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COMPOUNDS & ADVANCED SILICON

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Arkansas tops-out MUSiC silicon carbide research & fabrication facility

Power Integrations buying Odyssey • Diamond Quanta emerges
Guerrilla RF buys Gallium Semi • ETRI develops 3kV-class Ga_2O_3

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p29 Nexperia is now offering its 1200V SiC MOSFETs in D²PAK-7 SMD packaging, with a choice of 30mΩ, 40mΩ, 60mΩ and 80mΩ on-resistance values..

p61 Phlux, Airbus and Sheffield University have begun an ESA project to build more efficient free-space optical communications satellite terminals.

Cover image: College of Engineering dean Kim Needy signs a beam, joined by Margaret Sova McCabe (vice chancellor for research and innovation) and Charles Robinson (chancellor), to top-out the new Multi-User Silicon Carbide Research and Fabrication Facility (MUSiC) at the University of Arkansas. **p22**

editorial

Compound growth in power semis

Driven by the transition of power electronics from silicon to wide-bandgap semiconductors, the silicon carbide (SiC) and gallium nitride (GaN) power semiconductor market will rise at a compound annual growth rate of 22.9% from $1.41bn in 2024 to $11.08bn in 2034, forecasts Fact.MR (see page 6). SiC power modules in particular should grow from $476.3m to $3.64bn.

SiC materials & power device maker Wolfspeed has reported a dip in revenue in first-quarter 2024 due to weaker-than-expected industrial and energy markets, but demand from electric vehicle manufacturers continues to outpace SiC production capacity expansion (page 24).

Germany's Infineon, for example, has just agreed to provide SiC power products to China's Xiaomi for its new SU7 EV until 2027 (page 22).

Also, regardless of short-term fluctuations in market demand, longer-term plans in R&D make progress, aided by authorities aiming to re-establish domestic semiconductor manufacturing and assemble secure supply chains.

For example, the University of Arkansas has just topped-out of the Multi-User Silicon Carbide Research and Fabrication Facility (MUSiC) — sited next to the USA's National Center for Reliable Electrical Power Transmission — which will enable the federal government (via national laboratories), businesses and other universities to prototype with SiC (page 22).

In another example of supply chain collaboration, Penn State University has signed a memorandum of understanding for Morgan Advanced Materials to supply graphite materials and solutions for R&D on SiC crystal growth by both Penn State and external partners at a new SiC growth facility, due to be fully operational by the start of 2025 (page 21). The agreement includes Morgan becoming a founding member of the Penn State Silicon Carbide Innovation Alliance (SCIA, launched in early April), which is centred on the onsemi Silicon Carbide Crystal Center at Penn State's Material Research Institute established in May 2023.

Also, based on its core SmartCut silicon-on-insulator technology, France-based Soitec's SmartSiC wafers are to be commercialized further by X-FAB Silicon Foundries offering it through a joint supply chain consignment model, for producing SiC power devices on 150mm-diameter SmartSiC wafers at its plant in Lubbock, Texas (see page 20).

Soitec is also developing its upstream supply chain through a partnership for Japan-based Tokai Carbon to co-develop and supply 150mm and 200mm polycrystalline SiC substrates designed specifically for SmartSiC wafers. The partnership "marks yet another key step in the ramp-up of Soitec's SmartSiC technology to address fast-growing markets such as electric mobility and industrial electrification," says the firm.

Regarding GaN power electronics, San Jose-based GaN power IC firm Power Integrations (PI) has agreed to acquire New York-based Odyssey Semiconductor Technologies, which develops high-voltage power switching components based on its vertical GaN process technology (see page 30). "Our goal is to commercialize a cost-effective high-current and high-voltage GaN technology to support higher-power applications currently served by SiC, at a much lower cost and higher performance enabled by the fundamental material advantages of GaN over SiC," says PI.

While SiC is garnering much attention and funding currently, GaN promises to follow on diversifying from its current RF-focused commercialization (which has drawn gallium arsenide-focused device maker Guerrilla RF to acquire RF GaN firm Gallium Semiconductor — see page 31).

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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).

Regular issues contain:
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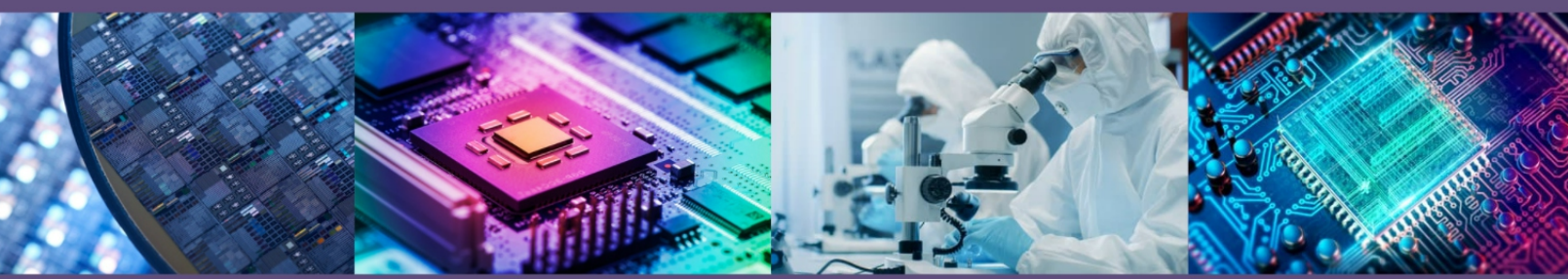

CSconnected is home to the world's first regional ecosystem based on the manufacture of compound semiconductor enabled hardware, located in south Wales

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SiC and GaN power semiconductor market growing at 22.9% CAGR from $1.41bn in 2024 to $11.08bn in 2034

Silicon carbide power module sales to reach $3.64bn by 2034

The global silicon carbide (SiC) and gallium nitride (GaN) power semiconductor market will rise at a compound annual growth rate CAGR of 22.9% from $1.41bn in 2024 to $11.08bn in 2034, forecasts a report by Fact.MR.

Due to characteristics that make them suitable for high-temperature and high-frequency applications, SiC and GaN power semiconductors are finding extensive use in the automotive, renewable energy, industrial, and consumer electronics sectors.

In the automotive sector, they are used in the manufacturing of energy-efficient electric and hybrid vehicles. Due to their effective energy conversion ability, SiC and GaN power semiconductors in industrial settings are used in renewable energy inverters and motor drives. Ongoing R&D activity worldwide is set to enhance the features of SiC and GaN power semiconductors even more over the coming years.

"The miniaturization trend in consumer electronics is a key factor driving high demand," notes Fact.MR.

Innovation and acquisition enhancing product offerings

The SiC and GaN power semiconductor market is highly competitive. Industry giants are adopting product expansion strategies including mergers and acquisitions to boost their product offerings and market reach.

For example, in October 2023 Infineon Technologies AG announced the acquisition of GaN Systems Inc. Meanwhile, in 2023, Japan's Flosfia began offering power chips made from gallium oxide, which can offer even higher energy efficiencies than GaN and SiC.

Regional dynamics: automotive and renewable energy sectors

SiC and GaN power semiconductors have become integral to automotive manufacturing in the USA, spurred by stringent regulations governing vehicle safety and greenhouse gas emissions. As auto-makers strive to incorporate fuel-efficient components into their vehicles, the adoption of SiC and GaN power semiconductors has surged in automotive system production. Their high energy efficiency plays a crucial role in enhancing the performance of electric vehicle power trains.

The increasing popularity of renewable energy sources like solar panels and distributed energy storage systems has driven the use of silicon carbide and gallium nitride power semiconductors in the production of these systems. Moreover, the growing trend for industrial automation has further fueled the growth of the SiC and GaN power semiconductor market in China, which is forecasted to grow at a 22.9% compound annual growth rate from $154.4m in 2024 to $1.21bn in 2034

The SiC and GaN power semiconductor market in the USA is hence forecasted to grow at a 23.4% CAGR from $149.9m in 2024 to $1.22bn in 2034.

Meanwhile, China stands out as a major hub for semiconductor manufacturing. The nation's robust production capabilities and extensive export of consumer electronics have fueled the demand for SiC and GaN power semiconductors. Additionally, the increasing popularity of renewable energy sources like solar panels and distributed energy storage systems has driven the use of SiC and GaN power semiconductors in the production of these systems. Moreover, the growing trend for industrial automation has further fueled the growth of the SiC and GaN power semiconductor market in China, which is forecasted to grow at a 22.9% CAGR from $154.4m in 2024 to $1.21bn in 2034.

SiC power module sales to reach US$3.64bn by 2034

Among the array of semiconductor materials used in power modules, silicon carbide stands out as the most prevalent, due to its ability to minimize energy loss during power conversion. This inherent advantage translates into reduced reliance on expensive cooling systems, making SiC an increasingly appealing choice for semiconductor purchasers.

Another notable benefit of SiC power modules is their exceptionally low switching loss, particularly in applications like EV chargers and solar inverters. This technical advantage further boosts SiC power module manufacturers as they broaden their product offerings and market presence.

These trends underscore the projection that the demand for SiC power modules will continue to surge over the next decade, with sales growing at a 22.6% CAGR from $476.3m in 2024 to $3.64bn by 2034.

www.factmr.com/report/381/sic-gan-power-semiconductor-market

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UK Semiconductor Institute announced to support key components of government's Semiconductor Strategy

Single point of contact to promote sector to investors and attract foreign investment

A new independent UK Semiconductor Institute will for the first time bring together government, universities and the private sector to support key components of the government's National Semiconductor Strategy to grow the sector, which is backed by £1bn.

The aim is that, in the future, the Institute will be established as an independent organization tasked with ensuring that chip researchers have the tools and infrastructure needed to drive their work forward in these focus areas and convert their innovation into market-ready products, subject to final checks.

As further international semiconductor agreements are made, the Institute will also act as a coordinated entry point for technology businesses and international partners who want to work with the UK semiconductor sector to boost innovation, research and commercialization.

