiconductor cluster. In 2023, he led the expansion of the Catapult into clusters of compound semiconductor expertise across the UK, establishing a Future Telecoms Hub in Bristol and opening offices in the North East of England and Scotland.

Since becoming CEO, CSA Catapult has created significant value for UK industry, leading key collaborative R&D programs such as @FutureBEV, ESCAPE and Secure 5G. In that time, he led engagement with companies like BMW, McLaren Applied, BT Group and National Gas. CSA Catapult has a series of international strategic international partnerships with organizations in Taiwan, India and Malaysia to strengthen UK supply chains.

**www.csa.catapult.org.uk**

# Innovate UK grants £11.5m for 16 projects to boost semiconductor manufacturing and supply chains

As he opened an industry conference of G7 nations, the UK Government's Science Minister Lord Patrick Vallance announced the 16 projects that will share £11.5m in funding — provided by Innovate UK (which provides funding and support for business innovation as part of UK Research and Innovation) — that will help drive innovation.

The funding announcement came as the G7 Semiconductors Point of Contact group kicked off with a stakeholder forum at Arm's HQ in Cambridge, where member states, research organizations, and industry representatives discussed key issues affecting the global semiconductor industry. Established under Italy's G7 Presidency earlier in 2024, the G7 Semiconductors Point of Contact group aims to address issues impacting the semiconductor industry, including early-stage innovation, crisis coordination, sustainability, and the impact of government policies and practices. The meeting immediately followed the OECD Semiconductor Informal Exchange Network gathering, where countries and stakeholders shared strategies for strengthening global semiconductor supply chains and addressing shared challenges in the semiconductor industry.

A new report by Perspective Economics reveals that the UK semiconductor sector, which includes over 200 companies in research, design and manufacturing, is valued at almost £10bn and could grow to £17bn by 2030. "Key findings here show that the UK already sees significant revenue from the sector and, by building on strong innovation, we can see significant opportunity to increase this, together with our ~2% share of global semiconductor revenues; ultimately creating much more than the 86,000 jobs currently in the wider economy," notes report contributor Charles Sturman, CEO of TechWorks. "The industry is set to grow rapidly in the next decade, and the right mix of scale-up support and industrial policy can secure future growth of the UK semiconductor sector," he adds.

"Backing UK innovators offers a real opportunity to growth these firms into industry leaders, strengthening our £10bn sector and ensuring it drives economic growth," commented Vallance. "Our support in these projects will promote critical breakthroughs such as more efficient medical devices that could significantly lower costs and faster manufacturing processes to improve productivity," he added. "Hosting the G7 Semiconductors Point of Contact group is also a chance to showcase the UK's competitive and growing sector."

Projects receiving funding include Vector Photonics Ltd of Glasgow, Scotland, UK, in collaboration with the University of Glasgow, which aims to enhance the power and cost-effectiveness in everyday technology of gallium nitride (GaN)-based blue lasers, which are key in devices such as medical equipment, quantum displays and car headlights.

Another project, led by Southampton-based Quantum Advanced Solutions Ltd with the University of Cambridge, is developing advanced shortwave infrared (SWIR) sensors, which improve vision in critical sectors like defence, by supporting surveillance in challenging conditions in low-visibility environments, such as during adverse weather conditions or atmospheric disturbances. The project aims to simplify production using quantum dot materials, offering higher sensitivity and performance, cutting costs and making the technology more accessible to multiple sectors including manufacturing and healthcare.

"Innovate UK's investment in this program directly supports the National Semiconductor Strategy launched in 2023 and aims to ensure the UK's place in the global landscape," notes Andrew Tyrer, deputy director, Electronics, Sensors and Photonics, at Innovate UK.

"Semiconductors are key enablers for the UK ambitions across all critical technology areas," adds Iain Mauchline, innovation lead — Electronics, Sensors and Photonics, at Innovate UK. "Funding these diverse projects highlights the strengths and depth of the UK's semiconductor ecosystem."

**www.gov.uk/government/publications/national-semiconductor-strategy**

# Innovate UK details 16 projects receiving £11.5m grant

Innovate UK has detailed the 16 projects that are to share £11.5m of funding as part of a collaborative R&D drive into ways to:

- scale up semiconductor manufacturing within the UK;
- improve supply chain resilience within the UK;
- establish innovations and new manufacturing techniques;
- expand the capability or performance of existing manufacturing techniques;
- encourage relationships between product designers and manufacturers to develop new manufacturing techniques or expanding capability;
- encourage new collaborations across industry and academia.

This is the final competition of an £18m program supporting the UK government's national semiconductor strategy (which plans to build on the UK's strengths in semiconductors to grow the sector, increase resilience and protect national security).

The competition follows previous competition rounds, which saw investments of £1.5m in semiconductor feasibility studies ('Improving and Scaling-up Semiconductor Manufacturing – CR&D') and £4.3m invested in skills and training.

## The 16 project titles, their grants and participants

**Industrial epitaxy of ULTRARAM computer memory**
— £680,675 to:
- Quinas Technology Ltd,
- Cardiff University,
- IQE plc,
- Lancaster University.

**UpQSens: upscaling manufacture of quantum dot-based CMOS SWIR sensors in the UK**
— £1,189,114 to:
- Quantum Advanced Solutions Ltd,
- University of Cambridge.

**Developing new UK packaging capability for highly miniaturised, compound semiconductor-based photovoltaic components to enable autonomous and sustainable IoT at scale**
— £564,018 to:
- Lightricity Ltd,
- Alter Technology TUV NORD UK Ltd,

**Commodity High Performance InP lasers on a 6" wafer platform (CHIPIN6)**
— £409,942 to:
- Compound Semiconductor Centre Ltd,
- Ffotoneg Ltd,
- SPTS Technologies Ltd,
- Cardiff University.

**FlexPlanner/FAR: automated solutions to dramatically improve wafer-fab efficiency, while simultaneously reducing reliance on manufacturing skilled labour**
— £999,943 to:
- Flexciton Ltd,
- Seagate Technology Ireland.

**Scale up of avalanche photodiodes for future terabit optical networks (CAPTAIN)**
— £830,123 to:
- Phlux Technology Ltd,
- Sivers Photonics Ltd,
- The University of Sheffield,
- Hilight Semiconductor Ltd.

Semiconductor impact calculator **'RESiLABLE' to deeply decarbonise and increase supply-chain resilience of UK semiconductor manufacturing**
— £256,500 to:
- Minviro Ltd,
- Swansea University.

**Industrial development of novel photoresists for high-NA EUV enabling UK-based semiconductor manufacturing scale-up**
— £1,701,542 to:
- Irresistible Materials Ltd,
- Endevour Speciality Chemicals Ltd.

**Onshoring and Scale Up of 3C-SiC substrates for cubic GaN microLEDs** — £303,125 to:
- Kubos Semiconductors Ltd,
- Advanced Epi Materials And Devices Ltd,
- Oxford Instrument plc,
- Wafer Technology Ltd.

**UK integrated supply chain to support Vishay (UKISC-V)**
— £321,184 to:
- RAM Innovations Ltd,
- KuasaSemi Ltd,
- Vishay Ltd.

**Enhancement of power devices with 3C-SiC**
— £585,921 to:
- IceMOS Technology Ltd,
- University of Warwick.

**UK-GRAFT: the UK graphene research and fabrication technology foundry**
— £1,402,258 to:
- Paragraf Ltd,
- UK Electronic Skills Foundation,
- University of Birmingham,
- Cupio Services Ltd,
- University of Glasgow.

**Establishing new manufacturing techniques for high-value semiconductor manufacturing of X-ray dosimeters for radiotherapy in the UK**
— £528,683 to:
- Silverray Ltd,
- University of Surrey.

**GRAPHICS (Gallium nitride based advanced photonic crystal structures)**
— £650,132 to:
- Vector Photonics Ltd,
- University of Glasgow.

**INTERPOSE-UK (Advanced integrated circuit interposers for semiconductor packaging in UK)**
— £438,498 to:
- BAE systems (operations) Ltd,
- Oxford Lasers Ltd,
- PRP Optoelectronics Ltd,
- University of Southampton.

**APEX-G (Advanced high-power, extended-wavelength VCSEL arrays for volume infrared and green laser applications)**
— £608,210 to:
- Integrated Compound Semiconductors Ltd,
- NPL Management Ltd,
- Microchip Technology Caldicot Ltd,
- Compound Semiconductor Centre Ltd.

www.ukri.org

# UK Government buys Coherent's Newton Aycliffe fab to secure defence supply chain

## Fab to be renamed Octric Semiconductors UK

Materials, networking and laser technology firm Coherent Corp of Saxonburg, PA, USA (formerly II-VI Inc before it bought Coherent in July 2022) has sold its semiconductor fabrication plant in Aycliffe Business Park, Newton Aycliffe, County Durham, UK, which was acquired by II-VI Inc in 2017.

"Divesting the Newton Aycliffe plant is part of our effort to optimize our portfolio and streamline our operations, which allows us to focus our investment and capital on the areas of greatest long-term growth and profitability," says CEO Jim Anderson.

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

Coherent said in April 2023 that a decline in business demand had prompted a restructuring of the firm's operations, with a focus on reducing costs, and that it would cut Newton Aycliffe staffing by more than 100 by end-May 2023.

The fab has been bought for a reported £20m by the UK Government's Ministry of Defence, which aims to secure for the UK's Armed Forces what it describes as "critical to the defence supply chain and major military programs and exports", as "the only secure facility in the UK with the skills and capability to manufacture gallium arsenide (GaAs) semiconductors". These are used in military platforms (including to boost fighter jet capabilities).

The acquisition should not only safeguard the future of the facility but also secure up to 100 skilled jobs in north-east England. The fab will be renamed Octric Semiconductors UK.

The announcement precedes the Investment Summit in October, in which UK government aims to reset relations with trading partners around the world and create a pro-business environment that supports innovation and jobs at home and supports economic growth.

The acquisition is expected to boost UK defence industrial capacity and exports, as the government intends to invest in the company over the coming years.

Semiconductors will be crucial in securing the UK's future military's capabilities, said Defence Secretary John Healey to staff while visiting the site. "This acquisition is a clear signal that our government will back British defence production. We'll protect and grow our UK defence supply chain, supporting North East jobs, safeguarding crucial tech for our Armed Forces and boosting our national security," he added.

The strategic investment should ensure that the facility is capable of producing GaAs semiconductors as well as more powerful semiconductors in the future, which will include the latest technology.

The UK government says that it recognizes the strategic importance of semiconductors as a critical technology for the UK's future and a significant enabler of the government's growth and clean energy missions. It adds that work has already started to implement best-practice governance to ensure appropriate financial oversight to secure future success.

**www.gov.uk/government/publications/national-semiconductor-strategy**
**www.coherent.com**

# Altum RF showcases products and expertise at EuMW

Altum RF of Eindhoven, The Netherlands (which designs RF, microwave and millimeter-wave semiconductors for commercial and industrial applications) showcased its featured products and technical expertise at European Microwave Week (EuMW 2024) in Paris, France (24–26 September).

With over 40+ gallium arsenide (GaAs) and gallium nitride (GaN) MMICs from X-band to over 100GHz, Altum RF is featuring several products at EuMW, including new components for satcom, telecoms (with E-band), radar, and test & measurement markets.

Highlights include Altum RF's new E-band family of power amplifiers and low-noise amplifiers, which support demanding mmWave telecom and SATCOM applications by offering high output power and gain for longer-range links. The E-band power amplifiers include an on-chip integrated power detector.

Product highlights include:

- ARF1006: 71–76GHz, E-band power amplifier, 1.0W $P_{sat}$, bare die;
- ARF1007: 81–86GHz, E-band power amplifier, 0.9W $P_{sat}$, bare die;
- ARF1018: 71–76GHz, E-band power amplifier, 1.8W $P_{sat}$, bare die;
- ARF1019: 81–86GHz, E-band power amplifier, 1.6W $P_{sat}$, bare die;
- ARF1206: 71–86GHz low-noise amplifier, 2.5–3.5dB NF from 71–86GHz, bare die;
- ARF1206L5: 71–86GHz low-noise amplifier, 3–5dB NF from 71–86GHz, 5mm x 5mm surface-mount package.

**www.altumrf.com**

# Soitec kicks off European project Move2THz to develop future high-frequency InP-based semiconductors

## Applications span photonics for mega data centers and AI to RF front-ends & integrated antennas for 6G and sub-THz radar sensing

A European research and industry consortium led by engineered substrate manufacturer Soitec of Bernin, near Grenoble, France has begun work to develop a future generation of high-frequency semiconductors based on indium phosphide (InP).

These technologies are set to address applications ranging from photonics for mega data centers and AI to radio frequency front-ends and integrated antennas critical for 6G mobile communication, sub-THz radar sensing and beyond.

Indium phosphide devices can operate at frequencies approaching or exceeding 1THz, offering superior speeds and increased energy-efficiency compared with silicon technologies.

The 27-member consortium Move2THz aims to lay the groundwork for a robust European supply and manufacturing ecosystem for InP semiconductors and tackle barriers to their wider adoption, including the cost and availability of InP-based advanced substrates. The three-year project is a recipient of European Union funding via the Chips Joint Undertaking and its members, including top-up funding from the governments of France, Switzerland, Germany, Sweden, the Netherlands, and Belgium, under Grant Agreement n° 101139842.

"This project marks a key milestone in the integration of ever more powerful and energy-efficient semiconductor technologies," says Soitec's general secretary Emmanuelle Bely. "Together, we are paving the way for innovation based on indium phosphide that will transform critical sectors such as 6G telecommunications, photonics and artificial intelligence. Furthermore, it fully embodies our shared ambition to create a strong and autonomous European ecosystem capable of meeting the technical and economic challenges to large-scale adoption of these cutting-edge technologies."

Work formally began at a 9–10 July kick-off meeting at Soitec's headquarters. The consortium members are:

- **France** – Soitec (project lead), French Alternative Energies and Atomic Energy Commission, STMicroelectronics, National Center for Scientific Research, Institute of Electronics, Microelectronics and Nanotechnology (IEMN), InPACT, III-V Lab, Almae Technologies, The University of Bordeaux;
- **Germany** – Fraunhofer-Gesellschaft (EMFT and IZM), FBH (Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenz-technik), Aixtron, University of Duisburg-Essen, Freiberger Compound Materials, Microwave Photonics, Advanced Modeling Solutions (AdMOS);
- **Belgium** – Imec, Université catholique de Louvain, Incize;
- **Switzerland** – Diramics, ETH Zürich, Albis Optoelectronics;
- **Sweden** – Chalmers University of Technology, Low Noise Factory;
- **The Netherlands** – Eindhoven University of Technology, Smart Photonics;
- **Lithuania** – Teraglobus.

**www.move2thz.eu**
**www.soitec.com**

# Teledyne e2v HiRel partners with distributor Flip

Teledyne e2v HiRel Electronics of Milpitas, CA, USA (part of the Teledyne Defense Electronics Group that provides solutions, sub-systems and components to the space, transportation, defense and industrial markets) has partnered with distributor Flip Electronics of Alpharetta, Georgia, which will maintain inventories of its wafers for military applications, ensuring a consistent and reliable supply of critical components.

"Our semiconductor longevity programs provide a significant competitive advantage to our customers," claims Mont Taylor, Teledyne e2v HiRel's VP of business development. "Partnering with Flip Electronics allows us to offer a more resilient supply chain and respond swiftly to our customers' needs and the evolving market conditions," he adds." This collaboration underscores our commitment to delivering high-quality, reliable solutions."

Flip has secured the remaining quantity of WS57C291 WSI (Waferscale Integration Inc/ STMicroelectronics) UV EPROM wafer inventory from Teledyne that are used to build DLA-qualified Standard Microcircuit Drawing parts such as: 5962-87650 UV EPROM and 5962-88734 PROM.

The announcement "highlights Flip Electronics' commitment to supporting our customers' long-term capacity needs and maintaining their supply chain by providing, in some cases, obsolete parts," says Flip's CEO Jason Murphy. "This partnership will improve our ability to serve our customers and meet the rigorous requirements of military and space applications."

The strategic partnership is said to strengthen the supply chain and mitigate the risks of obsolescence in high-reliability semiconductor devices, ensuring that both companies can continue to meet the critical demands of their military and space sector customers.

**www.flipelectronics.com**
**www.tdehirel.com**

# Fraunhofer IAF low-noise amplifiers used aboard ESA's Arctic Weather Satellite

## InGaAs-based mHEMTs enhanced for MMICs in LNA modules

On 16 August, the European Space Agency (ESA) launched the Arctic Weather Satellite (AWS) to a polar low-Earth orbit 600km above the Earth, with the aim of collecting accurate weather data of the Arctic for the first time and improving forecasts and climate observations worldwide.

The AWS uses a microwave radiometer that contains four low-noise amplifiers (LNAs) from Fraunhofer Institute for Applied Solid State Physics IAF of Freiburg, Germany. They are essential components of the passive microwave radiometer with which the AWS measures temperature and humidity in the Arctic more precisely than ever before. This should contribute to a better understanding of both the Arctic and the climate change that is particularly visible in it.

"The more powerful a low-noise amplifier is, the more accurately and reliably a system can collect data. They play a major role in satellite-based Earth observation, as the microwave radiation that reaches the satellite radiometer is very weak," explains Dr Fabian Thome, deputy head of Fraunhofer IAF's High Frequency Electronics business unit. "It is a great confirmation and motivation that we are contributing to better research into the Arctic and its effects on the global climate."

**LNAs for frequency ranges around 54, 89 and 170GHz**

The AWS microwave radiometer consists of a rotating antenna that picks up the natural microwave radiation emitted by the Earth's surface and transmits it to four feedhorns and four receivers. The antenna and receiver each belong to one of four groups comprising a total of 19 channels, which together cover a frequency spectrum of 50–325GHz: Eight channels with frequencies from 50GHz to 58GHz measure temperature, one channel at 89GHz detects clouds, another at 165.5GHz both clouds and humidity, five channels between 176GHz and 182GHz are only responsible for humidity, while finally there are four channels at 325GHz plus/minus 1.2GHz to 6.6GHz measure humidity and also detect clouds. The radiometer is hence able to create high-resolution vertical humidity and temperature profiles under all weather conditions.

**Artificial impression of the Arctic Weather Satellite in orbit at an altitude of about 600km (© ESA/Mlabspace).**

Fraunhofer IAF has provided a total of four LNAs for three of the four channel groups: one module for the frequency range around 54GHz, two identical modules for 89GHz (connected in series for greater overall amplification), and one module for the 170GHz range. The researchers have enhanced proven technologies based on indium gallium arsenide (InGaAs) and realized metamorphic high-electron-mobility transistors (mHEMTs) for monolithic microwave integrated circuits (MMICs).

**InGaAs mHEMT technology for MMICs**

In tests, the LNA for the frequency range around 54GHz achieved a noise figure of 1.0–1.2dB with a gain of 31–28dB, significantly improving the state of the art. With noise figures of 1.9–2.3dB at 23–25dB gain (89GHz) and 3.3–4.1dB at 25–30dB gain, the other AWS LNAs are exactly in the range of the existing state of the art (John et al, 'Low-Noise Amplifiers for the Arctic Weather Satellite', 2023 53rd European Microwave Conference (EuMC)).

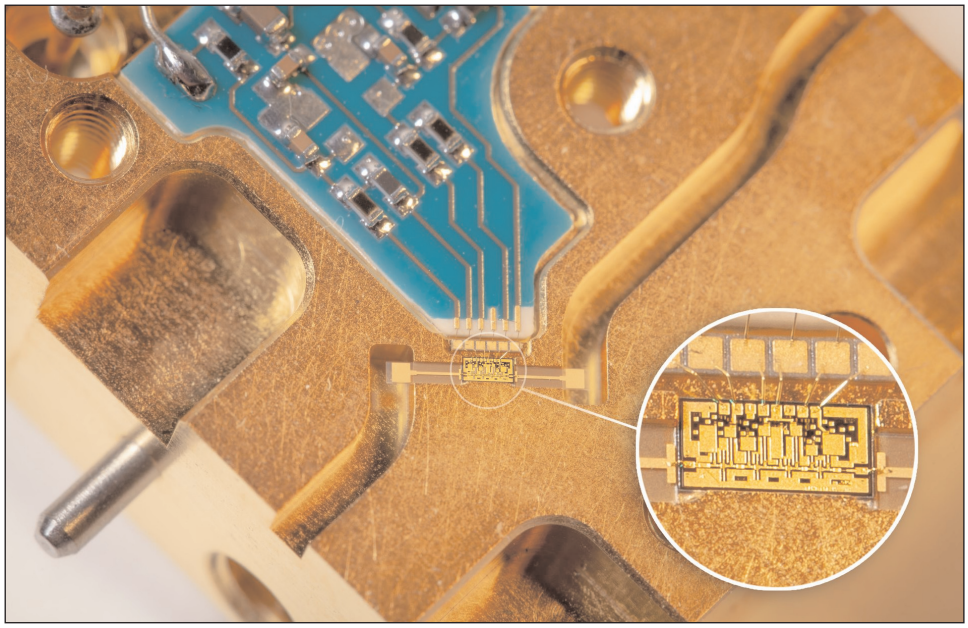
In developing the modules, the researchers worked closely with the direct client ACC Omnisys (AAC Clyde Space) of Sweden, which built the radiometer system for OHB Sweden and ESA. Fraunhofer IAF was able to use its research infrastructure and expertise along the entire value chain in the development and production of the modules: Teams from microelectronics, epitaxy, technology and precision mechanics worked together and carried out all the key steps from circuit design to material growth, processing and measurement as well as process technology, separation, assembly technology through to module construction and integration until the LNA modules were ready for use. An initial qualification of the modules for use in space also took place at the institute before the hardware was handed over for receiver integration.

**AWS and EPS-Sterna: New Space for more precise weather forecasts, nowcasting and climate monitoring**

The AWS mission is to collect more precise weather data in the Arctic for the first time, which will enable short-term forecasts for the polar region, including nowcasting (for the next few hours). As the Arctic has a strong influence on global weather, the data also enables better global weather forecasts. This also applies to the climate, since climate change is progressing faster in the Arctic than in other regions of the world. At the same time, changes in the Arctic have an impact on the global climate due to feedback effects.

If the AWS mission is successful, ESA plans to launch a global constellation of identical small satellites into space to enable more precise and shorter-term weather forecasts and climate observations on a global scale. The plan for this EUMETSAT Polar System — Sterna (EPS-Sterna) is to have six satellites in three different orbits at the same time to collect long-term weather data from the polar regions. The satellite set will be renewed three times, so that a total of 18 satellites will be used during the time of the mission. Two satellites are planned as replacements. The first of six EPS-Sterna satellites is due to be launched in 2029.

With this project, ESA is pursuing the New Space approach for the first time. New Space is characterized by projects being carried out in the shortest possible time with significantly fewer resources. In the case of AWS, whose total mass is only 150kg, only three years passed from project start to rocket launch, during which a fraction of the cost was incurred compared with previous projects. Further advantages of New Space are the greater resilience of constellations — the failure of a satellite in the network can be compensated for or replaced quickly and cheaply — and the flexibility of missions, which can be extended or shortened if necessary, without consuming large amounts of resources.



**Close-up of the 89GHz LNA MMIC integrated into the respective AWS microwave radiometer LNA module (© Fraunhofer IAF).**

**Fraunhofer IAF at EuMW**

At European Microwave Week (EuMW 2024) in Paris, France (24–26 September), Fraunhofer IAF presented exhibits of the LNA modules installed in the AWS radiometer as well as other high-frequency electronics from the application areas of satellite communications, mobile communications or low-temperature measurement technology.

Fraunhofer IAF researchers were also represented in the conference program with the following topics:

- 'THz circuit and front-end developments based on InGaAs-channel mHEMT devices' by Dr Laurenz John;
- 'High-Gain 664GHz Low-Noise Amplifier Modules Based on Advanced InGaAs HEMT Technologies' by Dr Axel Tessmann;
- 'mm-Wave GaN Varactors and E-/W-Band Phase Shifter' by Dr Philipp Neininger.

**www.eumweek.com**
**https://ieeexplore.ieee.org/document/10290663**
**www.esa.int/Applications/Observing_the_Earth/Meteorological_missions/Arctic_Weather_Satellite**
**www.iaf.fraunhofer.de/en/researchers/electronic-circuits.html**

# MACOM added to PHLX Semiconductor Sector Index

MACOM Technology Solutions Inc of Lowell, MA, USA (which designs and makes RF, microwave, analog and mixed-signal and optical semiconductor technologies) says it has recently been added to the PHLX Semiconductor Sector Index (SOX).

The PHLX Semiconductor Sector Index is a capitalization-weighted index comprising the 30 largest US-traded semiconductor companies involved primarily in the design, distribution, manufacture and sale of semiconductors, ranked by market capitalization. It was created in 1993 by the Philadelphia Stock Exchange, which is now owned by NASDAQ.

"It is a milestone to be included in the PHLX Semiconductor Sector Index and I congratulate our entire team for making this possible," says president & CEO Stephen G. Daly.

**https://indexes.nasdaqomx.com/Index/Weighting/SOX**
**www.macom.com**

# Broadcom producing RF FEMs for Wi-Fi 7 mobile based on Tower's 300mm RF silicon-on-insulator

Specialty analog foundry Tower Semiconductor Ltd of Migdal Haemek, Israel has announced the production of Wi-Fi 7 RF front-end module (FEM) devices based on its 300mm RFSOI (radio frequency silicon-on-insulator) technology. Partnering with Broadcom Inc, Tower has enabled fully integrated Wi-Fi FEM devices on a single RFSOI die, delivering superior performance and efficiency compared with existing non-SOI technologies.

"The unique advantages of Tower's RFSOI technology have enabled Broadcom to design and bring to market a set of compact, high-performance FEMs for Wi-Fi 7 mobile applications," comments Vijay Nagarajan, Broadcom's VP of marketing, wireless communications and connectivity. "These FEMs — a product of our long-standing partnership with Tower — are tailored to meet the stringent size and power efficiency requirements for mobile Wi-Fi applications."

The collaboration extends Tower's RFSOI platform to enable "innovative architectural options for integrated front-end module designs, including unique devices for low-noise amplifiers (LNAs) and power amplifiers, and high-gate-density standard cells for size reduction in logic area," says Tower's president Dr Marco Racanelli. "Broadcom's premier capabilities in RF FEM product design complement our technological strengths, allowing both companies to achieve unprecedented performance and integration," he adds. "This partnership underscores our dedication to aligning roadmaps with our customers and advancing groundbreaking products."

The highly integrated process reduces chip area despite the complexity of having to support new features and frequency bands. Tower's RFSOI technology platform delivers what is claimed to be best-in-class silicon-based switch and LNA performance, as evidenced by its widespread adoption. Integrating a PA device into this technology eliminates the additional signal loss of propagating signals between separate dies, while the high-resistivity SOI substrate enhances PA efficiency by supporting passive elements like inductors with a higher quality factor.

**www.broadcom.com**
**www.towersemi.com**

# JEDEC publishes test method for addressing switching energy loss associated with output capacitance hysteresis

## Document applies to both wide-bandgap and silicon power devices

The JEDEC Solid State Technology Association (which develops standards for the microelectronics industry) has published 'JEP200: Test Methods for Switching Energy Loss Associated with Output Capacitance Hysteresis in Semiconductor Power Devices'. Developed jointly by the JC-70.1 Gallium Nitride and JC-70.2 Silicon Carbide Subcommittees of JEDEC's JC-70 Wide Bandgap Power Conversion Semiconductor Committee (which was formed in October 2017 with 23 member companies, rising to over 80 now), JEP200 can be downloaded free from JEDEC's website.

The proliferation of soft-switching power conversion topologies brought about the need to accurately quantify the energy stored in a power device's output capacitance because the energy impacts the efficiency of power converters. Developed in collaboration with academia, JEP200 addresses the critical power supply industry need to properly test and measure the switching energy loss due to the output capacitance hysteresis in semiconductor power devices and details test circuits, measurement methods and data extraction algorithms.

The document applies not only to wide-bandgap power semiconductors such as GaN and SiC but also silicon power transistors and diodes.

"Professionals in high-frequency power conversion systems have long sought a standardized approach to testing new switching energy losses," says the JC-70 Committee's vice chair Dr Jaume Roig, a member of onsemi's technical staff. "This document now provides helpful guidance on testing energy losses related to output capacitance hysteresis caused by displacement currents. With this clarity, system optimization can proceed more accurately," he adds.

"JEDEC's JC-70 committee has the expertise necessary to meet the demands of the entire power semiconductor industry, and the development of JEP200 demonstrates how the JEDEC process enabled the committee to swiftly respond to an industry need," says JEDEC president John Kelly. "JEP200 encompasses GaN, SiC and Si power devices, helping the industry navigate design challenges caused by the growing number of new power conversion topologies."

Interested companies worldwide can join JEDEC to participate in the work of the JC-70 Committee. The next committee meeting is being held on 6 November, in conjunction with the 11th IEEE Workshop on Wide Bandgap Power Devices and Applications (WiPDA 2024) in Dayton, Ohio, USA (4–6 November).

**https://wipda.org/**

**www.jedec.org/standards-documents/docs/jep200**

# Wolfspeed accelerating shift of device fabrication to 200mm Mohawk Valley Fab, while mulling closure of 150mm Durham device fab

## Doubling in EV revenue year-on-year driving Mohawk Valley Fab utilization to 25% one quarter early

For its fiscal full year (to end-June), Wolfspeed Inc of Durham, NC, USA — which makes silicon carbide materials as well as silicon carbide (SiC) and gallium nitride (GaN) power-switching & RF semiconductor devices — has reported annual revenue growth of 6.4%, from $758.5m in fiscal 2023 to $807.2m for fiscal 2024. Specifically, Materials Products revenue rose by 12.1% from $349.3m to $391.6m, and Power Products revenue by 1.6% from $409.2m to $415.6m.

N.B. All figures are for continuing operations only, after Wolfspeed completed the sale (announced on 22 August 2023) of its radio frequency business Wolfspeed RF to MACOM Technology Solutions Holdings Inc of Lowell, MA, USA.

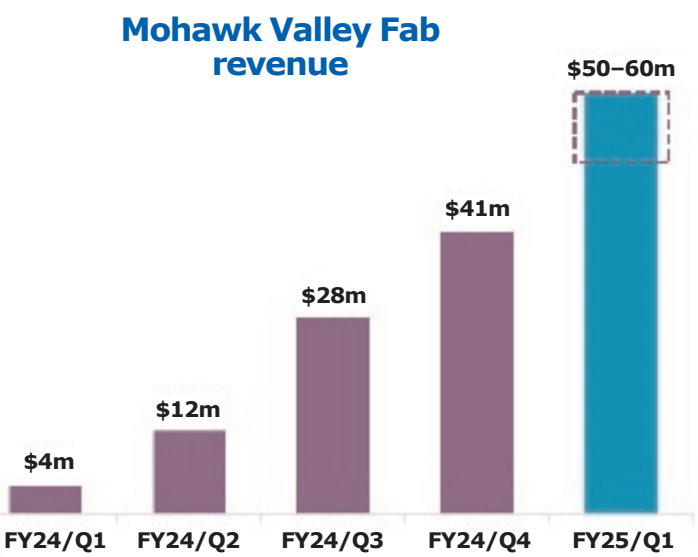
Fiscal fourth-quarter 2024 revenue was $200.7m, slightly above the midpoint of the $185–215m guidance range, but only level with last quarter and down on $202.7m a year ago.

Materials Products revenue was $96.1m, down on last quarter's $98.6m (its second highest ever) but up on $95.6m a year ago and exceeding the expected $90–95m, driven by the continued strong execution (better-than-expected yields and output on 150mm-diameter silicon carbide wafers).

Power Products revenue was $104.6m, up on $102.1m last quarter but down on $107.1m a year ago.

- The Durham 150mm-wafer device fab contributed $64m of revenue, above the midpoint of the $55–70m guidance range but down 40% year-on-year due to continued weakness in Industrial & Energy (I&E) markets (which comprise most of the Durham fab's products) after inventory buildups across many end-market channels, predominantly in Asia.
- The Mohawk Valley Fab in Marcy, NY (opened in April 2022 to produce SiC power devices on larger, 200mm wafers) contributed $41m, up 46% from $28m last quarter and just $1m a year ago. However, this was at the lower end of the expected $40–50m range due to an EV customer deferring delivery of several million dollars' worth of product. "We expect to recognize this revenue in fiscal 2025, and believe we would have landed in line or slightly above the midpoint of our Mohawk Valley revenue guidance, excluding this push-out," says president & CEO Gregg Lowe. EV-related revenue still more than doubled quarter-on-quarter and tripled year-on-year, to over 50% of total Power Products revenue (up from just 25% a year ago) and 85–90% of Mohawk Valley's revenue. "EV revenue has grown for three consecutive quarters despite a declining auto semiconductor market."

On a non-GAAP basis, quarterly gross margin has fallen further, from 31% a year ago and 15% last quarter to just 5%, albeit slightly above the midpoint of the revised 0–8% guidance range. The original guidance had been 8–16%, including the impact of 1200 basis points from $24m of expected under-utilization costs (due mainly to Mohawk Valley, which reached 20% utilization in June, ahead of schedule). However,




- **FY24/Q4 revenue contribution of $41m**
- **FY25/Q1 targeted revenue of $55m at the midpoint**
- **Achieved 20% utilization in June 2024, ahead of schedule**
- **On track to achieve 25% utilization by end of September 2024, a quarter ahead of schedule**
- **Expect to reach ~30% utilization in the March 2025 quarter**
- **Mohawk Valley Fab offers 25% greater yields and 40% lower die costs than the equivalent at Durham**

there was also an unexpected impact of 500 basis points from an equipment incident at the Durham fab disclosed in June (that resulted in a temporary capacity reduction, leading to under-utilization charges, repair costs and lower yields). Overall, there was a shift in product mix from I&E to EV (which has lower margins).

Full-year gross margin has hence fallen from 35% in fiscal 2023 to 13% for fiscal 2024, including the impact of $124m of under-utilization costs.

Total operating expenses rose from $128.9m last quarter to $148.3m. However, this was partly due to a rise from $14.4m to $20.5m in factory start-up costs related to materials expansion efforts and construction of The JP (John Palmour Manufacturing Center for Silicon Carbide) in Siler City, NC (which activated its initial furnaces before the end of June).

Net loss has hence risen further, from $44.9m ($0.36 per diluted share) a year ago and $77.7m ($0.62 per diluted share) last quarter to $112m ($0.89 per diluted share). This exceeds the original guidance of $91–109m ($0.72–0.86 per diluted share) due to the Durham fab's equipment incident, but it is slightly better than the midpoint of the revised guidance given in June of $122–105m ($0.96–0.83 per diluted share). Full-year net loss has increased from $153.7m ($1.24 per diluted share) in fiscal 2023 to $325.9m ($2.59 per diluted share) for fiscal 2024.

Quarterly adjusted EBITDA has worsened further, from –$25.4m a year ago and –$32.3m last quarter to –$73.9m (leading full-year adjusted EBITDA to more than double from –$83m to –$162.5m).

Net cash used in operating activities has risen further, from $38.7m a year ago and $136.2m last quarter to $239.5m (driving full-year operating cash outflow up from $102.2m in fiscal 2023 to $671.3m for fiscal 2024). Capital expenditure (CapEx) has increased further, from $400.2m a year ago and $480m last quarter to $644.2m (raising full-year CapEx from $794.1m in fiscal 2023 to a peak of $2095.5m in fiscal 2024).

Free cash flow was hence worsened from –$440.2m a year ago and –$615.8m last quarter to –$885m (tripling full-year free cash flow from –$901.2m in fiscal 2023 to –$2772.7m for fiscal 2024).

Wolfspeed ended the quarter with about $2.175bn of cash and liquidity on hand to support facility ramps and growth plans (down from $2.5bn last quarter and $2.955bn a year ago).

Power device design-ins were $2bn in fiscal Q4, contributing to over $9bn for full-year fiscal 2024 and $21bn cumulatively to date. "While there has been some near-term reductions in the projected EV adoption rate estimates, the adoption of silicon carbide in EVs has remained strong," notes Lowe. "About 70% of our $2bn design-ins from this quarter were related to 800V applications, underscoring our belief that this shift to higher-performing and more efficient architectures [from traditional 400V systems] will serve as a major tailwind for both silicon carbide generally and Wolfspeed specifically."

About $0.5bn of design-ins converted to design-wins in fiscal Q4, reflecting the initial ramp of production for those programs. The design-win backlog supports more than 125 different car models across more than 30 OEMs over the next several years.

**September-quarter guidance**

For its fiscal first-quarter 2025 (to end-September), Wolfspeed expects revenue to be roughly flat at $185–215m. Revenue will be lower from both I&E market headwinds and the Durham fab (impacted by about $20m due to the equipment incident). However, revenue from the Mohawk Valley Fab will grow by over 34% quarter-to-quarter to $50–60m (up from just $4 a year previously), 95% of which will be EV-related (tripling year-on-year, to over 60% of total Power Products revenue). "While the ramp of EVs is slower than previously projected, and many companies in the semiconductor industry are still confronting automotive headwinds, our revenue in the EV market continues to be strong because we are just at the beginning of the ramp of our automotive business across several geographies," says Lowe.

Gross margin is expected to be –2% to +6% (a +2% midpoint). This includes $24m of under-utilization costs from Mohawk Valley and about 1000 basis points of under-utilization, repair costs and yield impact in the Durham fab, related partly to the fab facility incident but also to lower utilization due to the weaker I&E market demand, where Wolfspeed aims to reduce inventory levels. "If you look at the underlying [level], we actually have a little bit of a margin pickup quarter-over-quarter, just as we start to see more volume flow through Mohawk Valley," says chief financial officer Neill Reynolds.

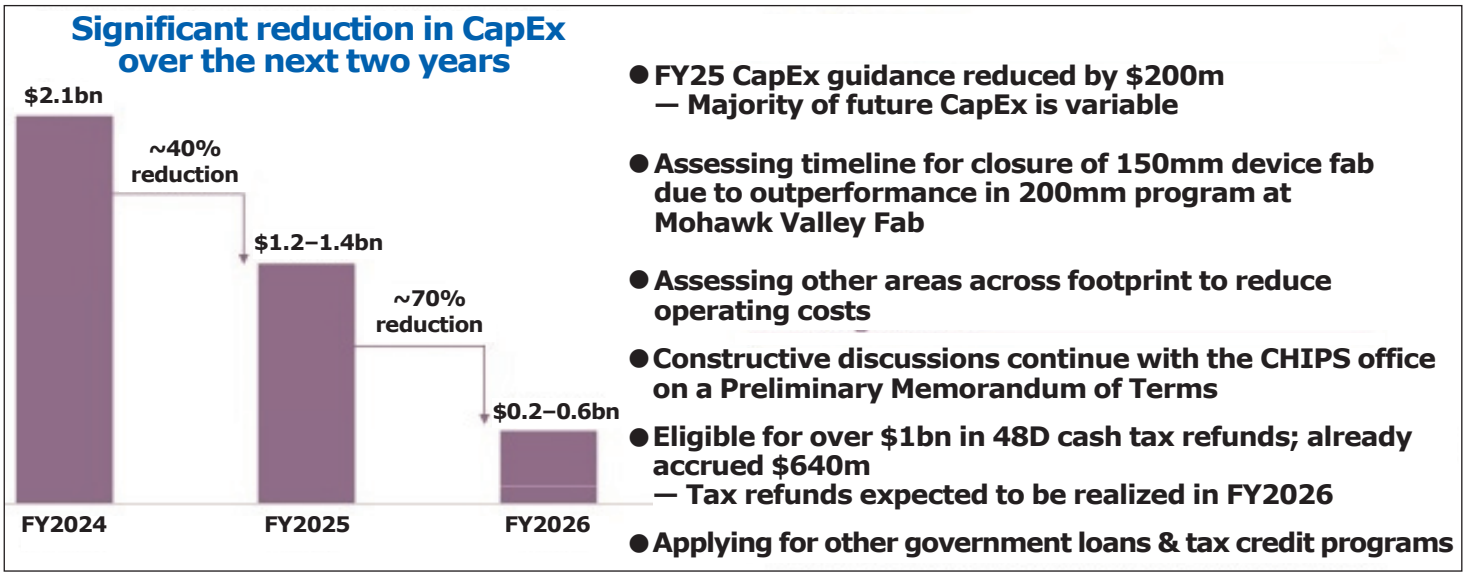
Targeted operating expenses are $124–129m, including factory start-up costs related to The JP rising to $25m. "As Mohawk Valley utilization increases [to 25% by end-September, a quarter ahead of schedule] and The JP starts to come online, we will start to see incrementally less under-utilization out of Mohawk Valley, but incrementally more start-up costs from The JP, which hit different lines of our profit & loss," notes Reynolds. Net loss should rise to $138–114m ($1.09–0.90 per diluted share).