"The UK Semiconductor Institute will unify the semiconductor sector to focus our talented researchers on securing our status at the cutting edge of semiconductor science," says Technology Minister Saqib Bhatti.

Building on a key focus of the Semiconductor Advisory Panel, the Institute will also bring industry together to boost the specialist skills needed to help grow the sector. This will build on £4.8m of backing for 11 skills programs across the UK announced earlier this year.

Announced one year after the launch of the UK's National Semiconductor Strategy, the Institute will set its key focus areas in line with those identified by the Strategy, which identified UK strengths in compound semiconductor chips, design and R&D.

Since the launch of the National Semiconductor Strategy, the UK government has launched ChipStart, a pilot incubator to provide start-ups with the technical and business help that they need to help bring new products to market. It has also invested £22m in two Innovation and Knowledge Centres in Bristol and Southampton to help to bring new UK chip technologies to the global market.

The UK has also secured access to the €1.3bn Chips Joint Undertaking of Horizon Europe (the European Union's scientific research initiative) and made sure that the UK Infrastructure Bank can invest its £22bn of financial capacity into semiconductor manufacturers. This enabled the bank's £60m contribution to the latest funding round of Pragmatic.

After extensive industry engagement, the creation of the UK Semiconductor Institute is a step towards implementing the UK Semiconductor Infrastructure Initiative, which was announced in the National Semiconductor Strategy in 2023. It was a key recommendation in a report commissioned by the UK Government's Department for Science, Innovation and Technology (DSIT) from the Institute for Manufacturing (IFM) and has the support of the Semiconductor Advisory Panel.

"The institute concept featured strongly in the IFM consultative study and it is seen as an effective way to create long-term momentum for our industry, help in engaging international partners and attracting investment in the sector," comments Jalal Bagherli, co-chair of the Semiconductor Advisory Panel.

The UK Semiconductor Institute will bring together government, academia and industry to help secure areas of world-leading strength in semiconductor technologies of the future, notes Martin McHugh, CEO at CSA Catapult. "The UK Semiconductor Institute will ensure the UK has a strategic and coordinated approach to developing new technologies, improving skills and exploiting areas in which the UK has existing strengths.

One of these strengths is compound semiconductors, and we look forward to working closely with the UK Semiconductor Institute to further the advancement of this critical technology that will accelerate our route to net zero through electrification and provide a secure and resilient telecoms network for the future," he adds.

"We were delighted to complete the largest European semiconductor venture raise in December 2023, co-led by UK Infrastructure Bank and M&G, with 70% of the round coming from UK investors," says Pragmatic's CEO David Moore. "This funding will accelerate continued expansion of our manufacturing capacity in the Northeast of England, taking volume from billions of flexible integrated circuits (FlexICs) to tens of billions per year. As a UK-based semiconductor company, servicing a global customer base, we welcome efforts to provide access to technology to foster the growth of emerging businesses, drive the expansion of the sector talent pool and promote international partnerships. The institute represents a significant opportunity for building out new infrastructure in support of areas where the UK can lead on the global stage, including advanced materials and disruptive, new approaches to semiconductor manufacturing at scale," he adds.

"The establishment of a UK Semiconductor Institute is welcomed by techUK and other members of the Chips Coalition, including Global Tech Advocates and TechWorks,"

says Julian David, CEO of techUK. "We have worked with UK government to develop the National Semiconductor Strategy and we look forward to turning that strategy into action," he adds. "By bringing together government, universities and the private sector, the Institute will be pivotal in advancing R&D, skills development, and fostering international collaboration. This collaboration will secure a robust and innovative future for the UK's semiconductor landscape," he believes.

"Semiconductor technology is the single most important component of all transformative technologies such as AI, telecommunications, quantum and electrification. As economic success becomes more dependent on semiconductors, it is crucial that the UK develops a long-term vision and strategy from research into commercial product and supportive partnerships with international partners to enable homegrown innovation to become global success stories," says Charlie Sturman of TechWorks. "As the UK trade body for Deep Tech and Semiconductors, Techworks is pleased to support the formation of this institute as a critical step in this direction."

The independent UK Semiconductor Institute will provide a UK focal point of support for semiconductor companies at all stages of their growth, notes Janet Collyer, senior independent director at EnSilica, independent non-executive director at the Aerospace Technology Institute, chair of the board at Quantum Dice and at Machine Discovery. "This capability is particularly important in the key areas of attracting diverse talent to the sector, accelerating production revenue by shortening the transition from lab innovation to production volume manufacture — 'the Lab to Fab' — and securing ongoing investment on schedule for timely national expansion during the scale-up phase."

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

CSconnected appoints Howard Rupprecht as new managing director

Chris Meadows to remain on board as non-executive director

The South Wales-based compound semiconductor cluster CSconnected Ltd says that Howard Rupprecht will take over as its managing director, with effect from 1 June. Rupprecht has semiconductor industry and business development experience from both the public and private sectors, and has been a director of CSconnected since January.

Chris Meadows, who has led CSconnected since its formation in 2017, will continue to support a number of committed activities during the remainder of 2024 and will remain on CSconnected's board as a non-executive director.

"I would like to thank Chris for his relentless efforts in developing CSconnected and ultimately building a strong and highly recognized global brand for the Welsh compound semiconductor cluster. It's good to be building on such a solid foundation as the team introduces new initiatives to support future cluster growth," says Rupprecht.

"We are entering a new phase of expansion of the South Wales compound semiconductor cluster, driven by the rapid growth our industrial partners and a global semiconductor industry forecast to surpass $1tr per annum by 2030," notes professor Wyn Meredith, chair of CSconnected. "Howard's appointment heralds an expansion of the CSconnected team to support the Welsh position in UK semiconductor initiatives such as the £160m South Wales Investment Zone, and the £1bn UK Semiconductor strategy."

www.csconnected.com

UK–APAC Tech Growth Programme report highlights opportunities in Taiwan

Nascent mid-stream compound semiconductor industry in Taiwan an opportunity for UK firms

Opportunities for UK companies across the semiconductor industry in Taiwan are revealed in a new report by international business development consultancy Intralink, which delivers the UK–APAC Tech Growth Programme on behalf of the UK Government.

Taiwan dominates many parts of global chip design and manufacturing, but the report says it is seeking to strengthen its position further in the face of a constrained energy supply, talent outflow and strong competition from China and South Korea. The report reckons that this opens the door to UK companies with innovative solutions and an aspiration to expand globally.

The semiconductor industry comprises about 12% of Taiwan's GDP and is valued at £74.7bn, according to the Taiwan Semiconductor Industry Association. The report says that Taiwanese companies account for 78% of foundry (manufacturing) revenue, 21% of integrated circuit (IC) design revenue and 52% of assembly, test and packaging (ATP) revenue globally. It is the island's key industry and its growth is being accelerated by increased demand for chips, driven in turn by advancements in AI, 5G, 6G, electric vehicles and high-performance computing.

However, the report also highlights that, while Taiwan is strong in the 'mid-stream' manufacturing and ATP segments of the industry, it relies on international companies for many 'upstream' technologies, i.e. the production of raw materials and components used in the manufacturing process such as silicon wafers, chemicals, gases and photomasks. It also relies on international technologies to facilitate the 'downstream' stage, during which its chips are integrated into end products such as mobile phones and cars.

Intellectual property (IP) is an area of particular relevance to UK semiconductor firms, according to report author Stewart Randall, head of Intralink's Electronics Practice.

He argues that well-established UK chip IP companies such as ARM and Imagination are highly regarded in Taiwan, and this confers credibility onto smaller British IP companies seeking to strike deals.

Taiwan has a nascent mid-stream compound semiconductor industry but needs world-leading technologies, such as those being developed by many UK firms.

Taiwan operates the largest foundries in the world but relies on imports of semiconductor manufacturing equipment

The report identifies areas that represent immediate opportunities for UK firms in Taiwan, including:

- **Compound semiconductors** — e.g. for technologies such as telecommunications, optoelectronics and solar cells. Taiwan has a nascent mid-stream compound semiconductor industry but needs world-leading technologies, such as those being developed by many UK firms.
- **Manufacturing equipment** — Taiwan operates the largest foundries in the world but relies on imports of semiconductor manufacturing equipment. A number of UK companies have already forged successful commercial relationships in this area.
- **Resource management** — Taiwan is keen to expand its manufacturing capacity but is struggling to balance the water required by its foundries with the needs of agriculture and the general population. It is also seeking ways to optimize its energy usage, adopt cleaner and renewable energy sources and implement energy-efficient technologies to reduce its carbon footprint and comply with international sustainability standards. This presents significant potential for UK tech firms to offer innovative solutions in these fields.

"The Taiwanese government and industry welcome overseas technologies that can help grow the island's position as the world's semiconductor leader," notes Randall. "While breaking into Taiwan can seem challenging, the UK–APAC Tech Growth Programme can make it easier," he adds. "As a first step, the programme can help companies to understand Taiwan's specific needs and the competitive landscape. It can then support them in starting to build connections, generate leads, sign partnerships and secure sales deals."

Backed jointly by the UK Department for Business & Trade and Department for Science, Innovation & Technology, the UK–APAC Tech Growth Programme is aimed at scaleups throughout the UK with significant international growth potential.

The UK–APAC Tech Growth Programme helps UK tech companies to expand in South Korea, Japan, Singapore, Vietnam, Malaysia, the Philippines, Thailand, Indonesia, Australia and New Zealand, as well as Taiwan.

www.intralinkgroup.com/en-GB/services/Asia-Market-Expansion/TGP

CSA Catapult appoints Jonathan Flint as new chair

Current chair Rob Bryan remains as non-executive director

Compound Semiconductor Applications (CSA) Catapult in Newport, South Wales, UK has appointed Jonathan Flint CBE as the new chair of its board of directors. He will lead the board to help deliver the mission and purpose of CSA Catapult, as well as overseeing the corporate governance of the organization.

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 centre 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.

Graduating in Physics from Imperial College in 1982, Flint holds an MBA from Southampton University Management School.

He started his career designing scientific and communications satellites at Marconi, where he worked for 20 years, before and after its acquisition by BAE Systems. He held both technical and managerial roles before becoming a managing director at Marconi and then at BAE Systems.

In 2005, Flint was appointed CEO of Oxford Instruments — the first substantial spin-out company from Oxford University — where he served for 11 years.

Flint is currently chairman of Quantic and executive chairman of Refeyn.

Flint has also been a non-executive director for Stadium plc and senior independent non-executive director for UK defence and communications equipment contractor Cobham plc.

Flint was president of the Institute of Physics (IOP) between 2019 and 2021 and has been a Fellow since 2007. He is also a Fellow of the Royal Academy of Engineering. He was awarded a CBE in 2012 'for services to Business and Science'.

"I look forward to being part of the next phase of the organization's journey as it scales up its efforts to help UK industry develop next-generation technologies," comments Flint. "Compound semiconductors are already revolutionising our approach to tackling society's biggest problems, such as increasing the efficiency of electric vehicles and reducing the vast amounts of energy consumed by data centers. CSA Catapult plays a critical role in helping to bring these applications to market and ensuring that the UK remains a global leader in this technology," he adds.

Flint takes over from the current chair Rob Bryan, who has completed his term of office and will remain as a non-executive director.

"Rob's extensive knowledge and experience of the innovation ecosystem and the wider Catapult landscape has been instrumental in leading CSA Catapult to its many successes to date and is something I will no doubt call upon as I begin the new role," comments Flint.

"I look forward to supporting him through the next phase of CSA Catapult's journey," says Bryan. "Jonathan brings with him extensive experience at both executive and non-executive level from the science and innovation industry, which will be invaluable to the Catapult," he adds. "It's been an honour to serve as Chair and to see the Catapult mature into an organization that now spans the breadth of the country in support of our thriving compound semiconductor ecosystem. From a standing start in 2018, the Catapult now employees around 100 people, has engaged in over 200 industrial collaborations and secured over £18m in collaborative R&D funding."

"Innovate UK works to support growth and increased productivity across the UK through our portfolio of products and services," says Dave Wilkes, director — Innovation Ecosystem at Innovate UK. "The Innovate UK Catapult Network provides a unique combination of world-class expertise and facilities, connecting research excellence with business impact," he adds. "Jonathan Flint CBE's appointment as chair of the Compound Semiconductor Applications Catapult will bring a broader industry focus and support the Catapult's mission to stimulate business growth in the UK by unlocking the potential of compound semiconductors across a range of sectors."

www.csa.catapult.org.uk

Skyworks' quarterly revenue falls 12.9% to $1.046bn

Reduction in CapEx boosts cash generation despite inventory correction in Mobile products

For its fiscal second-quarter 2024 (to 29 March) Skyworks Solutions Inc of Irvine, CA, USA (which manufactures analog and mixed-signal semiconductors) has reported revenue of $1046m, down 12.9% on $1201.5m last quarter and 9.5% on $1153.1m a year ago.

Revenue from Skyworks' largest customer was down seasonally by 19% sequentially and down 3% year-on-year, comprising about 68% of total revenue.

Mobile products revenue declined 19% sequentially (falling back from 71% to 66% of total revenue). "We saw below-normal seasonal trends, with lower-than-expected end-market demand [especially in the month of March]," notes chairman, CEO & president Liam K. Griffin. This resulted in some buildup of inventory in the channel.

Broad Markets product revenue was up 1% sequentially (rising from 29% to 34% of total revenue, after overcoming near-term inventory corrections in wireless infrastructure, automotive and industrial). "The December quarter represented the bottom and we delivered modest sequential growth in March, reflecting a turning point," says Griffin.

On a non-GAAP basis, gross margin has fallen further, from 50% a year ago and 46.4% last quarter to 45% (at the bottom of the 45–46% guidance range). In addition to being the firm's seasonally weakest quarter, this reflects the after-effect of having reduced factory utilization to drive down internal inventory for a fifth consecutive quarter (by $91.5m, from $927m to $835.5m).

Operating expenses have risen further, from $191m (15.9% of revenue) last quarter to $192m (18.4% of revenue). However, this is below the guidance range of $193–197m, reflecting Skyworks' ongoing focus on managing discretionary expenses while continuing to make strategic investments in technology and product roadmaps in both Mobile and Broad Markets in order to drive share gains and increased diversification.

Net income has fallen further, from $323.1m ($2.02 per diluted share) a year ago and $317m ($1.97 per diluted share) last quarter to $250.7m ($1.55 per diluted share – although this was $0.03 above the $1.52 guidance).

Despite the challenging macroeconomic environment and quarterly volatility, Skyworks' business model generated strong operating cash flow of $300.2m.

Capital expenditure was $27.6m (less than 3% of revenue), cut from $45.3m a year ago, as Skyworks has got past the years of spending 10–12% of revenue to build out its manufacturing assets (especially its filter operation, as well as its back-end operation involving complex integration, assembly & test). The firm is now focusing more on creating additional capacity through operational improvements (including driving efficiency, yield improvements, test time reductions, and die shrinks). "We can substantially grow the revenue without having to add a lot more CapEx," notes senior VP & chief financial officer Kris Sennesael. "It's going to remain for many, many years here in the low single digits as a percent to revenue, and that will continue to fuel a very strong free cash flow."

Free cash flow was hence $272.6m (26.1% of revenue). "We continue to drive robust cash flow through high levels of profitability, prudent working capital management and moderating CapEx," says Sennesael.

During fiscal Q2, Skyworks paid $109.1m in dividends (up from $98.7m a year ago, and roughly level with $108.9m last quarter).

Cash and cash equivalents grew to $1205.4m, up by $175.7m from $1029.7m last quarter. Debt remained about $993m.

Since quarter-end, Skyworks' board of directors has declared a cash dividend of $0.68 per share of common stock, payable on 11 June, to stockholders of record at the close of business on 21 May.

Business highlights during fiscal Q2 included:

- delivering integrated platforms to the leading 5G smartphone OEMs, including flagship and mid-tier model launches at Samsung, Google and Oppo;
- expanding the design-win pipeline and initiating new programs in automotive, including infotainment systems, traction inverters, cloud-enhanced driver-assist, and CV2X on-board units;
- securing several audio SoC design wins with Sony PlayStation and Samsung for wireless gaming and soundbars.

June quarter to see end of inventory correction

For fiscal third-quarter 2024 (to end-June), Skyworks expects revenue to fall to $900m.

Mobile product revenue is expected to be down 20–25% sequentially, which is well below the normal seasonal weakness, while the firm clears out the build up of excess inventory that occurred in March and continued through April. However, Skyworks' Android-related business (Google, Samsung, and the China OEMs) has been stabilizing, and is approaching $100m per quarter. "The inventory correction is over," says Sennesael.

Broad Markets product revenue should see further modest sequential growth of 2–3% as inventory levels appear to be normalizing in certain end-markets. However, the wireless infrastructure and traditional data-center markets will

remain a headwind throughout 2024, as OEMs continue to digest excess inventory. "We are under-shipping natural demand right now as we allow the distribution channel and customers to consume excess inventory. It's going to take a couple of quarters for that business to really bounce back," notes Sennesael.

Gross margin should be 45–47%, growing by 100 basis points sequentially at the midpoint. Skyworks expects gross margin expansion during the remainder of 2024, driven by: cost-reduction actions internally as well as externally with all suppliers (including yield improvements and test time reductions); a favorable shift in product mix (from Mobile to higher-margin Broad Markets, as the latter recovers); and higher factory utilization rates (after the end of five consecutive quarters of drastically reducing internal inventory).

Operating expenses are targeted to be $192–198m as the firm continues to make strategic investments in both Mobile and Broad Markets to drive share gains and increase diversification.

At the mid-point of the revenue range, diluted earnings per share should fall to $1.21.

Longer-term outlook

In the September quarter, Skyworks will start to see the impact of "a unique situation with our largest customer where we were unable to consummate an award that we expected," notes Griffin. "As a result, we expect content headwinds from the upcoming cycle," he adds. "We were able to partially offset the socket loss with some additional content gains, including some new sockets that we don't have in the current version of the phone," says Sennesael. "On a net-net, we expect the content to be down a little more than 10% compared to the current phone model, and that will start having an impact in the September quarter," he adds. "We are strategically aligned with our largest customer and we're ready to engage in all of their strategic initiatives going forward," stresses Griffin.

For Android smartphones more generally, Sennesael says: "We are making some good traction with design wins. As end-customer demand continues to improve over time and new design wins roll in, we do expect that business to contribute to some nice year-over-year growth in the next four to eight quarters."

Regarding Broad Markets, Griffin expects the pace of the recovery to be measured throughout 2024, given the ongoing weakness in certain end-markets like infrastructure and automotive. "The next couple of quarters, we expect an acceleration of that sequential growth, getting back to initially modest year-over-year growth but then translating into strong double digit year-over-year growth in our Broad Markets business," says Sennesael.

"Over the long-term, we intend to leverage our connectivity technology across edge-connected IoT devices, automotive electrification and advanced safety systems, and AI infrastructure [driving cloud and data-center upgrades]," says Griffin.

"In edge IoT, we have a solid Wi-Fi 6E and Wi-Fi 7 design-win pipeline. We are in the early innings of a multi-year upgrade cycle, with high-end access points now being offered. Over the coming quarters, we anticipate retailers to roll out mainstream models, followed by carriers and MSOs for their gateways and router products," says Griffin.

"Despite near-term headwinds, we remain bullish on AI workloads, driving upgrades to Ethernet switches and optical modules, a positive long-term driver for our advanced precision timing solutions," he adds.