**Accelerating path to profitability**

"From an operating perspective, we are undertaking several initiatives that accelerate our path to profitability and ensure we slow our operating cash burn, achieve positive EBITDA in the second half of this fiscal year, and drive to positive operating cash flow by early fiscal 2026," says Reynolds.

"We have two priorities we are focused on: optimizing our capital structure for both the near term and long term and driving performance in our state-of-the-art 200mm fab," says Lowe.

"Our 200mm device fab [Mohawk Valley] is currently producing solid results at lower costs than our ►




Durham 150mm fab, while also presenting significant die cost advantages. This improved profitability gives us the confidence to accelerate the shift of our device fabrication from our 150mm fab to the 200mm fab in Mohawk Valley, while we assess the timing of the closure of our 150mm device fab in Durham," says Lowe. "We passed internal qualification for nearly all automotive powertrain products in late July and now have only a handful of customer qualifications left to complete, giving us the confidence that those products can be serviced out of Mohawk Valley sooner than we originally anticipated… By the March quarter, we plan to move nearly all EV powertrain production to Mohawk Valley," he adds.

"On the material side, our progress on our 200mm platform has been substantial. Crystal growth and substrate processing out of Building 10 in Durham continues to scale and we expect to be able to support a 25% wafer start utilization at Mohawk Valley in the September quarter, one quarter ahead of plan. As a result of continued productivity improvements, we are also now expecting Building 10 to support 30% wafer start utilization at Mohawk Valley in the March quarter of 2025. These productivity improvements allow for a more measured ramp and, therefore, measured spend on The JP," says Lowe.

"We have already processed the first silicon carbide boules from The JP [through the Durham fab line] and the quality is in line with the high-quality materials coming out of Building 10," he adds. The JP is expected to qualify furnaces by the end of September, produce initial silicon carbide boules by the end of calendar 2024, and have the full flow qualified and delivering wafers to Mohawk Valley by summer 2025.

"At the same time, we are taking proactive steps to slow down the pace of our CapEx by approximately $200m in fiscal 2025 and identify areas across our entire footprint to reduce operating costs," says Lowe. Reflecting the significant improvement in yields and efficiency in 200mm materials and device facilities, Wolfspeed has cut its forecasted fiscal 2025 CapEx from $1.4–1.6bn to $1.2–1.4bn (down from fiscal 2024's $2.1bn). "We have the flexibility to take this estimate down even lower, based on the demand and revenue outlook throughout the year," says Reynolds. "This level of CapEx ensures that we complete The JP Siler City materials factory on time and on budget, so that we deliver wafers to Mohawk Valley mid-next calendar year," he adds.

"Looking at fiscal year 2026, our CapEx will fall off sharply, as our facility expansion projects will be complete and the vast majority of our CapEx will be related to the production tools to fill those facilities and increase capacity," says Reynolds. "We expect our gross fiscal year 2026 CapEx to be in the range of $200–600m [supporting 50–60% utilization in Mohawk Valley], which does not include offsets for federal incentives, which could lower that number significantly. This would include some of the approximately $640m of Section 48D tax credits as part of the CHIPS Act that we have already accrued on our balance sheet… We expect to have more than $1bn of 48D tax credits that will help fund the business," he adds. "Our long-term CapEx plan is expected to generate more than $1bn in cash refunds from Section 48D tax credits from the IRS," notes Lowe. "We also remain in constructive talks with the CHIPS office on a Preliminary Memorandum of Terms for capital grants under the CHIPS Act… We are now down to negotiating the final terms and conditions," he adds.

"In addition to CHIPS, we are working closely with our lenders on plans to raise additional capital," says Reynolds. "We are also applying for other government lending and tax credit programs that may provide us with additional access to capital. Therefore, in addition to lowering CapEx and driving towards profitability, we expect to have access to several options that would enable us to end fiscal year 2025 above our $1bn minimum cash target."

www.wolfspeed.com

# Wolfspeed unveils 2300V baseplate-less silicon carbide power modules for 1500V DC bus applications

## Partnership formed with utility-scale inverter manufacturer EPC Power

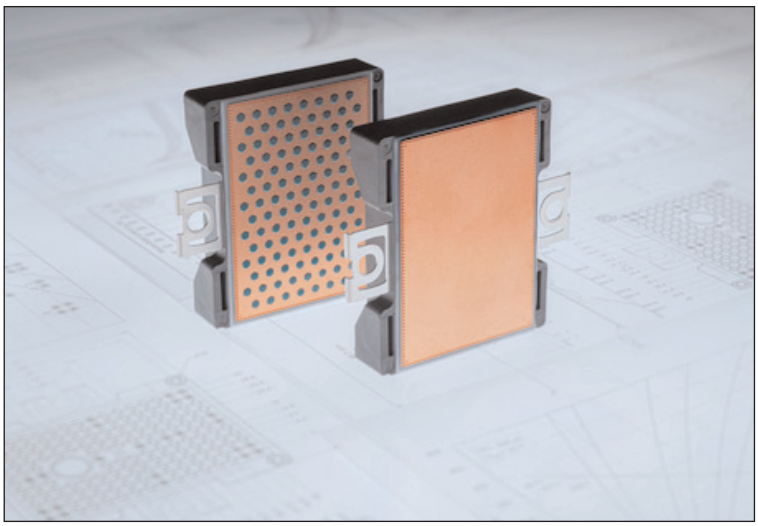
Wolfspeed Inc of Durham, NC, USA — which makes silicon carbide (SiC) materials and power semiconductor devices — has unveiled a silicon carbide module designed to transform the renewable energy, energy storage and high-capacity fast-charging sectors through improved efficiency, durability, reliability and scalability.

The 2300V baseplate-less silicon carbide power modules for 1500V DC bus applications were developed and launched utilizing Wolfspeed's 200mm silicon carbide wafers.

Wolfspeed is also partnering with North American utility-scale inverter manufacturer EPC Power, which will be employing the Wolfspeed modules in utility-grade solar and energy storage systems, offering a scalable high-power conversion system and high-performance controls and system redundancy.

"The solar and energy storage market remains among the fastest-growing segments of the renewable energy industry. As the pioneers of silicon carbide, we are driven to create solutions that will open the door to a new era of modern energy," says Jay Cameron, Wolfspeed senior VP & general manager, Power. "Energy efficiency, reliability and scalability are top of mind for our customers, such as EPC Power, who recognize the substantial advantages Wolfspeed's silicon carbide brings to the table," he adds.

"Silicon carbide devices open the door to a step-change in inverter performance and reliability," says EPC Power's president & CEO Devin Dilley. "With our commitment to extreme reliability, performance and security in our new 'M' inverter while also forging a deep commercial relationship with key suppliers, Wolfspeed was the obvious choice," he adds.



**Wolfspeed's 2300V baseplate-less silicon carbide power modules for 1500V DC bus applications.**

With mounting global investment in renewable energy, the solar energy market will reach a $300bn market capitalization by 2032, forecasts Allied Market Research. According to the International Energy Agency (IEA), 2024–2025 will see the highest energy demand growth rate since 2007, reinforcing the need for efficient and reliable clean power. Wolfspeed says that its silicon carbide solution helps to bridge this crucial gap, supporting the next era of modern energy technologies while reinforcing US clean energy manufacturing leadership.

"This platform further validates our investments in 200mm wafer technology and production as the potential of silicon carbide continues to be recognized by industry leaders across all mission-critical applications," says Cameron.

Switching performance

Wolfspeed says that its 2300V modules can improve system efficiency while reducing the number of passive components. They offer 15% greater voltage headroom compared with similar silicon carbide modules, improved dynamic performance with consistent temperature stability, and a substantial reduction in EMI filter size, it is claimed. The firm adds that its technology achieves a 77% reduction in switching losses over IGBTs and a 2–3x reduction in switching losses for silicon carbide devices intended for 1500V applications.

**Market scalability through design simplification**

2300V silicon carbide modules will allow system designers to leverage lower-cost printed circuit boards to cut manufacturing costs and significantly reduce development time compared with legacy bus bar solutions. Furthermore, Wolfspeed's 2300V modules can enable the industry to adopt the two-level topology, resulting in simplified system design and reduced driver count compared with IGBT-based three-level configurations. The benefits of 2300V modules support a building-block approach to easily scale power tenfold, from kilowatts to megawatts.

**Prolonged system lifetimes & durability**

Wolfspeed says that its 2300V silicon carbide modules can allow customers to further enhance the lifetime and durability of their systems. This is achieved through an optimized failure-in-time rate for continuous 1500V DC operation and improved cosmic ray susceptibility compared with a 2000V design. When used in a two-level implementation, 2300V modules reduce the amount of potential single points of failure across the system.

www.wolfspeed.com

# ST unveils fourth-generation silicon carbide power technology for next-gen EV traction inverters

## Smaller, more efficient products to ramp-up in volumes through 2025 across 750V and 1200V classes, targeting mid-size and compact EVs

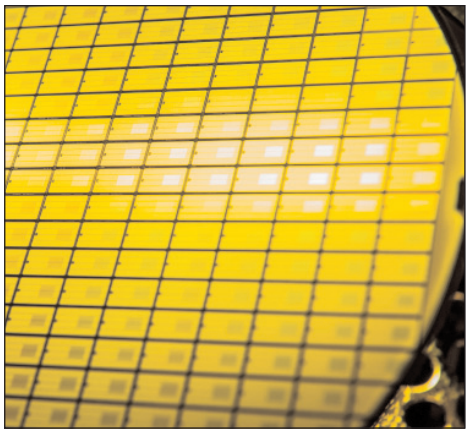
STMicroelectronics of Geneva, Switzerland is introducing its fourth-generation STPOWER silicon carbide (SiC) MOSFET technology, which is claimed to bring new benchmarks in power efficiency, power density and robustness. While serving the needs of both the automotive and industrial markets, the new Generation 4 technology is particularly optimized for traction inverters, the key component of electric vehicle (EV) powertrains. The firm plans to introduce further SiC technology innovations through 2027.

"We continue to advance SiC MOSFET technology with innovations in the device, advanced packages, and power modules," says Marco Cassis, president, Analog, Power & Discrete, MEMS and Sensors Group. "Together with our vertically integrated manufacturing strategy, we are delivering industry-leading SiC technology performance and a resilient supply chain to meet the growing needs of our customers."

This latest generation of SiC devices is conceived to benefit future EV traction inverter platforms, with further advances in size (with die 12–15% smaller than that for Generation 3 devices, on average) and energy-saving potential.

While the EV market continues to grow, challenges remain to achieve widespread adoption, and car makers are looking to deliver more affordable electric cars. 800V EV bus drive systems based on SiC have enabled faster charging and reduced EV weight, allowing car makers to produce vehicles with longer driving ranges for premium models.

ST says that its new SiC MOSFET devices, which will be made available in 750V and 1200V classes, will improve energy efficiency and performance of both 400V and 800V EV bus traction inverters, bringing



the advantages of SiC to mid-size and compact EVs — key segments to help achieve mass-market adoption. The new-generation SiC technology is also suitable for high-power industrial applications including solar inverters, energy storage solutions and data centers, significantly improving energy efficiency for these growing applications.

ST has completed qualification of the 750V class of the fourth-generation SiC technology platform and expects to complete qualification of the 1200V class in first-quarter 2025. Commercial availability of devices with nominal voltage ratings of 750V and 1200V will follow, allowing designers to address applications operating from standard AC-line voltages up to high-voltage EV batteries and chargers.

**Use cases**

ST says that its Generation 4 SiC MOSFETs provide higher efficiency, smaller components, reduced weight, and extended driving range compared with silicon-based solutions. These benefits are critical for achieving widespread adoption of EVs, and leading EV manufacturers are engaged with ST to introduce the Generation 4 SiC technology into their vehicles, enhancing performance and energy efficiency, the firm adds.

While the primary application is EV traction inverters, the Generation 4 SiC MOSFETs are also suitable for use in high-power industrial motor drives, benefiting from the devices' improved switching performance and robustness. This results in more efficient and reliable motor control, reducing energy consumption and operational costs in industrial settings.

In renewable energy applications, the Generation 4 SiC MOSFETs enhance the efficiency of solar inverters and energy storage systems, contributing to more sustainable and cost-effective energy solutions.

Additionally, the SiC MOSFETs can be utilised in power supply units for server data centers for AI, where their high efficiency and compact size are crucial for the significant power demands and thermal management challenges.

**Roadmap**

To accelerate the development of SiC power devices through its vertically integrated manufacturing strategy, ST is developing multiple SiC technology innovations in parallel to advance power device technologies over the next three years. The fifth generation of ST SiC power devices will feature a high-power-density technology based on a planar structure. At the same time, ST is developing an innovation that promises outstanding on-resistance $R_{DS(on)}$ value at high temperatures and further $R_{DS(on)}$ reduction, compared with existing SiC technologies.

At the International Conference on Silicon Carbide and Related Materials (ICSCRM 2024) in Raleigh, NC, USA (29 September–4 October), ST gave technical presentations and an industrial keynote on 'High volume industrial environment for leading edge technologies in SiC'.

www.st.com

# Toshiba launches 1200V third-generation silicon carbide Schottky barrier diodes

## Through-hole power devices reduce power loss and increase efficiency in industrial equipment

Japan-based Toshiba Electronic Devices & Storage Corp (TDSC) — which was spun off from Toshiba Corp in 2017 — has added the TRSxxx120Hx Series of 1200V products to its lineup of third-generation silicon carbide (SiC) Schottky barrier diodes (SBD) for industrial equipment, such as photovoltaic inverters, EV charging stations, and switching power supplies for industrial equipment. Toshiba has started shipments of the ten new products in the series: five in a TO-247-2L package and five in a TO-247 package.

By implementing an enhanced junction barrier Schottky (JBS) structure, the TRSxxx120Hx series allows what is claimed to be an industry-leading low forward voltage ($V_F$) of just 1.27V (typical). The merged PiN-Schottky incorporated into a JBS structure reduces diode losses under high-current conditions. The TRS40N120H of the new series accepts a forward DC current ($I_{F(DC)}$) of 40A (maximum) and a non-repetitive peak forward surge current ($I_{FSM}$) of 270A (maximum), with the maximum case temperature ($T_C$) of all devices being +175°C.


**Toshiba's 1200V third-generation SiC Schottky barrier diodes.**

Combined with the lower capacitive charge and leakage current, the products help to improve system efficiency and simplify thermal design. For example, at a reverse voltage ($V_R$) of 1200V, the TRS20H120H diode housed in the TO-247-2L package provides a low total capacitive charge ($Q_C$) of 109nC and low reverse current ($I_R$) of 2μA.

Toshiba will continue to expand its SiC power device lineup, and to focus on improving efficiency that reduces power loss in industrial power equipment.

**www.toshiba.semicon-storage.com/ap-en/semiconductor/product/**

# ROHM's fourth-generation SiC MOSFET chips adopted in three Geely ZEEKR EV models

## Integration in traction inverters extends cruising range and improves performance

Japan-based power semiconductor device maker ROHM Co Ltd says that power modules equipped with 4th-generation silicon carbide (SiC) MOSFET bare chips have been adopted for the traction inverters in three models of the ZEEKR electric vehicle (EV) brand of China's Zhejiang Geely Holding Group. Since 2023, these power modules have been mass produced and shipped from HAIMOSIC (SHANGHAI) Co Ltd — a joint venture between ROHM and Zhenghai Group Co Ltd — to Viridi E-Mobility Technology (Ningbo) Co Ltd, a tier-1 manufacturer under Geely.

Geely and ROHM have been collaborating since 2018, beginning with technical exchanges, then later forming a strategic partnership focused on SiC power devices in 2021. This has led to the integration of ROHM's SiC MOSFETs into the traction inverters of three models:

- the ZEEKR X, which features a maximum output exceeding 300kW and cruising range of more than 400km despite being a compact SUV;
- the 009 minivan, which features an intelligent cockpit and large 140kWh battery, achieving a maximum cruising range of 822km;
- the flagship model 001, which offers a maximum output of over 400kW from dual motors with a range of over 580km along with a four-wheel independent control system.


In each of these EVs, ROHM's power solutions centered on SiC MOSFETs are said to play a key role in extending the cruising range and enhancing overall performance.

ROHM plans to launch 5th-generation SiC MOSFETs in 2025 while accelerating market the introduction of 6th- and 7th-generation devices.

**www.geely.com**
**www.rohm.com/products/sic-power-devices**

# ROHM and UAES sign long-term supply agreement for SiC power devices

## Firms deepen collaboration, accelerating development of silicon carbide power solutions for electric vehicles

Japan-based power semiconductor device maker ROHM Semiconductor and China's largest tier-1 automotive supplier United Automotive Electronic Systems Co Ltd (UAES, a joint venture established in 1995 by China's Zhonglian Automotive Electronics Co Ltd and Germany's Robert Bosch GmbH) have entered into a long-term supply agreement for SiC power devices.

Since 2015, ROHM and UAES have been collaborating and conducting technical exchanges on automotive applications using SiC power devices. This partnership deepened in 2020 with the establishment of the SiC Joint Research Institute at UAES' headquarters in Pudong New Area, Shanghai. In 2021, ROHM's SiC power devices and peripheral components were highly evaluated by UAES, resulting in ROHM being selected as a preferred supplier.

The long-standing technical partnership has led to the production and adoption of automotive products equipped with ROHM SiC components, such as onboard chargers and inverters for electric vehicles. SiC power devices play a crucial role in enhancing the efficiency and performance of systems, contributing to extending the cruising range and reducing battery size.

The long-term supply agreement ensures UAES sufficient access to SiC power devices to meet the growing demand for SiC-based inverter modules, which have been supplied to customers since November 2023. Going forward, both firms aim to deepen their collaboration, speeding development of SiC power solutions for EVs.

"The growing popularity of electric vehicles in the Chinese market has made the adoption and integration of power semiconductors like SiCs increasingly important," notes UAES' deputy general manager Guo Xiaolu. "Choosing ROHM as our long-term supplier of SiC chips guarantees a stable supply for future mass production. We appreciate ROHM's past efforts and look forward to building a long-term collaborative relationship, with this agreement serving as a new starting point," he adds.

"By working together, both companies can provide cutting-edge, high-performance, high-quality automotive applications," says Tsuguki Noma, corporate officer and director of the Power Device business unit at ROHM. "Moving forward, we will continue to drive technological innovation in electric vehicles together with UAES by offering power solutions centered on SiC."

**www.uaes.com**
**www.rohm.com/products/sic-power-devices**

# DENSO and ROHM consider strategic partnership on automotive semiconductors

Automotive supplier DENSO Corp of Kariya, Aichi prefecture, Japan and ROHM Co Ltd are to begin considering establishing a strategic partnership on semiconductors.

DENSO and ROHM already work together through the trading and development of semiconductors for automotive applications. Going forward, both companies intend the partnership to establish a stable supply of highly reliable products, as well as various initiatives to develop high-quality and high-efficiency semiconductors.

To further solidify the partnership, DENSO will acquire a portion of ROHM's shares.

"DENSO positions semiconductors as key devices for realizing next-generation vehicle systems, and we have deepened our cooperative relationships with semiconductor manufacturers who have abundant experience and knowledge," says DENSO's president & CEO Shinnosuke Hayashi. "ROHM has a lineup of semiconductors in a wide range of areas important for automotive electronics, including analog semiconductors, power devices and discrete semiconductors, and has extensive mass-production experience. We believe that by integrating the automotive technologies and expertise we have cultivated over the years, we will be able to ensure a stable supply and accelerate technological development," he adds.

"DENSO and ROHM have been deepening collaboration for many years, and in recent years we have been working on joint development of analog semiconductors," notes ROHM's president Isao Matsumoto. "Partnership with DENSO and the acquisition of shares by DENSO will further strengthen our cooperative relationship. To realize carbon neutrality, it is important to collaborate on technology at the device level with an eye toward end products and systems. We can contribute to the realization of a sustainable society by deepening our integration with DENSO, who has advanced system construction capabilities in the automotive and industrial equipment fields."

**www.globaldenso.com**

# onsemi releases upgraded power modules to boost solar power generation and energy storage

## Silicon and silicon carbide hybrid solutions reduce footprint while increasing power output by 15%

Intelligent power and sensing technology firm onsemi of Scottsdale, AZ, USA has released its newest-generation silicon and silicon carbide (SiC) hybrid power integrated modules (PIMs) in an F5BP package, suited to boosting the power output of utility-scale solar string inverters or energy storage system (ESS) applications.

Compared with previous generations, the modules offer increased power density and higher efficiencies within the same footprint to increase the total system power of a solar inverter from 300kW up to 350kW. This means that a 1GW capacity utility-scale solar farm using the latest-generation modules can achieve energy savings of nearly 2MW per hour (the equivalent of powering more than 700 homes per year). Additionally, fewer modules are required to achieve the same power threshold as the previous generation, which can reduce power device component costs by more than 25%.

With solar power having achieved the lowest levelized cost of energy (LCOE), it is increasingly becoming the go-to source for renewable power generation around the world, notes onsemi. To compensate for solar power's variability, utility operators are also adding large-scale battery energy storage systems (BESS) to ensure stable energy flow to the grid. To support this combination of systems, manufacturers and utilities require solutions that offer maximum efficiency and reliable power conversion. Every 0.1% of efficiency improvement can equate to a quarter of a million dollars in annual operational savings for every gigawatt of installed capacity.

"As a variable energy source dependant on sunlight, continual advances in increasing system efficiencies, reliability and advanced storage solutions are needed to be able to maintain the stability and reliability of global grids during peak and off-peak power demand," says Sravan Vanaparthy, vice president, Industrial Power Division, Power Solutions Group, onsemi. "A more efficient infrastructure increases adoption and assures us that, as more solar power generation is built out, less energy is wasted and pushes us forward on a path away from fossil fuels."

The new F5BP-PIMs are integrated with 1050V FS7 insulated-gate bipolar transistor (IGBT) and the 1200V D3 EliteSiC diode to form a foundation that facilitates high-voltage and high-current power conversion while reducing power dissipation and increasing reliability. The FS7 IGBTs offer low turn-off losses and reduce switching losses by up to 8%, while the EliteSiC diodes are said to provide superior switching performance and lower voltage flicker (VF) by 15% compared with previous generations.

The PIMs employ an I-type neutral point clamp (INPC) for the inverter module and a flying capacitor topology for the boost module. The modules also use an optimized electrical layout and advanced direct bonded copper (DBC) substrates to reduce stray inductance and thermal resistance. In addition, a copper baseplate further decreases thermal resistance to the heat sink by 9.3%, ensuring that the module remains cool under high operational loads. This thermal management is crucial in maintaining the efficiency and longevity of the modules, making them effective for demanding applications that require reliable and sustained power delivery.

**www.onsemi.com**

# NREL to design silicon carbide-based power inverters for US ground combat vehicles

To transform US military ground combat vehicles, the US National Renewable Energy Laboratory (NREL) has been selected to redesign a critical component: the traction inverter, which controls the flow of electricity between a vehicle's battery, motor and drivetrain. The new silicon carbide (SiC)-based propulsion system will double the range of Army vehicles with a footprint four times smaller than its predecessors.

The three-year, $6m project has been fully funded by the Operational Energy Capability Improvement Fund (OECIF), which guides energy innovations for the US Department of Defense. It will be led by the US Army Combat Capabilities Development Command (DEVCOM), with researchers from both NREL and the Army Research Laboratory (ARL) providing technical expertise.

NREL's power electronics researchers will lead the development of a SiC-based power inverter dubbed PICHOT — a power inverter that is compact in scale and functions at a high operating temperature — that can offer 200% more range to US Army ground combat vehicles.

The inverter will be designed, fabricated and characterized in-house at NREL prior to evaluation at the US Army Ground Vehicle Systems Center's test labs. Its modular design will allow it to slot into many different hybrid-electric ground combat vehicles, from light- to medium-wheeled vehicles to Abrams and Stryker battle tanks. SiC-based semiconductors and novel thermal management will give it unmatched power density, allowing vehicles to travel further with less fuel.

**Reimagining propulsion system power electronics**

NREL says that, to create PICHOT, its power electronics are reimagining nearly every aspect of conventional power inverters.

First, researchers studied the current leading traction inverter used by US Army ground combat vehicles: the 200kW Zeus inverter, created by DEVCOM for high-power applications. Then, based on NREL's research into power electronics thermal management, they determined everything they could strip away from the predecessor technology — from the cooling equipment to the connectors.

Because traction inverters are typically installed next to other heat-generating elements in a combat vehicle, they need to be able to withstand high operating as well as ambient temperatures. This usually requires them to be packed with bulky cooling technologies, like cold plates or coolant reservoirs.

PICHOT will require none of these heavy cooling solutions. Instead, it will link to the existing engine coolant system, eliminating the need for additional coolant loops. In turn, unlike conventional silicon-based inverter systems — which become essentially powerless when exposed to operating environments over 70°C — PICHOT will be able to function at full power in environments of 105°C.

Due to NREL's expertise in power electronics packaging, PICHOT will be capable of the same 200kW output as its predecessor Zeus but at a quarter of the size — small enough to fit in a shoebox. Also, while most inverters require a plethora of electrical wiring for communication, PICHOT's main communication will be a tailored wireless system featuring remote control and monitoring while ensuring robust data security. It will also come equipped with a 'smart' feature that allows it to monitor its own state of health, predicting component failure before it occurs.

Compared with existing technologies, PICHOT is expected to enable 53% fuel savings, so Army vehicles will be able to stay in the field for nearly twice as long before needing to refuel. Combined with silent performance thanks to the hybrid-electric engine and electromagnetic interference shielding, Army ground combat vehicles are should become safer, longer-range and higher-performing than before.

"NREL is home to a highly skilled thermal management research group," notes Faisal Khan, chief researcher of power electronics in NREL's Center for Integrated Mobility Sciences, who will be principal investigator for the project. "Given the complexity of this project — designing a high-power-density traction inverter with stringent thermal management that can function in extreme environments — we are well equipped to handle this challenging work."

**Three-year timescale for design, fabrication and evaluation**

PICHOT will take three years to design, fabricate and evaluate. In the first year, NREL researchers will build a computer-generated model of the inverter and simulate its operations in the real world, ensuring that it will operate as planned.

Then they will build it using the laboratory's end-to-end prototype fabrication pipeline and demonstrate its effectiveness versus other combatants' standard vehicles.

Finally, the blueprints will become available to manufacturers at a forthcoming industry day. The final design will be manufactured at scale, with the potential to be leveraged in multiple kinds of US Army ground combat vehicles.

Also, as the Army prepares to implement climate strategies aligned with the USA's shift to lower-emitting vehicles, it is expected that new solutions, powered by clean energy, will provide more power, reliability and sustainability than before.

**www.nrel.gov/transportation/peem.html**

# Infineon nominated for Deutscher Zukunftspreis for developing 3300V vertical-channel SiC trench MOSFET

## Germany's Federal President to award winner in Berlin on 27 November

Infineon Technologies AG of Munich, Germany is one of three teams nominated by the jury for the Deutscher Zukunftspreis 2024, the German Federal President's Award for Technology and Innovation (to be awarded by Federal President Frank-Walter Steinmeier in Berlin on 27 November).

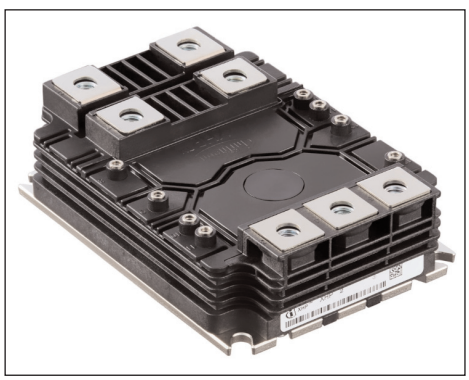
A team of developers from Infineon, together with Chemnitz University of Technology, has developed the first silicon carbide (SiC) MOSFET with a vertical channel (trench MOSFET) and innovative copper contacting in the 3300V voltage class. The new SiC modules and power converters equipped with the modules are said to represent a leap in semiconductor technology from conventional silicon to more energy-efficient silicon carbide, reducing switching losses in high-current applications by 90%.

Trench MOSFETs differ from planar MOSFETs in their cell structure and performance. While the current flow in planar MOSFETs is initially horizontal, trench MOSFETs offer purely vertical channels. This results in a higher cell density per surface area, which in turn significantly reduces the losses in the chip during energy conversion and hence increases efficiency.

The CoolSiC XHP2 module family is said to enable significant energy savings, for example in industrial power generation in solar parks or wind turbines, in power transmission and, above all, in end consumption, where high energies in the megawatt range are required. A single train with a silicon carbide drive system can save about 300MWh per year compared with the previous silicon-based solution. This is roughly equivalent to the annual consumption of 100 single-family homes. Together with drive technology manufacturers and rail operators, Infineon is contributing to decarbonization, while local residents also benefit from the lower noise level of trains with SiC modules when they pass through residential areas.

**The team around Dr Konrad Schraml (center), Dr Caspar Leendertz (right, both Infineon) and professor Dr Thomas Basler (TU Chemnitz) brought the 3300V CoolSiC XHP2 high-performance module to production maturity.**

Through developments in chip processing and design as well as contacting and module technology, the team led by Dr Konrad Schraml, Dr Caspar Leendertz (both Infineon) and professor Dr Thomas Basler (Chemnitz University of Technology) has brought the 3300V CoolSiC XHP2 high-performance module to production readiness. With ten times greater reliability against thermomechanical stress and a significantly higher power density compared with silicon modules, the new silicon carbide module can also be used to electrify large drives in diesel locomotives, agricultural and construction machinery, aircraft and ships, which were previously reserved for fossil fuels. The significantly higher switching frequencies permitted by the new module enable a significant reduction in weight and volume of power converters.



**The newly developed CoolSiC XHP2 module family.**

"This nomination shows that climate change and sustainable resource consumption have become central aspects of our society," notes Dr Peter Wawer, division president Green Industrial Power (GIP) at Infineon. "Innovative energy solutions and power semiconductors are a core component in decarbonization and fighting climate change," he adds.

**www.deutscher-zukunftspreis.de/de**
**www.infineon.com**

# Infineon pilots first 300mm power GaN wafer technology on existing large-scale 300mm silicon line

## 300mm gallium nitride to help achieve cost parity with silicon

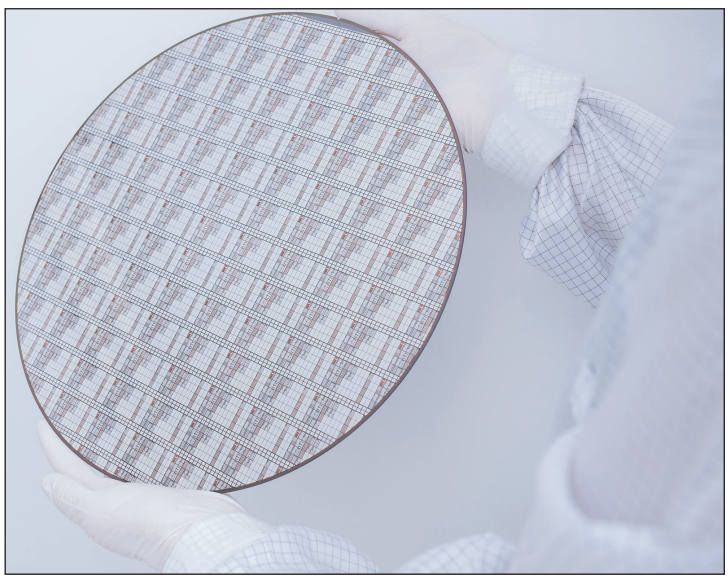
Infineon Technologies AG of Munich, Germany has developed what it says is the first 300mm power gallium nitride (GaN) wafer technology to be applied in an existing and scalable high-volume manufacturing environment, helping to drive the market for GaN-based power semiconductors. Compared with 200mm-diameter wafers, 300mm wafers allow the production of 2.3 times more chips per wafer.

GaN-based power semiconductors are finding fast adoption in industrial, automotive, and consumer, computing & communication applications, including power supplies for AI systems, solar inverters, chargers and adapters, and motor-control systems. GaN manufacturing processes lead to improved device performance, resulting in benefits in end-customers' applications as it enables efficiency performance, smaller size, lighter weight, and lower overall cost. Furthermore, 300mm manufacturing also ensures superior customer supply stability through scalability.

"The technological breakthrough will be an industry game-changer and enable us to unlock the full potential of gallium nitride," reckons CEO Jochen Hanebeck. "Nearly one year after the acquisition of GaN Systems, we are demonstrating again that we are determined to be a leader in the fast-growing GaN market. As a leader in power systems, Infineon is mastering all three relevant materials: silicon, silicon carbide and gallium nitride."

Infineon manufactured the 300mm GaN wafers on an integrated pilot line in existing 300mm silicon production in its power fab in Villach, Austria. The firm is leveraging well-established competence in the existing production of 300mm silicon and 200mm GaN. It will further scale GaN capacity aligned with market needs. Infineon reckons that 300mm GaN manufacturing will put it in a position to shape the growing GaN market, which is expected to reach several billion US dollars by the end of the decade.

**A technical engineer in the cleanroom at Infineon in Villach, Austria, holds a 300mm gallium nitride wafer.**



Infineon says it is implementing 300mm GaN to strengthen existing and enabling new solutions and application fields with an increasingly cost-effective value proposition and the ability to address the full range of customer systems.

The firm will present the first 300mm GaN wafers to the public at the electronica 2024 trade show in Munich (12–15 November).

A significant advantage of 300mm GaN technology is that it can utilize existing 300mm silicon manufacturing equipment, since gallium nitride and silicon are very similar in manufacturing processes. Infineon's existing high-volume silicon 300mm production lines are said to be suitable for piloting reliable GaN technology, allowing accelerated implementation and efficient use of capital. Fully scaled 300mm GaN production should contribute to GaN cost parity with silicon regarding on-resistance $R_{DS(on)}$, which means cost parity for comparable silicon and GaN products, it is reckoned.

**www.electronica.de/en**
**www.infineon.com/gan**

# Finwave and GlobalFoundries agree technology development and licensing deal

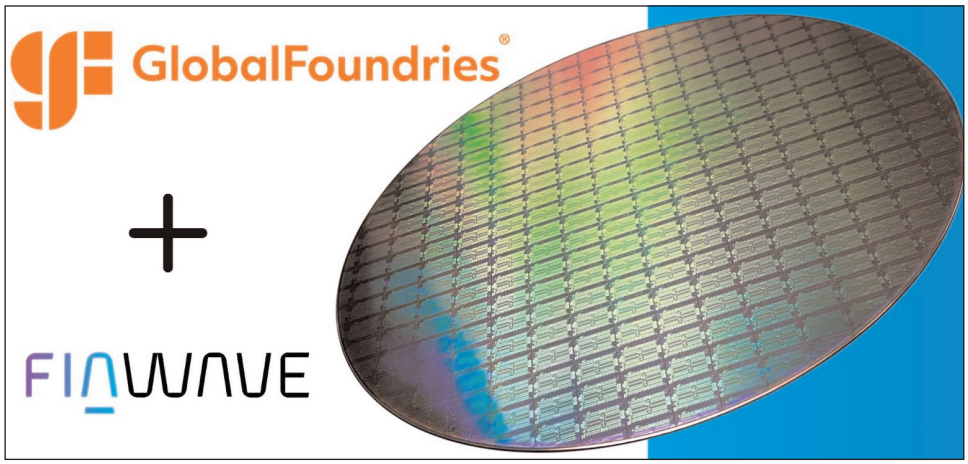
## Partnership to accelerate development and volume production of Finwave's E-mode MISHEMT RF GaN-on-silicon technology

Finwave Semiconductor Inc of Waltham, MA, USA has announced a strategic technology development and licensing agreement with GlobalFoundries (GF) of Malta, NY, USA.

Founded in 2012 by researchers at Massachusetts Institute of Technology (MIT) as Cambridge Electronics before being rebranded in June 2022 as Finwave Semiconductor (with offices in San Diego, CA and the Bay Area), the technology company's portfolio includes GaN FinFETs, enhancement-mode (E-mode) MISHEMTs, and high-performance RF switches.

The partnership merges Finwave's gallium nitride on silicon (GaN-on-Si) technology with GF's US-based high-volume manufacturing capabilities and legacy of RF innovation including RF silicon-on-insulator (SOI) and silicon-germanium (SiGe) solutions. The collaboration will focus on optimizing and scaling Finwave's E-mode MISHEMT technology to volume production at GF's 200mm semiconductor manufacturing facility in Burlington, Vermont.

Finwave's 200mm GaN-on-Si E-mode MISHEMT platform is claimed to offer exceptional RF performance, delivering excellent gain and efficiency at sub-5V voltages while ensuring high uniformity across 200mm wafers, as highlighted in Finwave's presentation at the 2024 International Conference on Compound Semiconductor Manufacturing Technology (CS MANTECH). Leveraging Finwave's technology, GF's 90RFGaN platform can deliver high power density and efficiency, enabling high-performance, optimized devices that save on footprint and cost, it is reckoned. The partnership presents a solution for high-efficiency power amplifiers in applications where traditional




gallium arsenide (GaAs) and silicon technologies fall short, including new higher-frequency 5G FR2/FR3 bands, 6G and mmWave amplifiers, and high-power Wi-Fi 7 systems, where superior range and efficiency are critical.

"By leveraging GlobalFoundries' extensive manufacturing capabilities and bringing Finwave's E-mode MISHEMT technology breakthrough to volume production, we are unlocking large growth opportunities as we address the increasingly demanding wireless communication landscape," says Finwave's CEO Dr Pierre-Yves Lesaicherre. "This partnership opens the door to further innovation and integration of RF front-ends onto a single GaN-on-Si device. This has never been done before, and has the potential to reduce cost and size, both of which are at a premium in cellphones," he adds.

**By leveraging GlobalFoundries' extensive manufacturing capabilities and bringing Finwave's E-mode MISHEMT technology breakthrough to volume production, we are unlocking large growth opportunities as we address the increasingly demanding wireless communication landscape**

"As next-generation wireless networks require devices that operate at higher frequencies, Finwave's low-voltage GaN-on-Si technology combined with GF's 90RFGaN platform will become a vital part of power amplifiers in future mobile phones, ensuring both robust performance and high power efficiency," expects Shankaran Janardhanan, VP & general manager of GF's RF business.

Developed over more than a decade, Finwave's E-mode MISHEMT technology has been supported by federal funding from the US Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E) through its program Seeding Critical Advances for Leading Energy technologies with Untapped Potential (SCALEUP), as well as private investments from deep-tech investors and strategic partners.

Leveraging GF's high-volume CMOS manufacturing capabilities, Finwave and GlobalFoundries aim to qualify this technology for mass production in first-half 2026.

**www.finwavesemi.com**
**www.gf.com**

# GlobalFoundries joins Silicon Catalyst as partner to speed start-ups' technology development

## GF joins incubator's ecosystem as both a strategic and in-kind partner

GlobalFoundries (GF) of Malta, NY, USA has joined the semiconductor startup ecosystem of Silicon Valley-based Silicon Catalyst (the only incubator+accelerator focused exclusively on semiconductor solutions) as a Strategic Partner and an In-Kind Partner (IKP). The partnership will provide innovative start-ups with access to GF's differentiated platforms to speed the development and commercialization of next-generation IoT, automotive and generative AI applications while anticipating future growth markets such as medical and quantum compute.

As a Strategic Partner, GF will work closely with Silicon Catalyst to recruit, evaluate and select early-stage startups seeking to participate in their program. As a member of the IKP ecosystem, GF will provide access to PDKs, MPWs, foundation IP, and reference designs to accelerate time to market for approved, early-stage companies on GF's 22FDX, silicon photonics, and gallium nitride (GaN) platforms.

"Our long-standing partnership with GlobalFoundries has been instrumental in bringing our groundbreaking optical I/O solution to market," comments Mark Wade, CEO & co-founder at Silicon Catalyst alumnus Ayar Labs. "Collaborating with programs like Silicon Catalyst, combined with access to GlobalFoundries' platforms, enables companies like Ayar Labs to focus on what we do best — pushing the boundaries of AI infrastructure to handle the growing size and complexity of AI models," he adds.

"By partnering with Silicon Catalyst, we will work with early-stage start-ups, giving us a first-hand view into emerging innovations, to push the boundaries of our differentiated technologies and deliver customized solutions that will give these companies a competitive edge as they go to market," says GF's chief technology officer Gregg Bartlett.

"Our partnership provides start-ups a unique opportunity to engage with GF and gain access to their differentiated, cost-effective solutions," says Silicon Catalyst's CEO Pete Rodriguez. "This valuable collaboration promises to fuel a new cycle of semiconductor innovation, while helping new companies address the challenges in moving from idea to realization."

Silicon Catalyst's ecosystem includes over 350 semiconductor industry advisors, 14 Strategic Partners, seventy In-Kind Partners, an extensive investor network, and strong connections to major domestic and international academic institutions. The collaboration will provide GF access to deep and broad semiconductor industry insight.

Three of Silicon Catalyst's portfolio company CEOs presented during the technical sessions at the AI Hardware and Edge AI Summit 2024 in San Jose, CA, USA (9–12 September).

**www.aihwedgesummit.com/events/aihwedgesummit**
**www.siliconcatalyst.com**
**www.gf.com**

# Navitas releases Gen-3 Fast SiC MOSFETs in D2PAK-7L and TOLL surface-mount packages

## Qualified to Q101 automotive-grade for 400V and 800V electric vehicle architectures

Navitas Semiconductor has released a portfolio of third-generation automotive-qualified silicon carbide (SiC) MOSFETs in D2PAK-7L (TO-263-7) and TOLL (TO-Leadless) surface-mount (SMT) packages.

Navitas' proprietary trench-assisted planar technology provides what is claimed to be world-leading performance over temperature and delivers high-speed, cool-running operation for electric vehicle (EV) charging, traction, and DC–DC conversion. With case temperatures up to 25°C lower than conventional devices, Gen-3 Fast SiC offers an operating life that is reckoned to be up to 3x longer than alternative SiC products, for high-stress EV environments.

Gen-3 Fast MOSFETs are optimized for the fastest switching speed and highest efficiency, and support increased power density in EV applications such as AC compressors, cabin heaters, DC–DC converters, and on-board chargers (OBCs).


Navitas' dedicated EV Design Center has demonstrated what is claimed to be leading-edge OBC system solutions up to 22kW with 3.5kW/liter power density, and over 95.5% efficiency.

400V-rated EV battery architectures are served by the new 650V Gen-3 Fast MOSFETs featuring $R_{DS(ON)}$ ratings from 20mΩ to 55mΩ. The 1200V ranges from 18mΩ to 135mΩ and is optimized for 800V systems.

Both 650V and 1200V ranges are AEC Q101-qualified in the traditional SMT D2PAK-7L (TO-263-7) package. For 400V EVs, the 650V-rated, surface-mount TOLL package offers a 9% reduction in junction-to-case thermal resistance ($R_{TH,J-C}$), 30% smaller PCB footprint, 50% lower height, and 60% smaller size than the D2PAK-7L. This enables very high-power-density solutions, while minimal package inductance of only 2nH ensures excellent fast-switching performance and lowest dynamic package losses.

The automotive-qualified 650V and 1200V G3F SiC MOSFET family in D2PAK-7L and TOLL surface-mount packages are released and available immediately for purchase.

**www.navitassemi.com**

# Japanese sales & marketing partner J Rep at Techno-Frontier

## Focus on SiC and GaN for AI data center, EV, industrial and fast-charging

Gallium nitride (GaN) power IC and silicon carbide (SiC) technology firm Navitas Semiconductor of Torrance, CA, USA teamed up with its Japanese sales & marketing partner J Rep (which specializes in power electronics) at Japan's largest power electronics trade show, Techno-Frontier 2024 in Tokyo (24–26 July) to highlight solutions including a hybrid GaN-SiC AI server power supply unit (PSU), a 3-phase GaN industrial motor drive requiring no heat-sink, and a GaN-based 8K-LED TV power supply that enables the thinnest and highest-efficiency solution.

Navitas and J Rep highlighted key technologies and new products including GaNSafe (which is claimed to be the world's most protected, most reliable and highest-performance GaN power IC for high-power, mission-critical applications such as AI data centers), Gen-4 GaNSense Half-Bridge ICs (which are said to be the most integrated GaN devices) and Gen-3 Fast GeneSiC power FETs (which use 'trench-assisted planar' technology for what is claimed to be world-leading performance over temperature, suiting electric vehicle and industrial systems).

"With the ability to operate at higher efficiencies and frequencies, Navitas' GaN and SiC next-generation clean energy semiconductors bring significant benefits to AI data centers, EV, energy storage systems (ESS), motor control, and fast-charging applications," says Navitas' Japan representative Takashi Murayama. "Techno-Frontier provides an ideal platform for Navitas to showcase these next-generation technologies to system engineers and key decision makers in these sectors, and show how they enable these fast-growing markets."

**www.jma.or.jp/tf/en/**
**www.j-rep.com**

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# USC-led CA DREAMS hub gets $31.9m DoD funding

## Northrop Grumman-led projects to focus on maturing GaN and developing 5G/6G-relevant prototypes

The US Department of Defense (DoD) is directing $31.9m in funding to the California Defense Ready Electronics and Microdevices Superhub (CA DREAMS), led by the University of Southern California (USC) Viterbi's Information Sciences Institute (ISI).

Comprising 16 founding partners in higher education and the semiconductor industry, CA DREAMS is one of eight regional innovation hubs established under the DoD Microelectronics (ME) Commons Program, which is funded by the CHIPS and Sciences Act of 2022 to develop onshore microelectronics hardware prototyping, lab-to-fab transition of semiconductor technologies and extended semiconductor workforce training. USC's MOSIS 2.0 service, established as part of CA DREAMS, is accelerating prototyping in labs and fabs and streamlining the transition of processes from lab to fab.

The award aims to accelerate the development of advanced semiconductor technologies through two distinct projects, executed by aerospace defense technology company Northrop Grumman:

1. $16.2m to mature gallium nitride (GaN) technology to enable broad-spectrum, high-power and high-efficiency solutions for future DoD electronic warfare (EW) systems.
2. $15.7m to support the development of 5G/6G-relevant prototypes to accelerate the availability of high-performance mmW phased-array front ends.

CA DREAMS representatives with US National Government officials.

**$16.2m to develop advanced gallium nitride technologies**

Northrop Grumman and the CA DREAMS team will develop GaN amplifier chipsets that operate from the microwave to the sub-millimeter-wave frequency spectrum, making advances at the semiconductor-device, the integrated circuit, and the package level. Pivotal to the project is demonstrating the benefit of the Microelectronics Commons ecosystem, where technology can be more rapidly accelerated by connecting traditional competitors as well as universities, and encouraging collaboration to reach a desired end-goal for the DoD.

The project team comprises USC, Northrop Grumman, Teledyne Technologies, HRL Laboratories, PseudolithIC, Monde Wireless Inc, Transphorm, UCLA and UC Santa Barbara.

Northrop Grumman is "a leader in developing advanced GaN technologies," comments CA DREAMS director Steve Crago. "Their involvement in this hub and leadership on this project ensure that we can rapidly translate cutting-edge research from our university labs into deployable solutions for the Department of Defense."

Traditional DoD prototyping cycles have taken years to demonstrate concept feasibility. In addition to meeting its technical goals, the project also expects to dramatically accelerate prototyping time and demonstrate capabilities in the X, V and W wave-bands in the first year, with subsequent years tackling submillimetre-wave bands. This would demonstrate an acceleration of the cycle from concept to delivery by 2–3x.

"This project is resolving a DoD-needed application and undertaking the challenges by working through various levels — from university to research and system architecture — all in a 12-month time span," says project lead Alex Zamora, RF/mixed-signal department manager, Northrop Grumman.

**$15.7m in funding for 5G/6G mmW phased-array prototypes**

Northrop Grumman and the hub team also aim to accelerate high-frequency wireless communications solutions for defense and commercial applications.

The award will support the development of 5G/6G-relevant prototypes to accelerate the availability of high-performance front ends, including phased-array antennas, beam-forming integrated circuits (ICs), and broadband amplifiers integrated using state-of-the-art (SOTA) advanced (2.5D and 3D heterogeneous integration [HI]) packaging for leading-edge size, weight, power and cost (SWAP-C) systems.

Northrop Grumman will collaborate with USC and other industry and academic partners to dramatically accelerate the development of high-frequency communications

solutions, leveraging advanced microelectronic technologies and critical lab-to-fab technology transitions, for dual-use applications.

"By leveraging the collective expertise of CA DREAMS and MOSIS 2.0, we're poised to make significant advancements in high-frequency communications that will benefit both defense and commercial sectors," says Steve Crago, CA DREAMS director at USC and associate director of the USC Viterbi Information Sciences Institute.

The project team consists of USC, Northrop Grumman, HRL Laboratories, Teledyne, Caltech, UCLA, UC Santa Barbara, UC San Diego, Vorago and GlobalFoundries. Its leaders are aiming to develop prototypes 12 or more months sooner than traditional timelines.

"The project team, enabled by ME Commons and CA DREAMS, has expertise spanning microelectronic fabrication process modules to commercial foundry production and university design to DoD systems," says Monte Watanabe, RF/mixed-signal assistant department manager, Northrop Grumman. "This collaboration will connect new levels of the microelectronics ecosystem and apply them toward diverse 5G/6G needs across future DoD and commercial systems."

The project will enable arrays of antennas to operate at higher frequencies for wideband communication applications, providing improved connectivity for DoD and commercial applications.

"Northrop Grumman Microelectronics Center is poised to apply its unique capabilities in RF microelectronics and advanced packaging to develop mmW phased-array prototypes with our team partners," says Watanabe. "We'll all be moving the needle to realize fieldable component and prototype capability that captures and transitions the latest microelectronics technology."

**www.viterbischool.usc.edu**

# Raytheon completes first AN/TPY-2 radar for Saudi Arabia

## Latest version features GaN technology for increased sensitivity

US-based Raytheon (a business of aerospace & defense company RTX) has delivered the first AN/TPY-2 radar for the Kingdom of Saudi Arabia. The AN/TPY-2 is a missile defense radar that can detect, track and discriminate ballistic missiles in multiple phases of flight.

This is the first AN/TPY-2 radar with a complete gallium nitride (GaN)-populated array in the system. GaN technology provides greater sensitivity to increase range as well as expand surveillance capacity. It is also a key enabler in allowing the AN/TPY-2 radar to support the hypersonic mission.

"The latest AN/TPY-2 radar is now in a different class, with Raytheon making more than 50 enhancements to the radar," says Paul Ferraro, president, Air & Space Defense Systems, Raytheon. "These upgrades will help Saudi Arabia to better defend itself from missile threats and will additionally benefit the entire fleet with enhanced sensing capability."

AN/TPY-2 operates in the X-band of the electromagnetic spectrum. This enables it to see targets more clearly and distinguish between an actual threat to a defended area and non-threat objects, like separation debris. When operating in Terminal mode, AN/TPY-2 is directly in the fire control loop of the Terminal High Altitude Area Defense (THAAD) ballistic missile defense system through its direct communication with the THAAD missile.

**www.rtx.com**

# Baylin receives CDN$2.25m order from sports and entertainment satellite broadcaster and services provider

## Advantech Wireless subsidiary to supply C- and Ku-band solid-state power block amplifiers

Toronto-based Baylin Technologies Inc says that its subsidiary Advantech Wireless Technologies Inc of Montreal, Canada (which makes satellite, RF equipment and microwave broadband communications systems) says that a "a major sports and entertainment satellite broadcaster and services provider" has placed orders totalling $2.25m for its C-band and Ku-band solid-state power block (SSPB) amplifiers.

The C-band portion consists of gallium nitride (GaN)-based Dakota SSPBs that will be vehicle-mounted to support the broadcaster's mobile network. The high-power 500W Genesis-HP Ku-band block-up converters will be installed at the customer's master teleport facility. Advantech's products were selected based on both their resilient architecture as well as their unique software capabilities.

"Broadcasting is an example of the need for high-power satellite technology," notes president & CEO Leighton Carroll. "Being selected to power sports broadcasts is another instance of customers choosing Advantech when they need reliable innovative technology. Our new line of amplifiers also allows us to simplify our supply chain while delivering enhanced capabilities."

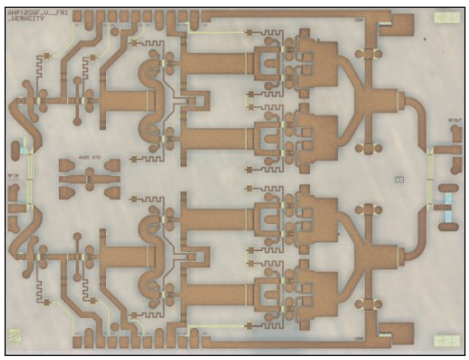
**www.advantechwireless.com**

# ESA's Magellan project developing GaN transistors and high-power amplifiers for millimeter-wave satcoms

## Project coordinator Fraunhofer IAF to develop GaN technology, implement HEMTs and MMICs and characterize and evaluate hardware; partners TESAT and UMS to apply MMICs for satcoms and commercialize components

Communication satellites and flying antenna platforms can contribute to the comprehensive and resilient operation of global mobile networks of the fifth and sixth generation (5G, 6G). However, as large parts of the millimeter-wave (mmW) frequency spectrum must be reallocated for this purpose, more powerful radio frequency technologies are required for satellite communication in the Ka- (27–31GHz), Q- (37.5–42.5GHz) and W-band (71–76GHz). These frequency bands offer greater power efficiency for mobile satellite internet (SatCom on the Move, SOTM) as well as feeder links and inter-satellite links (ISLs). To develop the necessary technology, the project Magellan — High Efficiency mm-Wave GaN Transistor High Power Amplifier for GEO and LEO Active Antenna Application — was launched in 2024.

In Magellan, the Fraunhofer Institute for Applied Solid State Physics (IAF) in Freiburg, Germany is working on behalf of the European Space Agency (ESA) to develop high-electron-mobility transistors (HEMTs) and amplifier circuits for highly efficient satellite communication based on gallium nitride (GaN). These are intended to operate in both low Earth orbit (LEO, 200–2000km above the earth's surface) and geostationary Earth orbit (GEO, 35,786km above the equator). Further project partners in Magellan are United Monolithic Semiconductors GmbH (which designs and produces RF and millimeter-wave components and ICs at its facilities in Orsay, France and Ulm, Germany) and TESAT-Spacecom GmbH & Co KG of Backnang, Germany (a manufacturer of systems and equipment for telecoms via satellite). The project will run from 2024 to 2027.



**GaN amplifier circuit for inter-satellite communication links in the V-band (here: 57–70GHz)/**

### GaN-based HEMTs and high-power amplifier MMICs with superior efficiency and linearity

"We want to develop a GaN technology that achieves significantly higher efficiency compared to the current state of the art. To make this happen, the gate length of the transistors is to be reduced to a size of less than 100nm," says Dr Philipp Döring, coordinator of the Magellan project at Fraunhofer IAF. However, very small structure sizes provoke disruptive short-channel effects, which have a negative impact on the reliability and performance of the component. The research team is therefore focusing on a new technology node with a cut-off frequency of more than 140GHz. With this GaN07 technology to be developed, the researchers can avoid most of the short-channel effects and still meet the project requirements for the component."

The second overarching project objective is to use the newly developed GaN HEMTs to realize monolithic microwave integrated circuits (MMICs) for solid-state power amplifiers (SSPAs) in the Ka-, Q- and W-bands. SSPAs are characterized by their compactness, robustness and low cost. The SSPAs manufactured using GaN07 HEMTs should also be more efficient, more linear and more resistant to cosmic radiation than currently available hardware. This overall package should make the GaN07 SSPAs very attractive for applications in space.

**Project partners at the kick-off meeting of Magellan at Fraunhofer IAF.**

### From technology development to industrialization

Fraunhofer IAF is coordinating the Magellan project. The institute is also using its research infrastructure to develop the new GaN07 technology, implement the HEMTs and MMICs based on it and characterize and evaluate the hardware produced. The partners TESAT and UMS are contributing their expertise in the application of MMICs in satellite communications and the commercialization of the components. The aim is to enable a European value chain from semiconductor development to space application.

The Magellan project is funded under the ESA ARTES (Advanced Research in Telecommunications Systems) Advanced Technology Program.

**www.ums-rf.com**
**www.tesat.de**
**www.iaf.fraunhofer.de/en/researchers/electronic-circuits/high-frequency-electronics/magellan.html**

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# Raytheon to develop ultra-wide-bandgap semiconductors for DARPA

## Phase 1 to develop diamond and aluminium nitride films and integration onto electronic devices; Phase 2 to optimize and mature diamond and aluminium nitride technology on larger-diameter wafers for sensors

US-based Raytheon (a business of aerospace & defense company RTX) has been awarded a three-year, two-phase contract from the United States Defense Advanced Research Projects Agency (DARPA) to develop foundational ultra-wide-bandgap semiconductors (UWBGS), based on diamond and aluminium nitride (AlN) technology, which allow increased power delivery and thermal management in sensors and other electronic applications.

During phase one, the Raytheon Advanced Technology team will develop diamond and aluminium nitride semiconductor films and their integration onto electronic devices. Phase two will focus on optimizing and maturing the diamond and aluminium nitride technology onto larger-diameter wafers for sensor applications.

"Raytheon has extensive proven experience developing similar materials such as gallium arsenide (GaAs) and gallium nitride (GaN) for Department of Defense systems," says Colin Whelan, president of Advanced Technology at Raytheon. "By combining that pioneering history and our expertise in advanced microelectronics, we'll work to mature these materials towards future applications."

The unique material properties of UWBGS offer several advantages over traditional semiconductor technologies, enabling highly compact, ultra-high-power radio frequency switches, limiters and power amplifiers. Their high thermal conductivity also allows the ability to operate at higher temperatures and in more extreme environments.

The team's goal is to spearhead the development of these materials towards devices that are well suited for both existing and future radar and communication systems with extended capability and range, including cooperative sensing, electronic warfare, directed energy, and circuitry in high-speed weapon systems such as hypersonics.

Work on the contract is being conducted at Raytheon's foundry in Andover, Massachusetts.

**www.rtx.com/raytheon**

# HexaTech awarded DARPA UWBGS contract to develop aluminium nitride substrate

## Potential three-year $10.2m program for 100mm-diameter substrates

HexaTech Inc of Morrisville, NC, USA (a subsidiary of Stanley Electric Co Ltd of Tokyo, Japan) has signed a multi-year contract with the US Defense Advanced Research Projects Agency (DARPA) as part of its Ultra-Wide Bandgap Semiconductors (UWBGS) program, which aims to develop foundational, high-quality materials necessary for realizing practical UWBG electronics and enabling UWBG applications.

HexaTech's role will focus on developing 100mm-diameter, low-defect-density aluminium nitride (AlN) substrates, which will be essential for further expanding the performance/application envelope of high-voltage and high-frequency electronic devices.

If fully exercised, the potential three-year contract is valued at $10.2m, and builds on HexaTech's previously announced 100mm development effort, accelerating the timeline and building on the scale of the firm's production process from crystal growth through substrate finishing.

**The result of this program will be the direct translation of 100mm AlN substrates into volume production**

"To fully support the technical potential of AlN substrates in both existing and new device technologies, expansion to 100mm in diameter, coupled with superior bulk quality characteristics, will be critical for several reasons, including device fabrication line capabilities, device performance, and reliability," notes Dr Rafael Dalmau, the program's principal investigator at HexaTech.

"The result of this program will be the direct translation of 100mm AlN substrates into volume production, enabling industry adoption by both commercial and defense foundries," says Gregory Mills, VP of business development. "Commercialization of high-quality, large-diameter AlN substrates for both existing and future customers will drive critical next-generation device performance gains."

**www.hexatechinc.com**

# Element Six to lead program under US DARPA's Ultra-Wide BandGap Semiconductors initiative

## Large-area CVD polycrystalline diamond and single-crystal diamond synthesis to realize 4-inch device-grade diamond substrates

Chemical vapor deposition (CVD)-based synthetic diamond materials firm Element Six of Oxford, UK (E6, part of the De Beers Group) is leading a program under the UWBGS (Ultra-Wide BandGap Semiconductors) initiative, established by the United States Defense Advanced Research Projects Agency (DARPA), to enable the next generation of semiconductor technologies.

Through the UWBGS program, DARPA's Microsystems Technology Office has stated its goal to develop high-quality ultrawide-bandgap (UWBG) materials, such as substrates, device layers, and junctions. These materials are key to realizing advanced electronics, including high-power RF switches, amplifiers for radar and communications, high-voltage power switches, high-temperature electronics for extreme environments, and deep-ultraviolet (UV) LEDs and lasers, underpinning a multi-billion dollar system market.

Diamond offers the potential for semiconductor device performance that reduces overall size, weight and power consumption (SWaP) thanks to properties such as its chemical and radiation inertness, high carrier mobility, heat conduction, and wide electronic bandgap.

E6's contribution to the UWBGS program will harness its expertise in large-area CVD polycrystalline diamond and high-quality single-crystal (SC) diamond synthesis to realize 4-inch device-grade SC diamond substrates.

"Industrial diamond has disrupted multiple markets since its first scale synthesis in the 1950s, and I am confident that technology breakthroughs in UWBGS will help unlock another 70 years of opportunities in the semiconductor industry," says professor Daniel Twitchen, chief technologist at Element Six.

Element Six's SC diamond was already a crucial enabler in the CERN Large Hadron Collider's monitoring systems, helping to lead to the discovery of the Higgs-Boson particle. In partnership with high-power semiconductor firm ABB, E6 realized the first high-voltage bulk diamond-based Schottky diodes. Furthermore, it recently completed the build and commission of an advanced CVD facility, leveraging its core technology in Portland, OR, USA, powered by renewable energy sources.

E6's polycrystalline diamond wafers measuring >4-inches are already enabling telecom infrastructures and defence applications, used as either optical windows in EUV lithography for state-of-the-art silicon chips, or in thermal management applications for high-power density silicon and gallium nitride (GaN) semiconductor devices.

For the UWBGS program, Element Six has partnered with other leaders in the field from across the globe, including Orbray in Japan (with large-area diamond expertise), Raytheon (leaders in GaN RF devices), Hiqute Diamond in France (with dislocation engineering expertise), and Stanford University and Princeton University in the USA (with materials bulk and surface processing characterization expertise). Through the collaboration of this global network, UWBGS is expected to push the boundaries of diamond innovation to enable a new generation of ultrawide-bandgap semiconductors.

**www.e6.com/en/products**

# Applied Ventures and ITIC-Taiwan join Wise-integration's Series B funding round

## AVITIC adds to €15m raised February

Fabless company Wise-integration of Hyeres, France — which was spun off from CEA-Leti in 2020 and designs and develops gallium nitride (GaN) integrated circuits and digital-control technologies for power supplies — says that the investment fund Applied Ventures-ITIC Innovation Fund (AVITIC) has joined its Series B funding round.

AVITIC is a joint venture fund of Applied Ventures LLC (the corporate venture arm of Applied Materials Inc of Santa Clara, CA, USA) and ITIC-Taiwan (Industrial Technology Investment Corp, the venture capital arm of Taiwan's R&D consortium Industrial Technology Research Institute). Wise-integration announced its €15m Series B funding round in February, led by IMEC.XPAND, accompanied by Supernova Invest, the lead of the previous round. The amount of the additional funding was not disclosed.

The Series B round will fuel mass production and commercial deployment of Wise-integration's flagship products, WiseGan and its disruptive digital-control technology WiseWare, and support for clients globally. The firm will also increase its focus on high-value markets such as the industrial, telecom and automotive sectors.

"We are pleased to have AVITIC join us as a strategic investor," says Wise-integration's CEO Thierry Bouchet. "Their support demonstrates the strong potential of our technology and vision. It elevates our global standing and sharpens our ability to harness GaN technology with cutting-edge digital control."

In addition to ramping up production of its flagship products, Wise-integration plans to use the Series B funding to accelerate development of a new generation of high-performance GaN technology designed to integrate with digital controls and boost the efficiency and performance of power systems across various sectors.

"With their WiseWare digital control and WiseGaN, it could further unleash the potential of GaN and boost the efficiency of power electronics," comments ITIC's president Michel Chu.

"Enabling next-generation power electronics is an important pillar of sustainability," notes Anand Kamannavar, VP & global head of Applied Ventures. "We look forward to supporting Wise-integration in developing their differentiated GaN technologies."

**www.av-itic.com**
**www.itic.com.tw**

# Wise-integration forms Hong Kong-based subsidiary to manage Asian business development

## Wise-integration Ltd to be gateway to Chinese market

During the PCIM Asia 2024 conference in Shenzhen, China (28–30 August), fabless company Wise-integration of Hyeres, France (which was spun off from CEA-Leti in 2020) launched the subsidiary Wise-integration Ltd — based in the Hong Kong Science and Technology Park (HKSTP) and led by James Ho as China business development director — to accelerate its growing business in China.

As well as serving as its financial hub for regional transactions and boosting its presence generally in the Asian market, the firm reckons that the subsidiary will enable it to take advantage of business opportunities in China.

"Asian companies are interested in partnering with Wise-integration to integrate our novel power-control technologies," says Wise-integration's CEO Thierry Bouchet. "With this Hong Kong-based subsidiary, we will focus on new opportunities in China, especially the premium consumer SMPS, light industrial, motor-control, light e-transportation and e-automotive markets."

Since its launch in 2020, Wise-integration has built a portfolio of more than 10 patent families with two product lines. WiseGan encompasses gallium nitride (GaN) power integrated circuits designed to maximize the benefits of GaN technology, including higher power density, efficiency and reduced heat generation. WiseWare is a 32-bit, MCU-based AC-DC digital controller optimized for GaN-based power supply architectures. It is said to offer simplified system design, a lower bill of materials and improved power density and efficiency.

In the past two years, Wise-integration has announced partnerships with companies in South Korea and Taiwan to help bring its technologies to those markets. Product markets include consumer electronics and industrial applications like robotics, as well as data centers and electric vehicles. All of its solutions address the increasing demands for miniaturization, electrification and efficient power management.

**www.pcimasia-expo.com**
**www.wise-integration.com**

# QPT joins Polytechnic of Coimbra's academic business incubator INOPOL

## QPT to engage with local entrepreneurial community, collaborate with students and work alongside academics in Portugal

Independent power electronics firm Quantum Power Transformation (QPT) Ltd of Cambridge, UK — which was founded in 2019 and develops gallium nitride (GaN)-based motor drives — has joined INOPOL, the academic business incubator of the Polytechnic of Coimbra (IPC), located near its R&D office in Portugal. The partnership will allow QPT to engage with the local entrepreneurial community, collaborate with talented students, and work alongside academics on innovative research.

INOPOL Entrepreneurship Academy is the organic unit of IPC responsible for fostering innovation and entrepreneurship while supporting the growth of startups and spinoffs. It also plays a key role in facilitating knowledge transfer between academia and industry, and helping students and graduates to connect with the job market. QPT reckons that IPC's expertise in engineering, including fields like power electronics and robotics, makes it a valuable partner for its R&D efforts into next-generation, more efficient electric motor technology.

For QPT, the partnership provides access to specialized facilities and talent, particularly through IPC's engineering school ISEC – Coimbra Institute of Engineering, which offers programs focused on power electronics, motors and drives. IPC's emphasis on practical research and its collaboration with regional industries align well with QPT's goals, especially in areas such as electric drives and renewable energy.

"We look forward to the opportunities this collaboration will create for our startups, students, researchers and the broader academic community, enhancing connections that will spark new ventures and contribute to the creation of impactful solutions," says INOPOL's director Sara Proença.

INOPOL's spirit of innovation "aligns perfectly with our vision," comments QPT's CEO Rupert Baines. "This collaboration opens doors for us to strengthen our research capabilities in power electronics and recruit exceptional talent. Together, we aim to push the boundaries of what's possible in industrial drives and energy solutions. Our work in Portugal complements and enhances our activities in Cambridge."

**https://inopol.ipc.pt**

# QPT appoints Simon Hart as board advisor

## Nottingham University Entrepreneur-in-Residence brings experience of electric motor drive platforms

Quantum Power Transformation has appointed Dr Simon Hart as an advisor to its board. He is an Honorary Associate Professor and Entrepreneur-in-Residence at the University of Nottingham, and holds C-level roles at several technology companies.

"He brings a wealth of experience in scaling up businesses to exploit innovative technologies," comments QPT's CEO Rupert Baines. "He also has first-hand experience with electric motors drive platforms from when he was at Emerson Industrial Automation and automotive power management, which is a key area for us, when he was at YASA. He is also very handy at innovative problem solving, with more than 40 patents to his name."

**Dr Simon Hart.**

"Although GaN offers huge potential, QPT identified issues with GaN devices, including thermal management and production of RF interference, which is why SiC [silicon carbide] is seen by the power electronics industry as the way forward for power electronics," notes Hart. "SiC, in reality, only gives a very short switching frequency range (to around 100kHz) before it hits similar problems, and this limit is related to harmonic losses in electric motors," he adds.

"The GaN issues are rooted in driving GaN at microwave frequencies, so QPT solved these problems by bringing microwave solutions to power electronics. Their qGaN technology enables GaN to be viable with a huge switching frequency range (1MHz or more) so it can deliver important power savings, for example slashing electric motor VFD electronic losses by up to 80%. This can make a huge impact on reducing the power usage of electric motors, which are an increasingly significant contributor to $CO_2$ production and therefore climate change."

**www.q-p-t.com**

# Shin-Etsu Chemical to develop QST for 300mm GaN

## Existing 150mm and 200mm QST substrate range extended to 300mm

Tokyo-based Shin-Etsu Chemical Co Ltd has created a 300mm (12-inch) QST substrate, and recently started supplying samples.

Developed by Qromis Inc of Santa Clara, CA, USA, QST (Qromis Substrate Technology) is dedicated to GaN epitaxial growth and was licensed to Shin-Etsu Chemical in 2019. Shin-Etsu Chemical has since sold 150mm (6-inch) and 200mm (8-inch) QST substrates and GaN-on-QST epitaxial substrates of each diameter. Meanwhile, in response to customer demand, the firm worked on further increasing the diameter and developed a 300mm (12-inch) QST substrate.

GaN device manufacturers cannot benefit from increasing the diameter of materials because of the lack of a large-diameter substrate suitable for GaN growth, despite the fact that they can use existing silicon production lines for GaN, notes Shin-Etsu Chemical. The new 300mm QST substrate is said to enable GaN epitaxial growth without warping or cracks (which was unattainable on silicon substrates), significantly reducing device costs. In addition to the enhancement of facilities for 150mm and 200mm QST substrates already in progress, Shin-Etsu Chemical is working on mass-producing 300mm QST substrates.

Since QST substrates have the same coefficient of thermal expansion as that of GaN, it is possible to constrain warping and cracks of GaN epitaxial layer on QST substrate of the SEMI standard thickness. This substrate material allows for high-quality and thick GaN epitaxial growth with a large diameter. Leveraging this feature, many customers are evaluating QST substrates and GaN-on-QST epitaxial substrates for power devices, high-frequency devices, and LEDs, says Shin-Etsu Chemical. Despite the challenging business environment, customers have entered the development phase to address the recently increasing interest in power devices, including power supplies for data centers.

The addition of the 300mm QST substrate to the 150mm and 200mm lineup can significantly accelerate the spread of GaN devices, reckons the firm.

Shin-Etsu Chemical exhibited the 300mm QST substrate at SEMICON TAIWAN 2024 in Taipei (4–6 September).

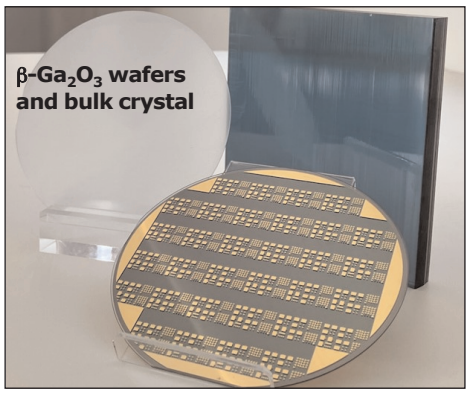
**www.semicontaiwan.org**
**www.shinetsu.co.jp**

# Japan's NCT gains NEDO funding for project to develop β-$Ga_2O_3$ wafers, power devices and power modules

## Novel Crystal Technology collaborating with Mitsubishi Electric and Japan Fine Ceramics Center

Novel Crystal Technology Inc (NCT) of Saitama, Japan, which develops and sells gallium oxide wafers, says that an R&D project related to beta-phase gallium oxide (β-$Ga_2O_3$) was adopted by Japan's New Energy and Industrial Technology Development Organization (NEDO). The project 'Development of Material Technology for High-Output and High-Efficiency Power Devices/High-Frequency Devices' is part of the 'Key and Advanced Technology R&D through Cross Community Collaboration Program' (K Program) promoted by Japan's Cabinet Office (CAO), the Ministry of Education, Culture, Sports, Science and Technology (MEXT), and the Ministry of Economy, Trade and Industry (METI).

For the project, which has a budget of ¥4.5bn and a planned duration of five years from fiscal 2024 to fiscal 2028, NCT will collaborate with related companies and academic institutions to develop β-$Ga_2O_3$ wafers, power devices, and power modules.




Specifically, NCT will work on the development of low-cost crystal growth technology for manufacturing 6-inch high-quality β-$Ga_2O_3$ wafers and 6-inch homoepitaxial growth technology with low defect density and high production throughput.

Also, in collaboration with Tokyo-based Mitsubishi Electric Corp, NCT will work on the development of a high-voltage β-$Ga_2O_3$ transistor with high breakdown voltage of 3.3kV or more, and low on-resistance which is less than half that of silicon carbide (SiC). Mitsubishi Electric will also work on the development of a power module in which multiple β-$Ga_2O_3$ transistor chips are assembled in parallel. Nagoya-based Japan Fine Ceramics Center will work on the construction of non-destructive, high-speed full-surface defect inspection technology for 6-inch β-$Ga_2O_3$ wafers.

**www8.cao.go.jp/cstp/anzen_anshin/kprogram.html**
**www.nedo.go.jp/koubo/IT3_100313.html**
**www.novelcrystal.co.jp**

# SweGaN raises €12m from financial & strategic investors

## Early-stage investor Navigare Ventures takes stake and contributes two board members

SweGaN AB of Linköping, Sweden, which develops and manufactures custom-engineered gallium nitride on silicon carbide epitaxial wafers, has closed an equity fundraising round of nearly €12m from financial and strategic investors.

As well as continuing to support the company's long-term growth plan, early-stage investor Navigare Ventures (a subsidiary of Wallenberg Investments AB) joins as an active shareholder. "Their long-term support will champion our customer confidence and foster strategic collaboration with SweGaN for future initiatives," says CEO Dr Jr-Tai Chen. "Navigare Ventures, as part of the Wallenberg ecosystem and their extensive industrial and scientific networks, will be a cornerstone in further establishing SweGaN in Sweden," he adds.

The capital raise also brings onboard several semiconductor-focused investors: Wafer Works from Taiwan; RFHIC, Ignite Innovation and BRV Capital Management from South Korea; and Lifelike Capital from the USA.

"SweGaN's unique technologies and skilled team position them to excel in semiconductor material manufacturing, poised to accelerate the adoption of new power semiconductors through innovative research and product development," believes Navigare's Dr David Sonnek. "Our long-term investment focus reflects a strong commitment to supporting SweGaN's mission to build expertise, expand capabilities, and strengthen regional supply chains critical to the European semiconductor industry," he adds.

"Beyond financial backing, Navigare Ventures brings invaluable expertise in corporate governance, financing strategies, and technology scouting, as well as customer perspective from major market players, which will be crucial during these pivotal years," says Jr-Tai Chen.

Two new executives have been appointed:

- as board member, Dr Alex Basu (investment manager at Navigare), who has extensive experience in deep-tech and board roles (including AlixLabs AB, EnginZyme AB, Pixelgen Technologies AB, and Rarity Bioscience AB).
- as deputy board member, Pontus de Laval (senior advisor at Navigare and the Knut and Alice Wallenberg Foundation, and former CTO of Saab), who has made significant contributions to Sweden's technology and defense sectors.

"We are excited to welcome Dr Alex Basu and Pontus de Laval to our board, where their experience will be instrumental," says Chen.

SweGaN expects the investment to propel strategic collaborations and boost material development for growing power device markets.

**www.navigareventures.com**
**www.swegan.se**

# Nissin Ion collaborates with University of Arkansas' program MUSiC

## US national Multi-User Silicon Carbide Research and Fabrication Facility working with ion implanter manufacturer on new-generation equipment

Nissin Ion Equipment Co Ltd (a group company of Nissin Electric Co Ltd of Kyoto, Japan), which manufactures and sells ion implanters and small- and medium-sized flat-panel displays (FPDs), is collaborating with the University of Arkansas' Multi-User Silicon Carbide Research and Fabrication Facility (MUSiC).

MUSiC will be the first openly accessible facility to create new power semiconductor technologies and integrated circuits that will be the seeds of start-up companies worldwide, due to the manufacturing capabilities and facilities of silicon carbide devices. The facility provides an opportunity for prototyping, demo and device design by any researchers and companies. It also plans to train students and develop the next generation of leaders in the semiconductor community. In the USA, several top silicon carbide power device manufacturers, as well as many fabless SMEs, have announced or are considering participating in the program.

Nissin Ion has been developing and manufacturing the IMPHEAT series, an ion implanter for silicon carbide high-temperature processing, and claims to have been one of the first to enter the SiC power device market. It will provide MUSiC with IMPHEATII, and start a three year joint research program in 2025 in collaboration with MUSiC, giving the firm the opportunity to gain wider ion implantation knowledge required for advanced devices. This will be reflected in next-generation equipment.

**research.uark.edu**
**https://nissin.jp/e**

# Axus delivers lowest cost of ownership for CMP processes on 200mm SiC wafers

## Customer data confirm Capstone platform delivers 2x higher throughput and more than 50% lower total cost per wafer

Axus Technology of Chandler, AZ, USA — a provider of chemical-mechanical planarization (CMP), wafer thinning and surface-processing solutions — has announced that its flagship Capstone CS200 platform tools offer what is claimed to be the industry's lowest cost of ownership (CoO) for CMP processes on 200mm silicon carbide (SiC) wafers. Compared to its closest competitor, Axus's small-footprint Capstone delivers twice the throughput at less than half the total cost per wafer.

The overall SiC manufacturing tool market will top $4.4bn by 2029, forecasts Yole Group. "The unique properties of SiC require specialized manufacturing tools and lines for processing power SiC devices," the market analyst firm noted earlier this year. Axus says that it anticipated this need, designing the Capstone from the ground up to deliver advanced processing capabilities for SiC in power electronics and other applications.

"Many 200mm fabs are looking to upgrade their installed base of CMP tools to products with leading-edge capability and functionality. Our ability to deliver industry-low CoO further underscores our strong market position and capacity to support this shift," says CEO Dan Trojan. "Capstone features a streamlined workflow and integrated cleaning capability, so it requires half the process steps of older CMP tools. This allows customers to greatly lower their CapEx investment," he adds.

Key CoO advantages of Capstone versus competitors are claimed to be:

- 2.5x wafers per hour throughput;
- 60% lower power consumption;
- 80% lower DI water consumption;
- 45% smaller footprint;
- 65% lower CapEx cost per wafer;
- 50% lower total cost per wafer.

Another factor contributing to Capstone's lower CoO is said to be its built-in process temperature control (PTC) technology, which enables processing at higher pressures and speeds without exceeding temperature limits of polishing pads and other sensitive components. This feature is vital for SiC and other materials with high hardness and planarization challenges that necessitate more aggressive process conditions.

Axus says that it built its proprietary CoO model using its own system specifications, publicly available specs for competitive tools, actual consumables costs, and real-world performance data supplied by customers. The comprehensive model factors in all CoO contributors: process variables (polish time and removal rates), polishing and cleaning consumables, power and deionized (DI) water usage, system footprint, and equipment CapEx including cost, utilization and wafer capacity.

**www.axustech.com**

# North Carolina State orders scia ion beam etch system

## Mill 200 system to be used to process wide-bandgap semiconductor materials in CLAWS hub

scia Systems GmbH of Chemnitz, Germany (which provides ion beam and plasma process equipment to the microelectronics, MEMS and precision optics industries) has sold a scia Mill 200 system to North Carolina State University (NCSU).

Installed in NCSU's new regional hub 'Commercial Leap Ahead for Wide Bandgap Semiconductors' (CLAWS), the ion beam etch system will process wide-bandgap semiconductor materials such as silicon carbide and gallium nitride to enable power electronic devices that operate at much higher voltages, frequencies and temperatures, and more efficiently.

**scia's Mill 200 ion beam etch system.**

"Due to its fully reactive gas compatibility, the scia Mill 200 is the right choice to enable reactive etching processes with enhanced selectivity and rate in wide-bandgap semiconductor materials" says scia's CEO Dr Michael Zeuner.

The Mill 200 provides high-precision etching of complex multilayer materials with excellent uniformity for wafer sizes up to 200mm, says the firm. Typical applications are 2D and 3D structuring of magnetic memory (MRAM), sensors, MEMS, and compound semiconductors.