"Lastly, automotive and industrial markets remain under pressure as they continue to undergo a steep inventory correction. However, we see opportunities for long-term growth in our automotive business. Automotive OEMs are increasingly focused on software-defined vehicles, the connected car and in-cabin user experience, all of which are generating higher levels of radio complexity," Griffin continues. "Despite near-term headwinds, we remain positive on growing EV penetration, creating demand for our power isolation products."

www.skyworksinc.com

Qorvo grows year-on-year after content gains with largest mobile customers and record defense revenue

Gross margin to bottom in June quarter while high-cost 5G Android inventory sells through

Qorvo Inc of Greensboro, NC, USA (which provides core technologies and RF solutions for mobile, infrastructure and defense applications) has reported revenue for full-year fiscal 2024 (ended 30 March) of $3769.5m, up 5.6% on fiscal 2023's $3569.4m, benefitting from significant content gains at its largest mobile customers, and record revenue from defense & aerospace (D&A) business. The two 10% customers were Apple (up further to 46%, from 37% in fiscal 2023 and 33% in fiscal 2022) and Samsung (consistent at 12%).

Fiscal fourth-quarter 2024 revenue was $941m, down 12.4% on $1073.9m last quarter but up 49% on $632.7m a year ago, and exceeding the $925m mid-point of guidance by $16m.

"Qorvo delivered year-over-year revenue growth in the March quarter in each of our three operating segments," notes president & CEO Bob Bruggeworth. "There are global macro trends [including mobility, connectivity, electrification and datafication] supporting our markets that are increasing customer requirements for efficiency, latency, throughput and other critical performance metrics," he adds.

By business segment, revenue comprised:

- **Advanced Cellular Group (ACG)** $653.6m, down 22.8% on $846.1m last quarter (due to the typical sequential decline associated with the Autumn ramp of Qorvo's largest customer) but up 56.5% on $417.7m a year ago, supported by strong content on multiple, large customer platforms;
- **Connectivity & Sensors Group (CSG)** $122.8m, up 12.8% on $108.9m last quarter and 49.9% on $81.9m a year ago after a fourth consecutive quarter of sequential growth, due to strength in Wi-Fi, automotive and other areas, despite slower-than-expected ramps in IoT-related areas;
- **High-Performance Analog (HPA)** $164.6m, up 38.4% on $118.9m last quarter and 23.7% on $133.1m a year ago (returning to year-on-year growth across all the businesses except base-stations). This was driven by stronger-than-anticipated sequential growth in defense & aerospace business to record revenue (becoming the largest contributor to HPA) due to large defense programs and SATCOM growth, plus continued improvement in end-markets other than base-stations.

On a non-GAAP basis, gross margin was 42.5%, up on 41.3% a year ago and above the 42% guidance. However, this was down from 43.8% last quarter as a higher percentage of Android 5G mass-market product was manufactured internally during periods of lower factory utilization, leading to higher unit costs. Full-year gross margin has fallen further, from 46.3% in fiscal 2023 to 44.5% for fiscal 2024, although this exceeded the guidance of 44%.

During the quarter, Qorvo reduced its net inventory balance further, by $16m from $727m to $710.5m (down from $796.6m a year ago), reflecting the firm's continued commitment to efficient inventory management. Shipments are now more closely aligned to end-market demand.

Operating expenses have grown further, from $227.4m a year ago and $234m last quarter to $253.2m, exceeding the forecasted $245m. This was driven mainly by R&D spending rising from $152.5m last quarter to $168.1m.

"We continue to invest in new product development to drive multi-year growth across our businesses," says chief financial officer Grant Brown. "Alongside our growth-oriented investments, we're investing to upgrade the core systems and processes we use to run our business. This multi-year initiative is intended to extend our competitive advantage and enable us to scale growth in diverse dynamic markets. Our goal is to increase operational efficiency, unlock internal data to leverage new software capabilities, including AI, and support our broad-based growth objectives. We expect this initiative will span approximately three years."

Net income was $135.5m ($1.39 per diluted share, surpassing the targeted $1.20), up on $25.7m ($0.26 per diluted share) a year ago but down from $205.9m ($2.10 per diluted share) last quarter.

"Revenue, gross margin and diluted EPS all exceeded the mid-point of the guidance range," notes Brown.

Operating cash flow was $202.3m. Capital expenditure rose from $26.4m last quarter to $32.7m (while remaining well under the targeted 5% of revenue for the full-year). Free cash flow was hence $169.6m.

During the quarter, Qorvo repurchased about $100m of stock (bringing the total for full-year fiscal 2024 to $400m).

Cash and cash equivalents fell during the quarter, from $1072m to $1029.3m. As of quarter-end, Qorvo had about $1.5bn of long-term debt outstanding.

Acquisitions & divestments

During the quarter, Qorvo completed the acquisition of Anokiwave Inc of Boston, MA, USA, a supplier of high-performance silicon integrated circuits for intelligent active

array antennas, with design centers and sales offices in Boston and in San Diego, CA. Its silicon beam-forming ICs and IF-to-RF conversion solutions are said to be complementary to Qorvo's transmit/receive RF front-ends for SATCOM, D&A, 5G and other beam-forming applications. The Anokiwave team has hence joined Qorvo's HPA segment. "The D&A content opportunity for Qorvo is especially strong in phased array, where our solutions can enable transmit/receive elements. Phased array radars can contain hundreds, up to tens of thousands of transmit/receive elements per system, underscoring the multiplier effect for Qorvo," says Bruggeworth. "Adding to this, we are developing more highly integrated placements that combine Anokiwave solutions with our existing RF and power management IC portfolios," he adds.

In mid-December, Qorvo said that it was divesting its assembly & test facilities in Beijing and Dezhou, China, via a new multi-year partnership with Luxshare Precision Industry Co Ltd of Dongguan City, Guangdong (which is acquiring their operations and assets, including the property, plant and equipment, as well as the existing workforce to enable continuity of operations). Qorvo will continue to maintain its sales, product and test engineering, and customer support staff in China "Adding Luxshare as a strategic partner will strengthen our position to serve our customers globally," reckons Brown. "We made significant progress towards achieving operational readiness and completing other work required to close the transaction [expected this June quarter]," he adds.

"As it relates to our manufacturing strategy, this is a further step in our ongoing efforts to reduce capital intensity," notes Brown. "This move aligns with previous actions, including the closure of our Florida manufacturing operations and the recent sale of our Farmers Branch facility in Texas. We are efficiently managing a complex supply chain, including our internal factories, which support all three operating segments and will remain an ongoing focus," says Brown. "We will leverage internal manufacturing where it uniquely differentiates our products and outsource production where we maintain a strong network of foundry and OSAT partners," he adds.

Strategic highlights during the quarter

● High-Performance Analog (HPA)

In defense & aerospace (D&A), design wins for the quarter spanned airborne and shipborne radars, SATCOM applications and solid-state power amplifier products. Qorvo secured its first design win for a BAW-based filter bank solution that enables new architectures for large defense customers. In low earth orbit (LEO) SATCOM applications, Qorvo is engaged to supply multiple products including LNAs, switches, mixers and BAW multiplexers to support ubiquitous, non-terrestrial connectivity.

"In power management, we are investing to expand its reach in markets where Qorvo enjoys long-standing customer relationships such as consumer, D&A and mobile, while also targeting more fragmented and more diverse industrial markets," says Bruggeworth. Qorvo secured a motor control design win and a power tool platform with a leading manufacturer of residential and commercial lawn and garden products, as well as new PMIC design wins at new and existing solid-state drive customers.

For power management opportunities in mobile, there are increasing requirements for compute and processing power in the device that are creating new growth vectors for Qorvo PMICs. "The opportunity is significant in both volume and content, and we are able to leverage our exceptional customer and ecosystem relationships," says Bruggeworth.

"Beyond RF power management, there are incremental power management opportunities in the phone where Qorvo is leveraging our expertise to reduce current consumption, improve battery life and better accommodate more data-intensive use cases," says Bruggeworth. "We have very strong power management IP that can be extended across markets, making our PMIC portfolio an engine for ►

Qorvo awarded damages in US patent lawsuit against RF BAW filter maker Akoustis

Verdict enables Qorvo to pursue injunction versus Akoustis products

Qorvo Inc of Greensboro, NC, USA (which provides core technologies and RF solutions for mobile, infrastructure and defense applications) says that on 17 May a federal jury in the US District Court for the District of Delaware returned a verdict in its favor, finding that RF bulk acoustic wave (BAW) filter maker Akoustis Technologies Inc and Akoustis Inc willfully and maliciously misappropriated its trade secrets and infringed certain Qorvo patents relating to BAW filter designs. The jury awarded Qorvo over $31.5m in compensatory damages and an additional $7m in punitive damages. This verdict enables Qorvo to pursue an injunction against Akoustis products.

The case was originally filed in October 2021. Qorvo says that it remains committed to protecting its intellectual property.

www.akoustis.com
www.qorvo.com

diversification, growth and profitability," he adds.

Qorvo is also extending its reach in broad markets by building out more ways to engage with existing and new customers, such as its recently launched QSPICE analog and mixed-signal circuit design and simulation tool. "QSPICE has gained quick traction with engineers by providing them measurable improvements in speed, functionality and reliability of circuit simulation," says Bruggeworth. "Since its launch, QSPICE has surpassed 20,000 unique downloads."

In power devices, customers continue to transition from silicon to silicon carbide, and design activity for Qorvo remained strong in its target markets. The firm continues to secure design wins for high-density server power supplies, and has added a second tier-1 North American server OEM.

"In infrastructure markets, Qorvo is leading the transition from DOCSIS 3.1 to DOCSIS 4.0 with a broad portfolio of products," says Bruggeworth. "In our base-station business, customers continue to award Qorvo design wins, however, we expect the demand environment to remain weak. Longer-term, we are very pleased to have been selected by a European-based OEM to support their 6G development efforts."

● Connectivity & Sensors Group (CSG)

Qorvo is supporting an increasing number of applications requiring the security and precision location awareness of its ultra-wideband solutions across mobile, consumer, automotive and other markets.