**www.scia-systems.com**

# Resonac and Soitec to co-develop bonded substrates for silicon carbide power semiconductors

Tokyo-based wafer manufacturer Resonac Corp (formerly Showa Denko K.K. until its integration with Showa Denko Materials Co Ltd at the start of 2023) has signed an agreement with engineered substrate manufacturer Soitec of Bernin, near Grenoble, France to jointly develop 200mm (8-inch) silicon carbide (SiC) bonded substrates, which can serve as the material for SiC epitaxial wafers used in power semiconductors.

"SiC is in high demand due to its advantages over silicon such as lower power loss and heat generation during power conversion, contributing to energy saving," notes Resonac.

"Silicon carbide is being adopted for electric vehicle (EV) and industrial applications, where it brings significant system cost advantage. To further accelerate this adoption, silicon carbide yield and productivity must be improved," says Soitec's chief technology officer Christophe Maleville.


Resonac's SiC epitaxial wafers

"However, SiC single-crystal substrates, which are the main material for SiC power semiconductors, require uniform crystals, advanced technology for production and time-consuming crystal growth, making productivity improvement a challenge," says Resonac.

Resonac produces SiC epiwafers with epitaxial layers grown on SiC single-crystal substrates. The firm is also developing 8-inch large-diameter wafers and has started shipping samples.

In the collaboration, Resonac will supply SiC single-crystal substrates to Soitec, which will then use them to manufacture SiC bonded substrates by applying its unique SmartCut technology. This bonds the processed monocrystalline 'donor' wafer to a polycrystalline SiC 'handle' wafer as a support substrate, and then splits a thin film from the donor single-crystal substrate, enabling the production of multiple SmartSiC wafers from one SiC single-crystal substrate. The bonding substrate technology has already been commercialized for silicon wafers, and Soitec has expertise in its practical application.

By allowing multiple re-uses of the prime-quality monocrystalline SiC wafer, the technology not only improves productivity but also reduces $CO_2$ emissions during SiC wafer manufacturing by up to 70%, offering environmental and cost benefits. As well as improving the production efficiency of 8-inch SiC wafers, the two companies also aim to diversify the SiC epiwafer supply chain.

Soitec has a new fabrication plant primarily dedicated to producing SmartSiC wafers for electric vehicles, renewable energy and industrial equipment component applications.

**www.resonac.com**
**www.soitec.com**

# ASMPT launches multi-beam laser dicing platform for SiC

## V-DOE achieves greater yields and improved quality in wafer separation

Singapore-based ASMPT Ltd — a supplier of hardware and software solutions for semiconductors and electronics manufacturing — has introduced the ALSI LASER1205 multi-beam laser dicing platform, which it says cuts precisely, gently and efficiently due to its V-shaped patterned diffractive optical element (V-DOE) that was developed and patented by ASMPT.

"With its superior electrical and thermal properties, silicon carbide (SiC) is an indispensable material for the energy transition. It can be used to produce innovative and compact power electronics for things like high-efficiency inverters," says ASMPT's business development & product marketing manager David Felicetti. "Unfortunately, SiC wafers are very thin and sensitive, which has often led to low throughput and high scrap rates during dicing and grooving."

The V-DOE uses multi-beam laser processes to separate semiconductor chips on a wafer. A DOE element splits the laser beam into multiple sub-beams that simultaneously work on different areas of the wafer, making it possible to efficiently cut through the layers of material, and thereby speed up the process and increases its precision. Also, the multi-beam technology minimizes the Heat Affected Zone (HAZ), which improves the quality of the diced chips and raises their die strength to 450–500Mpa. With this proven process and continuous innovation, ASMPT has managed to increase yields significantly while maintaining high productivity.

**Multi-beam technology improves quality and yields**

The ALSI Laser1205 can process wafers with thicknesses ranging from 10μm to 250μm with positioning accuracy better than 1.5μm. The cutting width is less than 12μm on 100μm of silicon with the multi-beam process, all while being 50% faster than traditional methods.

"With machines like the ALSI LASER1205, we can offer our customers the highest process quality paired with low operating costs," says Felicetti.

**https://semi.asmpt.com/en/**

# ASM International launches dual-chamber PE2O8 single-wafer 8”-wafer silicon carbide epi system

## Portfolio of single-wafer SiC epi systems extended from single-chamber 6” PE1O6 and 8” PE1O8 systems

At the 2024 International Conference on Silicon Carbide and Related Materials (ICSCRM) in Raleigh, NC, USA (29 September–4 October), ASM International N.V. of Almere, the Netherlands, which designs and manufactures semiconductor wafer processing equipment and process solutions, has introduced the dual-chamber PE2O8 silicon carbide (SiC) epitaxy system. Designed to address the needs of the SiC power device segment, the PE2O8 is claimed to be the benchmark epitaxy system for low defectivity and high process uniformity, all with the higher throughput and low cost of ownership needed to enable broader adoption of SiC devices.

As the general electrification trend drives more power device makers to utilize SiC for a growing number of high-power applications (such as electric vehicles, green power, and advanced data centers) the expanded demand and requirements for lower cost for SiC is driving a transition from 6” to 8” SiC substrates. At the same time, SiC device makers are designing higher-power devices that will benefit from better SiC epitaxy.

Since 2022, through its new SiC Epi product unit, ASM has been developing and refining its single-wafer SiC epitaxy system. With the structurally higher demand for electric vehicles and the improvement in overall SiC wafer and device yield, the equipment market for SiC epitaxy has grown substantially in recent years.


Utilizing a unique design, the dual-chamber PE2O8 system deposits SiC with ultra-precise control, enabling benchmark higher yield and higher throughput, it is claimed. The compact, dual-chamber design enables high productivity and low total costs of operation. Additionally, the system features an easy preventive-maintenance approach, helping to increase uptime and reduce the occurrence of unscheduled downtime. System deliveries have been ongoing to multiple customers globally, including leaders in SiC power device manufacturing.

“We are at a critical inflection for silicon carbide power products, as our customers transition from 6” to 8” wafers,” says Steven Reiter, corporate VP & business unit head of Plasma and Epi at ASM. “Delivering a high-quality epitaxy process on larger wafers with defectivity control is critical, and we have been the industry benchmark for process uniformity with our novel chamber design,” he claims. “We have now extended our system capability to improve our process control and our value for customers with lower cost of ownership.”

www.asm.com

# Aixtron renews contract of CEO Felix Grawert

## Existing contract extended by a further five years, until August 2030

Deposition equipment maker Aixtron SE of Herzogenrath, Germany says that its supervisory board has decided on the early extension of CEO Dr Felix Grawert’s existing contract by a further five years, until 13 August 2030.

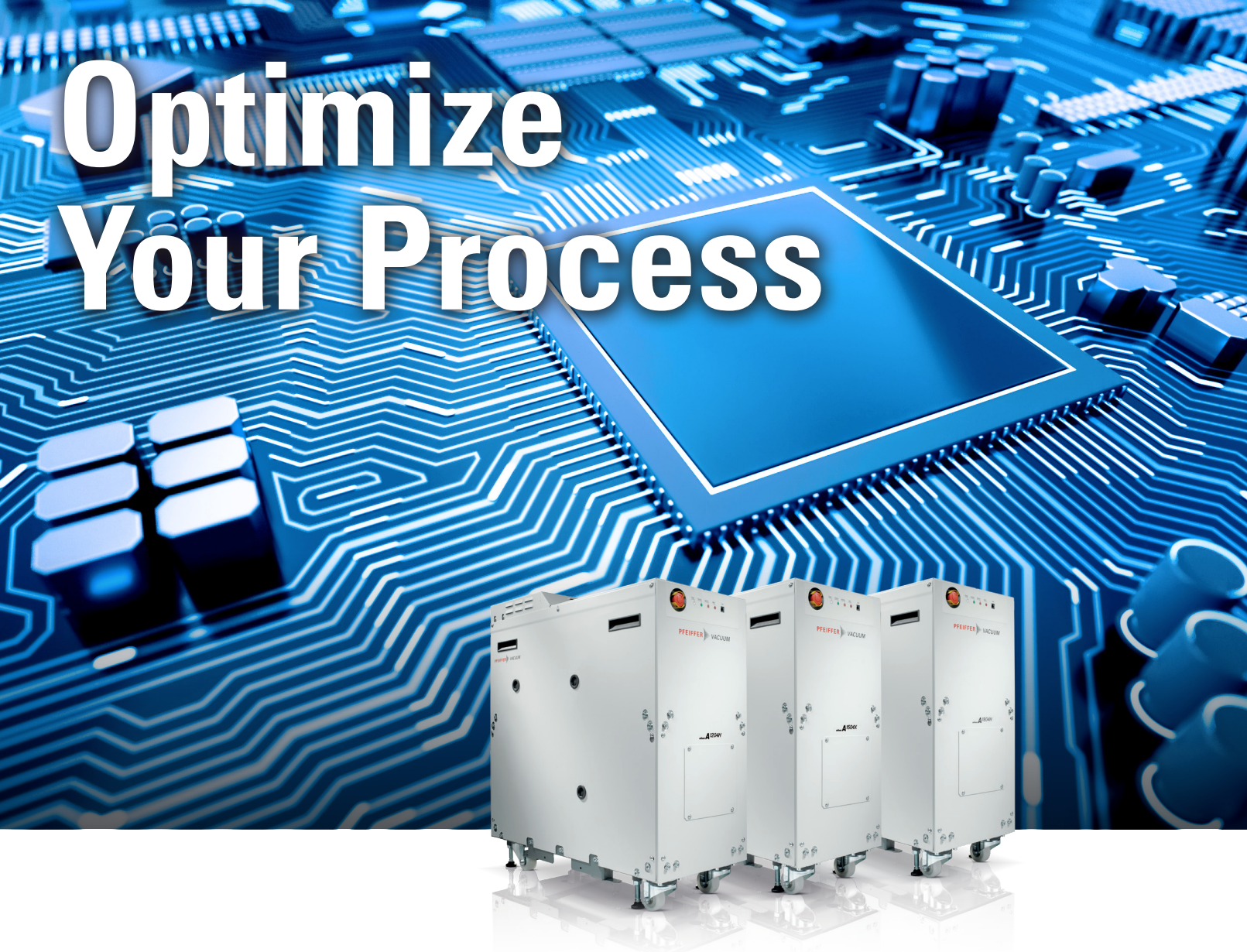
Grawert has been a member of the executive board since August 2017 and been chairman of the executive board/CEO since 2021. While CEO, he has been instrumental to the company's success in power electronics and growing revenue more than two-fold, says the firm.

“With Dr Grawert, Aixtron made significant progress in the equipment technology for power electronics and optoelectronics. These achievements enable Aixtron to play a central role in the global semiconductor industry,” says Kim Schindelhauer, chairman of Aixtron’s supervisory board.

Prior to joining Aixtron, Grawert worked at Infineon Technologies AG, and McKinsey & Company. He holds a PhD from the Massachusetts Institute of Technology (MIT), a Master of Science (MSc) from the Georgia Institute of Technology and a degree in electrical engineering (Dipl.-Ing.) from the University of Karlsruhe (TH).

www.aixtron.com

# Optimize Your Process



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# Riber reports positive earnings in first-half 2024, as revenue grows by 13%

## Order book grows by 18% year-on-year to €36m

For first-half 2024, molecular beam epitaxy (MBE) system maker Riber S.A. of Bezons, France has confirmed revenue of €13.7m, up 13% on €12.2m in first-half 2023, despite an uncertain macroeconomic environment.

MBE Systems revenue grew by 10% year-on-year from €8.5m to €9.4m. Services & Accessories revenue grew by 19% from €3.6m to €4.3m.

Gross margin rose from 32.3% to 34.8%.

Compared with a loss of €1.2m in first-half 2023, net income was positive at €0.2m, although this is due to net financial income of €0.2m.

At the end of June 2024, net cash was €7.1m, down from €9.7m at end-December 2023.

Primarily taking into account the half-year earnings and the distribution to shareholders from the issue premium paid out in June, shareholders' equity at end-June 2024 totaled €19.6m, down from €21.2m at end-December 2023.

**Order book grows by 18%**

During first-half 2024 there was a sharp rise in orders received, including eight MBE systems for both research and industrial production as well as a significant upturn in Services & Accessories business from an already favourable base.

The MBE System order book hence grew by 27%, from €23.7m at end-June 2023 to €30.2m at end-June 2024 (comprising 12 machines, including seven production machines).

The Services & Accessories order book is down by 14% from €6.7m to €5.8m, as a result of a high level of invoicing in first-half 2024.

The total order book hence rose by 18% from €30.5m at end-June 2023 to €36m at end-June 2024. However, this does not include the order announced in August for an MBE 412 cluster research system.

**Full-year revenue expected to grow to more than €40m**

Given the existing orders scheduled for delivery in 2024 and the opportunities for its systems, services & accessories, Riber expects further growth in full-year revenue to more than €40m, along with further improvement in earnings.

**www.riber.com**

# VEXLUM orders Riber MBE 412 cluster system

## Fully automated pilot line to grow optical devices spanning visible and near-IR spectrum

VEXLUM of Tampere, Finland — which was spun off from Tampere University of Technology's Optoelectronics Research Centre in 2017 — has ordered a fully automated Riber MBE 412 cluster system (for delivery in 2025) to establish a pilot line for the growth of optical devices spanning the visible and near-infrared spectrum. The line will focus mainly on VECSEL (vertical external-cavity surface-emitting laser) structures while also exploring other innovative technologies.

Vexlum specializes in developing III/V materials enabling VECSELs at new wavelengths, scalable manufacturing processes, and application-specific systems engineering. Recent breakthroughs include the use of VECSELs for quantum technology applications.

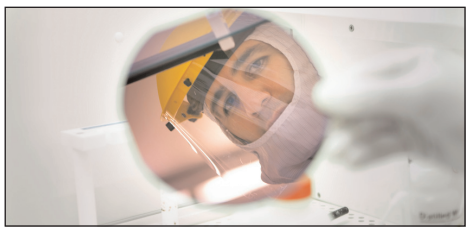
The MBE 412 cluster is a platform compatible with 4" substrates, offering flexibility in terms of equipment, modularity and adaptability, allowing users to continuously extend the system's capabilities, says Riber. Equipped with the EZ TOOL instrumentation package for real-time in-situ growth control and powered by Crystal XE control software, the fully automated system is the first of its kind in Finland and the 25th in operation since its launch in 2010.

**www.riber.com**

# Atomic layer etching firm AlixLabs awarded grant from imec-led, EU-supported PhotonHub Europe

AlixLabs AB of Lund, Sweden — which was spun off from Lund University in 2019 and has developed the Atomic Layer Etching (ALE) Pitch Splitting technology (APS) — is expanding into the photonics field thanks to a new research grant from imec-led and EU-supported PhotonHub Europe. The total value of the research project is about €197,000, of which PhotonHub will provide €58,500, with AlixLabs itself investing €129,000.

The R&D project with PhotonHub Europe will allow AlixLabs to work closely with nanoelectronics research center imec of Leuven, Belgium, granting access to photonics equipment and technology not present at AlixLabs. The project also enables AlixLabs to evaluate, prototype and benchmark its technology and processes in imec's laboratories, qualifying them for



worldwide industry use.

"Photonics is a hot topic in the future of semiconductor industry, and we are eager to explore application of our technology in this field," says research director Reza Jafari Jam. "We're thrilled about the opportunity to collaborate closely with imec and tap into the vibrant hub of European semiconductor research, enhancing our capabilities in developing high-performance photonic devices," he adds.

The goal of the project is to significantly enhance the performance of photonic devices, particularly ring resonators. With AlixLabs' ALE process, which allows for precise material manipulation at an atomic scale, the goal is to achieve defect- and damage-free surfaces for photonics devices. As surface quality directly contributes to better photon extraction and transmission, ALE in photonics is expected to result in more reliable devices with higher signal quality and enhanced operational qualities.

PhotonHub Europe was announced in 2020 and is funded by the European Union's Horizon 2020 program. It has 54 partners and over 500 experts from 15 EU member states, all aiming to create and launch new products in industries as diverse as health, digital infrastructure, manufacturing, safety, security, space & defence, agro-food and mobility & energy.

**www.photonhub.eu**
**www.alixlabs.com**

# Mojo Vision partners with CY Vision to develop HUDs with micro-LED technology

## Automotive displays to use AI and 3D imaging

Mojo Vision Inc of Saratoga, CA, USA — which is developing and commercializing micro-LED display technology for consumer, enterprise and government applications — has partnered with heads-up display (HUD) technology company CY Vision to develop HUDs built with micro-LED technology that incorporate augmented reality (AR) into automobiles. These HUDs will leverage artificial intelligence (AI) and 3D imaging to provide drivers with an immersive and personalized driving experience with informative, line-of-sight overlays that promote driver safety and provide essential information.

**Organizational readiness in the age of AI: from technology to transformation**

Both automakers and consumers can benefit from AR HUDs, as a next-gen driving experience can be a major factor for consumers in the car buying process. HUDs have the ability to keep drivers' eyes and focus on the road by visualizing information in the direct field of view — addressing a significant concern for drivers, as an estimated 25% of automotive accidents are caused by distracted driving.

**HUD capabilities for enhanced driving**

CY Vision's HUDs are said to provide the largest field of view and high-resolution images with 3D and AR capabilities.

With up to 20–50 times more light efficiency than conventional systems, high brightness, contrast and resolution, the images clearly and conveniently display important information to the user.

Additionally, CY Vision's HUDs eliminate existing image degradation such as sunlight reflection and color distortion.

These improvements are critical to the implementation and adoption of AR HUDs.

"The automotive industry is always looking for advancements in user experience, design and safety," says CY Vision's CEO Sandeep Ohri. "AR HUDs have the opportunity to be the next big advancement in automotive technology, and the core total addressable market for HUDs is estimated to reach over $10bn by 2034. We're excited to add cutting-edge micro-LED to our existing solutions, expanding our offerings and serving our customers' needs."

**Manufacturing benefits of micro-LEDs**

For auto makers to increase the integration of HUDs in the next generation of cars, the displays need to exceed manufacturer's standards and guidelines. By mixing cutting-edge display technology with established semiconductor processes, micro-LED technology provides a cost- and energy-effective opportunity to advance the development and implementation of high-performance HUDs, says Mojo Vision.

**For Mojo's micro-LEDs, auto HUDs with CY Vision will be a significant advancement towards widespread commercialization of this type of display technology. Automotive HUDs are the perfect use case for micro-LED technology as HUDs will significantly benefit from the size, energy use and display capabilities that micro-LEDs have to offer and will show the versatility and value of micro-LEDs in the display landscape**

The small size of the micro-LEDs can help CY Vision to design HUDs that integrate more seamlessly with the car's existing layout, it adds. As auto makers continue to add more high-tech features to cars, managing energy consumption is critical.

Mojo's display technology is 5–10 times more efficient than LED-illuminated LCD displays, providing a more energy-efficient component. Mojo's micro-LED technology can also help to enable CY Vision's HUDs to adapt to different-sized windshields through software, and to not require luxury optical elements or films, creating cost savings.

"Automotive HUDs showcase micro-LED's adaptability for being a superior display technology in multiple form factors," says Mojo Vision's CEO Nikhil Balram. "Micro-LEDs provide high performance without being obtrusive to structure and design. HUDs that will redefine the marketplace will require top-end resolution and quality, all of which micro-LED can provide at a cost-effective price point and low energy consumption," he adds.

"For Mojo's micro-LEDs, auto HUDs with CY Vision will be a significant advancement towards widespread commercialization of this type of display technology," comments Mojo board member Achin Bhowmik, former president of the Society for Information Display (SID). "Automotive HUDs are the perfect use case for micro-LED technology as HUDs will significantly benefit from the size, energy use and display capabilities that micro-LEDs have to offer and will show the versatility and value of micro-LEDs in the display landscape. Technologies that combine safety and enhanced experience are extremely important, and micro-LEDs will enable HUDs to reach their full potential."

**www.cyvision.com**
**www.mojo.vision**

# Polar Light partners with Finetech to connect pyramidal GaN micro-LEDs

## Cold compression aligns and bonds micro-LED arrays to indium pads on silicon back panel

For display applications, Polar Light Technologies (PLT) — which stems from research by founder professor Per-Olof Holtz and his team at Sweden's Linköping University — has created novel gallium nitride (GaN) pyramidal micro-LEDs that are directly bonded to indium pads on a silicon chip. This new method, where LEDs are built from the bottom up, avoids the surface damage seen in traditional top-down methods, resulting in much better optical performance.

The pyramidal shape allows the creation of very small LEDs that are brighter and more efficient at emitting light by reducing energy losses and increasing energy efficiency.

To connect these pyramidal micro-LEDs to silicon substrates, Polar Light has teamed up with Finetech of Berlin, Germany (a supplier of sub-micron and high-accuracy die bonding solutions) to develop a cold bonding technique that ensures accurate alignment with the electronics. In early trials, the method showed an 85% success rate, proving its potential for large-scale manufacturing.

**Pyramidal micro-LED to enable smaller, brighter and more efficient light emitters**

Polar Light's approach to making display front panels involves a bottom-up fabrication method using atomic layer regrowth. They grow GaN micro-LEDs in the shape of pyramids on a silicon carbide (SiC) substrate. This produces high-quality micro-LEDs as small as 300nm, without the damage caused by traditional top-down methods. As a result, the devices have near-perfect surfaces, which is crucial for optical properties.

The micro-LED displays can fit the resolution of a full TV screen into an area smaller than 5mm$^2$, with about 1000 x 1000 connection points spaced just 5µm apart. Polar Light's design also significantly reduces energy use, making the micro-LEDs highly efficient for next-generation micro-displays.

Compared with regular LEDs, the pyramidal micro-LEDs improve augmented-reality (AR) system efficiency by 50–200 times thanks to better internal and external quantum efficiencies and enhanced light utilization. By minimizing internal electric field interference and optimizing the interaction between charge carriers in the quantum wells, the micro-LEDs produce more light with sharper, narrower emission. This makes them suitable for applications like AR and micro-projectors, where precise light control is important, says Polar Light.

**Finetech develops cold compression bonding process for pyramidal micro-LEDs**

A complete micro-LED display consists of three main parts: the front panel (the actual display), the back panel (which includes all the electronics), and the connection between the two. For the process of connecting the front panel to the back panel made of silicon, a modified flip-chip bonding method was used in which the metallized GaN pyramids are precisely aligned and bonded to the indium pads on the silicon back panel.

**The pyramidal micro-LEDs improve augmented-reality system efficiency by 50–200 times thanks to better internal and external quantum efficiencies and enhanced light utilization**

Because of differences in how silicon carbide and silicon expand with heat, no heat could be used during the bonding process. Finetech and Polar Light developed a cold compression bonding method for aligning and bonding micro-LED arrays using an automated FINEPLACER femto 2 sub-micron die bonder. This machine is claimed to ensure excellent process control, with high accuracy in flatness, alignment and bonding force, which is crucial for connecting the fine-pitch indium bumps for high-performance displays.

In addition to its precision, the FINEPLACER die bonder is flexible enough to scale up production and adapt to new micro-LED technologies. Finetech also provides solutions for handling materials and cleaning with chemical or atmospheric plasma to avoid damage or contamination. This system allows for easy flipping of delicate indium bump arrays without tweezers, and it ensures that the materials are treated before bonding to improve overall quality.

**Polar Light and Finetech at MicroLEDConnect 2024**

At MicroLEDConnect 2024 in Eindhoven, The Netherlands (25–26 September), both firms presented their latest innovations for micro-LED display technology.

Finetech showcased solutions that improve accuracy, reduce costs and enable smooth scaling from R&D to large-scale micro-LED production.

The firm also presented a live session on Indium Bump Interconnect Flip Chip Bonding, showing how the technology is particularly beneficial for high-density flip-chip applications and can significantly enhance the reliability and efficiency of micro-LED devices.

**www.microledconnect.com**
**www.polar-light-technologies.com**
**www.finetech.de**

# Lumileds addresses micro-LED efficiency through external quantum efficiency and directionality

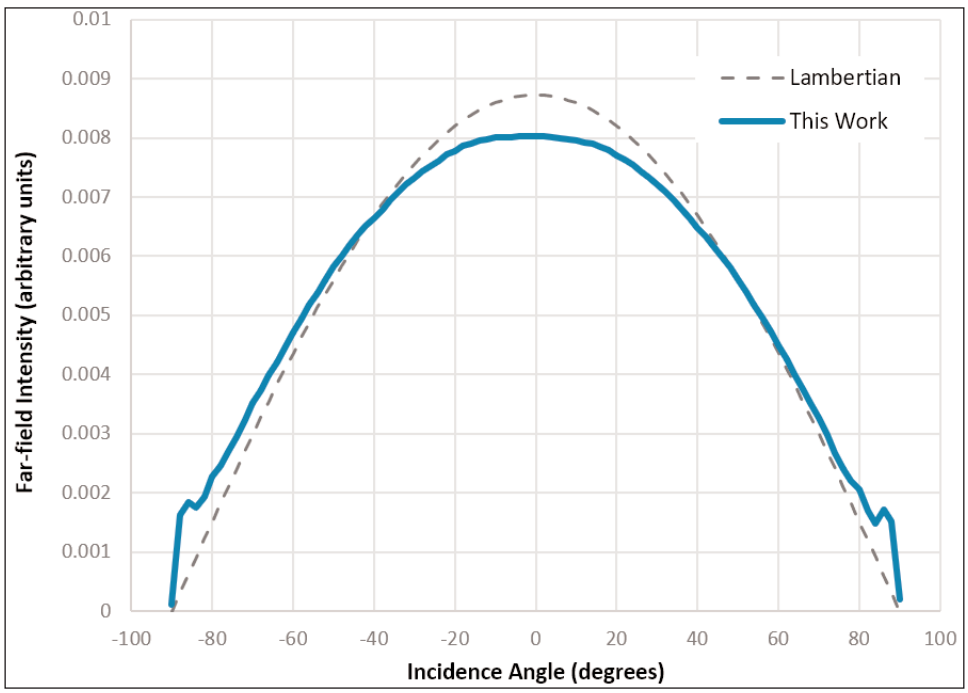
## R&D team achieves Lambertian distribution from micro-LEDs

LED product and lighting maker Lumileds LLC of San Jose, CA, USA says that, in the past few years, it has realized significant external quantum efficiency (EQE) performance for micro-LEDs. However, for micro-LEDs, and display applications in particular, EQE on its own is not a sufficient measure of performance.

To properly assess the efficiency of a micro-LED, one must also be able to measure the directionality of the light, says Lumileds. The directionality of light is critical for micro-LED displays, and displays are hence often characterized by radiant or luminous intensity, as seen from an angle.

"Most LEDs emit the majority of light from their top surface. This is especially true for thin-film LEDs," notes Brendan Moran, Lumileds' senior director of micro-LED development. "When we shrink the size of thin-film LEDs to become micro-LEDs, the side-emitting surfaces become a significantly greater portion of the overall light-emitting surfaces," he adds.

"The thickness of what we described as a thin film for a larger-size LED now becomes substantial relative to the length and width of the micro-LED. This is a key reason why micro-LEDs emit a large portion of light from their sides, resulting in a wide viewing angle distribution and a reduction of intensity emitted from the top surface. For display applications, even high-EQE micro-LEDs can have relatively low on-axis intensity."




The Lumileds R&D team has now developed micro-LEDs with a highly desirable light distribution that approximates Lambertian distribution. The team's innovation is said to result in brighter displays that consume less energy.

**www.lumileds.com**

# LUXEON 2835 Commercial Deep Dimming LED launched

Lumileds' new LUXEON 2835 Commercial Deep Dimming LED offers what is claimed to be the industry's most consistent dimming performance down to 1% dimming. With a $V_f$ range of just 0.05 split into two $V_f$ bins of 0.025, users no longer need to engage in complex binning processes, costly driver compatibility design, or burdensome testing.

The new LUXEON 2835 Commercial Deep Dimming LEDs are designed for LED-to-LED flux uniformity across the entire dimming curve — down to 1% — that is required to achieve consistent visual performance. From full intensity — 38.6lm@65mA — to 1% intensity at 0.65mA, every LED will provide the same flux performance in the application. Lumileds says that its advances allow for a forward voltage variance of just 0.05V, which simplifies driver design and compatibility. Uniform 1% light levels can hence be achieved without undesirable light flicker.

"Our innovation and effort to resolve inconsistent flux performance issues at the LED level eliminates the need for luminaire manufacturers to develop workarounds at the manufacturing level," says Mei Yi, director of product marketing. "With LUXEON 2835 Commercial Deep Dimming, luminaire manufacturers no longer need to add components or manage LED selection from the bins they receive. Both workarounds add cost, complexity and time to the manufacturing process. Now, we provide consistent flux performance across the dimming range directly at the LED level."

LUXEON 2835 Commercial Deep Dimming is available in correlated color temperatures (CCTs) of 2700–6500K, color rendering indexes (CRIs) of 70, 80 and 90, and with an efficacy range of 178–231lm/W.

**www.lumileds.com/products/**

# Lumileds demonstrates InGaN-based deep red LEDs with 7.5% wall-plug efficiency at 10A/cm²

## True-red micro-LEDs to facilitate full-color displays for AR

LED product and lighting maker Lumileds LLC of San Jose, CA, USA claims to be first to demonstrate that rich deep red light (615nm dominant wavelength corresponding with 635nm peak) can be produced with indium gallium nitride (InGaN) LEDs, achieving a wall-plug efficiency of 7.5% at a current density of 10A/cm$^2$. The firm says that its breakthroughs address the challenges associated with high indium concentrations, including spectral peak shifts and broadening with current density.

The InGaN material system is an attractive alternative to aluminium indium gallium phosphide (AlInGaP) for creating red light sources because it harmonizes manufacturing with green and blue LEDs, which are also based on InGaN. The large industrial capacity of InGaN gives economies of scale and is preferred for integration with silicon semiconductor manufacturing. InGaN red is especially promising for micro-LED applications because of its characteristic of maintaining efficiency at micron-scale sizes and low current density.

"The current efficiency for sub-10μm red micro-LEDs is an impediment to cost-effective and efficient micro-LED displays," notes Rob Armitage, director of nitride epitaxy development. "Our work on red InGaN validates our roadmap to meeting cost and efficiency thresholds for adoption."

In addition to demonstrating high-efficiency red InGaN, Lumileds has established red, green and blue light emission from a single InGaN epitaxial stack. Subsequently, the firm translated this into micro-LEDs with what is claimed to be excellent color quality and electrical characteristics. Integration of the three primary colors into single micro-LEDs has a tremendous impact on achieving low-cost high-yield micro-LED display assembly and will ultimately enable compact full-color displays for augmented-reality (AR) applications, says Lumileds.

Armitage is an invited speaker at the 12th International Workshop on Nitride Semiconductors (IWN 2024) in Honolulu, Hawaii (3–8 November), discussing the development of InGaN LEDs for color displays.

**www.lumileds.com**

# Lumileds' new LUXEON 5050 HE Plus LED delivers 199lm/W for outdoor and industrial lighting

## Thermal resistance reduced and flux bin widths narrowed

With efficiency and energy sustainability being key drivers of LED selection for industrial and outdoor lighting applications, Lumileds says that its new LUXEON 5050 HE Plus can deliver luminous efficacy of 199lm/W and luminous flux of 746lm, as well as reducing application power consumption by 18% or more in critical infrastructure applications common to cities and businesses around the world. Further, the lower energy consumption of the LUXEON 5050 HE Plus supports the transition to low-carbon or no-carbon electricity supply. OEMs can achieve greater sustainability in their manufacturing process by reducing the physical material in both the heatsink and the system's driver.

As global energy costs continue to increase, efficiency gains pay increasing dividends to end-users and communities that need to lower municipal costs, reduce energy consumption, and support sustainability goals, says Lumileds. All these objectives can now be achieved while also addressing dark-sky initiatives. With correlated color temperature (CCT) options as low as 1800K and color rendering indexes (CRIs) of 70 or 80, the LUXEON 5050 HE Plus is suitable for both on- and off-grid lighting solutions, reckons the firm.

"Efficiency remains the key driver for outdoor and industrial lighting and the focus of our continuous improvement programs," says Mei Yi, director of product marketing. "The efficacy gains achieved with our LUXEON 5050 HE Plus make it the highest-performing 5050 LED available today, and these gains offer dramatic performance advantages for on-grid lighting and solar, off-grid solutions."

In addition to the efficacy and output combination, Lumileds has:

- reduced thermal resistance to an Rth of 1.1k/W so that smaller, less costly heatsinks can be used;
- established narrower flux bin widths of 25lm to facilitate accurate system design;
- hot-color targeted the LEDs at 85°C; and
- advanced the most robust package to support a maximum drive current of 1.2A.

The LUXEON 5050 HE Plus joins a portfolio that includes the LUXEON 5050 Round, LUXEON 5050 Square, and LUXEON 5050 HE. Both the HE and HE Plus have a square light-emitting surface. The performance advances available in the HE Plus versions is also now available in Lumileds' SunPlus 5050 LEDs for the horticulture industry.

**www.lumileds.com/products/high-power-leds/luxeon5050**

# EPO dismisses Everlight's invalidation action against Seoul Semi's 'No Wire LED' patent

## WICOP patent affirmed across 18 European countries

South Korea-based Seoul Semiconductor Co Ltd and its affiliate Seoul Viosys have won a patent litigation case against Everlight, a Taiwanese LED company ranked sixth globally.

In August, the boards of appeal of the European Patent Office (EPO) dismissed Everlight's invalidation action against Seoul's WICOP patent 'No Wire LED technology', affirming the WICOP (Wafer Integrated Chip on PCB) patent portfolios registered across 18 European countries.

Since the ruling of the UK Patents Court in 2018, Seoul says that it has won all patent lawsuits against Everlight and its distributor, spanning five countries over the past seven years. Seoul has won lawsuits related to WICOP technology applied in lighting, automotive and display applications, as well as those involving fundamental LED patents.

The No Wire LED technology is used not only in display products such as micro-LEDs but also in new technologies like adaptive driving beam (ADB) headlamps and STOP lamps that communicate with and help protect drivers and pedestrians in the automotive sector.

Seoul says that it has invested nearly $100m annually (10% of its sales) in R&D over the past 20 years to create new lighting. This investment has led to the development of technologies such as SunLike (which produces natural light that can alleviate the health effects of artificial indoor lighting) and No Wire Technology WICOP. Seoul Semi has 18,000 patents related to the LED industry.

"Immoral companies continue to sell infringing products by simply changing a product's name even after patent infringement judgments, and some large corporations knowingly use infringing products to save a few cents," says Seoul's founder & CEO Chung Hoon Lee. "It drives young startup founders and innovative companies to despair."

**www.SeoulSemicon.com**

# ams OSRAM a finalist in Deutscher Zukunftspreis

## Digital light technology brings intelligence and precision to road traffic lighting, enabling safety-relevant applications such as projection

In cooperation with Dr Hermann Oppermann of the Fraunhofer Institute for Reliability and Microintegration IZM in Berlin, Dr Norwin von Malm (senior director New Technologies) and Stefan Groetsch (who leads the corresponding team within System Solution Engineering) at ams OSRAM GmbH in Premstätten, Austria and Munich, Germany comprise one of three teams nominated as a finalist for the Deutscher Zukunftspreis 2024 (German Future Award), the Federal President's Award for Technology and Innovation (to be awarded by Federal President Frank-Walter Steinmeier in Berlin on 27 November).

Key nomination criteria include innovative performance, patentability as well as completed or imminent implementation that must also result in creating new jobs.

The team has been nominated to recognize innovations underlying its digital LED headlamp technology,

**Hermann Oppermann, Norwin von Malm and Stefan Groetsch**

which illuminates the road ahead precisely and brightly without blinding other road users, enhancing general road safety. For this, ams OSRAM developed all-new LED technology that is smaller, more efficient and more intelligent than before, rendering more precise light distribution.

ams OSRAM's innovation features more than 25,600 LEDs in a matrix consisting of 320 x 80 light points. With each individual LED being controlled by a digital signal, the headlamp works similarly to a video projector. Not only does it illuminate the road ahead precisely and efficiently, but it can also project warning symbols onto the road, such as a snowflake symbol to warn of icy conditions or a special symbol if a wrong-way driver is heading in the vehicle's direction.

"The German Future Award is a long-standing tradition for us at ams OSRAM: in 2007, an ams OSRAM team won this prestigious award to honor our thin-film technology, and in 2016 we were among the nominees," notes CEO Aldo Kamper. This demonstrates "the great significance of intelligent light and sensor technologies for our digital society."

Beyond the road traffic area, 'digital light' provides the technological basis for new applications that could revolutionize the interface between people and electronics, it is reckoned.

**www.deutscher-zukunftspreis.de/de**

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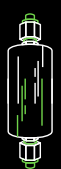
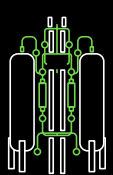
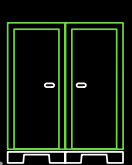


Point-of-Use Purifiers



Frame-Mounted Purifiers



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# BluGlass partners with Macquarie University and Aurizn on blue ocean subsurface temperature and depth mapping LiDAR project

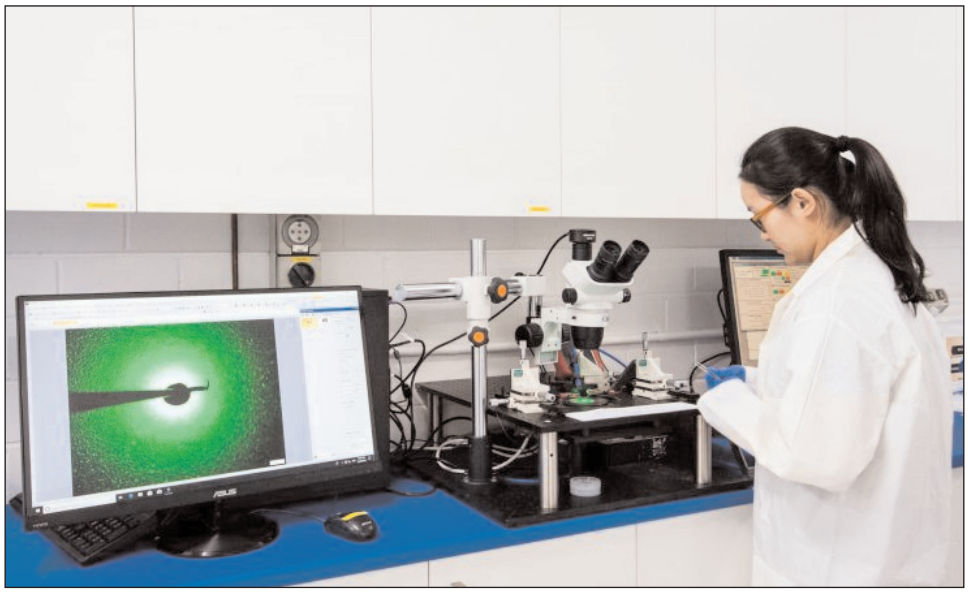
## Australia's Economic Accelerator grant to fund development of blue- and aquamarine GaN lasers

BluGlass Ltd of Silverwater, Australia — which develops and manufactures gallium nitride (GaN) blue laser diodes based on its proprietary low-temperature, low-hydrogen remote-plasma chemical vapor deposition (RPCVD) technology — has signed an agreement with Macquarie University (project lead) and defence company Aurizn to develop and test a new laser-based method to measure subsurface water temperature and depth. BluGlass will provide visible GaN lasers, partially funded by an Australia's Economic Accelerator (AEA) seed grant to support the commercialization of visible lasers in maritime applications.

The 12-month project will develop and run commercial trials of fully functional blue ocean LiDAR (light detection and ranging) technology to improve maritime situational awareness in defence and environmental settings where satellites and marine buoys are currently used. Blue ocean LiDAR will improve detection of underwater objects, provide increased accuracy in predicting coral bleaching events, and refinement of climate modelling technology.

While invisible infrared (IR) lasers have gained mass adoption in fiber-optic and space communications, they are ineffective in sub-marine applications, as their wavelengths are almost entirely absorbed by water. Underwater laser communication and remote sensing require visible lasers in shorter wavelengths, typically between violet and green.

"The unique semiconductor lasers developed by BluGlass operate between 420nm to 520nm, making them ideal for these demanding applications," says project lead



Dr Ondrej Kitzler, a research fellow in the MQ Photonics Research Centre at Macquarie University.

Specifically, BluGlass will provide high-power multi-transverse-mode devices for the ocean LiDAR, targeting usable underwater wavelengths in the blue and aqua-marine ranges. The project will harness the advantages that visible GaN lasers have over existing lower-power and solid-state lasers, such as compact size, high power conversion efficiency, low manufacturing cost, wavelength tunability, beam divergence control, lifetime, and ability to shift wavelength rapidly.

"The project leverages each partner's unique development and commercial strengths to combine leading-edge photonic and detector technologies in novel applications with significant market potential," says BluGlass CEO Jim Haden. "We are excited to see our BluGlass GaN lasers deployed in underwater environments for field testing and validation," he adds.

"This project builds on the development of remote electro-optical sensing systems that Aurizn has spearheaded in partnership with Defence," notes Aurizn's chief scientist Dr Peter Amerl. "We look forward to applying our expertise to help guide the project to ensure suitable outcomes for both defence and national security use".

While BluGlass' revenue from the partnership is immaterial, the project has significant technological and commercial potential. Following completion of the project, the parties intend to enter formal negotiations to progress the blue ocean LiDAR prototype to commercialization, production and manufacturing.

BluGlass says that the project aligns with its target markets and technology development roadmaps, including development collaborations that it is working on with University of California, Santa Barbara (UCSB) as well as the CLAWS Hub led by North Carolina State University (NCSU), as part of the Microelectronics Commons program for defence and dual-use technologies run by the US Department of Defence.

**www.bluglass.com.au**

# NUBURU partners with Ohio State's CDME to showcase blue lasers in additive manufacturing

## BlueScan technology to be installed in powder bed fusion system

NUBURU Inc of Centennial, CO, USA — which was founded in 2015 and develops and manufactures high-power industrial blue lasers — has announced a partnership with the Center for Design and Manufacturing Excellence (CDME) at Ohio State University in Columbus, Ohio. The firm received a purchase order for its BlueScan solution, which includes a BL-250 laser, scanner and optics. This technology will be installed within a powder bed fusion system at CDME's development lab.

The advantages of blue lasers for enhancing additive manufacturing processes with both powder and wire have been well established, says NUBURU. With the introduction of the BL Series, beam quality has improved significantly, facilitating integration of the BL laser into powder bed fusion machines. The installation at CDME will enable direct comparisons with existing techniques, driving innovation and efficiency in additive manufacturing. Additionally, interested third parties can collaborate with CDME to guide this pioneering research.

"CDME recognizes the transformative potential of blue lasers to significantly enhance productivity and quality in powder bed fusion applications," says NUBURU's CEO Brian Knaley. "CDME, a renowned center of excellence in additive processing, has chosen to integrate our BL products into their technology portfolio. This partnership comes at a time when the global additive manufacturing market size is poised to cross $21.58bn in 2024 and is likely to attain a valuation of $110.13bn by 2033. The additive manufacturing industry is projected to develop at a CAGR of 19.85% from 2024 to 2033, driven by advancements in 3D printing technologies, innovative AM materials, government initiatives, and R&D projects [according to Precedence Research]," he adds.

**The system will be available for contract development, allowing us to explore new material innovations with NUBURU's advanced blue laser technology**

"We are excited to build upon the work NUBURU has initiated and compare the characteristics of blue lasers against traditional infrared laser approaches," says John Middendorf, CDME's director of additive manufacturing. "Once installed later this year, the system will be available for contract development, allowing us to explore new material innovations with NUBURU's advanced blue laser technology."

**www.lasers4netzero.com**
**www.nuburu.net**

# Blue Laser Fusion wins US DoE INFUSE project award

## Firm collaborating with Caltech on high-energy pulsed laser technology to advance fusion energy commercialization

Blue Laser Fusion Inc (BLF) of Santa Barbara, CA, USA has won a US Department of Energy (DOE) INFUSE project award to develop a novel high-energy pulsed laser for inertial fusion energy applications in collaboration with the California Institute of Technology (Caltech).

The project focuses on high-energy pulsed laser amplification using an optical enhancement cavity (OEC) to generate the high pulse energy and fast repetition rates required for high-gain, efficient fusion energy generation, says the firm.

Funded by the DOE, the work leverages the expertise of Caltech's Adhikari Research Group led by professor Rana Adhikari, a leader in experimental gravitational physics and OEC lasers for LIGO. The project was awarded as part of the DOE's Innovation Network for Fusion Energy (INFUSE) initiative, which awarded $4.6m to private–public collaborations in 2024 to accelerate the development of cost-effective, innovative fusion energy technologies in the private sector. The DOE INFUSE program's overarching objective is to ensure US energy, environmental & security needs.

"By cooperating with Caltech, Blue Laser Fusion will have access to world-class expertise and capabilities to advance our OEC laser innovations," says CEO Dr Shuji Nakamura, who founded Blue Laser Fusion in 2022.

BLF's technology innovations include a high-efficiency, cost-effective megajoule-class pulse energy laser with a fast repetition rate, coupled with a high-gain, low-cost solid-fuel target to achieve commercial fusion. The firm's IP portfolio includes more than 50 patents and applications internationally. Technical areas of IP protection and innovation competence include multiple levels of the value chain, such as optical enhancement cavity (OEC) lasers, fuel targets and energy and fusion systems.

**https://infuse.ornl.gov/awards/high-energy-pulsed-laser-amplification-using-optical-enhancement-cavities**
**www.bluelaserfusion.com**

# Phlux appoints VP of operations, director of engineering, and VP of marketing as it expands to larger premises

Following its recent relocation to larger premises (supporting ongoing growth and expanding operations), Sheffield University spin-off Phlux Technology —which designs and manufactures 1550nm avalanche photodiode (APD) infrared sensors — has appointed Christian Rookes as VP of marketing, Brian Williams as VP of operations, and John Fuller as director of engineering.

Christian Rookes, who has over 25 years of experience in semiconductor and technology sectors, joins Phlux to lead marketing efforts and drive market expansion. His expertise in market analysis, product definition, strategic business development, and communicating complex technologies will be key, it is reckoned, as Phlux seeks to establish itself in high-performance infrared sensors.

Williams is an executive manager with over 35 years' experience in the semiconductor sector. His expertise in building high-performance teams, streamlining operational processes, and establishing scalable supply chains will be instrumental in driving the next phase of development to scale Phlux's technology.

John Fuller has extensive engineering leadership experience, with a focus on agile methodologies and organizational change. As director of engineering, he will drive product development and optimize resources to support Phlux's growth. His experience as engineering director at Gas Sensing Solutions, coupled with his automotive sector expertise across national and international markets, will guide Phlux's expansion in the infrared sensor landscape.

"Their combined experience and vision will be crucial as we continue to scale our business," comments CEO Ben White.

In line with its ongoing expansion, Phlux has also announced its move to a larger facility located within the newly renovated Pennine 5 campus in Sheffield. The new premises provide the necessary space and resources to support the growing team and increasing product demand.

The relocation enables the firm to enhance its R&D capabilities, streamline production and test development processes, and better serve its global customer base. The new open-plan facility is designed to foster collaboration and innovation, reinforce company culture, and reflect the firm's brand and values.

"Our new headquarters represents more than just a physical move — it symbolises our forward momentum and ambitious plans for the future," says White. "As we continue to grow, our focus remains on pushing the boundaries of infrared sensor technology and delivering exceptional products to our customers."

**www.phluxtechnology.com**

# SuperLight unveils first compact ultrafast pulse laser

SuperLight Photonics of Enschede, the Netherlands — a spin-off from the University of Twente that is developing a wideband laser light source for measurement & detection — has launched what it claims is first ultrafast laser to produce ultrashort pulse lengths in a compact form factor. The SLP-0280 delivers 25fs pulses with a center wavelength of 1750nm (+/–200nm).

SuperLight says its patented PAD (Patterned Alternating Dispersion) technology applies non-linear pulse compression in a highly efficient way. The resulting 25fs pulses are obtained with substantially lower pulse energy than is traditionally needed for such pulse compression. Based on a photonic integrated circuit (PIC) platform, the form factor is substantially reduced compared with similar lasers. The SLP-0280 is also claimed to outperform traditional complex systems, and set a new benchmark as an ultrafast, low-noise, ultra-stable, small-form-factor laser.

The SLP-0280 is designed for both scientific and industrial applications. In the scientific domain, it is suitable for terahertz generation in high-end spectroscopy, non-destructive imaging applications, material characterization and biomedical applications. Its capabilities are particularly valuable in pump-probe spectroscopy, non-linear microscopy such as 2P (two-photon excitation microscopy) or SHG (second-harmonic generation) microscopy, and transient absorption microscopy, where low-power probe pulses are essential for observing ultrafast dynamics without disrupting the material under study.

Additionally, the SLP-0280 can be used for timing and laser stabilization, e.g. for measuring delays and synchronization in fiber networks.

As with all SuperLight Photonics products, the SLP-0280 features a small-form-factor class III laser classification with rapid start-up time, no calibration requirements, high uptime, and maintenance-free operation.

"The SLP-0280 addresses the specific needs of the ultrafast laser community, providing a powerful yet compact solution that redefines what's possible in both scientific and industrial contexts," says founder & chief technology officer Haider Zia.

SuperLight Photonics unveiled the SLP-0280 at the European Conference on Optical Communication (ECOC 2024) exhibition in Frankfurt, Germany (23–25 September).
It is also exhibiting it at VISION 2024 in Stuttgart, Germany (8–10 October) and PIC Summit Europe 2024 in Eindhoven, the Netherlands (15–16 October).

**www.superlightphotonics.com**

# Innovate UK-funded MARCONI project to facilitate secure quantum key distribution with high-performance OEM receiver modules

## Phlux to provide Noiseless InGaAs APD sensors for four-channel single-photon avalanche detector

Backed by funding from Innovate UK (which provides funding and support for business innovation as part of UK Research and Innovation) under the 'Scalable Quantum Network Technologies: Collaborative R&D' program, the £1.5m MARCONI project on quantum key distribution (QKD) is developing and demonstrating high-fidelity modular and scalable receiver modules. QKD is a secure communication method that leverages the principles of quantum mechanics to generate and distribute cryptographic keys between two parties, ensuring that any attempt at eavesdropping can be detected. The MARCONI initiative is expected to not only strengthen the UK's position in addressing the challenge of bringing scalable quantum network technologies to market but also enhance national security and economic growth.

Specifically, the project aims to introduce two new OEM QKD receivers based on different technologies, which are interchangeable at the optical connection point. These receivers will be constructed using UK components, ensuring a robust domestic supply chain for critical quantum networking technologies.

For smaller setups and short-distance communications, a four-channel single-photon avalanche detector (SPAD) system will feature Noiseless InGaAs (indium gallium arsenide) avalanche photodiode (APD) infrared sensor technology from Sheffield University spin-off Phlux Technology, packaged by Bay Photonics Ltd of Paignton, UK. For larger, long-distance applications, a superconducting nanowire single-photon detector (SNSPD) system will be employed, incorporating enhanced SNSPDs from the University of Glasgow, cooled by a novel 1K system from Sheffield-based Chase Research Cryogenics Ltd and coupled with a new compact timetagger from Redwave Labs Ltd of Didcot, UK. Redwave Labs will optimize the control electronics and timetaggers for both systems, which will be coupled with an optical receiver module from the Fraunhofer Centre for Applied Photonics (CAP) of Glasgow, Scotland, UK.

The University of Cambridge will showcase these receivers in entanglement-based discrete variable-QKD transmission across both metro and long-haul networks, using the BBM92 protocol. This demonstration will highlight the scalability and performance of the MARCONI receivers.

The MARCONI project addresses two critical needs: establishing a UK-led supply chain for quantum networking components and enhancing the scalability of quantum networks. The QKD market is forecasted to grow to about $5bn by 2028. By developing high-performance OEM receiver modules for both small and large installations, MARCONI aims to disrupt the market and reduce reliance on single-source suppliers.

It is reckoned that MARCONI's innovations promise economic and security advantages, including job creation and safeguarding within the UK supply chain, enhanced national security through the adoption of more secure QKD systems, reduced import dependency for high-performance photonics systems, and boosting the reputation and impact of the UK photonics industry. As system integrator, Redwave Labs will lead the commercialization efforts for the QKD receiver modules. The project is expected to generate substantial revenue and growth opportunities for all consortium partners.

**www.bayphotonics.com**
**www.redwavelabs.com**
**www.chasecryogenics.com**
**www.cap.fraunhofer.co.uk**
**www.phluxtechnology.com**
**www.ukri.org/opportunity/scalable-quantum-network-technologies-collaborative-rd**

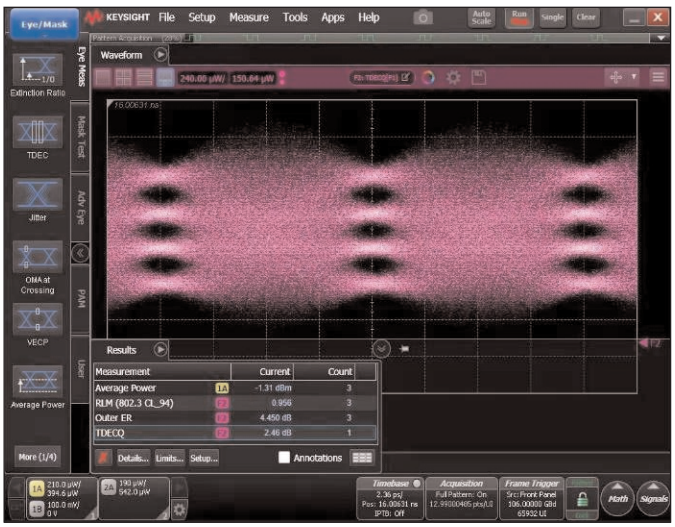
# InSiGa and POET demo laser driver and optical engine combo at CIOE 2024

## POET's 200Gx4 transmit optical engine using InSiGa's 200G/lane EML driver for 800G and 1.6T modules

At the 2024 China International Optoelectronic Expo (CIOE) in the Shenzhen World Exhibition and Convention Center (11–13 September), China-based Chengdu InSiGa Semiconductor Technologies Co Ltd and POET Technologies Inc of Toronto, Ontario, Canada — designer and developer of the POET Optical Interposer, photonic integrated circuits (PICs) and light sources for the data-center, telecom and artificial intelligence (AI) markets — have developed and are showcasing in a live demonstration the combination of POET's 200Gx4 transmit optical engine using InSiGa's 200G/lane EML driver ISG-D9616 for 800G and 1.6T modules.

AI and big data have led to a significant increase in bandwidth in recent times and this higher bandwidth requirement can be supported by next-generation 800G/1.6T optical modules. 200Gbs/lane requirement is now required to achieve the highest-bandwidth modules that can be used to support AI and emerging data-center applications. A unique solution for 200Gx4 applications has been developed that is based on POET's silicon-based optical interposer technology using InSiGa's patented DC-coupled 200G/lane EML driver. This approach is claimed to provide the most compact solution and allow for optimal performance, as no external components are required between the EML and the driver. The design is built upon the implementation of similar optical engines using 100G/lane EML driver ISG-D5616 used in 400G optical engines designed by POET.

ISG-D9616 is a single-channel DC-coupled EML driver that can be flip-chipped or wire bonded directly to the EML. This differential input and single-ended output driver does not need any bias-T or capacitor between the driver and the EML. The differential input to the driver also offers cross-talk immunity, especially for 112Gbaud/s applications. The driver is very compact, with a die size of 0.7mm x 0.9mm. The driver needs no external 50Ω termination for the EML, making the design very simple and eliminating RF degradation due to extra bond wire inductance between the EML and the 50Ω termination. ISG-D9616 is sampling to customers now.




**Measured eye at 106Gbaud/s ER=4.5dB, TDECQ=2.4dB.**

POET's 800G FR4 and DR4 transmit optical engines (OE) consist of high-speed externally modulated lasers (EMLs), integrated EML drivers (ISG-D9616) and optical multiplexer (for FR4) assembled on POET's optical interposer. The drivers and lasers are flip-chip attached at wafer scale and passively aligned to waveguides and multiplexer. The OEs have been designed specifically for use in 800G FR4 & 1.6T 2xFR4 and 800G DR4 & 1.6T DR8 OSFP and QSFP-DD pluggable transceivers.

"We were thrilled to work with InSiGa to be able to bring this unique combination of engine and driver to market as end-user demand for 800G optical modules is skyrocketing," says POET's chairman & CEO Dr Suresh Venkatesan. "Both module companies and end-users want to see the path to next-generation performance at 1.6T and beyond… The ease of implementation, product roadmap and extraordinary performance of this combined solution should garner wide attention," he adds.

"InSiGa has developed a number of platform-based products and ISG-D9616 is one such product that is derived from extensive R&D efforts spent on the 53Gbaud/s EML driver ISG-D5616. This approach allows for customers to quickly replace products for higher-baud-rate applications without making substantial changes to their designs," says InSiGa Technologies' CEO & chairman Dr Vikas Manan. "One of the major challenges working with EML-based designs is cross-talk and reflection-related issues due to impedance mismatch with the EML. ISG-D9616 takes care of both these issues, thus allowing better performance and ease of design," he adds. "We are very excited to work with POET on their silicon optical interposer-based platform. The optical engines developed by POET offer customers a very compact and high-performance solution that is not easy to achieve with conventional EML-based designs."

**www.insiga.com**
**www.poet-technologies.com**

# POET streamlines global engineering organization in response to AI market demand

## Closure of Allentown, PA operation to save US$2m annually

POET Technologies Inc of Toronto, Ontario, Canada — designer and developer of the POET Optical Interposer, photonic integrated circuits (PICs) and light sources for the data-center, telecom and artificial intelligence (AI) markets — has announced a reorganization of its engineering team to streamline design, component engineering and new product introduction (NPI) activities globally, in response to active customer demand for 800G-and-higher products directed at the AI systems and hyperscale data-center markets.

While the major AI network and systems companies are located in North America and China, almost all module makers — including POET's existing customers for optical engines — are located in China, Taiwan and other Asia Pacific countries. To better serve these and other customers, POET has established a Global Engineering Organization based in Singapore, led by Dr Mo Jinyu, senior VP, with the new product introduction (NPI) and component engineering teams reporting to her.

NPI is responsible for taking optical engine and module products from prototype design to initial manufacturing, coordinating with the product design and production teams along the way. All of these functions benefit from tight integration and geographic proximity. Critical product design and architecture, key customer relationships, global marketing & sales, and intellectual property management all continue to remain centered in California's Silicon Valley, while POET's finance, investor relations and other administrative functions are managed from its headquarters in Toronto.

As a result of this reorganization, the functions of engineering design and manufacturing interface — previously managed by POET's Allentown, PA organization — will be transferred to POET's Shenzhen operation, with other functions being transferred to Singapore. Compared to its annualized spend at the beginning of the year, the annual savings realized from the closing of Allentown on or before 31 March 2025 will be US$1.8–2m annually, with one-time costs estimated to be about US$250,000.

"Now that the company has a strong balance sheet, we can now confidently plan for our future, by streamlining the organization with a laser focus on securing design wins, delivering products and taking volume production orders from customers." says chairman & CEO Dr Suresh Venkatesan. "We fully expect that the partnerships and customers that we have announced over the past few months will mature into module designs that will qualify with end users and convert to optical engine revenue later this year and into 2025, with ultra-high growth in the years to follow."

# POET selected by Mentech to supply engines for 800G and 1.6T optical modules

## Optical product maker places initial orders to supply AI system operators and hyperscale data centers

POET says that its transmit and receive optical engines have been selected by Mentech Technology of Shenzhen, China(which supplies datacom and telecom components, including 200-800G optical modules for data-center networking infrastructure) for use in the development of 800G pluggable transceivers. The sample purchase orders are for initial builds and engineering development.

"Our end users expect us to deliver great-performing products that allow them to reach their business goals and grow their market share. A key to our progress is having outstanding vendors who can ensure that our entire eco-system remains innovative and cutting edge," says Mentech's chief technology officer Dr Qian Yinbo. "Adding POET's optical interposer platform technology helps us to expand our capabilities. The small form factor and flexibility of POET's highly integrated optical engines allow us to smoothly transition our products to higher speeds when our customers are ready for us to do so.

"POET has worked closely with Mentech to reach this pivotal stage in our relationship, and we look forward to seeing their 800G and 1.6T modules, powered by POET optical engines, out in the marketplace," says Dr Mo Jinyu, POET's senior VP & general manager in Asia.

Optical module design efforts usually take 6–9 months, followed by end-customer testing of an additional 3–6 months. Mentech is expecting an early launch of these new products incorporating POET's optical engines.

**www.mentech.com**
**www.poet-technologies.com**

# OpenLight and Epiphany partner on PIC design

## Epiphany's expertise in integrating active and passive components in photonic designs to combine with OpenLight's PDK technology

Photonic application-specific integrated circuit (PASIC) chip design and manufacturing company OpenLight of Santa Barbara, CA, USA (which launched as an independent company in June 2022, introducing the first open silicon photonics platform with heterogeneously integrated III-V lasers) has partnered with fabless photonic design house Epiphany, aimed at advancing the photonic integrated circuit (PIC) design ecosystem.

Epiphany gains access to OpenLight's open heterogeneously integrated III-V-based process design kit (PDK), providing more options and flexibility for mutual customers. OpenLight hence further broadens the scope of design possibilities, paving the way for more innovative and optimized PIC solutions across datacom, LiDAR, AI, healthcare and quantum computing applications.

According to market research firm IDTechEx, the overall PIC market will exceed $22bn by 2034, driven by key advances in technology and applications. The integration of PICs is expected to enhance business processes across multiple sectors by improving energy efficiency, reducing operational costs and supporting faster and more reliable network connections.

"Unlike typical silicon-based semiconductors, there's a significant shortage of talent capable of designing advanced PICs. Our goal is to make the transformative benefits of heterogeneously integrated silicon photonics PICs accessible to more users," says OpenLight's CEO Dr Adam Carter. "By partnering with Epiphany, we're bringing on PIC design experts who can immediately support customers to create unique, custom solutions using our technology. We're not just bridging gaps — we're paving a superhighway for innovation, accelerating development and lowering cost barriers," he adds.

"The integrated photonics landscape is evolving at a breakneck pace, yet it remains a fragmented ecosystem with significant barricades," says Epiphany's co-founder & CEO Jörn Epping. "With OpenLight's technology, we can leverage our expertise in integrated actives and passives to streamline design processes and address the lack of integration and accessibility while speeding up the adoption of integrated photonics technology across industries."

The market for heterogeneously integrated PICs is still developing, with standardized processes and common optical test approaches yet to be established. OpenLight's open PDK is said to offer significant advantages, with a comprehensive library of design components, supporting multiple platforms and technologies and facilitating collaboration between different players in the photonics ecosystem — from designers and manufacturers to end users.

With Epiphany's expertise in integrating active and passive components in photonic designs and OpenLight's PDK technology, the PIC design services are said to offer enhanced functionalities and customization to meet customer needs.

**www.openlightphotonics.com**
**www.epiphany-design.com**

# POET demos optical engines for AI at CIOE 2024

## Firm highlighting 800G 2xFR4 OSFP module reference design and 200G/lane transmit and receive optical engines

At the 2024 China International Optoelectronic Expo (CIOE) in Shenzhen (11–13 September), POET gave live demonstrations of the following optical products designed for the rapidly accelerating AI systems and hyperscale data-center markets:

- 800G 2xFR4 OSFP module reference design with POET's newly released 400G transmit engine and fully qualified 800G receive engine; and
- 200G/lane transmit and receive optical engines for use in 800G and 1.6T optical modules.

Chairman & CEO Dr Suresh Venkatesan and senior VP & general manager for Asia Dr Mo Jinyu led a team of POET engineers and executives at the exhibition.

"CIOE is an essential conference for POET. In previous years, our attendance has led to some of our most important customer relationships, and we expect this year's event will open more doors for the company," says Venkatesan. "Customers appreciate the versatility of the Optical Interposer platform, the ease of engineering POET's optical engines into modules and the resulting cost and performance advantages. There is also a growing recognition that POET's approach to chip-scale integration may be indispensable to meeting the speed and bandwidth requirements of artificial intelligence (AI) applications in the AI server and hyperscale data-center markets."

At CIOE, POET shared a booth with Super Photonics (SPX), its joint venture in Xiamen, China. SPX showcased production-ready optical engines that should be on the market by the end of 2024.

**www.poet-technologies.com**

# POET and Mitsubishi Electric collaborate to develop 3.2T optical engines for AI networks

POET Technologies Inc of Toronto, Canada — designer and developer of the POET Optical Interposer, photonic integrated circuits (PICs) and light sources for the data-center, telecom and artificial intelligence (AI) markets — has entered into a collaboration with Mitsubishi Electric Corp of Tokyo, Japan to co-develop integrated optical engine chipsets for 3.2T pluggable transceivers targeting optical connectivity in the rapidly growing artificial intelligence networking market. POET and Mitsubishi Electric aim to complete the 1.6T and 3.2T optical engine chipsets in early 2025 and then jointly demonstrate the products to major customers during first-half 2025.

"POET's optical engines will open the possibility of creating new products where electronics photonics convergence is successfully achieved at an advanced level of integration between InP and Si-based interposer, which take us and our valued customers into the next generation of data networking for AI and hyperscale data centers," says Yasuhiro Yamauchi, general manager of Mitsubishi Electric's Optical Device Department. "This promises to be a momentous technological achievement when it is unveiled."

Mitsubishi Electric will contribute its highly differentiated 400G electro-absorption modulator integrated lasers (EMLs) to the project. Using its Optical Interposer platform technology, POET will integrate the EMLs along with drivers, optical waveguides and other key functional building blocks to produce 1.6T and 3.2T optical engine chipsets.

"The AI and datacom networks need a pluggable transceiver solution for 3.2T, and POET's Optical Interposer is one of the few technologies that can achieve that performance. When our Mitsubishi Electric colleagues understood the full functionality of the Optical Interposer and its potential to optimize the performance of their leading-edge lasers, they knew that we offered the right solution for their needs," says POET's chairman & CEO Dr Suresh Venkatesan. "What we have worked so hard to achieve over these past five years is coming true. POET's products are steadily being adopted by the industry, and we expect demand to accelerate as our customers gain further understanding of the power efficiency and cost savings that we offer to them and their customers."

AI and cloud data-center networks are the leading consumers of pluggable optics. The global optical transceiver market for 800G and 1.6T is projected to grow at a CAGR of 33% from $2.5bn in 2024 to $10.5bn by 2029, forecasts LightCounting.

**www.poet-technologies.com.**
**www.MitsubishiElectric.com/semiconductors/opt**

# POET and Luxshare expand product offerings for AI

POET has expanded its partnership with Luxshare Technology Co Ltd (a subsidiary of Luxshare Precision Industry Co Ltd of Dongguan, China that designs and makes datacom facilities and enterprise-level products) to provide more optical modules targeted at AI network equipment and AI service providers.

Luxshare and POET agreed to produce additional types of optical transceiver modules after testing 800G 2xFR4 OSFP modules using POET's receive optical engines. These showed exceptional performance, prompting Luxshare to adopt a broader range of POET's optical engines into its offerings.

The additional products include POET's transmit and receive optical engines for Luxshare's 400G and 800G pluggable transceivers for single-mode-fiber applications. These transceivers will combine POET's 100G/lane and 200G/lane optical engines with Luxshare's optical module designs. The optical modules will be manufactured and sold globally by Luxshare Tech.

"Luxshare Tech is committed to providing our current and prospective customers with high-performance, low-cost transceivers and modules that deliver the power savings that are coveted by AI developers, data-center hyperscalers, and the computing industry," says Mike Gao, general manager of Luxshare's Opto-electronic business unit. "POET's interposer-based optical engines have surpassed our expectations," he adds. "The solutions we are working on will deliver faster and more energy-efficient data communications within the next year."

Selected POET optical engines are being integrated into existing Luxshare products that are already on the market. Along with the 800G 2xFR4 OSFP module, Luxshare is developing a series of DSP-based and linear pluggable optics products for 400G and 800G speeds using POET's optical engines. These projects will generate complete solutions that include transmit and receiver engines that are built on the POET Optical Interposer platform technology.

"We are delighted to deepen this partnership with Luxshare Tech to bring to market products that are hotly demanded by AI and datacom customers," says POET's chairman & CEO Dr Suresh Venkatesan. "To have one of the largest companies in our industry acknowledge the value that POET brings to their supply chain is validation of the commercial appeal of our products."

**http://en.luxshare-tech.com**

# Sivers and Ayar Labs introduce first CW-WDM MSA-compliant 16-wavelength light source with demo at ECOC

## Sivers' 16-wavelength DFB laser array integrated into SuperNova multi-wavelength light source module

At the European Conference on Optical Communication (ECOC 2024) conference in Frankfurt, Germany (23–25 September), Sivers Semiconductors AB of Kista, Sweden (which supplies integrated chips and modules for photonics and wireless solutions), in collaboration with silicon photonics-based chip-to-chip optical connectivity firm Ayar Labs of Santa Clara, CA, USA, introduced what is said to be the industry's first CW-WDM MSA-compliant 16-wavelength light source.

Sivers and Ayar hosted a joint live demonstration showcasing the 16-wavelength distributed feedback (DFB) laser array, integrated into the Ayar Labs SuperNova multi-wavelength light source module.

As foundational AI models continue to grow in size and complexity, they demand increased GPU/accelerator processing power and memory capacity. By integrating optical I/O directly within the GPU or accelerator package, this solution enables communication across the GPU cluster, ensuring scalable and efficient infrastructure to meet the expanding demands of AI workloads. Optical connections also significantly reduce power consumption while delivering 5-10x faster communication speeds within the cluster, optimizing GPU utilization and accelerating AI performance.

"We continue to deliver industry-leading laser arrays from our InP100 platform driving performance improvements through increased output powers and higher wavelength count," says Andrew McKee, managing director of Sivers Semiconductors' Photonics business unit.

"Sivers Semiconductors has been a key partner in our journey to bring high-bandwidth, low-latency optical I/O to market at scale," says Ayar's chief technology officer Vladimir Stojanovic. "This demonstration of our second-generation SuperNova light source, combined with Sivers' 16-wavelength laser array, highlights the significant progress we've made together," he adds. "With AI models continuing to grow in size and complexity, our innovative optical solution enables AI scale-up fabrics with unprecedented power, performance, and efficiency, boosting the economics of rapidly evolving AI workloads."

**https://ayarlabs.com/**
**www.sivers-semiconductors.com**

# HyperLight raises $37m in Series B funding round to accelerate product development and meet demand

## Summit Partners' CEO joins board of TFLN PIC firm

HyperLight Corp of Cambridge, MA, USA — which designs and manufactures photonic integrated circuits (PICs) based on its proprietary production-grade thin-film lithium niobate (TFLN) platform — has raised $37m in a Series B funding round led by Summit Partners and including existing investors Xora Innovation (a deep tech venture fund backed by Temasek) and Foothill Ventures. Summit Partners' managing director & CEO Peter Chung joins HyperLight's board of directors.

Existing PICs have performance limitations due to their material properties and have become bottlenecks for high-performance optical communication, says HyperLight. The firm claims that its TFLN PICs deliver unmatched bandwidth and energy efficiency well-aligned with the current and future needs of AI/data-center infrastructure, telecoms optical networks, and high-performance computing. Since it was founded in 2018, HyperLight has delivered industrial-scale TFLN PICs with a trusted supply chain. The new financing allows it to accelerate product development and meet rapidly growing customer demand.

"We believe TFLN will be the photonics platform of the future and identified HyperLight as an emerging category leader," comments Chung. "The HyperLight team has established an impressive track record of pioneering innovation and strong execution. In a short time, the company has evolved this critical technology into market-ready products with a production-ready supply chain," he adds.

"We are thrilled to welcome Summit Partners as a new investor given their capabilities and deep experience in photonics, including investments in E-TEK Dynamics, Finisar, MACOM and Acacia Communications," says HyperLight's president & CEO Mian Zhang. "This financing round, supported by investors with demonstrated experience in the photonics industry, will enhance our ability to serve the current and future needs of our customers as a trusted innovation partner."

**www.summitpartners.com**
**www.hyperlightcorp.com/communication-transmitter-photonic-integrated-circuit**

# Lumentum showcases enhanced photonic innovations for AI-driven, next-generation networks at ECOC

## Firm demos 800G ZR+ transceivers and tunable SFP28 ER modules; shares insights on energy-efficient optics for scalable AI networks

Lumentum Holdings Inc of San Jose, CA, USA (which designs and makes optical and photonic products for optical networks and lasers for industrial and consumer markets) showcased its latest photonic solutions at the European Conference on Optical Communication (ECOC 2024) in Frankfurt, Germany (23–25 September). Highlights were as follows.

**Advancing AI and high-capacity networks with enhanced 800G ZR+ transceivers**

Lumentum featured its recently enhanced 800G ZR+ coherent pluggable transceivers, optimized for extended-reach and higher-optical-power applications, including expanded long-reach, high-capacity data-center interconnect use cases driven by AI. Due to constraints in delivering electrical power for their expanding AI infrastructure, cloud operators increasingly need to interconnect geographically dispersed data centers, placing greater demands on optical network capabilities.

The enhanced performance in Lumentum's 800G ZR+ transceivers stems from its hybrid photonic integrated circuits, which leverage in-house proprietary indium phosphide (InP) technology for superior transmission performance.

Live demonstrations of 800ZR+ and 400G ZR+ transceivers were conducted at ECOC, showcasing their high performance.

Recognized in the 2024 Lightwave Innovation Review Awards, these transceivers have the flexibility to interface directly into routers and are designed to address rapidly growing data traffic in data-center interconnects and a wide range of other high-capacity applications across metro, regional and long-haul networks.

**Tunable SFP28 ER modules for increased bandwidth demands and improved network connectivity**

Lumentum also demonstrated its latest tunable SFP28 ER module, a high-performance optical transceiver supporting 25Gbps DWDM links over distances up to 40km. Designed to perform in the more extreme industrial temperature range, this module supports the growing bandwidth demands of cable MSOs driven by DOCSIS 4.0 and FTTH deployments. It also enhances 5G transport network connectivity by offering a high-performance solution that leverages existing C-band fiber infrastructure.

**Participation in OIF 800ZR, 400ZR+ and multi-span optics interop and CMIS demos**

In addition to its live demonstrations, Lumentum participated in the Optical Internetworking Forum (OIF) interoperability demonstration. This showcase featured Lumentum's 800ZR coherent transceivers, highlighting advancements in 800ZR and 400ZR+ optics interoperability. The demo included the first public 800ZR multi-vendor DSP interoperability, as well as OpenZR+, 100ZR and OpenROADM/ITU-T, all operating over multiple, multi-span networks.

Lumentum also demonstrated its OpenZR+ and 400ZR QSFP-DD transceivers in the Common Management Interface Specification (CMIS) demonstration, showcasing the benefits of supporting the CMIS standard across multiple applications. The CMIS standard has become essential for managing pluggable modules, providing a uniform method for monitoring, initialization and control. Lumentum's OpenZR+ module shows how CMIS compliance allows a host to monitor status, control the optical channel, manage output power, and switch between 400G and 100G application modes.

**Capacity and efficiency challenges in AI networks**

At ECOC, Lumentum discussed how new optical solutions can improve energy efficiency in AI networks. Lumentum's chief technology officer for Cloud and Networking, Matt Sysak, delivered a presentation 'Energy Efficient Optics for Sustainable Scaling of AI Networks'.

Drawing from Lumentum's recent whitepaper, the presentation explored how the company's optical technologies can potentially slash network power consumption by up to 80%, resulting in savings of over 17MW of power and a reduction of up to 10,000 metric tons of $CO_2$ emissions per AI training cycle.

Also, Lumentum's senior director of product line management Simon Warren participated in a workshop 'When Could Multi-Band Systems Become More Cost-Effective Than Parallel C-Band Systems?', which explored the adoption of C+L-band systems to manage growing traffic demands, potential saturation issues, and shifts toward wider-bandwidth solutions like S+C+L systems, as well as the role of emerging fiber technologies in scaling networks.

**OIF interoperability at ECOC: 34 member firms showcase solutions for data centers, AI/ML technologies and disaggregated systems**

At ECOC, OIF hosted a dynamic interoperability demo with 34 member companies, showcasing solutions that enhance performance, efficiency and capacity for future data centers, AI/ML and disaggregated systems. Live demos showcased interoperability in 800ZR, 400ZR, multi-span optics, energy-efficient interfaces, co-packaging, 224G and 112G common electrical I/O and CMIS.

**www.lumentum.com**

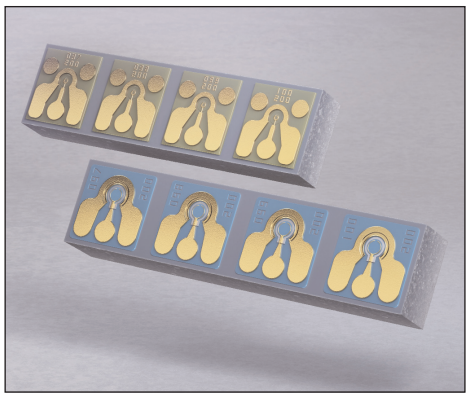
# TRUMPF boosts performance of datacom VCSELs with proprietary subwavelength surface-grating technology

## Grating technology improves polarization stability & signal performance

TRUMPF Photonic Components GmbH of Ulm, Germany (part of the TRUMPF Group) — which makes vertical-cavity surface-emitting lasers (VCSELs) and photodiodes — says it has improved its proprietary subwavelength surface-grating technology for datacom VCSELs.

Subwavelength grating technology leads to better relative intensity noise (RIN) performance, reduces sensitivity against optical feedback and avoids polarization flips. As a result, the signal quality in a complex optical link is improved and higher data rates enabled without any change to the light–current–voltage (LIV) characteristics. The benefits of this technology work for all offered wavelengths.

"Our proprietary, advanced subwavelength grating technology has been a proven, key feature in our



**TRUMPF's 100G VCSEL and photodiode, offered as a matching pair solution.**

VCSEL solutions for two decades now and has been employed in many millions of consumer devices," says Ralph Gudde, VP of marketing & sales. "This technology found its way into our datacom products and offers customers a performance that sets them apart," he adds.

Advanced optical data communication systems benefit from the high-speed data transmission that the VCSEL-based technology offers. TRUMPF says that its new 100G wavelength division multiplexing (WDM) VCSELs emitting at 850nm, 880nm, 910nm and 940nm have a ground–signal–ground (GSG) pad layout and are flip-chip bondable. They will have a bandwidth of 25GHz, are fully passivated and mechanically protected. TRUMPF is offering both VCSELs and photodiodes as a matching pair solution in various configurations like singlets, 1x2, 1x4, 1x8 and/or 1x12 arrays. The VCSELs are specifically designed to meet the demands of data centers, AI/ML, high-performance computing, and other bandwidth-intensive applications, as they deliver stable and reliable data transmission at high speeds.

# TRUMPF presents next-generation VCSEL devices for LPO and CPO at ECOC

## Subwavelength gratings reduce RIN and burst noise; composite VCSELs provide improved single-mode robustness, faster speed and lower thermal impedance

At the European Conference on Optical Communication (ECOC 2024) in Frankfurt, Germany (23–25 September), TRUMPF Photonic Components presented upcoming advances in VCSEL technology aimed at meeting evolving demands of the future datacom market.

"These improvements focus on increasing functionality per chip area to support low-noise LPO [linear-drive pluggable optics] links and densely integrated CPO [co-packaged optics] technology," says Roman Koerner, head of R&D. Key innovations include subwavelength gratings to reduce relative intensity noise (RIN) and

**TRUMP's datacom VCSEL.**

burst noise, as well as composite VCSELs for improved single-mode robustness, faster speed and lower thermal impedance. Designed for wavelengths like 1060nm and 1310nm to minimize fiber attenuation, this technology will play a crucial role in the next generation of high-performance optical transceivers, reckons the firm.

Advanced optical data communication systems benefit from the high-speed data transmission that the VCSEL-based technology offers. TRUMPF says that it continues to invest heavily in its technology for higher data rates and is offering both VCSELs and photodiodes as a matching pair solution in various layouts like singlets, 1x2, 1x4, 1x8 and/or 1x12 arrays. The VCSELs are specifically designed to meet the demands of data centers, AI/ML, high-performance computing, and other bandwidth-intensive applications, as they deliver stable and reliable data transmission at high speeds.

**www.ecocexhibition.com**
**www.trumpf.com/s/VCSEL-solutions**

# TRUMPF and Optomind showcase 100Gbps VCSEL performance in 800Gbps transceiver at ECOC

## Performance optimized for short reach using TRUMPF VCSEL inside Optomind's transceiver

TRUMPF Photonic Components GmbH of Ulm, Germany (part of the TRUMPF Group) — which makes vertical-cavity surface-emitting lasers (VCSELs) and photodiodes — and its customer Optomind Inc of Suwon, South Korea, which provides optical interconnect solutions for data centers including artificial intelligence (AI) and high-performance computing (HPC) networks, showcased 100Gbps VCSEL performance at the European Conference on Optical Communication (ECOC 2024) in Frankfurt, Germany (23–25 September).

"We are delighted to have achieved a solid performance of 800Gbps in our transceiver, leveraging innovative optics technology and TRUMPF's improved 100Gbps/ch VCSEL," says Optomind's chief marketing officer Yung Son. "We look forward to solidifying our partnership with TRUMPF as the strategic best-in-class VCSEL supplier for distinguished transceiver and active optical cable (AOC) to our customers," he adds. With increasing demand for multi-channel high-speed data transmission in AI/ML-based hyperscale cloud computing space, 800Gbps data rate at 100Gbps per lane and beyond is essential.