In mobile, ultra-wideband placements are among many Qorvo solutions supplied to Samsung in support of their Galaxy S24 flagship brand.

In consumer markets, recent wins include a robotic lawn mower that leverages Qorvo's ultra-wideband to provide the precision location accuracy required to enable this application.

In automotive, customer engagements are expanding to enable a range of applications that leverage Qorvo's ultra-wideband radar capabilities. Automotive applications for ultra-wideband technology include secure access and digital key, as well as kick sensors and the reliable detection of both intrusion and occupancy. During the quarter, customer activity included an ultra-wideband design win enabling secure access for an EV manufacturer in North America.

Qorvo was also selected to supply automotive Wi-Fi 6E solutions in support of a different North American EV OEM. It was also selected to supply its V2X solution for an automotive OEM in Europe on a platform ramping in calendar 2025. For an EV OEM in Asia, Qorvo was selected to enable their 5G network access device with six solutions, each of which contain Qorvo's low-band, mid-high-band, ultra-high-band, diversity receive, average power tracker and high-performance BAW filtering. Production for this program begins this year. This 5G reference design will also be marketed to additional automotive OEMs and tier-1s.

For Wi-Fi markets, Qorvo is migrating its newest and most advanced BAW technology across its Wi-Fi portfolio. The firm launched 6GHz Wi-Fi 7 filters using its next-generation BAW and will soon launch Wi-Fi 7 iFEMs that combine its next-generation BAW with its PA, switch and LNA content in a single placement. Qorvo also ramped its newest Wi-Fi 7 long non-linear FEMs for a tier-1 network operator in the USA and sampled next-generation, high-efficiency Wi-Fi 7 FEMs aligning with a leading mobile Wi-Fi chipset.

In connected home applications, Qorvo began sampling its next-generation Matter SoC and secured a design win with a leading network operator in the USA to supply its BLE/Zigbee SoC to remote controls for home gateways.

In force sensing touch sensors, Qorvo expanded its engagements in trackpads and other consumer applications.

● Advanced Cellular Group (ACG)

"We are the primary RF supplier to the Android ecosystem and our strong roadmap and multi-year collaboration positions us to benefit as the Android ecosystem continues to transition to 5G," says Bruggeworth. During the quarter, Qorvo supported the Galaxy S24 launch with its low-band, mid-high-band, ultra-high-band, secondary transmit and receive, tuning, Wi-Fi and ultra-wideband solutions. "This highlights the strength of our portfolio and the breadth of our opportunity at Samsung, and we are pleased to support them across their flagship and mass market 5G smartphones," says Bruggeworth.

For mass-market Android 5G smartphones, Qorvo is seeing strong pull for its recently launched low-, mid-, high-band PAD (power amplifier duplexer). "Qorvo's LMH solution reduces surface area by 40% by combining in one placement the low-, mid- and high-band main PAD content traditionally offered in two placements," notes Bruggeworth. Qorvo has expanded customer engagements to include the top four China-based 5G Android OEMs, and volume shipments are set to commence this calendar year.

"To broadly support all customers with best-in-class portfolios, we continue to advance new technologies across our products," says Bruggeworth. "We are proliferating our next-generation BAW technology across high-performance discrete and integrated solutions," he adds. Qorvo also recently released a next-generation LRT SAW process to complement its advanced BAW and SAW processes in select bands. The first module combining its LRT SAW and BAW filters will support a flagship launch later this summer.

Outlook — gross margin to bottom out in June quarter as high-cost 5G Android inventory sells through

For fiscal first-quarter 2025 (to end-June 2024), Qorvo expects revenue to fall to $850m. This is dominated more than ever by

Qorvo's increasing exposure to the seasonal ramp patterns at its two largest customers, leading to a decline in ACG revenue in the high single digits. "We're coming off a big flagship ramp at our second largest customer with tremendous content," notes Bruggeworth. "We're offsetting that with growth outside of them." Similarly, while Qorvo expects D&A business to grow year-on-year in fiscal 2025, the seasonal timing of large defense programs (given its dominant size within HPA) — together with a slower rollout of DOCSIS 4.0 — should lead to a decline in HPA revenue in the low double digits. CSG revenue should be roughly flat.

Gross margin should dip to a low point of 40–41%. As well as the typical seasonal decline in Qorvo's largest customer (comprising products that contain higher levels of external content) plus the seasonal decline in defense programs, this reflects a higher percentage of Android 5G mass-market product that was manufactured during periods of lower utilization. As these higher-cost inventories sell through [mostly by end-June], it paves the way for future gross margins that reflect increasing levels of utilization. Utilization across Qorvo's US fabs has already risen from the 40%s in fiscal Q1 last year to the 60%s now. "We still have meaningful opportunity to improve and reach more optimal levels, in the 80%s or higher, across the board," says Brown.

Operating expenses should be about $260m, with variability related to the timing of program development spend and other factors. This includes about $5m of other operating expense related to modernizing core systems and business processes. During fiscal 2025, Qorvo expects to record about $40m of expense related to this project, with quarterly variability related to the achievement of progress-based milestones.

Diluted earnings per share is expected to fall to $0.60–0.80 in fiscal Q1.

"Absent any macro-related disruptions, we do expect to grow both revenue and gross margin modestly in fiscal 2025 on a year-over-year full-fiscal-year basis," says Brown. "Given the timing of the content gains at our largest customer and the success in the defense market, our revenue seasonality will be more closely aligned to those annual ramp profiles. That's clear in our Q1 guidance, but will also be included in our full fiscal year," he adds.

"For September, we expect gross margin to improve substantially as three headwinds reverse: the seasonal ramp will reflect more external content; defense revenue is expected to grow sequentially; and the under-utilization impact should fall to less than or around 100 basis points versus the 300 basis points that we experienced last quarter," he adds.

Gross margins is expected to then be roughly flattish in the December quarter and then down slightly the following March quarter. "We continue to expect full-year [fiscal 2025] gross margin to improve modestly year-on-year [to the mid-40%s]," says Brown.

Qorvo believes that in can still return to 50%-plus gross margin over time. "Business mix will play a role," says Bruggeworth. "From an overall manufacturing perspective, we expect to benefit from continued die size reductions, wafer size increases, and we can continue reducing our capital intensity. We're continuously looking at factory footprints for opportunities to optimize and consolidate our operations, and you've already seen us take steps there such as divesting our Farmers Branch facilities as well as our Beijing and Dezhou facilities."

www.qorvo.com

UMC introduces first 3D IC solution for RFSOI

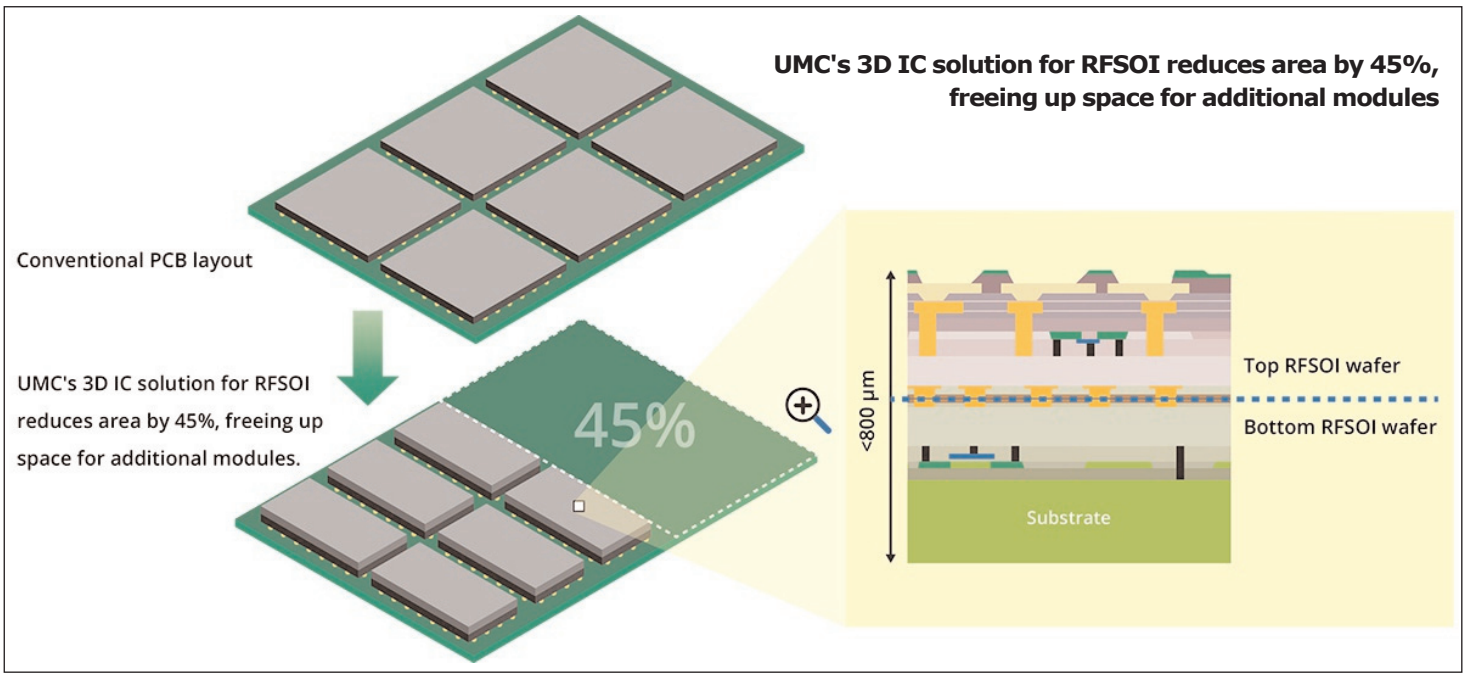
Stacked silicon cuts die size by over 45%, enabling integration of more RF components in 5G-enabled devices

Semiconductor foundry United Microelectronics Corp of Hsinchu, Taiwan has announced what it claims is the first 3D IC solution for radio-frequency silicon-on-insulator (RFSOI) technology. Available on UMC's 55nm RFSOI platform, the stacked silicon technology reduces die size by more than 45% without any degradation of RF performance, enabling customers to efficiently integrate more RF components to address the greater bandwidth requirements of 5G.