"We are pleased with continuing collaboration with Optomind to demonstrate the performance of our VCSEL at PAM4 112Gbps/ch in their transceiver, which validates the use of it in a real-world application," says Ralph Gudde, TRUMPF's VP of marketing & sales. "A full-featured version with enhanced technology for superior performance over longer-link transmission, and at higher temperatures, is nearing the release this year," he adds. "TRUMPF is diversified, has a strong technology background, and brings solid long-term commitment as a technology partner and a key supplier into the datacom business."

Advanced optical data communication systems benefit from the high-speed data transmission that the VCSEL-based technology offers. TRUMPF says that it continues to invest heavily in its technology for higher data rates and is offering both VCSELs and photodiodes as a matching pair solution in various layouts like singlets, 1x2, 1x4, 1x8 and/or 1x12 arrays. The VCSELs are specifically designed to meet the demands of data centers including for AI/ML, high-performance computing, and other bandwidth-intensive applications, as they deliver stable and reliable data transmission at high speeds.

**www.sensor-test.de/en**

# ENET unveils 100G ZR QSFP28 DCO DWDM tunable transceiver

## Cost-effective, low-power 100Gb/s performance for the optical edge, enhancing network capacity without major equipment upgrades, ensuring efficient path to 100G edge aggregation

Optical networking solutions firm ENET of Aliso Viejo, CA, USA (a brand of NSI Industries LLC) has released a cost-efficient, low-power 100G ZR QSFP28 DCO DWDM tunable transceiver. Specifically designed for the optical edge, it addresses the growing need for upgrading edge aggregation infrastructure to 100Gb/s rates as data traffic continues to surge. The solution significantly increases network capacity by incorporating dense wavelength division multiplexing (DWDM) technology, allowing multiple signals to travel over the same fiber.

**ENET's 100G QSFP28 DCO DWDM transceiver**

"This transceiver simplifies and reduces upgrade costs without necessitating the replacement of existing equipment, enabling easy integration into existing head-end devices," says technical operations manager Chris Hazell. "This new offering from ENET facilitates the seamless adoption of 100Gbit/s technology at the network edge, all while maintaining edge-level pricing."

**www.enetusa.com**
**www.nsiindustries.com**

# Source Photonics unveils 1.6T and 800G PAM4 transceiver family at ECOC

## 200G PAM4 EMLs enable AI/ML and cloud data-center deployments towards next-gen 51.2T and 102.4T switch platforms

With a live demonstration at the European Conference on Optical Communication (ECOC 2024) in Frankfurt, Germany (23–25 September), Source Photonics Inc of West Hills, CA, USA (which provides communications and data connectivity solutions for hyperscale and AI data centers, metropolitan area networks and access networks) announced product availability of its transceiver portfolio, including 1.6T and 800G optical modules/AOC/DAC based on single-lambda 200G PAM4 technology, the latest 800G 4_200G DR4/FR4/LR4 and 400G/800G optical modules supporting immersion liquid cooling. The firm says that this represents a critical milestone for enabling next-generation 51.2T and 102.4T switch platforms for accelerated AI compute infrastructure.

Source Photonics' latest 1.6T product series includes DR8, 2xFR4 optical modules and DAC/ACC copper cables. The 800G product series includes SR8, DR8, 2xFR4 based on single-lambda 100G, and DR4, FR4, and LR4 modules based on single-lambda 200G, as well as DAC/ACC/AEC copper cables packaged in either OSFP or QSFP-DD form factors covering multiple optical connector and interface options.

Source Photonics began production shipments of 100G single-lambda PAM4-based 100G/400G transceivers when 400G industry adoption started to take off from 2021. Over 7.5 million high-speed 28/53GBd externally modulated laser (EML) chips have since been shipped. The newly released product-grade 100GBd EMLs enable 200Gb/s single-lambda PAM4 signaling for shipping 1.6T and 800G transceivers. The 800G FR4/LR4 optical modules were demonstrated at the ECOC exhibition. The optical modules leverage self-developed 200G PAM4 EML lasers operating around the O band, including CWDM wavelengths of 1271nm/1291nm/1311nm/1331nm and LWDM wavelengths at 1295.5nm/1300.0nm/1304.5nm/1309.1nm. It operates error free under KP4 + inner code FECi threshold of $4.85 \times 10^{-3}$ at 113.4GBaud, and supports up to 10km single-mode fiber transmission, exceeding IEEE Std 802.3ck-2022 and IEEE P802.3dj D1.1 specifications.

"Highly integrated and reliable 200G PAM4 EMLs double the optical bandwidth of current solution to enable 1.6Tbps pluggable modules for scaling AI cluster in data centers, which facilitate the industry transition to 51.2Tbps per RU networking architectures," says chief technology officer Dr Frank Chang. "The latest generation of 800G family of products reduces power consumption per bit by over 20%." The transceivers support backward compatibility and flexibility for smoothly upgrading from 400G to 800G and then 1.6T. "The successful commercialization of 800G DR4/FR4/LR4 and the associated 1.6T DR8/2xFR4/2xLR4 optical transceivers represent our commitment in optical connectivity innovation to deliver next-generation pluggable transceivers," says Chang.

**Source Photonics at ECOC 2024 exhibition**

Live demonstrations of the 800G 4x226.8G PAM4 FR4/LR4 QSFP-DD optical modules were conducted during the ECOC 2024 exhibition, together with 1.6T, 800G, 400G/800G 2PIC, LPO/LRO, 10/25G/100G tunable and 25/50G PON high-performance optical transceiver solutions. Also at ECOC, Source Photonics delivered a speech on 200G/lane-based 800G/1.6T optical transceivers.

**www.ecocexhibition.com**
**www.sourcephotonics.com**

# Fast Photonics demos latest 1.6T SiPh-based transceiver

At the European Conference on Optical Communication (ECOC 2024) in Frankfurt, Germany (22–26 September), high-speed optical transceiver module and subassembly manufacturer Fast Photonics Technology Co Ltd of Richardson, TX, USA demonstrated the silicon photonics (SiPh)-based 1.6T optical transceiver. The transceiver utilizes the industry's latest 8x 200G/lane silicon photonic integrated circuits and is based on the firm's next-generation transceiver technology. The demonstration shows full operation of a 1.6T DR8 OSFP module at reaches up to 2km.

The new 1.6T transceiver line offers what is claimed to be best-in-class power dissipation and cost-competitive pricing. To mitigate any potential supply chain disruptions, Fast Photonics is offering these products from dual manufacturing sites.

The 1.6T product line offers DSP, LPO and LRO products in both multi-mode and single-mode. Initial products will be in OSFP formats.

"This launch marks a significant milestone in our commitment to delivering top quality products with availability from both North American and Asian manufacturing sites," says Anthony Musto, VP of sales & marketing.

**www.fast-photonics.com**

# Hyper Photonix highlights 400G and 800G silicon photonics transceivers at ECOC Ethernet Alliance interoperability demo

## Transceivers showcased in form factors including DSP and LPO

In the Ethernet Alliance interoperability demonstrations at the European Conference on Optical Communications (ECOC 2024) in Frankfurt, Germany (22–25 September), silicon photonics (SiP) optical transceiver designer and manufacturer Hyper Photonix Ltd of Bellevue, WA, USA highlighted its 400G and 800G Hyper Silicon photonics transceivers in live demonstrations alongside other key industry players.

"Like in previous years, this is a great opportunity for Hyper Photonix to showcase its range of 400G and 800G Hyper Silicon photonics transceivers in various form factors, including DSP and LPO designs, in an industry-wide live demonstration that highlights Ethernet product interoperability across various host switching platforms and test equipment solutions," says CEO Xavier Clairardin. "Our company is at the forefront of optical networking technology and brings innovative high-speed and low-power silicon photonics optical connectivity solutions critically needed in demanding AI/ML applications today and in the future."

As the demand for higher bandwidth and energy efficiency intensifies with artificial intelligence (AI) and machine learning (ML) deployments, Hyper Photonix says that it is continuously innovating, and its most recent developments in linear-drive pluggable optics (LPO) leverages its Hyper Silicon platform to deliver low-power transceivers ranging from 4.5W at 400G and 9W at 800G and DSP-comparable TDECQ and BER performance.

**www.ecocexhibition.com**
**www.ethernetalliance.org**
**www.hyperphotonix.com**

# MACOM showcases high-speed analog connectivity solutions at ECOC

## Live demos included 200G per lane high-performance analog products and 800G innovations and QSFP112 solutions

MACOM Technology Solutions Inc of Lowell, MA, USA (which designs and makes RF, microwave, analog and mixed-signal and optical semiconductor technologies) showcased its latest connectivity products at the European Conference on Optical Communication (ECOC) in Frankfurt, Germany (23–25 September).

MACOM's portfolio spans a wide range of optical and copper connectivity solutions, including high-speed optical receiver solutions, lasers, laser and modulator drivers, optical clock recovery (OCR) modules, optical post-amplifiers, photodiodes and transimpedance amplifiers, and advanced clock and data recovery integrated circuits.

Live demonstrations and semiconductor solutions presented included the following:

- 200G per Lane High Performance Analog Products: These support both optical and copper connectivity, enhancing network flexibility and performance to 1.6T speeds.
- 800G Innovations and QSFP112 Solutions: The company's latest advancements in high-speed data transmission technologies at 100G per lane.
- 25G PON Designs: New developments in passive over network technology designed for next-generation broadband.
- FMCW LiDAR and 25G/50G Optical Automotive Ethernet: Innovative solutions in automotive networking and sensor technology.
- PCIe-over-Fiber: See how PCIe technology is being extended over fiber optics for low-latency longer-reach applications.
- MACOM PURE DRIVE Transimpedance Amplifiers and Laser Drivers: Tailored to provide efficient interconnect linear pluggable optics (LPO) solutions for data centers, enterprise and telecom.
- High-Performance Linear Equalizers: Designed for Ethernet, InfiniBand, and Fibre Channel applications, supporting 100Gbps to 1.6Tbps Active Copper Cables.

**www.ecocexhibition.com**
**www.macom.com**

# Coherent introduces first L-band 800G ZR/ZR+ pluggable transceivers

Materials, networking and laser technology firm Coherent Corp of Saxonburg, PA, USA has introduced the industry's first L-band 800Gbps coherent pluggable transceiver in a QSFP-DD form factor, showcased at ECOC 2024 in Frankfurt, Germany (23–25 September) and to begin customer sampling in fourth-quarter 2024.

Hyperscale data centers and telecom carriers require solutions to expand fiber capacity at lower costs. By expanding from C-band to L-band, fiber capacity can double from 32Tbps to 64Tbps. Historically, L-band has been supported with proprietary systems from network equipment manufacturers. Coherent's new standardized 800G ZR/ZR+ pluggable module now allows disaggregation, supporting an open ecosystem in a smaller and more efficient form factor.

"Building on the success of the world's first C-band 140GBaud IC-TROSA, Coherent has successfully extended the technology to the L-band with our new pluggable module," says Dr Beck Mason, executive VP, telecommunications. "We now feature both C-band and L-band 800G coherent transceivers with high optical output power, which delivers best-in-class transmission performance. We continue to advance the state of the art of optical transmission in core networks by leveraging the inherent capabilities of our indium phosphide technology platform to benefit our end customers," he adds.

"With the ever-growing bandwidth demands of DCI and telecom networks, L-band transmission has become essential," says Kyle Hollasch, lead analyst for transport hardware at Cignal AI. "L-band ROADM shipments have nearly doubled over the past 12 months, and hyperscale DCI requirements are poised to grow the market for L-band pluggable coherent transceivers even more rapidly."

With the availability of L-band 800G ZR/ZR+ transceivers in both QSFP-DD and OSFP form factors, Coherent says it enhances the capacity and performance coverage of IP-over-DWDM (dense wavelength division multiplexing) applications. These modules enable coherent interfaces directly on routers and switches, eliminating the need for additional optical equipment, thus reducing costs by more than 400%.

The 800G ZR/ZR+ transceiver leverages the Coherent L-band 140 Gbaud IC-TROSA-integrated coherent optical subassembly, which features a high-efficiency, internally designed and manufactured indium phosphide modulator and receiver combined with an embedded wavelength-tunable laser. This delivers compelling cost, power, size and performance advantages compared with L-band implementations based on silicon photonics, which need micro-EDFAs, adding cost and power dissipation and consuming precious real estate in compact form factors such as QSFP-DD.

"Driven by emerging data-hungry applications, the rapid adoptions of generative AI solutions, and ubiquitous video consumption from any place and device, we marvel at the relentless trajectory of bandwidth consumption," says AE Natarajan, executive VP, chief development officer, Juniper Networks. "Adding L-band 800 ZR/ZR+ pluggable solutions to the toolbox, effectively doubling the capacity of existing fiber plants, is invaluable and reassuring to network operators. Fortunately, many operators had the foresight to deploy L-band-ready line systems, anticipating the future need to scale network capacity rapidly. By leveraging the QSFP-DD form factor, Coherent enables vendors like Juniper to deliver highly flexible and scalable IPoDWDM solutions that facilitate port-by-port configuration of 800G direct-detect and/or coherent optics, and now C-band or L-band DWDM optics, mitigating bottlenecks in a myriad of cloud and telecom use cases."

At ECOC, Coherent demonstrated the 800G L-band transceiver module in a PTX10002-36QDD Juniper router, showcasing its capabilities in an IP-over-DWDM configuration. The module is designed for various line modulation formats and supports 800 Gbps extended-reach, 600Gbps and 400Gbps long-reach applications.

**www.coherent.com**

# Coherent announces general availability of first 100G ZR QSFP28-DCO transceiver

Coherent has announced the general availability and production release of what is claimed to be the industry's first 100G ZR QSFP28 digital coherent optics (DCO) transceiver.

Leveraging the efficiency of Steelerton digital signal processor (DSP) technology from Coherent, the 100G ZR QSFP28-DCO module is said to set a new standard for low power consumption, operating at an industry-leading 5W in a highly compact form factor. The DSP is integrated with a silicon photonics optical front-end and a power-optimized tunable laser, based on Coherent's indium phosphide platform. The combination of proprietary DSP and optics designs exemplifies the value of vertical integration for performance and scalability, says Coherent.

"We're thrilled by the strong customer demand across multiple market segments and are excited to scale commercial deployments with our partners globally," says Dr Beck Mason, executive VP, telecommunications, at Coherent.

"Digital coherent technology is moving closer to the edge to support ever-increasing demand for more bandwidth," comments Vladmir Kozlov, CEO of LightCounting LLC. "Coherent's 100G QSFP28 offers the industry the opportunity to seamlessly upgrade 10G DWDM networks with 100G transceivers without the need to re-engineer the network and allows reuse of existing 100G router and switch ports," he adds.

"10G DWDM is widely deployed at the edge of the network, but carriers are searching for higher-bandwidth 100G solutions," says Scott Wilkinson, lead analyst at Cignal AI. "Low-power QSFP28 is required at the edge, and Coherent's 100ZR solution is well positioned to be the upgrade format of choice. It provides a span budget, ease of installation, and the chromatic dispersion tolerance of coherent with a format that smoothly integrates into existing hardware. This solution allows carriers to easily and economically increase capacity 10x at the edge of the network," he adds.

"This transceiver sets a new benchmark in power efficiency, consuming far less energy than any other coherent solution on the market," comments Christoph Glingener, chief technology officer of Adtran. "It enables operators to easily upgrade their edge and access networks from 10Gbps to 100Gbps data rates, while lowering both capital and operational expenses."

The 100G ZR QSFP28-DCO is available in variants supporting both the SFF-8636 and CMIS management interface standards, ensuring compatibility with a wide range of existing network infrastructures. The seamless upgrade path on deployed QSFP28-equipped devices and the 300km dispersion-limited reach make the 100G ZR QSFP-DCO a versatile solution. Additionally, the integration of Flextune auto-tuning technology ensures zero-touch provisioning, significantly simplifying operations and reducing deployment complexity for carriers.

**www.Coherent.com**

# CW DFB InP lasers for silicon photonics transceivers

Coherent has launched new family of high-efficiency continuous wave (CW) distributed feedback (DFB) lasers specifically engineered for silicon photonics transceiver modules.

Designed to operate in the O-band (1310nm region), the CW indium phosphide (InP) lasers are said to redefine the capabilities of silicon photonics modulators used in 800G and 1.6T optical transceivers. The transceivers are on the forward edge of data transmission technology, addressing the bandwidth demands caused by the rapid adoption of machine learning networks within AI-driven data centers.

Featuring a proprietary low-series-resistance design, the CW lasers are reckoned to achieve about 15% greater power efficiency compared with the existing industry standard. This addresses the critical demand for reduced power consumption in silicon photonics transceivers, providing an advantage in operational efficiency.

"By lowering power consumption, we're addressing one of the most pressing challenges faced by our customers today. And with our upcoming expansion to a state-of-the-art 6-inch InP fab in Sherman, Texas, by 2026, we expect production capacity to be 5x our current production rate, a significant ramp given the complexity of this material," says Dr Kou-Wei Wang, VP of InP directly modulated lasers & photodiodes. "We are committed to leading the market with technology and supply chain capacity as our customers increase demand in the InP laser sector."

The first offering in the new laser family is a 70mW 1310nm laser, designed for uncooled, non-hermetic operation up to 85°C junction temperature. Commercial shipments begin in September. Coherent will release a higher-power laser for cooled operations, along with lasers tailored for the CWDM grid, in 2025.

The firm says that the lasers are not only efficient but also robust, offering what is claimed to be exceptional reliability due to the elimination of aluminium in the active quantum well region.

# First Solar inaugurates $1.1bn, 3.5GW Alabama CdTe PV manufacturing facility

## Lawrence County facility creates more than 800 manufacturing jobs

Cadmium telluride (CdTe) thin-film photovoltaic (PV) module maker First Solar Inc of Tempe, AZ, USA has inaugurated its new $1.1bn fully vertically integrated thin-film solar manufacturing facility in Lawrence County, Alabama. The facility, which adds 3.5GW of fully vertically integrated nameplate solar manufacturing capacity in the USA, is expected to create over 800 technology manufacturing jobs in the state.

"This production facility is destined to become a major player in the US renewable energy market," said Alabama Governor Kay Ivey. "Moreover, the Alabama workers at this facility will help break the nation's dependence on foreign-made solar panels and contribute to our energy independence."

Along with First Solar's three operating factories in Ohio, the Lawrence County facility brings the company's nameplate manufacturing capacity to almost 11GW in the USA and over 21GW globally, once fully ramped. Already the largest fully vertically integrated solar manufacturer in the Western Hemisphere, First Solar is also constructing a $1.1bn, 3.5GW facility in Louisiana, which is expected to be commissioned in second-half 2025. The firm expects to have over 14GW of annual nameplate capacity in the USA and 25GW globally by the end of 2026.

"This is the first of two fully vertically integrated solar manufacturing facilities that solidify the role of the Gulf Coast states in enabling America's all-of-the-above energy strategy," says CEO Mark Widmar. "This energy technology manufacturing facility produces American solar panels, with American-made components sourced from a supply chain that spans the country. The hundreds of people that operate this facility represent the next generation of American energy workers and are joined by thousands more steelworkers, glassworkers, miners, truck drivers, railroad workers, and others that enable our mission to support our country's energy security."

**First Solar has inaugurated its new $1.1bn fully vertically integrated thin-film solar manufacturing facility in Lawrence County, Alabama.**

First Solar's highly differentiated manufacturing process allows it to transform a sheet of glass into ready-to-ship thin-film solar panels in about 4 hours. The Alabama facility's entire solar value chain — equivalent to transformation from semiconductor to wafer to cell to module — operates under one roof, using one tightly controlled process with rigorous quality assurance and control. The Series 7 modules produced in Lawrence County use Alabama-sourced steel, smelted, rolled and fabricated within a 25-mile radius of the facility.

**As the firm grows to 14GW in annual US nameplate capacity by the end of 2026, it will support an estimated 30,060 direct, indirect and induced jobs across the country, representing $2.8bn in annual labor income**

First Solar says that it is unique among the world's largest solar manufacturers because it is the only US-headquartered company and does not manufacture in China. The firm's operational manufacturing footprint in Ohio and Alabama and Louisiana represent over $4bn in US manufacturing investments.

A study commissioned by First Solar and conducted by the University of Louisiana at Lafayette projects that, as the firm grows to 14GW in annual US nameplate capacity by the end of 2026, it will support an estimated 30,060 direct, indirect and induced jobs across the country, representing $2.8bn in annual labor income. Additionally, the study estimates that every direct job that First Solar supports in 2026 will support 7.3 jobs nationwide.

www.firstsolar.com

# First Solar issues 2024 Sustainability Report

According to its 2024 Sustainability Report, cadmium telluride (CdTe) thin-film photovoltaic (PV) module maker First Solar Inc of Tempe, AZ, USA has established new industry benchmarks including verifiable leadership in ultra-low-carbon solar technology, high-value recycling, respect for human rights, and transparent reporting. First Solar is the largest solar manufacturer in the Western Hemisphere and the world's largest high-value solar panel recycler.

"As we celebrate 25 years of First Solar in 2024, we also celebrate 25 years of an unwavering commitment to the principles of Responsible Solar, which embodies sustainability, improves people's lives, has zero tolerance for human rights abuses, and meaningfully supports the fight against climate change," says CEO Mark Widmar. "The results of building our company on a principled foundation are apparent from our verifiable leadership in environmental and social performance and reporting," he adds. "The third-party validated benchmarks that confirm our leadership are essential to further differentiate ourselves from the competition while challenging the industry to do better."

First Solar says that its manufacturing process allows it to transform a sheet of glass into ready-to-ship thin-film solar panels in about 4 hours. Its CdTe is claimed to lead the industry in environmental performance and competitiveness, allowing the firm to produce solar panels with a carbon footprint up to four times lower than those utilizing crystalline silicon cells made from Chinese polysilicon, even if assembled into panels in the USA. The technology was recently validated when First Solar's Series 6 Plus and Series 7 TR1 became the world's first solar panels to achieve an EPEAT Climate+ designation by meeting the ultra-low-carbon threshold of ≤400kg $CO_{2e}$/kWp, enabling greater avoided emissions across their lifetime.

"As the Clean Energy Buyers Institute warned, if the solar manufacturing industry continues its business-as-usual approach by relying on cheap, subsidized coal electricity to produce polysilicon, it runs the risk of overtaking aluminium production in carbon intensity," says First Solar's chief product officer Pat Buehler. "We must act now to change course by actively reducing the carbon footprint of solar technologies while also investing in high-value recycling that addresses the end-of-life management of decommissioned solar panels in a sustainable manner. Our industry must embody sustainability, not simply pay lip service to it."

First Solar operates high-value recycling facilities in the USA, Germany, India, Malaysia and Vietnam, representing 88,000 metric tons of nameplate annual recycling capacity at the end of 2023, capable of recycling about 2.6 million modules per year. The firm established the industry's first global recycling program in 2005 and has recycled nearly 400,000 metric tons of PV modules to date, more than any other PV recycler or PV recycling program, it is reckoned. In 2023, First Solar's high-value module recycling program recorded an average global material recovery rate of 95%, including glass, aluminium, steel, laminate and semiconductor material.

"We continue to reinforce that our industry's work in driving the energy transition and fighting climate change does not serve as a credit against its social and human rights responsibilities," says Samantha Sloan, VP of global policy, sustainability & marketing. "And we lead by example, operating one of the world's most tightly controlled and traceable solar supply chains and the industry's only manufacturing footprint to have completed social audits by a credible third party."

First Solar says that it remains the only major solar manufacturer to have not just conducted independent third-party, on-site social audits across its global manufacturing footprint in 2023 but also to have achieved the highest possible rating. The audits conducted under the Responsible Business Alliance's (RBA) Validated Assessment Program (VAP) awarded the company's operational facilities in the USA, Vietnam and Malaysia with platinum status as of December 2023. Not reliant on Chinese crystalline silicon supply chains, First Solar does not source materials from Xinjiang, China.

The Business and Human Rights Resource Centre commented in its 2023 Renewable Energy Human Rights Benchmark report that the solar panel manufacturing industry lags "significantly on human rights commitments and practices." However, it also highlighted First Solar as being one of only two companies of the six evaluated major solar manufacturers to have a strong human rights commitment in place. First Solar outperformed the other five companies assessed in the Benchmark report.

Since the start of this decade, First Solar has embarked on a $4.1bn manufacturing expansion strategy that has seen it grow from about 6GW operational in 2020 to over 16GW global nameplate capacity at the end of 2023. The firm currently operates manufacturing facilities in the USA, India, Malaysia and Vietnam. Two factories, one in Alabama (expected to be commissioned in second-half 2024) and the other in Louisiana (to come online in second-half 2025) are projected to take the company's global footprint to over 25GW of annual nameplate capacity in 2026. Additionally, the firm is investing about half a billion dollars in R&D infrastructure in Ohio, including the Jim Nolan Center for Solar Innovation (commissioned earlier this year).

**www.firstsolar.com**

# Red/yellow InGaN micro-LED photodetectors for visual light communications

**Researchers demonstrate high-data-rate reception from white LED transmitters.**

Researchers from Xiamen University in China and National Yang Ming Chiao Tung University in Taiwan report on the potential for using yellow and red indium gallium nitride (InGaN) micro light-emitting diodes (μLEDs) as both transmitters and receivers in visual light communication (VLC) systems [Tingwei Lu et al, ACS Photonics (2024) vol.11 issue 8, p3390].

A feature of the red/yellow μLEDs used as photodiode (PD) receivers was that they tended to naturally filter out longer visible wavelengths, responding only to the blue emissions from white LEDs based on yellow phosphors. The blue emissions can be modulated at fairly fast rates, unlike phosphor emissions, which tend to have a slow decay rate.

The researchers comment: "Compared with the silicon-based photodiodes commonly used in VLC systems, InGaN-based photodiodes have attracted academic interest owing to their advantages of low noise and high sensitivity."

The research showed much higher responsivity for the studied red/yellow μLED photodiodes to blue light, relative to previous reports using shorter-wavelength μLED photodiodes.

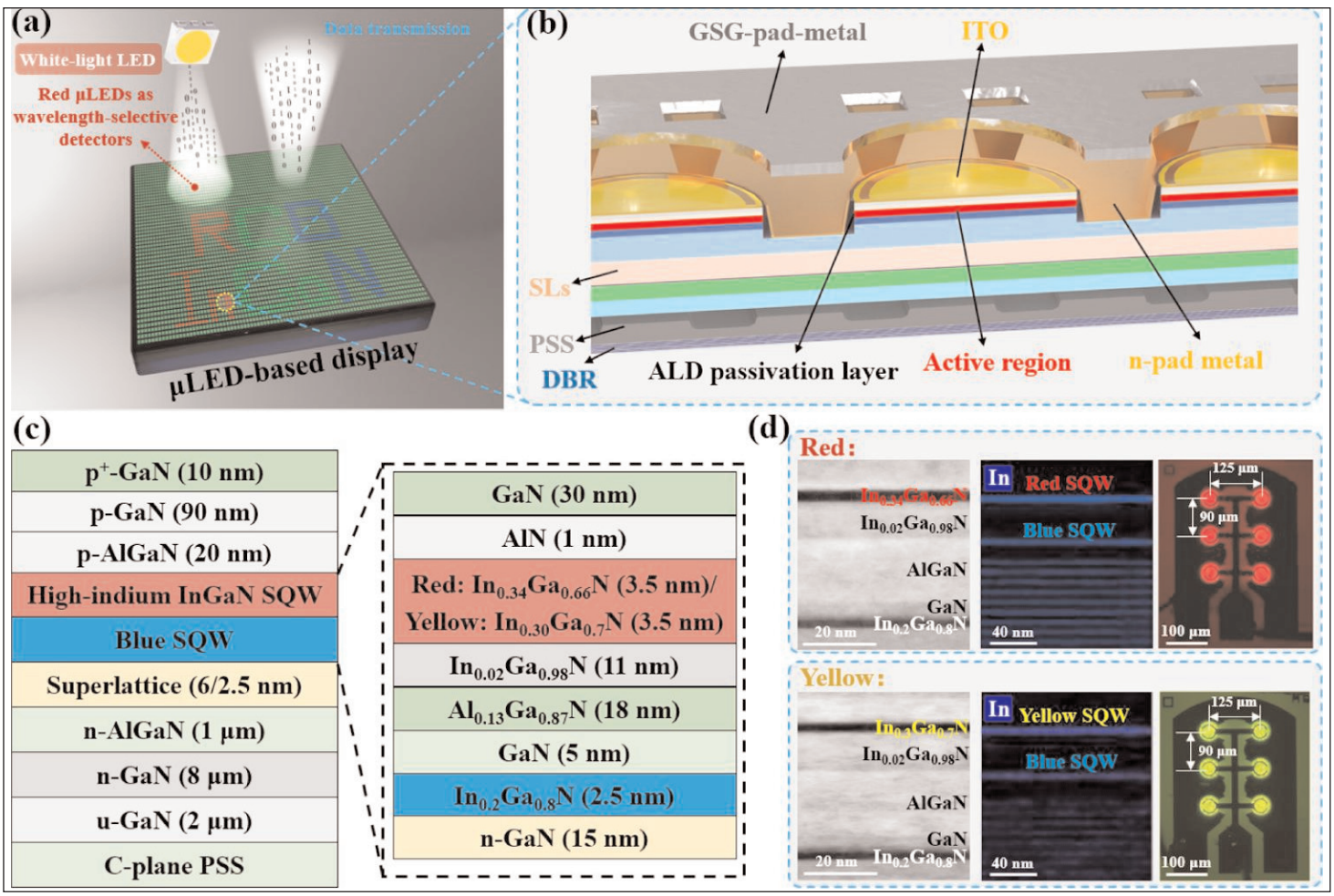



**Figure 1. (a) Display, transmitter and wavelength-selective photodiodes multi-functional μLED applications. (b) Red and yellow μLED scheme and (c) epitaxial structure. (d) Transmission electron microscope (TEM) images, indium element energy-dispersive x-ray spectroscopy (EDS), and optical micrograph images.**

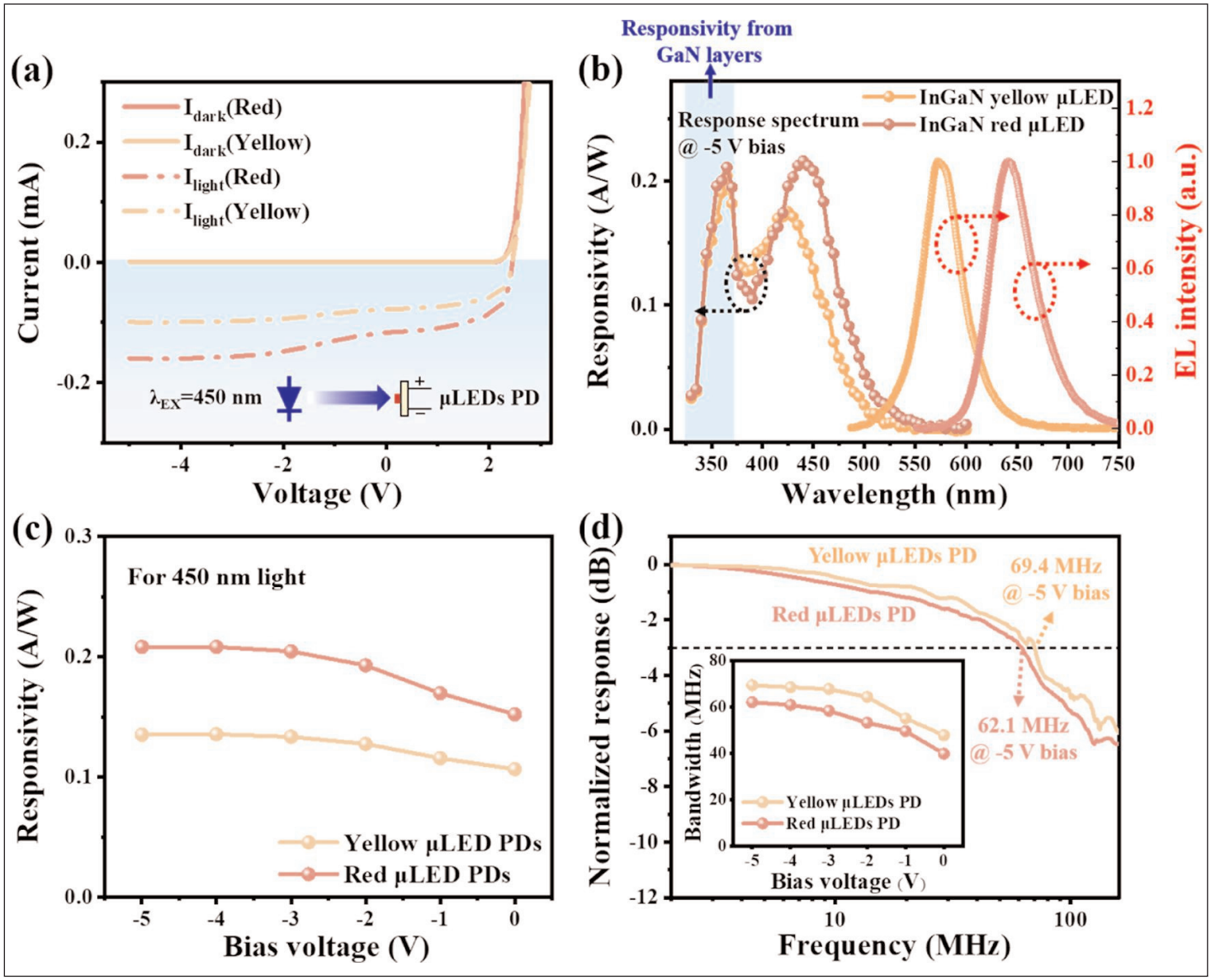



**Figure 2. (a) Dark and 450nm laser diode (LD) illuminated current–voltage curves of red and yellow µLED photodiodes. (b) Responsivity and electroluminescence (EL) spectra. (c) Responsivity for 450nm light under different bias voltage. (d) Frequency response and calculated the bias-dependent receiving bandwidth.**

The team adds: "Wavelength-selective photodetector applications further extend the versatility of long-wavelength µLEDs to provide technological complements to novel display and communication technologies."

The researchers also point out that few previous studies have focused on the detection performance of long-wavelength µLEDs acting as photodiodes.

The researchers fabricated 2x3 parallel-connected red and yellow µLED arrays (Figure 1). The epitaxial material was grown on patterned sapphire substrates (PSSs). The devices used 50µm-diameter circular transparent indium tin oxide (ITO) electrodes with a view to enhancing current injection efficiency. The pitches between the µLEDs were 125µm in the horizontal direction and 90µm in the vertical direction. (Looking at diagrams in the paper, I suspect that horizontal refers to 2 columns (c), and the vertical to 3 rows (r), opposite to the rxc of matrix theory/ linear algebra, for example.)

The devices included a distributed Bragg reflector (DBR) applied to the backside of the PSS for increased luminescence efficiency. The sidewalls were passivated with atomic layer deposition (ALD) aluminium oxide ($Al_2O_3$).

The researchers comment: "The ALD passivation layer was effective in reducing the trapping of photo-generated carriers by sidewall defects, thus increasing the responsivity of the µLED photodiodes."

The red and yellow µLED differed only in the long-wavelength indium content of the single InGaN quantum well (SQW). The SQW was grown on various combinations of GaN/AlGaN and a lower-indium-content InGaN blue SQW in an effort to manage the thermal and lattice mismatch stresses between the higher-indium-content InGaN, and the base GaN and PSS materials.

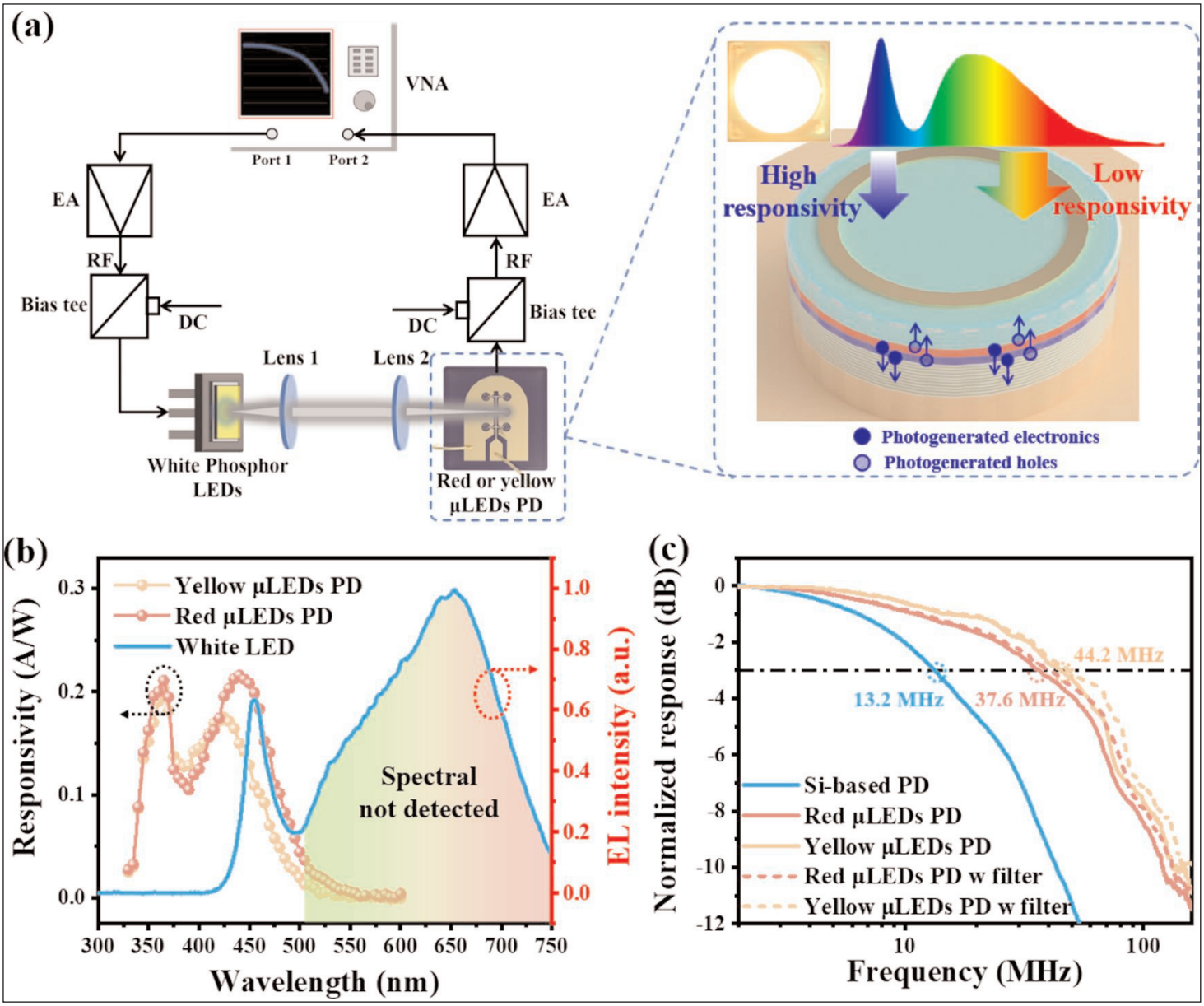



**Figure 3. (a) Bandwidth measurement setup for white light VLC system. (b) Response spectra of red/yellow μLED photodiodes overlaid with typical phosphor white LED EL emission. (c) Frequency responses measured by silicon- or long-wavelength μLED-based photodiodes.**

SQW devices tend to be less affected by stress problems such as the quantum-confined Stark effect (QCSE). The Stark effect refers to energy-level shifts due to applied electric fields. The stress management suppressed the polarization electric field that gives rise to the QCSE in the active region, improving both light emission and detection efficiency.

The current–voltage performance of the red and yellow μLEDs were 2.81V and 2.83V, respectively, at 20A/cm$^2$ current density injection, the small difference being attributed to the narrower bandgap for red emission.

The light output powers reach around 2mW for the red device and 4mW for the yellow device at 2kA/cm$^2$, at which point the performance is beginning to saturate. The team comments on the lower power for the red devices: "Compared to the yellow μLEDs, the red μLEDs are more severely affected by QCSE due to the higher indium content."

The peak wavelengths of the μLEDs blue-shifted on increased current injection, 1–2000A/cm$^2$: 642–559nm for the red, and 573–524nm for the yellow. Apropos of nothing, we note that the 'red' encroaches on the yellow range, and the 'yellow' ends up emitting green light.

The researchers comment: "For high-indium-content InGaN LEDs, the polarization-related electric field inside the QW is more severe, which leads to a more pronounced blue-shift."

The team also measured the modulation performance of the devices under different current density. The −3dB bandwidths for the red and yellow μLEDs were, respectively, 143.3MHz and 162.5MHz at 100A/cm$^2$, and 439.7MHz and 532.5MHz at 2000A/cm$^2$.

Tests with 16-ary quadrature amplitude modulation

(16-QAM) orthogonal frequency-division multiplex (OFDM) signal transmission showed bit-error rates (BERs) within the forward error correction (FEC) limit when operated at 570Mbit/s and 650Mbits/s (Mbps) for the red and yellow μLEDs, respectively.

The bit rates could be increased by increasing the current to 2000A/cm$^2$, at the cost of the severe blue-shift red/yellow to yellow/green: 1.9Gbps and 2.4Gbps, respectively.

In photodiode operation the devices showed two response peaks (Figure 2). The shortest wavelength peak at 360nm (ultraviolet) was attributed to absorption in the GaN layers. The longer wavelength peak was at 440nm for the red device and 425nm for the yellow device. The responsivities at the second peaks were 0.216A/W and 0.175A/W, respectively.

The researchers report further: "Red and yellow μLED photodiodes attained responsivities up to 0.208A/W and 0.135A/W for 450nm light, respectively, higher than those of the reported LED-based photodiodes."

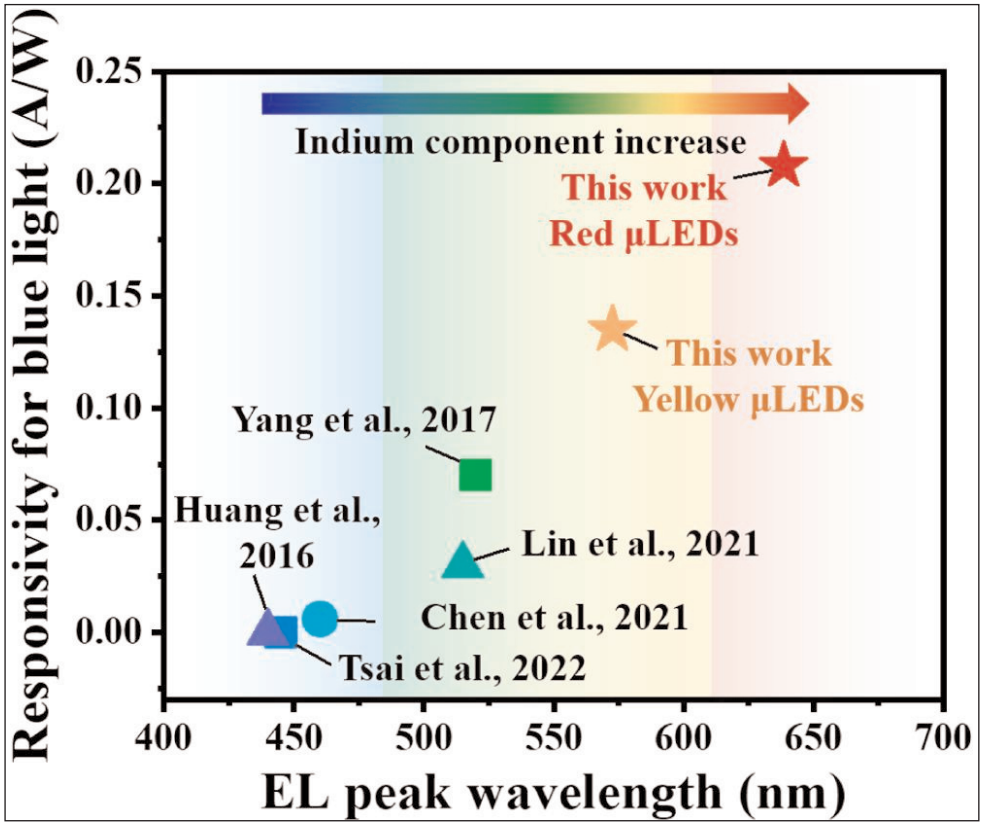



**Figure 4. Responsivity benchmarks of LED-based photodiodes for blue light versus EL peak wavelength.**

The response reduced as the absorption edges of the red/yellow InGaN SQWs was approached. This cut out responses to red and yellow light, enabling higher-bit-rate VLC via white LEDs, filtering out the yellow phosphor emissions and focusing on the direct blue LED emission.

The −3dB receiving bandwidths for the red and yellow μLED photodiodes from modulated 450nm laser diode light were 62.1MHz and 69.4MHz, respectively, at −5V bias.

The researchers also demonstrated a white VLC setup consisting of a white LED transmitter and the red/yellow μLED photodiodes (Figure 3). The spectrum of a typical white LED shows a narrow peak from the blue driving LED and a broad peak from a yellow phosphor that attempts to fill out other visible wavelengths to give an acceptable white illumination. The −3dB modulation bandwidths were 13.2MHz, 37.6MHz and 44.2MHz for the silicon-based and red/yellow μLED photodiodes, respectively. The InGaN-based devices had almost 3x the modulation performance over traditional silicon photodiodes.

White LED transmission/μLED photodiode reception data rates reached 1.2Gbps for the red device and 1.05Gbps for the yellow device.

The researchers compared their device response from 450nm blue light to that of other groups using photodiodes based on shorter-wavelength LEDs (Figure 4). The team comments: "To the best of our knowledge, this is the highest responsivity to blue light among reported LED-based photodetectors."

The team is also to report shortly on a VLC system using wavelength division multiplexing (WDM) of InGaN blue, green and red μLED devices with a claimed 11.14Gbps aggregated data rate. ■

**https://doi.org/10.1021/acsphotonics.4c00861**

*Author: Mike Cooke*

# Strain-engineering for green LEDs on silicon

**Using single AlN buffer increased internal quantum efficiency from 33% to 78%.**

Researchers report on improved 78% internal quantum efficiency (IQE) for green indium gallium nitride (InGaN) light-emitting diode (LED) epitaxial structures grown on silicon (Si) using only a single aluminium nitride (AlGaN) buffer layer [Yayu Dai et al, Appl. Phys. Lett., v125, p022102, 2024]. Although electroluminescence results were not presented, the IQE boost could lead to more power-efficient standard and micro-LEDs for green and red wavelengths.

For blue LEDs produced on silicon it is typical to use both an AlN nucleation layer and step-graded AlGaN buffer to bridge the large thermal expansion mismatch between silicon and GaN. GaN templates grown on such a buffer structure tend to have a residual compressive stress when the temperature is cooled to room temperature, which inhibits indium incorporation in the subsequent InGaN layers that are used to emit visible light. For longer green and red emissions, even more indium is needed in the InGaN layers than for blue.

"The proper strain management of GaN-on-Si is of paramount importance to fabricate the InGaN-based long-wavelength micro-LEDs grown on silicon toward full-color micro-displays," explains the team drawn from University of Science and Technology of China, Suzhou Institute of Nano-Tech and Nano-Bionics, Guangdong Institute of Semiconductor Micro-nano Manufacturing Technology, and Suzhou LEKIN Optoelectronics Technology Co Ltd.

There are substrates other than silicon that can be used to produce LEDs, but these are smaller, and usually much more expensive. Not only does silicon come in large diameters, enabling low-cost mass production, but also most drive systems are based on silicon electronics. Monolithic integration of the drive and light-emission components could further reduce electronic system complexity and cost.

The epitaxial materials (Figure 1) were grown by metal-organic chemical vapor deposition (MOCVD) on silicon. Two samples were processed, one using a conventional step-graded AlGaN buffer on AlN; one using just an AlN buffer before the n-GaN contact/buffer/template.

The researchers report of the conventional sample A: "The Al-composition step-graded AlN/AlGaN multiple-layer buffer used in GaN template A in this work is commercially available and has been used in the mass production of GaN-on-Si blue LEDs, showing high efficiency and great reliability."

X-ray analysis gave a higher threading dislocation (TD) density for the sample B 2μm GaN template than for sample A: $2.5\times10^9/cm^2$ and $9.0\times10^8/cm^2$, respectively. The further green InGaN LED layers were grown by co-loading both samples into a MOCVD chamber.

The LED structure consisted of 160nm $In_{0.05}Ga_{0.95}N$/GaN superlattice (SL), multiple quantum wells (MQWs), a 20nm electron-blocking layer and a 35nm p-GaN contact layer. The MQW light-emitting region consisted of three pre-wells of 2nm blue-emitting $In_{0.12}Ga_{0.88}N$/GaN, and five wells of 2.5nm green-emitting $In_{0.25}Ga_{0.75}N$/GaN. The wells were separated by 10nm GaN barriers.

Micro-photoluminescence (PL) analysis (Figure 2) showed sample B to have a more homogeneous emission pattern than sample A. Further, B's pattern had no visible dark spots, unlike sample A. The researchers comment: "The dark spots in micro-PL images typically represent non-radiative recombination centers caused by thermal degradation of the InGaN MQWs."

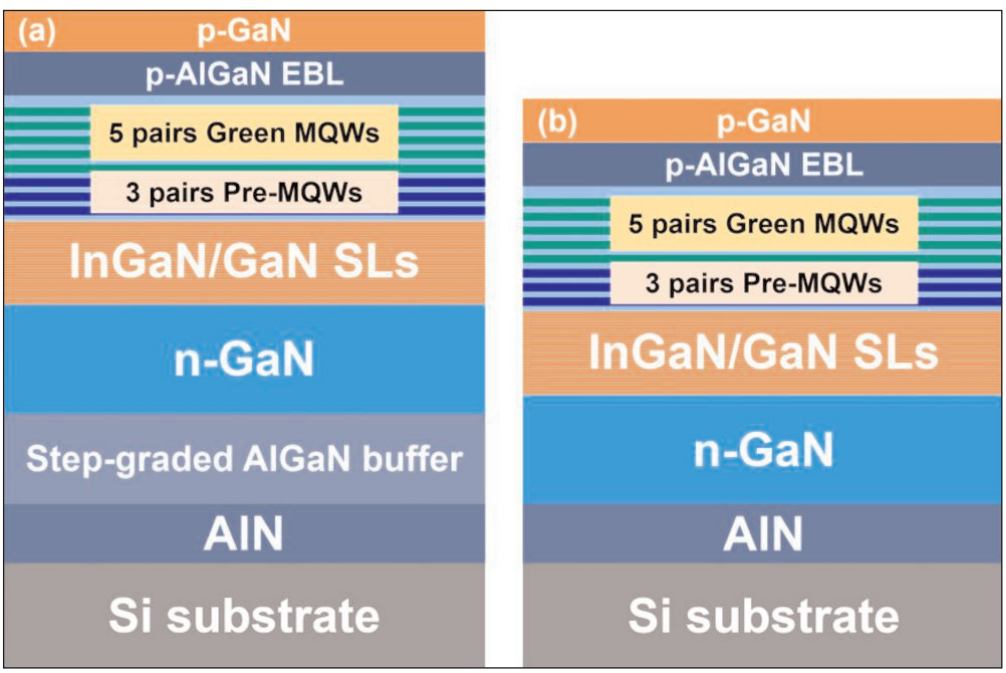



**Figure 1. InGaN-based green LED schemes: (a) Sample A with Al-composition step-graded AlN/AlGaN multiple-layer buffer; (b) B with AlN single-layer buffer.**

**Table 1. IQE, $\tau_1$,$\tau_2$, $\tau_{2r}$ and $\tau_{2nr}$ of samples A and B.**

| Sample | IQE | $\tau_1$ | $\tau_2$ | $\tau_{2r}$ | $\tau_{2nr}$ |
|---|---|---|---|---|---|
| A | 33% | 2.9ns | 24.6ns | 74.5ns | 36.7ns |
| B | 78% | 1.8ns | 38.4ns | 49.2ns | 174.5ns |

Further inspections using a scanning electron microscope (SEM) and cathodoluminescence (CL) showed V-pit densities for sample A and B of $7.0x10^8/cm^2$ and $2.0x10^9/cm^2$, respectively. These values are consistent with the threading dislocation values. V-pits generally form on threading dislocations.

The team comments: "It has been theoretically and experimentally confirmed that V-pits with thinner QWs at the sidewalls can generate a potential barrier and screen the effect of TDs, which facilitates hole injection and enhances radiative recombination, regarded as an effective method to improve the efficiency of InGaN-based LEDs."

So, a higher threading dislocation density is not necessarily a bad thing. The CL images showed A to have dark spot clusters, which show up as dark spots at the optical microscope level, while sample B's CL spots are more evenly spread, giving a better optical morphology.

The PL spectra showed sample B to have longer 40nm red-shifted peak relative to sample A. Raman spectroscopy also showed that sample B was almost strain-free, unlike sample A. The compressive stress in sample A was estimated to be 0.37GPa (sample B's stress was ~0GPa).

The researchers comment: "The Raman spectra confirm that the AlN single-layer buffer used in the GaN template B can effectively relax the residual compressive stress of the subsequent GaN layer, which is expected to reduce the misfit strain between GaN and InGaN, thus facilitating the indium incorporation of InGaN MQWs."

High-angle annular dark field (HAADF) scanning transmission electron microscopy (STEM) images also showed degradation of the MQW structure in sample A relative to B due to the residual strain (Figure 3).

By comparing the PL intensity at 5K and 300K, the researchers estimate the room-temperature internal quantum efficiency (IQE) at 33% and 78% for samples A and B, respectively.

The researchers also performed a time-resolved PL study, extracting fast ($\tau_1$) and slow ($\tau_2$) lifetimes. The researchers comment on $\tau_1$ that it reflects carrier transfer from weakly to strongly localized states. The slow $\tau_2$ decay is related to carrier recombination in the localized states.

The researchers combined the slow decay rates with their knowledge of the slow decays to present radiative ($\tau_{2r}$) and non-radiative ($\tau_{2nr}$) lifetimes (Table b). ■

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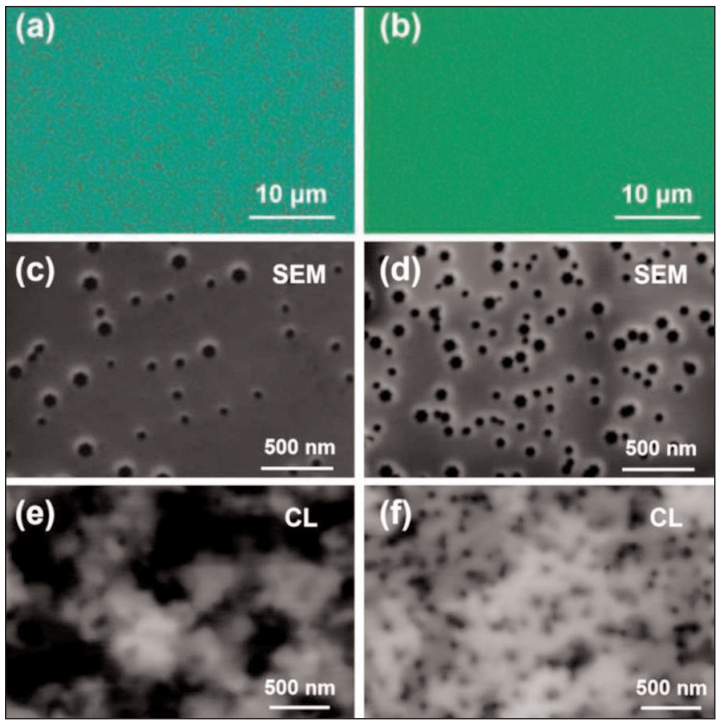


**Figure 2. Micro-PL, top-view SEM and panchromatic CL images of InGaN MQWs for sample A (a), (c) and (e) and sample B (b), (d) and (f), respectively.**

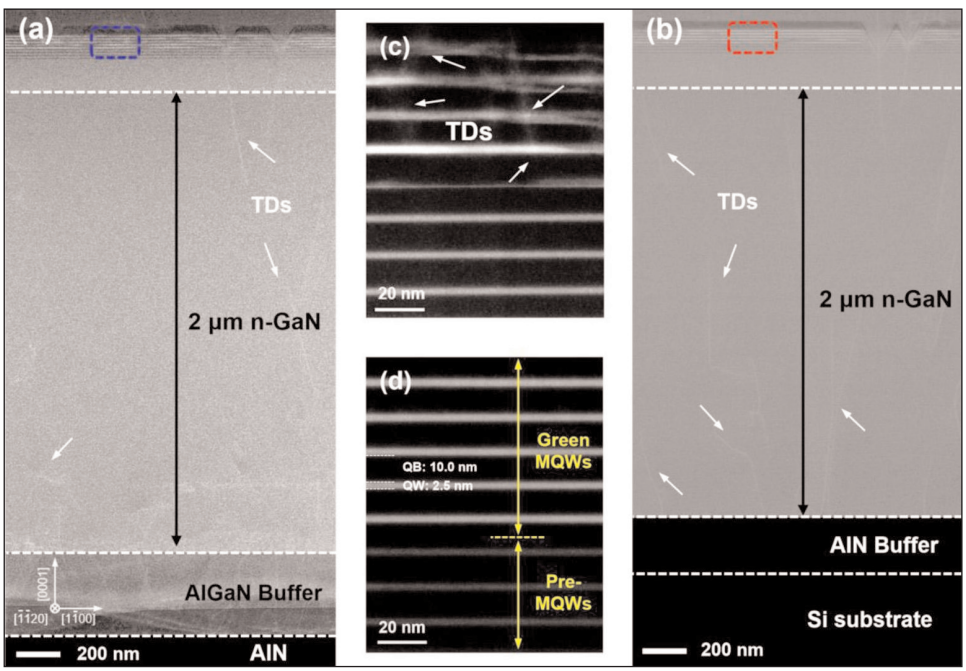


**Figure 3. Cross-section HAADF-STEM images of InGaN-based LED material for (a) sample A and (b) sample B, and enlarged images of active MQW regions marked with blue and red rectangles for (c) sample A and (d) sample B.**

# Zinc oxide homojunction LEDs

## Nanoparticles provide hole injection into a pn-junction.

Shimane University and S-Nanotech Co-Creation Co Ltd in Japan report on phosphor-converted full-color and white-light emission from zinc oxide (ZnO) pn homojunctions, using p-ZnO nanoparticles (NPs) from an arc-discharge process [Phys. Status Solidi RRL, p2400149, 2024].

Hole injection from bulk ZnO is difficult to arrange as there is no effective acceptor doping process known at present. Even without doping, ZnO is n-type conducting. Some attempts at producing pn heterojunctions have been reported, but homojunction structures should benefit from reduced strain and result in better efficiency devices in general.

The Shimane/S-Nanotech team suggests that reducing the effective dimension of the ZnO might enhance the p-type doping effect of nitrogen, which has been found in previous studies.

The researchers explain: "Low-dimensional p-type ZnO is relatively easier to fabricate than thin films, and its use in LEDs, as compared to the use of planar films, provides several benefits. Low-dimensional p-type ZnO can be used to readily confine carriers within one-dimensional structures, thus enhancing the junction area and minimizing the dependency on temperature sensitivity. Thus, several attempts have been made to fabricate low-dimension ZnO-based LEDs."

The use of p-ZnO nanoparticles could widen the opto-electronic potential of ZnO for light-emitting diodes (LEDs), photodetectors, solar cells, transparent conductive oxides, and lasers. A particular attraction of ZnO for white and visible color emissions, compared with the mainstream indium gallium nitride (InGaN) devices is the much lower cost of the base Zn material, relative to the extremely rare In and Ga elements.

Nanoparticles were fabricated in a plasma chamber using an electric arc formed between a pointed carbon cathode and a flat zinc ingot anode in an oxygen/nitrogen ($O_2$/$N_2$) atmosphere at 150Torr pressure when biased above the striking/ignition voltage. The relatively low pressure enabled a lower striking voltage with a cathode–anode separation of around 1mm. The arc ionized the gas molecules and created free electrons. Some electrons recombined with ions to give a purplish glow in the plasma chamber. The arc current was 50A DC.

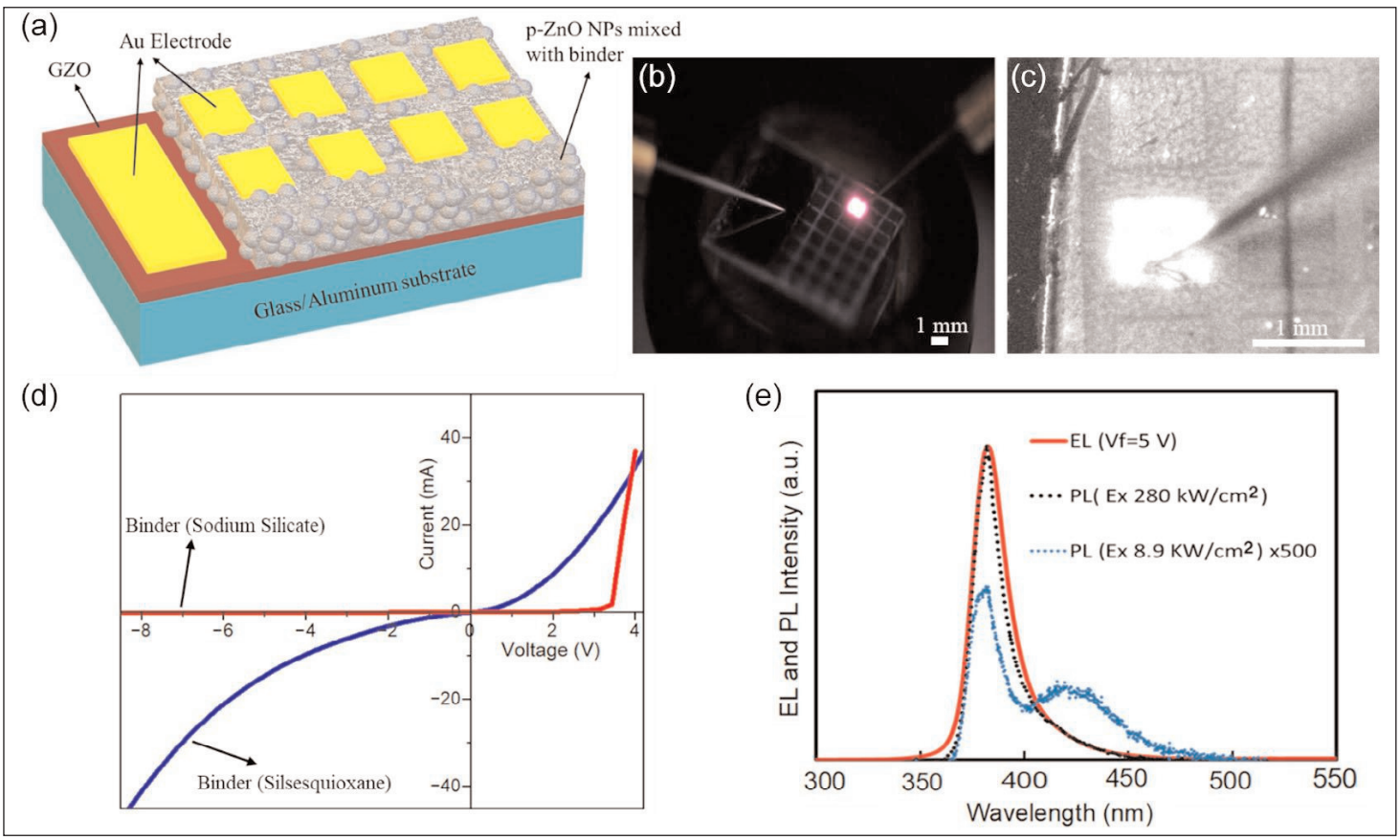


**Figure 1. a) Scheme for ZnO nanoparticle-based LED. Photographic images: b) UV emission at 8V bias captured using CCD camera with ultraviolet/infrared (UV/IR) filter removed; c) UV emission detected by UV-sensitive monochrome camera. d) Current–voltage characteristics of LEDs; e) EL and PL spectra of ZnO nanoparticle layer.**

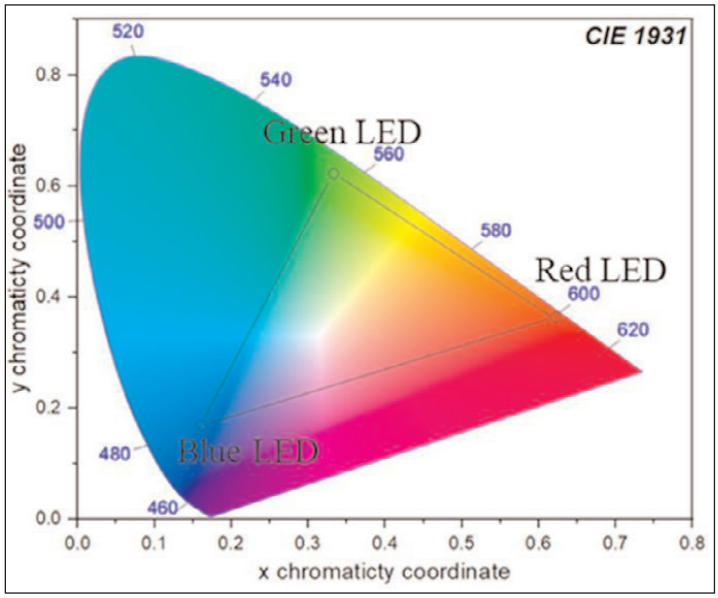


**Figure 2. Color gamut obtained by applying RGB CASN, SiAlON and SBCA phosphors, respectively.**

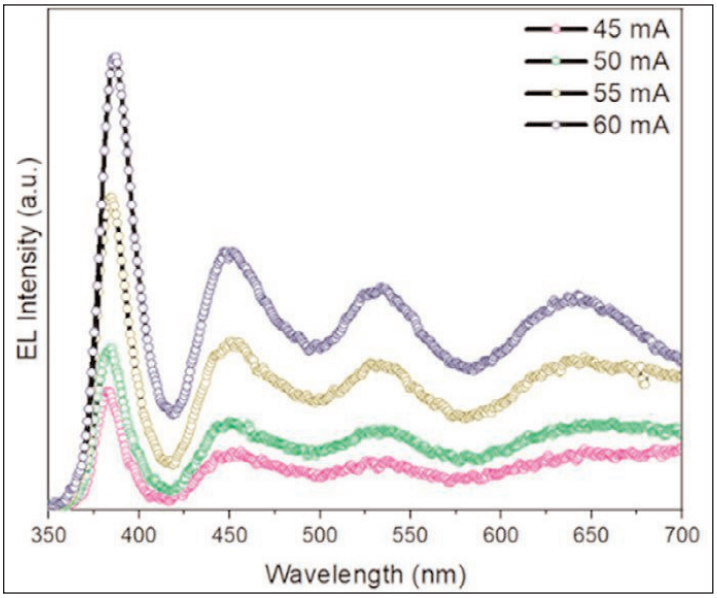


**Figure 3. WLED EL spectra with variable injection current.**

The researchers report: "The ionized gases produced in an arc discharge are accelerated by an electric field and combine with the incoming cooled gas (a mixture of $O_2$ and $N_2$) to form ZnO nuclei, which subsequently grow into nanorods or nanoparticles as they impinge on the cooled walls of the plasma chamber and are rapidly quenched."

The ZnO NPs contained N impurities. Photoluminescence studies suggested that the dominant incorporation was of single-atom N replacing O ($N_O$) in the ZnO wurtzite lattice, rather than diatomic $N_2$ incorporation as $(N_2)_O$. The NO form should act as an acceptor, while $(N_2)_O$ is expected to be a double donor.

The researchers fabricated LEDs with the p-ZnO nanoparticles on gallium-doped n-ZnO (GZO) layer on aluminium (Al)/glass substrates (Figure 1). The GZO was applied by sputtering. The p-ZnO nanoparticles from the arc-discharge process were spin-coated with the binder onto the GZO. After annealing at 300°C, the p-ZnO nanoparticle layer was 3μm thick. Gold (Au) was used for the electrodes. The turn-on voltage was about 3.4V, corresponding to the ZnO bandgap of 3.37eV.

The electrical performance depended on the binder layer holding the ZnO nanoparticles. The researchers report that using sodium silicate ($Na_2SiO_3$) gave much reduced leakage under reverse bias, compared with silsesquioxane. The team suggests that $Na_2SiO_3$ provides a better means to passivate defects. The rectification on/off ratio at ±4V was 1600 for devices with the preferred $Na_2SiO_3$ binder.

The electroluminescence (EL) from the device biased at 5V gave a narrow spectral line around 383nm wavelength with 23nm full-width at half maximum (FWHM) from near-band-edge emissions.

The intensity of the EL peaked under 25mA current injection. The reduced intensity at higher currents is attributed to self-heating effects. The self-heating also seemed to red-shift the peak wavelength in the longer-wavelength direction.

The researchers comment: "The red-shift may be attributed to thermally induced bandgap narrowing or a change in the carrier concentration caused by varying the injection current." The higher temperature may also decay the possibility of excitons (electron–hole bound states), further reducing EL intensity.

The researchers used a Peltier electrothermal module to control the LED temperature. Above 30°C operating temperature the EL intensity was much reduced.

The team also studied application of phosphors with a view to RGB color emission and white-light illumination.

For RGB emissions (Figure 2), the team applied three europium-doped phosphor types in UV-curable resin: red-emitting CASN calcium aluminium silicide nitride ($CaAlSiN_3:Eu^{2+}$), green β-SiAlON silicon aluminium oxynitride ($(Si,Al)_3(O,N)_4:Eu^{2+}$), and blue SBCA ($(Sr,Ba)10(PO_4)_6Cl_2:Eu^{2+}$).

The researchers comment: "The gamut area can be further enhanced by selecting phosphors with a higher saturation. Furthermore, the residual UV light from the LEDs can be reduced using a UV filter or by increasing the phosphor thickness to optimize visible light."

A phosphor blend was applied for phosphor-converted white LED (pc-WLED) emission (Figure 3) with chromaticity coordinate of (0.32,0.33). Average color rendering index (Ra) was 90. Color temperature of 6226K is 'cool white'.

The researchers comment: "Increasing the injection current for the WLED resulted in negligible peak shifts for the three visible wavelengths (red, green, blue), which led to the high chromatic stability of the pc-WLED."

Color fidelity ($R_f$) was 93. Color gamut ($R_g$) was 106. ■

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*Author: Mike Cooke*

# TMAl reflow GaN-on-silicon for fully vertical electronics

**Avoiding intentional AlN buffer growth enables high current flow through GaN/Si interface.**

École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland claims the first demonstration of direct growth of gallium nitride (GaN) at high temperature on silicon (Si) substrates simply by using a trimethyl-aluminium (TMAl) preflow, without any intentional AlN buffer [Alessandro Floriduz et al, Jpn. J. Appl. Phys., v63, p060904, 2024].

Among the benefits of the process could be the realization of "more efficient fully vertical GaN-on-Si devices, in which the silicon substrate may become a functional part of the device, as well as novel devices that require effective current conduction to the substrate," according to the team.

Vertical current flow diode/transistor devices are particularly sought for power electronics, and the GaN/Si combination could promote both high-power performance and low production cost.

The researchers comment: "For GaN-on-Si devices, a fully vertical structure (where current flows vertically through electrodes located on opposite sides of the wafer) is preferable, to avoid current crowding and achieve low on-state resistance."

While fully vertical GaN devices have been demonstrated on silicon, the substrate and low-conduction buffer layers usually need to be removed, increasing production cost and hindering commercial adoption.

Unfortunately, the conventional GaN/Si process uses an AlN interlayer, which is usually highly insulating due to the 6eV energy gap between the conduction and valence bands.

The EPFL team prepared samples using metal-organic chemical vapor deposition (MOCVD) on 2-inch Si(111) n-type phosphorus-doped wafers. The researchers compared the use of a TMAl preflow against the conventional growth of an AlN interlayer on silicon before GaN epitaxy.

The difference in growth conditions was that during the preflow the line from the nitrogen precursor, ammonia ($NH_3$), was shut off. It was only when the TMAl line was shut off that the $NH_3$ and TMGa supplies were opened and the GaN growth began. The resulting

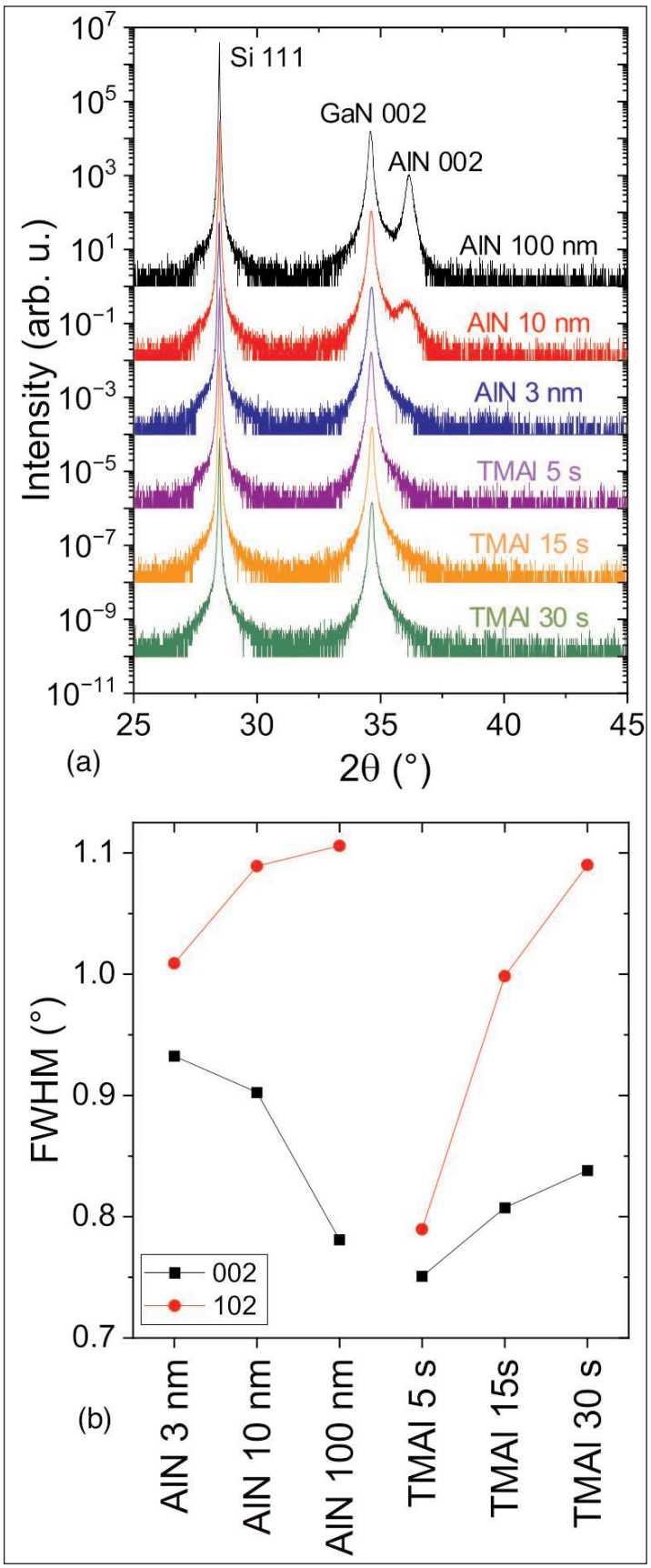


**Figure 1. (a) Symmetric 2θ–ω XRD scans and (b) FWHM values of XRCs for GaN 002 and GaN 102 diffraction peaks.**

GaN layers were Ga-polar, as confirmed by non-etching in potassium hydroxide solution.

The main control variable was the durations of the steps. The temperature and pressure during the preflow and GaN growth were 925°C and 50mbar, respectively. The carrier gas was hydrogen. The AlN growth was at the higher temperature of 1000°C. The silicon wafer was prepared for the MOCVD by thermal cleaning at 100mbar pressure, and 1000/1050°C for preflow/AlN interlayer, respectively. The GaN layers were doped with silicon, targeting an electron concentration around $4x10^{18}/cm^3$.

The GaN layer thickness was 110nm to avoid cracking on the thickest 100nm AlN interlayer grown. The GaN growth resulted in single-crystal material in all cases.

Optical microscope inspection showed a rough surface in the cases of thin 3nm AlN interlayer and for short TMAl preflow of 5 seconds. Also, the longest 30s TMAl preflow sample showed degradation towards the wafer edge, which the team attributes to "an excessive accumulation of Al on the wafer surface due to the longer preflow, leading to meltback etching of the silicon wafer, initiated by Si–Al reactions. This accumulation occurs at the wafer periphery due to the horizontal reactor design (single 2-inch wafer carrier with rotation) and the low gas velocity during preflow."

Atomic force microscope (AFM) investigation showed that the preflow method resulted in smoother GaN surfaces than the best AlN interlayer. The 15s and 30s preflows root-mean-square roughness values were both of the order of 1nm, with no observable holes in the GaN layer. The very short 5s preflow gave a very rough surface of 23nm, larger than those with AlN interlayer (1.5nm for 100nm, 3nm for 3nm).