As mobile device manufacturers pack more frequency bands in newer generations of smartphones, the UMC's 3D IC solution for RFSOI addresses the challenge of integrating more RF front-end modules (RF-FEM), for transmitting and receiving data, into a device by vertically stacking dies to reduce surface area. RFSOI is the foundry process used for RF chips such as low-noise amplifiers, switches and antenna tuners. Utilizing wafer-to-wafer bonding technology, UMC's 3D IC solution for RFSOI resolves the common issue of RF interference between stacked dies. The firm has received multiple patents for this process, which is now ready for production.

"We are proud to lead the industry in offering this state-of-the-art solution utilizing our innovative 3D IC technology for RF-FEM. This groundbreaking technology not only solves the challenges of increased frequency band demands in smartphones in the 5G/6G era but also helps in mobile, IoT and virtual reality devices with faster data transfer by accommodating more frequency bands in parallel," says Raj Verma, associate VP of technology development at UMC. The firm will continue to develop stacked die solutions to meet customers' RF needs, such as for 5G millimeter-wave, in the future, he adds.

www.umc.com



UMC's 3D IC solution for RFSOI reduces area by 45%, freeing up space for additional modules

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X-FAB and Soitec team to offer SmartSiC at Lubbock plant in Texas

Partnership to bring power devices based on Soitec's SmartSiC wafers to X-FAB's fabless client network

Specialty semiconductor foundry X-FAB Silicon Foundries SE of Tessenderlo, Belgium and Soitec of Bernin, near Grenoble, France are to begin work to offer Soitec's SmartSiC wafers for the production of silicon carbide power devices at X-FAB's plant in Lubbock, Texas.

The collaboration follows completion of the assessment phase, during which silicon carbide (SiC) power devices were manufactured at X-FAB Texas on 150mm SmartSiC wafers. Soitec will offer X-FAB's customers easy access to the SmartSiC substrate through a joint supply chain consignment model.

SmartSiC is a proprietary technology based on Soitec's SmartCut process, in which a thin layer of a high-quality monocrystalline (mono-SiC) 'donor' wafer is split off and bonded to a low-resistivity polycrystalline (poly-SiC) 'handle' wafer. The resulting substrate offers improved device performance and manufacturing yields. The process allows multiple re-uses of a single donor wafer, significantly reducing cost and related CO_2 emissions.

In this fast-growing market, Soitec is ramping production of SmartSiC substrates at its new plant in Bernin. X-FAB is increasing production capacity for SiC devices at its Lubbock plant. Use of the SmartSiC substrate enables X-FAB's customers to design smaller devices, resulting in efficiency improvements through an increased number of dies per wafer. The benefit of reduced CO_2 emissions from the substrate manufacturing process will also contribute to X-FAB's initiative to reduce its overall carbon footprint.

"We want to provide our customers the full range of opportunities to design innovative and robust SiC devices for electric vehicles, renewable power and industrial applications," says X-FAB's VP procurement Sophie Le-Guyadec. "To offer the most advanced silicon carbide processes and manufacturing capabilities, we jointly agreed to provide our customers easy access to Soitec's innovative SmartSiC via a consignment model," she adds.

"Soitec's SmartSiC substrates and X-FAB's foundry services are a perfect fit to meet increasing demand for new SiC products," believes Emmanuel Sabonnadiere, Soitec executive VP automotive & industry. "This cooperation is a significant milestone for the deployment of SmartSiC in the US market and internationally, thanks to X-FAB's global footprint."

www.xfab.com

Soitec and Tokai Carbon to co-develop poly-SiC substrates for SmartSiC wafers

Soitec and carbon and graphite product maker Tokai Carbon of Tokyo, Japan have entered into a strategic partnership for the development and supply of polycrystalline silicon carbide substrates specifically designed for Soitec SmartSiC wafers.

SmartSiC engineered substrates are targeted at accelerating the adoption of silicon carbide for electric mobility, industrial and smart grid applications by delivering superior manufacturing and cost efficiencies with an improved environmental footprint.

Under the partnership, which will see Tokai Carbon supply 150mm and 200mm poly-SiC wafers to Soitec, the two companies aim to harness their R&D capabilities to enhance the SmartSiC ecosystem. Tokai Carbon's technology and manufacturing capacity in polycrystalline silicon carbide (polySiC) combined with the right to use Soitec specifications for polySiC coarse wafers compliant with Soitec SmartSiC is expected to make a strategic contribution to the global ramp-up of SmartSiC wafer production.

"This partnership with Tokai marks yet another key step in the ramp-up of Soitec's SmartSiC technology to address fast-growing markets such as electric mobility and industrial electrification," says Soitec's chief operations officer Cyril Menon. "Tokai's top-quality SiC products and R&D capabilities, combined with Soitec's innovative SmartSiC technology, can help to accelerate global adoption of electric mobility and other SiC technologies. This is an important milestone in terms of perception and value creation for the SmartSiC ecosystem," he reckons.

"The polycrystalline SiC substrate to be supplied to Soitec is a strategic product in our solid SiC product series," says Tokai Carbon's CEO Hajime Nagasaka. "We have high expectations for this product in the SiC semiconductor market, which is expected to expand significantly in the future," he adds. "The partnership with Soitec is also very meaningful in terms of contributing to the realization of a sustainable society."

www.soitec.com

Penn State and Morgan Advanced Materials partner on silicon carbide R&D

Carbon materials provider becomes a founding member of Silicon Carbide Innovation Alliance

Penn State University and UK-based Morgan Advanced Materials (which provides ceramics and carbon materials) have signed a memorandum of understanding (MoU) to catalyze R&D of silicon carbide (SiC). The agreement includes a new five-year, multi-million-dollar initiative and a commitment by Morgan to become a founding member of the Penn State Silicon Carbide Innovation Alliance (SCIA, launched in early April), as well as to supply the graphite materials and solutions needed for SiC development to Penn State for use by internal and external partners.

The initiative is a coalition of industry leaders, academic institutions and government support led by materials science & engineering professor Joshua Robinson, acting associate dean for research in Penn State's College of Earth and Minerals Sciences.

"Partnerships like this will maximize our impact in next generation SiC crystal research and workforce development," says Robinson.

The MoU outlines how the partners aim to advance carbon research and evaluate how Morgan's carbon material product impacts SiC wafer fabrication.

Silicon carbide crystals are grown at temperatures greater than 3600°F in a physical vapor transport (PVT) furnace that utilizes a significant amount of carbon to maintain the temperature during the growth process. Carbon materials made by Morgan act as insulating layers that reduce heat loss and the amount of electricity needed to keep the furnaces running during the weeks-long process.

Morgan Advanced Materials has been manufacturing carbon- and graphite-based materials essential for growing SiC crystals since the 1990s. Morgan established a Carbon Science Centre of Excellence in Innovation Park in 2016 that has fostered several collaborations with Penn State researchers.

Morgan Advanced Materials visited Penn State to sign the MoU.

"The new agreement with Penn State seamlessly aligns our goal of establishing Morgan as a key player in the silicon carbide market — we are not only advancing our own graphite competencies but also contributing to the development of high-value products in the market," says Morgan Advanced Materials' Thomas Connolly chief technology officer.

A new SiC growth facility in Penn State's Academic Activities Building at University Park, funded via support from Penn State's Office for the senior VP for research and the US Air Force Office of Scientific Research (through award #FA9550-23-1-0561), is expected to be fully operational by the beginning of 2025. This will house a pilot-scale facility that will emulate the entire SiC bulk crystal growth supply chain.

The Corporate Engagement Center played a key role in expanding Morgan's commitment to Penn State. The center's leadership anticipates that the alliance will attract additional industry partners.

"Partnerships with public and private entities have allowed Penn State to be the first university in decades to house SiC equipment from boule to wafer processing," notes Andrew Read, senior VP for research at Penn State. "We greatly appreciate Morgan's continued commitment to Penn State."

Affiliate colleges and units in this partnership include the Eberly College of Science, the College of Earth and Minerals Sciences, the College of Engineering, the Materials Research Institute and the Applied Research Laboratory. Access to the PVT furnace will give researchers from these units and beyond the opportunity to develop a deeper understanding of the parameters that impact crystal growth and to identify, investigate and address challenges facing the market, driving innovation and progress.

www.scia.psu.edu
www.morganadvancedmaterials.com
www.mri.psu.edu

University of Arkansas tops out Multi-User Silicon Carbide Research and Fabrication Facility

21,760ft² facility includes 8000ft² of fabrication & testing cleanrooms

The University of Arkansas (U of A) has celebrated a milestone with the topping-out of the Multi-User Silicon Carbide Research and Fabrication Facility (MUSiC).

More than 100 students, faculty, state leaders and citizens were on hand to sign the steel topping-out beam and hear remarks from the College of Engineering's dean Kim Needy and Alan Mantooth, Distinguished Professor of electrical engineering.

The new facility will enable the federal government — via national laboratories — businesses of all sizes and other universities to prototype with silicon carbide, a capability that does not presently exist elsewhere in the USA.

Work at the facility aims to bridge the gap between traditional university research and the needs of private industry and is expected to accelerate technological advancement by providing a single location where chips can go from developmental research to prototyping, testing and fabrication.

From left, College of Engineering dean Kim Needy signs a beam while Margaret Sova McCabe (vice chancellor for research and innovation) and Charles Robinson (chancellor) observe.

Located next to the National Center for Reliable Electrical Power Transmission at the Arkansas Research and Technology Park, the 21,760ft² facility will address obstacles to US competitiveness in the development of silicon carbide electronics used in a wide range of electronic devices, circuits and other consumer applications. The building will feature about 8000ft² of cleanrooms for fabrication and testing.

Education and training within the facility should also accelerate workforce development, helping to supply the next generation of engineers and technicians in semiconductor manufacturing.

www.research.uark.edu

Infineon supplying silicon carbide power modules to Xiaomi EV for new SU7 smart EVs

Two HybridPACK Drive G2 CoolSiC 1200V modules used in SU7 Max

Infineon Technologies AG of Munich, Germany is to provide HybridPACK Drive G2 CoolSiC silicon carbide (SiC) power modules and bare die products to Xiaomi EV of Shanghai, China for its recently announced SU7 electric vehicle until 2027.

Infineon's CoolSiC-based power modules are said to allow higher operating temperatures, resulting in what are claimed to be best-in-class performance, driving dynamics and lifetime. Traction inverters based on the technology can, for example, further increase EV range. The HybridPACK Drive is Infineon's market-leading power module family for electric vehicles, with almost 8.5 million units sold since 2017.

Infineon provides two HybridPACK Drive G2 CoolSiC 1200V modules for the Xiaomi SU7 Max. In addition, it supplies Xiaomi EV with a broad range of products per car including, for example, EiceDRIVER gate drivers and more than ten microcontrollers in various applications. The two companies also agreed to further cooperate on SiC automotive applications to fully utilize the benefits of Infineon's SiC portfolio.

Xiaomi's new SU7 smart EV.

"Infineon is an important partner with leading technologies and resilient manufacturing capabilities in power semiconductors as well as a highly scalable microcontroller product portfolio," comments Zhenyu Huang, VP of Xiaomi EV & general manager of the Supply Chain Department. "The cooperation between the two companies will not only help stabilize the supply of silicon carbide for Xiaomi EV but also help us build a high-performance, safe and reliable luxury car with leading-edge features for our customers," he adds.

"We are very pleased to work with dynamic players such as Xiaomi EV and provide them with silicon carbide products designed to enhance the performance of electric cars even further," says Peter Schiefer, president of Infineon's Automotive division. "As the leading partner to the automotive industry, we are well positioned with our broad product portfolio, system understanding and multi-site manufacturing base to shape the mobility of the future."

www.infineon.com/coolsic

Infineon unveils roadmap for power supply units in AI data centers

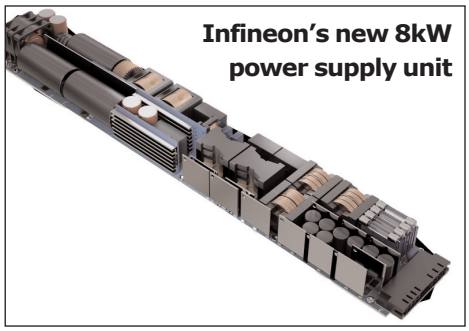
Combination of silicon, SiC and GaN to yield 8kW PSU in Q1/2025, then first 12kW PSU

Infineon Technologies AG of Munich, Germany has unveiled a roadmap of energy-efficient power supply units (PSU) specifically designed to address the current and future energy need of artificial intelligence AI data centers.

By introducing what is described as unprecedented PSU performance classes, Infineon is enabling cloud data-center and AI server operators to reduce their energy consumption for system cooling. The PSUs reduce power consumption and CO_2 emissions, resulting in lower lifetime operating costs. The powerful PSUs are not only used in future data centers but can also replace existing power supply units in servers and increase efficiency.

In addition to the existing PSUs with an output of 3kW and 3.3kW available today, the new 8kW and 12kW PSUs should contribute to further increasing energy efficiency in future AI data centers. With the 12kW reference board, Infineon will offer what is reckoned to be the first power supply unit that achieves this level of performance and supplies future data centers with power.

"We are addressing a critical question of our era — how to efficiently meet the escalating energy demands of data centers," says Adam White, division president Power & Sensor Systems at Infineon. "It's a development that was only possible by Infineon's expertise in integrating the three semiconductor materials silicon (Si), silicon carbide (SiC) and gallium nitride (GaN) into a single module."



Infineon's new 8kW power supply unit

Infineon is responding to the requirements of data-center operators for higher system efficiency and lower downtimes. The growth of server and data-center applications has led to an increase in power requirements, necessitating the development of power supplies with higher power ratings from 800W up to 5.5kW and beyond. This increase is driven by the growing power requirements of graphic process units (GPU) on which AI applications are computed.

High-level GPUs now require up to 1kW per chip, reaching 2kW and beyond by the end of the decade. This will lead to higher overall energy demand for data centers. Depending on the scenario, data centers will account for up to 7% of global electricity consumption by 2030; an order of magnitude comparable to India's current electricity consumption.

Infineon says that its new PSUs contribute to efforts to limit the CO_2 footprint of AI data centers despite the rapidly growing energy requirements. This is made possible by a particularly high level of efficiency that minimizes power losses. The firm's new-generation PSUs achieve an efficiency of 97.5% and meet the most stringent performance requirements. The new 8kW PSU is capable of supporting AI racks with an output of up to 300kW and more. Efficiency and power density is increased to 100 Watts per in^3 compared with 32W/in^3 in the available 3kW PSU, providing further benefits for the system size and cost savings for operators.

The 8kW power supply unit will be available in first-quarter 2025.

Infineon at PCIM Europe 2024

Infineon is presenting its products and solutions for decarbonization and digitalization in booths #470 and #169 (Hall 7) at Power, Control and Intelligent Motion (PCIM) Europe 2024 in Nuremberg, Germany (11–13 June). Company representatives are also giving several presentations at the accompanying PCIM Conference and Forums, followed by discussions with the speakers.

www.mesago.de/en/PCIM/
www.infineon.com/pcim

Wolfspeed quarterly revenue hit by weak industrial and energy markets

Mohawk Valley Fab revenue more than doubles sequentially; on track for 20% utilization in June quarter as die costs beat Durham fab

For its fiscal third-quarter 2024 (to end-March 2023), Wolfspeed Inc of Durham, NC, USA — which makes silicon carbide (SiC) materials and power semiconductor devices — has reported revenue of $200.7m, down 4% on $208.4m last quarter but up 4% on $192.6m a year ago.

N.B. All figures are for continuing operations, after Wolfspeed completed the sale (announced on 22 August) of its radio frequency business Wolfspeed RF to MACOM Technology Solutions Holdings Inc of Lowell, MA, USA for $75m in cash plus 711,528 shares of MACOM common stock (valued at $50m).

Materials product revenue was the second highest ever at $98.6m, down on $101m last quarter but up on $91m a year ago and exceeding the $90–95m guidance, driven by better-than-expected yields and output on 150mm-diameter silicon carbide wafers.

Power Device product revenue was $102.1m, up only slightly from $101.6m a year ago and down on $108m last quarter. "The Industrial and Energy [I&E] market remains challenged and remains weaker than our original expectations, primarily due to inventory buildups across many end-market channels, predominantly in the Asian markets," says CEO Gregg Lowe. This has mainly affected the Durham fab, whose products are primarily I&E-related. However: "We continue to see growth from our EV [electric vehicle] customers, as EV device revenue increased approximately 48% year-over-year," notes chief financial officer Neill Reynolds. The new Mohawk Valley Fab, which uses 200mm-diameter SiC wafers and currently serves almost entirely EV customers, contributed $28m in revenue, more than doubling from $12m last quarter and up from just $1m a year ago, and near the top of the $20–30m guidance range. During the quarter, Mohawk Valley Fab completed five more product transfers, including two MOSFET die and three discrete MOSFETs.

"We are pleased with the significant operational milestones achieved in the quarter for Wolfspeed as we continue to be the world's first fully, vertically integrated 200mm silicon carbide player at scale," says Lowe. "We are making progress on our Mohawk Valley ramp, more than doubling revenue sequentially in the quarter and reaching more than 16% wafer start utilization in April, giving us confidence in our ability to achieve our 20% utilization target in June."

The new Building 10 in Durham is already consistently producing high-quality 200mm automotive-grade MOSFET substrates, yielding more than the existing 150mm wafer production in Durham and surpassing internal expectations. Building 10 is hence on track to support ~25% utilization at Mohawk Valley.

"Construction continues at The JP [John Palmour Manufacturing Center for Silicon Carbide], our 200mm materials factory in [Siler City] North Carolina. During the quarter, we started installing furnaces and connected the facility to the power grid [facilitated by general contractor Whiting-Turner], and we recently hosted our topping out ceremony [attended by US Senator Thom Tillis as well as state and local officials, community partners, and employees]," Lowe says.

"Mohawk Valley will be the flywheel of growth for Wolfspeed, and The JP will be instrumental in supplying it with high-quality materials," says Lowe. "We are encouraged by the operational progress these facilities have made and how it will support our long-term growth trajectory."

On a non-GAAP basis, gross margin has fallen further, from 34% a year ago and 16.4% last quarter to 15% (below the midpoint of the 13–20% guidance). However, this includes an impact of about 1500 basis points from $30.4m of under-utilization costs, impacted by the shift in mix from I&E to EV (which has lower margins), partially offset by the incremental contribution from the Mohawk Valley Fab.

"Unit costs at Mohawk Valley continued to improve, driven by increasing yields and lower cycle times as we ramp the fab," notes Reynolds. Die cost from 200mm substrates at Mohawk Valley, even including the full burden of Mohawk Valley fab under-utilization, is now lower than that of the same product produced out of the Durham fab at 150mm.

Operating expenses have risen further, from $125.9m last quarter to $128.9m, due partly to a rise from $10.5m to $14.4m in factory start-up costs from construction of The JP and materials expansion efforts.

Driven by the significant increase in both under-utilization costs at Mohawk Valley and start-up costs at The JP, net loss has risen further, from $42.6m ($0.34 per diluted share) a year ago and $69.6m ($0.55 per diluted share) last quarter to $77.7m ($0.62 per diluted share, slightly better than the midpoint of the $71–87m ($0.57–0.69 per diluted share guidance).