The x-ray diffraction (XRD) rocking curve (XRC) scans were collected from

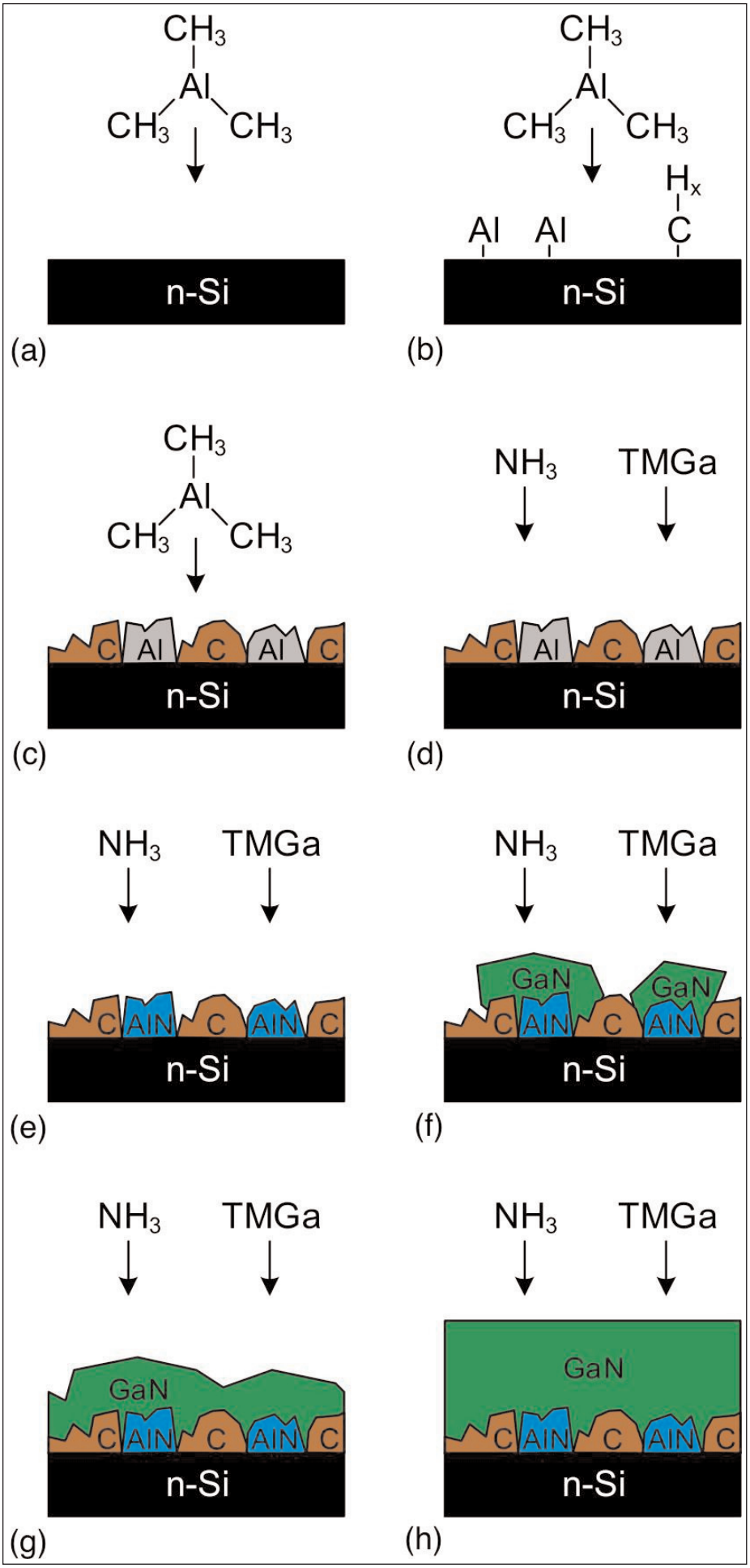


**Figure 2. Suggested growth mechanisms: (a–c) Preflow deposition of Al and C. (d–e) Nitridation of Al during early GaN step. (f) 3D GaN growth on AlN regions. (g) Coalescence. (h) 2D layer-by-layer growth.**

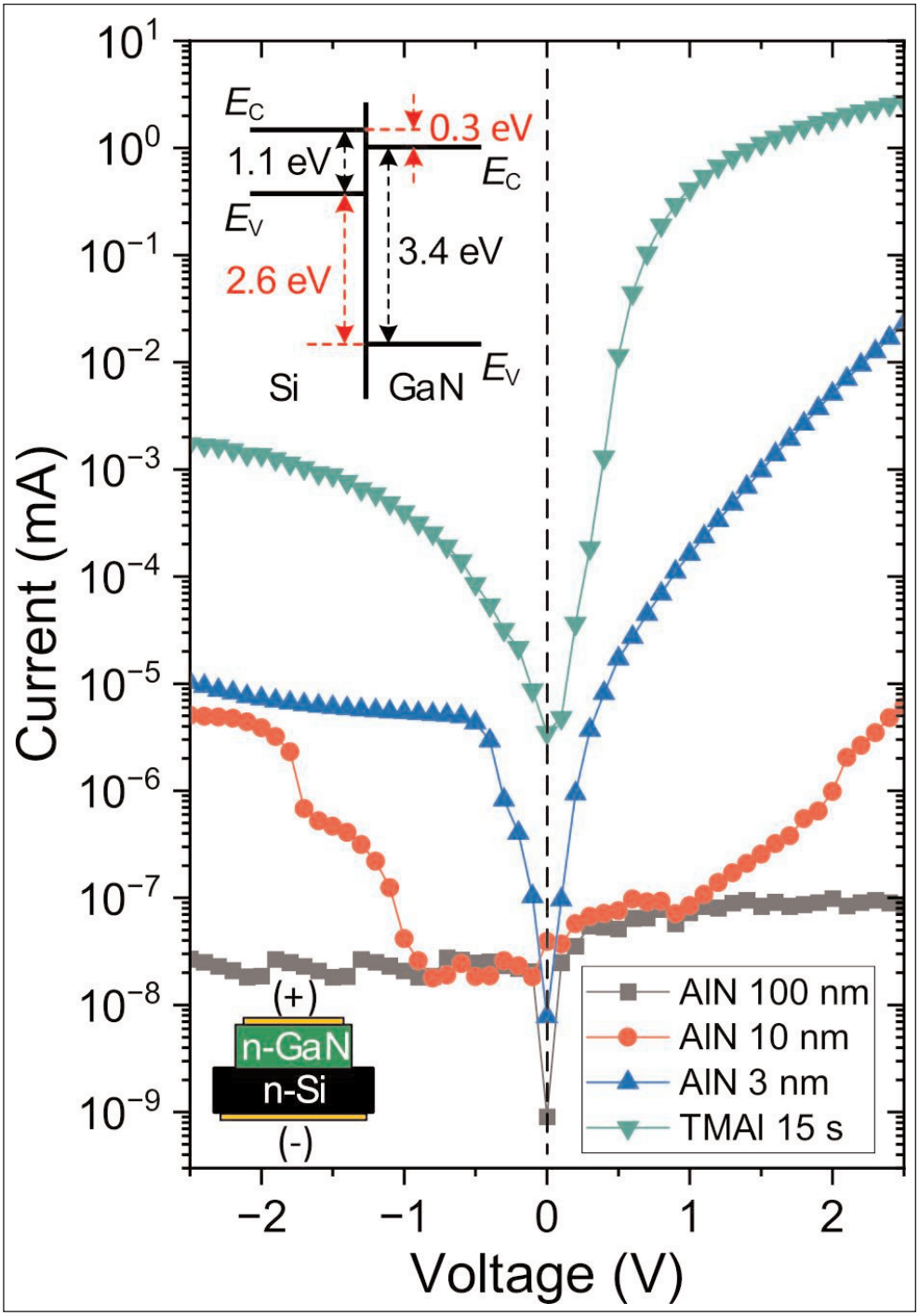


**Figure 3. Current–voltage (I–V) measurements of n-GaN/n-Si heterostructures, directly grown with 15s TMAl preflow (green), and with conventional AlN buffers. Forward bias refers to positive voltage applied to n-GaN (bottom-left inset). Top-left inset schematically represents band alignment of GaN and silicon.**

the 002 and 102 planes (Figure 1). The researchers report: "Narrower XRC peaks were obtained in GaN samples directly grown with the TMAl preflow, indicating an improved crystalline quality compared to the use of conventional AlN buffers."

The full-width at half-maximum (FWHM) of the 002 peak is sensitive to the presence of screw and mixed dislocations, while the 102 scans give information on edge dislocations. Although the 5s preflow was apparently more crystalline, the lack of edge dislocations was related to the lack of coalescence of the GaN epitaxial layer, resulting in a rough surface with holes.

The researchers comment: "Increasing the TMAl preflow time to 15s and 30s resulted in fully coalesced samples, which consequently exhibited broader GaN 102 peaks."

The researchers add: "By optimizing the preflow time, the direct high-temperature growth of GaN on Si with a TMAl pre-treatment not only successfully results in a fully coalesced surface without traces of meltback etching, but it also greatly improves the GaN surface morphology and its crystal quality compared to using AlN buffers."

The researchers suggest (Figure 2) that the preflow step creates a surface layer consisting of Al and carbon (C, from the 'organic' part of the MOCVD), and compounds such as aluminium carbide ($Al_4C_3$). When the ammonia flow starts during the GaN growth the Al is nitrided to AlN and acts as a nucleation point for GaN crystal growth in a 3D mode. The C-containing regions act as nanomasks, "favoring lateral growth, as well as dislocation bending and annihilation (analogously to epitaxial lateral overgrowth)." When the GaN islands coalesce the growth transitions to a 2D mode.

The researchers also measured the current flow across the Si/GaN interface under bias with a view to fully vertical electronic device structures (Figure 3). Clearly, the preflow technique resulted in much higher current (~3 orders of magnitude) under forward and reverse bias than even the thinnest 3nm AlN interlayer. The small conduction-band energy difference of 0.3eV gives an asymmetric current response to a bias (around three orders of magnitude at larger biases).

The electrodes used in these measurements were chromium/gold on the GaN layer, and indium on the silicon wafer backside. ■

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*Author: Mike Cooke*

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# Magnesium intercalation in gallium nitride

**Superlattices of 2D monolayers show record high strain, enhancing hole transport.**

Researchers based in Japan report on their studies of magnesium (Mg)-intercalated gallium nitride (GaN) superlattices (MiGs), using a spontaneous process [Jia Wang at al, Nature 631, 67 (2024)].

The team included researchers from Nagoya University, Meijo University, and Osaka University. Work at Nagoya and elsewhere has previously been reported on GaN p–n junction and p-type GaN Schottky barrier diodes, which use the MiGs structure to enhance performance.

The researchers comment: "In our electrical characterizations, we demonstrate that incorporating the MiGs structure modifies the surface potential of GaN. This provides considerable technological advantages, enhancing the barrier height of n-type Schottky barrier diodes on undoped GaN and enabling the otherwise difficult realization of ohmic contact on p-type GaN."

Mg is the most common means to create p-type conductivity (hole transport) in GaN, where the Mg atoms grab electrons from the valence band, leaving relatively mobile holes. The researchers see this as a zero-dimensional (0D) effect, in contrast to their 2D MiGs structures.

The team comments: "The origin of ionized acceptors in the MiGs structure is probably induced by the polarization field owing to the periodic polarity transition in GaN, rather than interstitial Mg, which is electrically inactive."

The researchers suggest that the MiGs phenomenon could also be used to increase Schottky barrier heights for improved Schottky diode performance.

Another aspect may be enhanced temperature management, although this would depend on the results of future characterization work, in particular the improved thermal transport the record-high compressive strain achieved in the c-direction.

The team also comments: "Analogous to strained silicon, applying strain to modify the band structure of GaN has been identified as a strategy to enhance carrier mobility. However, achieving and maintaining high elastic strain in GaN to demonstrate this enhancement has been difficult."

The MiGs structure (Figure 1) was created by physical vapor deposition (electron-beam evaporation or sputtering) of 50nm Mg on single-crystalline wurtzite GaN, followed by annealing at atmospheric pressure. Lower pressure, as used in most epitaxy processes, would increase the sublimation rate of Mg, reducing the effectiveness of the intercalation effect. The Mg was not capped during the annealing. The anneal temperatures were in the range 500–800°C. The duration was typically around 10 minutes.

The researchers comment: "The rapid interstitial diffusion of Mg within GaN resulted in its segregation into single monolayer atomic sheets. These sheets then expanded in size, resembling climbing motion of edge dislocations, and aligned vertically (along the c-axis) with each other in an even and orderly manner."

The incorporation of the MiGs domains had a non-

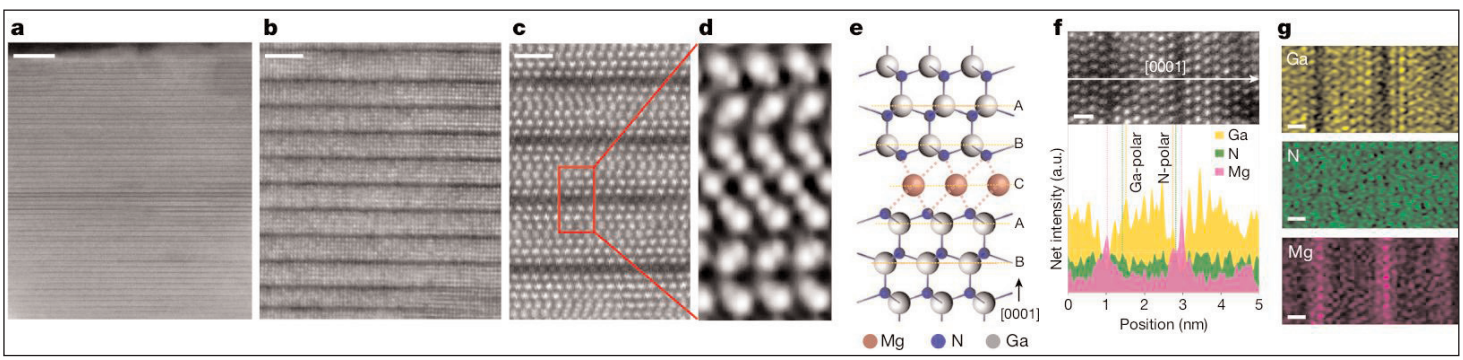



**Figure 1. a-c. Cross-sectional high-angle annular dark-field scanning transmission electron microscopy (HAADF-STEM), progressively magnified, of 2D-MiGs. Dark lines indicate monoatomic 2D-Mgi sheets perpendicular to c-axis (the [0001] direction). d. Integrated differential phase contrast (iDPC)-STEM image (red box in c, magnified). e. Schematic of MiGs structure from d, detailing positions of constituent atoms. f. Atomically resolved energy-dispersive x-ray (EDS) spectra across localized portion of superlattice. HAADF-STEM image (top) with arrow shows line-scanning direction. g. Atomically resolved EDS elemental maps for Ga, N and Mg in same region as f. Scale bars: 10nm (a); 2nm (b); 1nm (c); 500pm (f, top); 500pm (g).**

uniform distribution, owing to the reaction's spontaneous, diffusion-driven nature.

The researchers did not take special measures to prevent oxidation during storage of the Mg-deposited GaN before annealing (typically within a day). However, the annealing itself was carried out in an inert atmosphere of nitrogen or argon, since the temperatures involved greatly increased the potential for Mg oxidation. Photoresist patterning lift-off steps also avoided water-based processing, which quickly degraded Mg, replacing water with isopropyl alcohol (IPA).

It was found that the charge polarization of the GaN matrix swapped between Ga- and N-polar between the Mg layers.

The researchers write: "This observation is consistent with the theoretical model, which predicts the energetically stable configuration of a monolayer of interstitial Mg segregation (2D-Mgi) onto (0001) GaN, favoring a quarter substitutional occupation of Mg in the nearest Ga layers."

The researchers also found that the 2D-Mg sheets tend to attract each other, "similar to the attraction between two edge dislocations of opposite sign caused by the cancellation of the strain field." They add: "This stabilizes the structure, allowing them to align vertically and expand into a larger-diameter domain, underscoring the driving force to form an ordered superlattice structure."

One application where the MiGs structure might be useful is for creating ohmic p-contacts (Figure 2). The p-GaN was activated before deposition of the Mg by annealing to drive out hydrogen, which passivates the Mg acceptors.

The researchers report: "The threshold temperature and time for the onset of MiGs formation may vary slightly depending on the initial Mg concentration in GaN. Typically, it is higher (for example, 600°C for 10 min) for unintentionally doped GaN and lower (550°C for 10 min) for GaN that is initially heavily doped with Mg."

The team attributes the reduced contact resistivity to an increase in tunneling probability, related to a combination of factors that could include increased acceptor concentrations and decreased effective hole masses.

The smaller hole mass is related to an expected raising of the 'split-off' (SO) band, relative to the

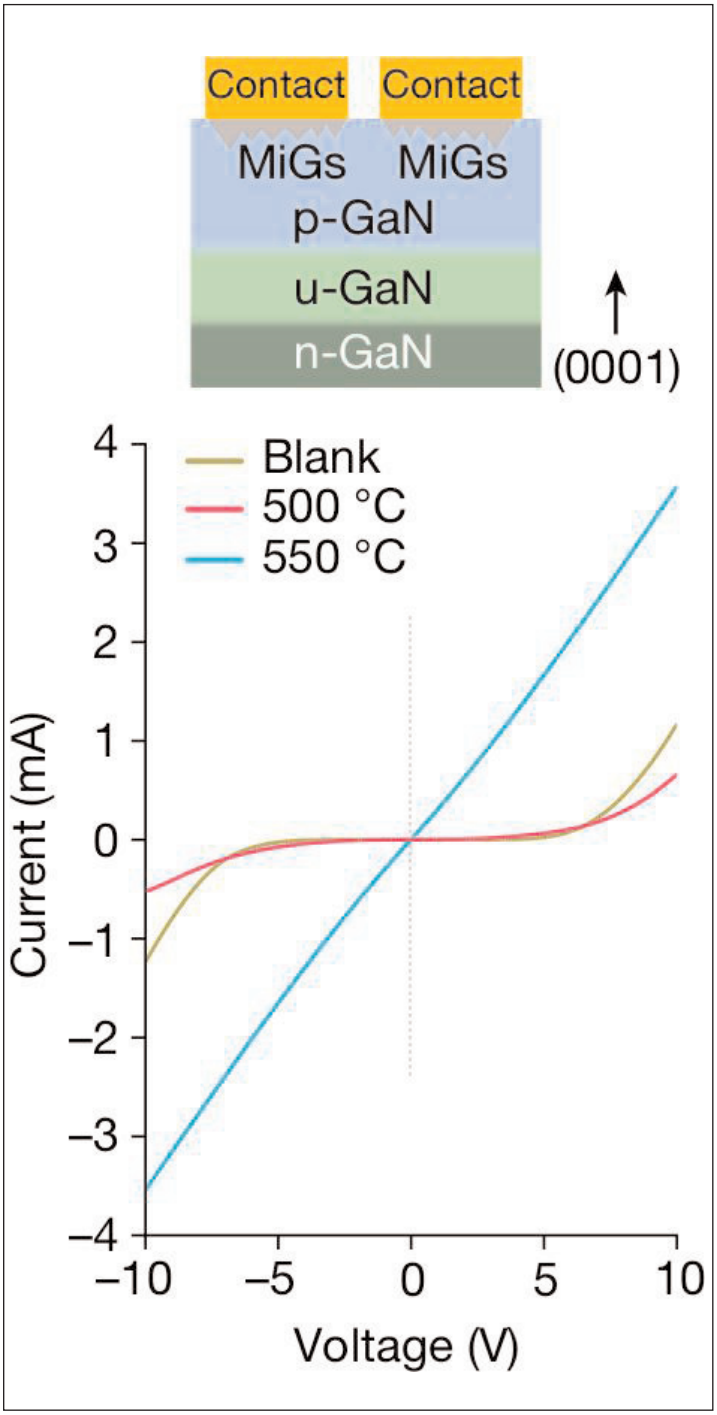
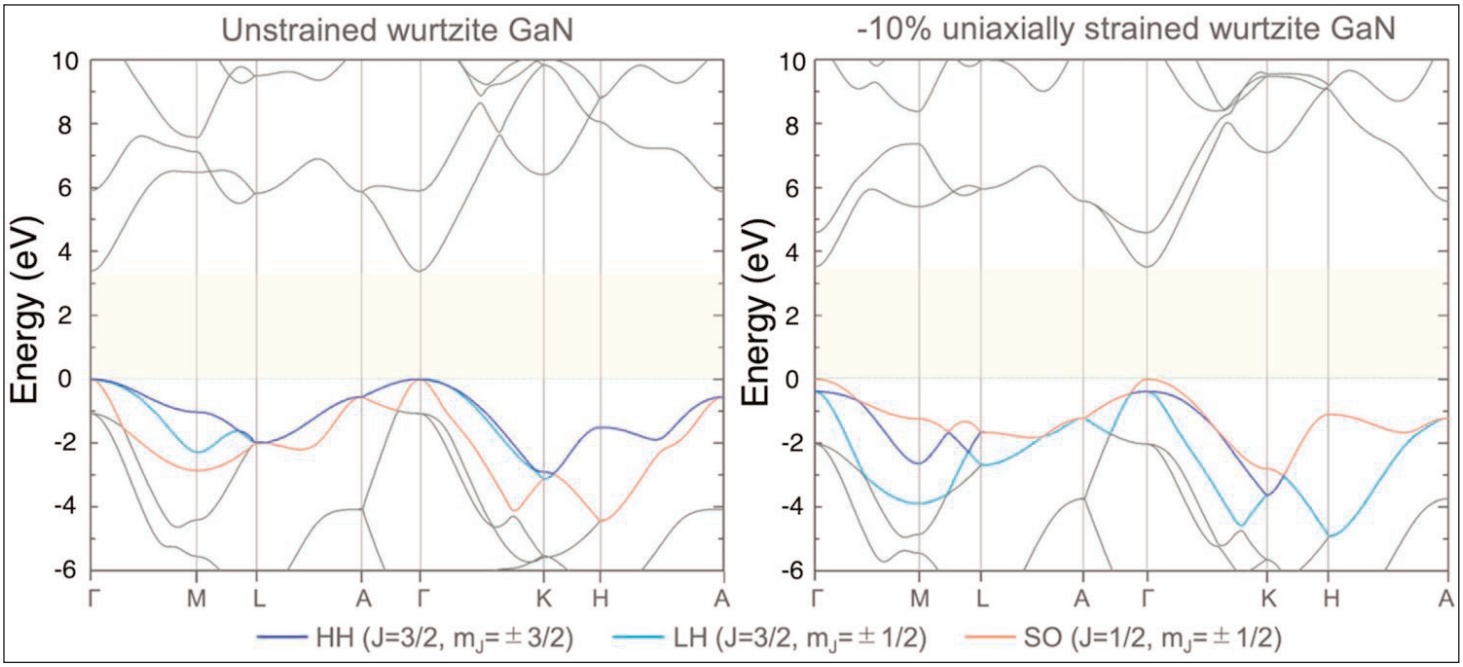



**Figure 2. Current–voltage (I–V) characteristics of transfer-length-method test structures fabricated on p-type GaN samples, annealed with selective-area-patterned metallic Mg film at 500°C (10 min) and 550°C (10 min) compared with blank sample.**

**Table 1. Summary of electrical measurement without and with MiGs: n = Hall-effect hole concentration; ρ = in-plane, van der Pauw resistivity; $\rho_{DC}$ = THz-TDE resistivity; $\sigma_{DC}$ = THz-TDE conductivity.**

| Sample number | n (x$10^{17}$/cm$^3$) | ρ (Ω-cm) | $\rho_{DC}$ (Ω-cm) | $\sigma_{DC}$ (S/m) |
|---|---|---|---|---|
| 1 (without MiGs) | 1.6 | 1.6 | 1.7 | 61 |
| 2 (with MiGs) | 3.0 | 1.4 | 0.26 | 380 |
| 3 (without MiGs) | 4.3 | 1.3 | 1.1 | 89 |



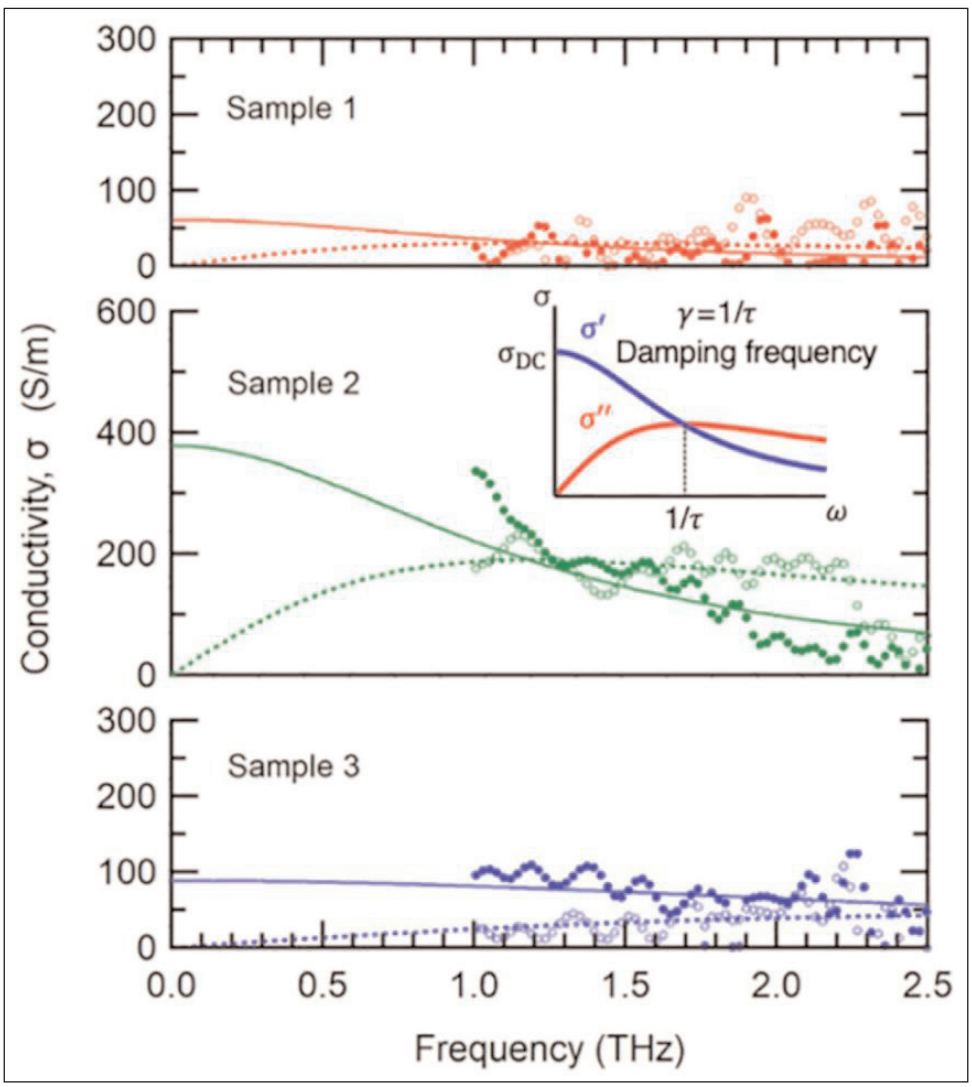




**Figure 4. Real (σ′) and imaginary (σ″) parts of the conductivity, according to terahertz time-domain ellipsometry (THz-TDE). Inset: Drude model expectation used to determine DC conductivity. Samples 1 and 3 represent light-doped and heavily-doped p-GaN without MiGs. Sample 2 used the same material as 1, but with added MiGs regions.**

**Figure 3. Calculated electronic band structures of unstrained wurtzite GaN (left) and –10% compressively-strained wurtzite GaN (right).**

light hole (LH) and heavy hole (HH) bands due to the compressive strain found in the MiGs structure (Figure 3), of the order –10% out-of-plane, according to HAADF-STEM strain mapping. The 'A' direction of the band structure represents carrier motion in the vertical 'c' growth direction of the wurtzite GaN. The SO band has lighter holes, particular when traveling along the Γ (the symmetry point) to A direction, enabling increased mobility under electric field/potential biases.

The team used THz-TDE to assess the conductivity (Figure 4). Unlike the more usual van der Pauw measurements, THz-TDE allows assessment of vertical conductivity in the c-direction. van der Pauw structures measure only in-plane conduction (Table e). In particular, while the van der Pauw resistivities were similar for all three samples, the THz-TDE showed p-GaN with MiGs having more than 4x enhanced conductivity. ■

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# ETRI develops p-type selenium-tellurium alloy transistor

**South Korea's Electronics and Telecommunications Research Institute shows how it is possible to overcome the low mobility of p-type semiconductors while improving display refresh rates and power consumption.**

South Korea's non-profit, government-funded Electronics and Telecommunications Research Institute (ETRI) has developed a p-type Se–Te (selenium–tellurium) alloy transistor that can be easily deposited at room temperature via a simple process using a chalcogenide-based p-type semiconductor material. In addition, they have also developed a new technology that can systematically adjust and control the threshold voltage of n-type transistors through charge injection control of Te thin films in the hetero-junction structure of n-type oxide semiconductor and p-type Te (Kyunghee Choi et al, ACS Applied Materials & Interfaces, vol. 16, issue 18, p23459).

One of the most widely used materials in the current display industry is the indium gallium zinc oxide (IGZO)-based n-type oxide semiconductor. In the case of p-type semiconductors, p-type LTPS (low-temperature polycrystalline silicon) is used due to the lack of processability and electrical properties compared to n-type oxide semiconductors, but there has always been many limitations in that it is much more expensive to manufacture and the size of the substrate is limited.

However, with the increase in demand for higher refresh rates (240Hz+) in high-resolution displays, especially at SHV-class resolution displays (8K-4K), interest in the development of p-type semiconductors has reached its peak in recent years. Since n-type semiconductor-based transistors, which have been used in existing displays, have limitations in effectively implementing displays with high refresh rates, demand for p-type semiconductors is rising rapidly.

To meet these needs, ETRI developed a p-type semi-conductor by adding Te to Se, increasing the crystal-lization temperature of the channel layer, depositing an amorphous thin film at room temperature and crystal-lizing it through a subsequent heat treatment process. As a result, they have improved mobility and achieved a higher level of on/offline current ratio characteristics compared with existing transistors.

The researchers have also confirmed that, when a Te-based p-type semiconductor was introduced as a heterojunction structure over an n-type oxide semi-conductor thin film, the threshold voltage of the n-type transistor can be adjusted by controlling the flow of electrons within the n-type transistor, depending on the thickness of Te. In particular, they have improved the stability of the n-type transistor without the need of a passivation layer, by adjusting the thickness of Te in the heterojunction structure.

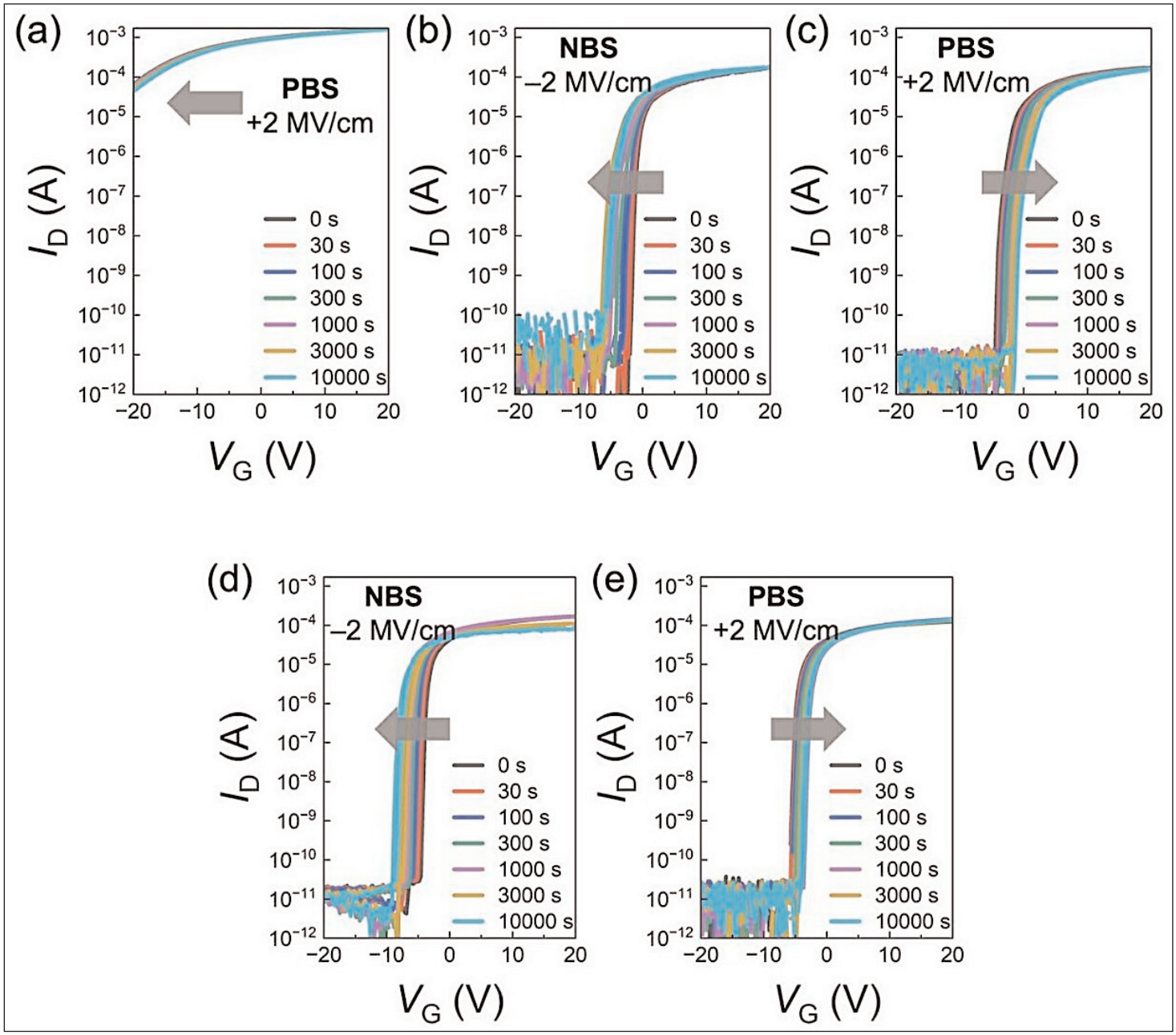
By utilizing these achievements, it is expected that the growth of the next-gen display industry will reach new heights, enabling the development of new displays with better resolution and lower power consumption at the same time.

In fact, this new discovery can also impact the semi-conductor industry. Currently, many leading global semiconductor manufacturers are focusing on the development of new scale-down processes that can increase the integration of their products but, according to the analysis of many industry insiders, the level of integration in semiconductors has reached its limit.

Accordingly, in recent years, new integration methods have been introduced to stack multiple semiconductor chips at once. Among them, TSV (through-silicon vias) is the most well known, where multiple wafers are stacked and a hole is drilled into the wafers to ensure electrical connection. The TSV method has the advantage of effective utilization of space and reduced power consumption. However, there are still many limitations that need to be addressed, including high processing costs, low yield, etc.

To overcome the limitations of TSV, the industry has come up with monolithic 3-dimensional (M3D) integration, where the materials are stacked onto a single wafer instead of stacking multiple layers at once. Unfortunately, the M3D method has not yet reached commercialization due to various issues such as the limited use of high-temperature processes, etc.

However, many experts consider that the hetero-junction thin-film transistor and p-type semiconductor device developed by ETRI can operate stably even in processes below 300_, pushing the industry a step




**Transfer curves of the (a) Al:IZTO under PBS of +2 MV/cm for 10,000 s before passivation, single Te heterojunction TFTs with passivation under (b) NBS and (c) PBS, double Te heterojunction TFTs under (d) NBS and (e) PBS of $V_D$ = 1 V, –2 MV/cm and +2 MV/cm for 10,000 s.**
**Graphic courtesy of: ACS Applied Materials & Interfaces (2024). DOI: 10.1021/acsami.4c02681.**

closer to the commercialization of M3D.

"This is a monumental achievement that can be widely utilized in next-gen displays such as OLED TVs and XR devices, as well as future researches in other fields such as CMOS (complementary metal oxide semiconductor) circuits and DRAM memories," says Cho Sung-Haeng, principal researcher of ETRI's Flexible Electronics Research Section.

Researchers of ETRI say that they are planning to optimize the Te-based p-type semiconductors to large-sized substrates of 6-inches or more and to secure its potential for commercialization by applying them to various circuits, ultimately finding new ways to implement them into new fields.

The research was carried out as a part of the National Research Council of Science and Technology's Creative Convergence Research Project 'M3D Oxide Semiconductor-Based Ultra-Low Power, High-Band, Large-Capacity DRAM Development', the Ministry of Trade, Industry and Energy's Industrial Technology Challenge Track 'TFT for the Development of a Non-Silicon Semiconductor for High-Resolution & Large-Sized Displays and Core Technologies for CMOS Manufacturing', and ETRI's Research Project for the Next Generation 'Development of High-Performance Semiconductor Transistors for Ultra-Low Power Multi-Value Devices'. ■

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www.riff-co.com

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

## 15 Assembly/packaging materials

**ePAK International Inc**
4926 Spicewood Springs Road,
Austin, TX 78759, USA
Tel: +1 512 231 8083
Fax: +1 512 231 8183
www.epak.com

**Gel-Pak**
31398 Huntwood Avenue,
Hayward, CA 94544, USA
Tel: +1 510 576 2220
Fax: +1 510 576 2282
www.gelpak.com

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

**Materion Advanced Materials Group**
2978 Main Street,
Buffalo, NY 14214, USA
Tel: +1 716 837 1000
Fax: +1 716 833 2926
www.williams-adv.com

## 16 Assembly/packaging equipment

**CST Global Ltd**
4 Stanley Boulevard,
Hamilton International
Technology Park,
Blantyre, Glasgow G72 0BN, UK
Tel: +44 (0) 1698 722072
www.cstglobal.uk

**Kulicke & Soffa Industries**
1005 Virginia Drive,
Fort Washington,
PA 19034,
USA
Tel: +1 215 784 6000
Fax: +1 215 784 6001
www.kns.com

**Palomar Technologies Inc**
2728 Loker Avenue West,
Carlsbad, CA 92010,
USA
Tel: +1 760 931 3600
Fax: +1 760 931 5191
www.PalomarTechnologies.com

**PI (Physik Instrumente) L.P.**
16 Albert St . Auburn ,
MA 01501, USA
Tel: +1 508-832-3456,
Fax: +1 508-832-0506
www.pi.ws
www.pi-usa.us

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

## 17 Assembly/packaging foundry

**Quik-Pak**
10987 Via Frontera,
San Diego, CA 92127, USA
Tel: +1 858 674 4676
Fax: +1 8586 74 4681
www.quikicpak.com

## 18 Chip foundry

**CST Global Ltd**
4 Stanley Boulevard, Hamilton International Technology Park,
Blantyre, Glasgow, G72 0BN,
UK
Tel: +44 (0) 1698 722072
www.cstglobal.uk

**United Monolithic Semiconductors**
Route departementale 128,
BP46, Orsay, 91401,
France
Tel: +33 1 69 33 04 72
Fax: +33 169 33 02 92
**www.ums-gaas.com**

## 19 Facility equipment

**RENA Technologies NA**
3838 Western Way NE,
Albany, OR 97321, USA
Tel: +1 541 917 3626
**www.rena-na.com**

**Vacuum Barrier Corporation**
4 Barton Lane, Woburn, MA 01801,
USA
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Fax: +1 781 933 9428
**www.vacuumbarrier.com**

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## 20 Facility consumables

**PLANSEE High Performance Materials**
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Austria
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info@plansee.com
**www.plansee.com**

**W.L. Gore & Associates**
401 Airport Rd, Elkton,
MD 21921-4236,
USA
Tel: +1 410 392 4440
Fax: +1 410 506 8749
**www.gore.com**

## 21 Computer hardware & software

**Crosslight Software Inc**
121-3989 Henning Dr.,
Burnaby, BC, V5C 6P8,
Canada
Tel: +1 604 320 1704
Fax: +1 604 320 1734
**www.crosslight.com**

**Semiconductor Technology Research Inc**
10404 Patterson Ave.,
Suite 108, Richmond,
VA 23238,
USA
Tel: +1 804 740 8314
Fax: +1 804 740 3814
**www.semitech.us**

## 22 Used equipment

**Brumley South Inc**
422 North Broad Street,
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Fax: +1 770 808 8308
**www.ClassOneEquipment.com**

## 23 Services

**Riff Company Inc**
1484 Highland Avenue,
Cheshire, CT 06410,
USA
Tel: +1 203-272-4899
Fax: +1 203-250-7389
**www.riff-co.com**

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

## 24 Resources

**Al Shultz Advertising Marketing for Advanced Technology Companies**
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7140 San Jose, CA 95126, USA
Tel: +1 408 289 9555
**www.alshuktz.com**

**SEMI Global Headquarters**
San Jose, CA 95134,
USA
Tel: +1 408 943 6900
**www.semi.org**

**Yole Développement**
69006 Lyon,
France
Tel: +33 472 83 01 86
**www.yole.fr**

# event calendar

**If you would like your event listed in *Semiconductor Today*'s Event Calendar, then please e-mail all details to the Editor at mark@semiconductor-today.com**

**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**

**15–16 October 2024**
**PIC Summit Europe**
Evoluon, Eindhoven, Netherlands
**E-mail**: picsummit@photondelta.com
**www.picsummiteurope.com**

**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)**
Honolulu, O'ahu, Hawaii, USA
**E-mail**: info@iwn2024.org
**www.iwn2024.org**

**4–6 November 2024**
**11th IEEE Workshop on Wide Bandgap Power Devices and Applications (WiPDA 2024)**
Dayton, Ohio, USA
**E-mail**: WiPDAreg@ieee.org
**https://wipda.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, San Francisco, 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**

# advertisers' index

**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**

**29 April – 1 May 2025**
## 28th Annual Components for Military & Space Electronics Conference & Exhibition (CSME 2025)
Four Points by Sheraton (LAX), Los Angeles, CA, USA
**E-mail**: info@tjgreenllc.com
**www.tjgreenllc.com/cmse**

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

**4–9 May 2025**
## 2025 Conference on Lasers & Electro-Optics (CLEO)
Long Beach, CA, USA
**E-mail**: info@cleoconference.org
**www.cleoconference.org**

**6–8 May 2025**
## PCIM 2025 (Expo & Conference on Power Electronics, Intelligent Motion, Renewable Energy and Energy Management)
Nuremberg, Germany
**E-mail**: pcim_visitors@mesago.com
**www.mesago.de/en/PCIM/main.htm**

**27–30 May 2025**
## 2025 IEEE 75th Electronic Components and Technology Conference (ECTC)
Gaylord Texan Resort & Convention Center, Dallas, TX, USA
**www.ectc.net**

## Microwave Week

**15–17 June 2025**
## IEEE Radio Frequency Integrated Circuits Symposium (RFIC 2025)
San Francisco, CA, USA
**E-mail**: support@mtt.org
**www.rfic-ieee.org**

**15–20 June 2025**
## 2025 IEEE/MTT-S International Microwave Symposium (IMS 2025)
San Francisco, CA, USA
**E-mail**: exhibits@horizonhouse.com
**www.ims-ieee.org/about-ims/past-and-future-ims**

**22–27 June 2025**
## World of PHOTONICS CONGRESS — International Congress on Photonics in Europe
ICM — International Congress Center, Messe München, Munich, Germany
**E-mail**: info@photonics-congress.com
**www.photonics-congress.com/en**

**22–25 July 2025**
## ALD/ALE 2025: AVS 25th International Conference on Atomic Layer Deposition (ALD 2025) featuring the 12th International Atomic Layer Etching Workshop (ALE 2025)
Jeju Island, South Korea
**E-mail**: della@avs.org
**www.ald2025.avs.org**

**21–26 September 2025**
## 28th European Microwave Week (EuMW 2025)
Jaarbeurs, Utrecht, the Netherlands
**E-mail**: eumwreg@itnint.com
**www.eumweek.com**

**28 September – 2 October 2025**
## ECOC 2025: 51st European Conference on Optical Communication
Bella Center, Copenhagen, Denmark
**E-mail**:ecoc2025@cap-partner.eu
**www.ecoc2025.org**

**7–9 October 2025**
## SEMICON West 2025
Phoenix, AZ, USA
**E-mail**: semiconwest@semi.org
**www.semiconwest.org**

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