Adjusted EBITDA has worsened slightly from $30.5m a year ago to $32.3m.

Operating cash flow was –$136.2m (versus +$6.4m a year ago). Capital expenditure (CapEx) was $480m (more than doubling from $230.5m a year ago). Free cash flow

was hence –$615.8m (increasing from –$225.4m a year ago).

Wolfspeed ended the quarter with over $2.5bn of cash and liquidity on hand to support facility ramps and growth plans.

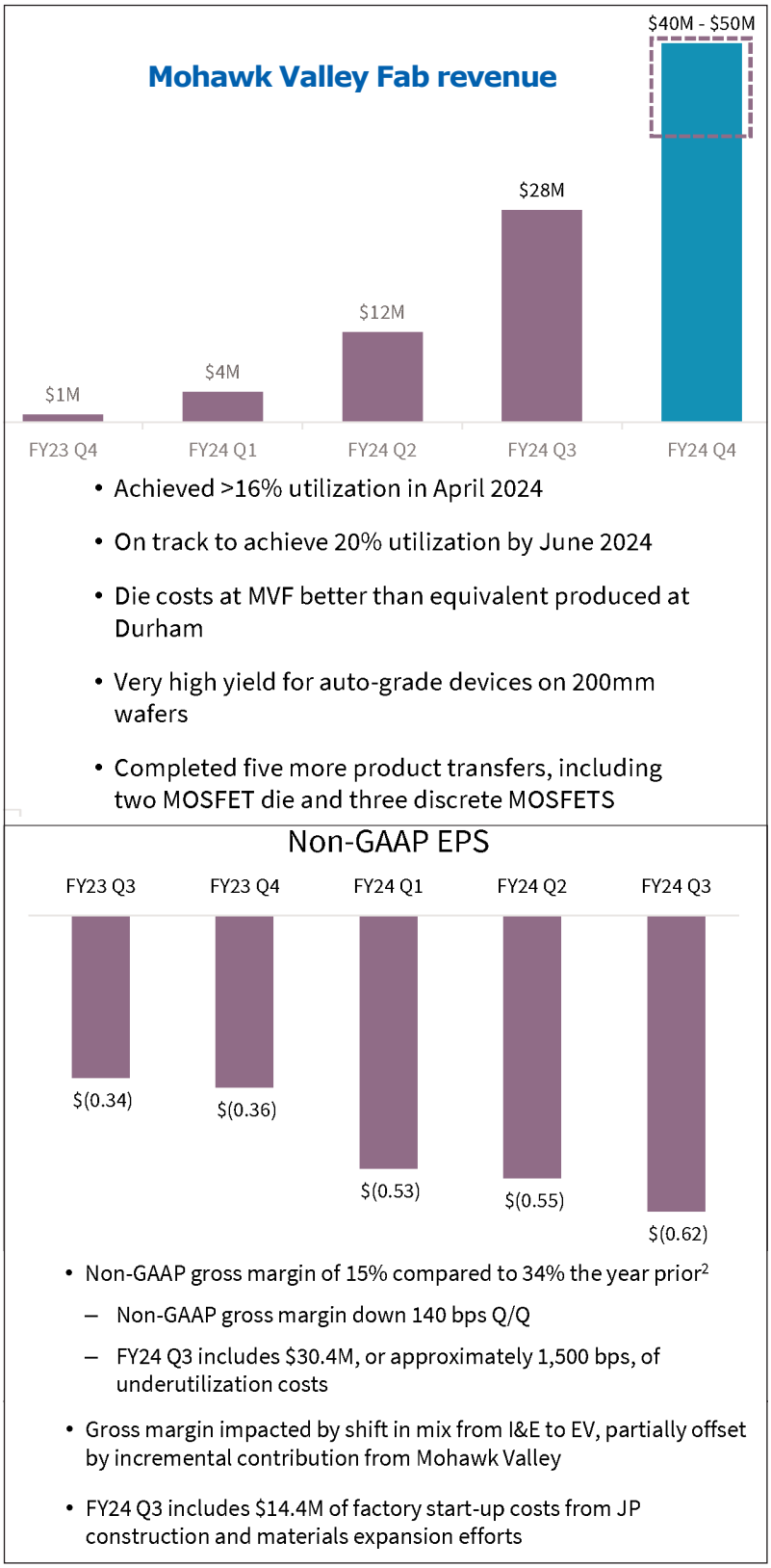
In fiscal Q3, Power device design-ins were the second highest ever, at $2.8bn (about 80% of which were for EV applications), totaling more than $7bn of design-ins for fiscal 2024 so far (and $25.2bn cumulatively). Device demand for EVs continues to outstrip supply, despite broader market headwinds, notes Wolfspeed.

Design-wins in fiscal Q3 were $0.87bn (70% for EV applications). "Design-wins typically mature over the next 5–7 years, which provides ample revenue visibility for the foreseeable future," notes Lowe. "Our backlog of design-wins now support more than 125 car models across more than 30 OEMs over the next 3–5 years," he adds.

"Unlike I&E, we continue to see a ramp of EVs that have adopted our silicon carbide devices. While this is a disruptive time in the industry and we continue to see OEMs adjusting and modifying their near-term EV production plans, we remain substantially supply constrained for our silicon carbide devices," says Lowe. "As demand remains well above our current supply, we can be nimble and shift much of our supply to other customers to accommodate for these near-term changes. Underscoring this continued EV demand is our strong design-in and design-win performance this quarter," he adds. "Our second highest quarter of design-ins to date, and more than $5bn of design-wins so far this fiscal year [of which 80% are for EV applications], tell a compelling story."

"While the industrial & energy end-markets pose short-term headwinds to our results, we firmly believe in the strength of our long-term prospects," says Lowe. "We currently have more than $4.7bn of design-ins for the industrial & energy applications, representing more than 6000 opportunities ramping in the next several years. We see even further potential coming from industrial segments as the electrification of all things continues across the broad set of applications and, as such, are undeterred by the short-term fluctuations in demand," he adds.

"In recent months, in materials, key customers such as Infineon and ROHM have come back to Wolfspeed for expansion of multi-year, 150mm wafer supply agreements," notes Reynolds. "In addition, last year, after surveying the materials landscape, Renesas selected Wolfspeed for a 10-year supply agreement, including 200mm substrates that included a $2bn capacity reservation deposit, which we believe is the largest CRD in the history of semiconductors."



Shift of product mix from I&E to EV to impact revenue and margins

For fiscal fourth-quarter 2024 (to end-June), Wolfspeed expects revenue to be steady, at $185–215m. Specifically, Materials product revenue should fall back slightly to $90–95m. The Mohawk Valley Fab's

contribution to Power Device product revenue should rise to $40–50m. Meanwhile, Power Device product revenue from the Durham fab is expected to fall further to $55–70m (down from $106m a year previously) as its product mix shifts significantly from Industrial & Energy (I&E) to EV.

"Our ability to shift our production from I&E to EV speaks to the flexibility that our business model provides us," says Lowe.

"It will be at least the second half of this calendar year before we see inventory levels return to normal [after rising to $421.2m (213 days of inventory) in fiscal Q3/2024, up from $370.2m or 199 days in fiscal Q2/2024 and just $284.9m or 162 days in fiscal Q3/2023]. But much of the product we had already produced and slated to ship has a match elsewhere in our pipeline and we are continuing to work to find the best match for that inventory now," says Reynolds.

"In the short-term, as demand shifts away from I&E, we will see an impact on revenue and gross margin. We will shift as much production capacity as possible [in both Durham and Mohawk Valley] to EV products in the near-term, although the same underlying production will not generate the equivalent revenue or gross margin results," says Reynolds. "We anticipate this to be the case until we start to see a recovery in I&E markets in the first half of calendar year 2025. This does not, however, change our view that I&E products will be a substantial and important part of our product portfolio and capacity investment over the longer term."

Gross margin should be just 8–16% in fiscal Q4. However, at the 12% midpoint, this includes $29m (1450 basis points) of under-utilization costs, mainly from the Mohawk Valley Fab.

Operating expenses are expected to fall to $116–122m. This is despite a rise to $20m in factory startup costs related to materials expansion efforts at The JP (which is expected to fire up its initial furnaces by the end of June, qualify furnaces by the end of September, and produce initial silicon carbide boules by the end of calendar 2024).

"As Mohawk Valley fab utilization increases and The JP starts to come online, we will start to see incrementally less under-utilization, but incrementally more startup costs, which hit different lines of our P&L," notes Reynolds.

Net loss is hence expected to rise to $91–109m ($0.72–0.86 per diluted share).

Including the final draw of the Renesas customer deposit, Wolfspeed now expects to end fiscal 2024 with $2.2–2.4bn of cash from liquidity.

CapEx to dip until return to cash flow break-even after fiscal 2025

"Looking at CapEx, we expect to spend about $2bn in fiscal 2024, our peak year," says Reynolds. This includes $2.2bn of gross CapEx, offset by about $200m of government incentives.

In fiscal 2025, Wolfspeed expect a $600–800m reduction in gross CapEx to $1.4–1.6bn, focused primarily on The JP and Mohawk Valley. This does not include potential government incentives, grants and subsidies that would further lower net CapEx and potentially be received within fiscal 2025.

"Government funding meets our minimum requirements, and liquidity and financing plans are clearly in place," says Reynolds. "We continue to work with the [US] CHIPS [Act] program office… our interactions with the CHIPS office have been very constructive and we look forward to completing our work with them in the near future. Depending on the timing of when these incentive payments are approved and then funded, it will be very important for the company to maintain flexibility on the financing front. This may include some interim financing under current financing facilities or otherwise that would allow us to enhance our balance sheet and cash position as we proceed with the Siler City [JP] construction and add more tools in the Mohawk Valley fab," he adds. "We expect the initial phase of The JP facility to be largely complete by the end of calendar 2024, closing out the vast majority of our fixed facility spend. At that point, our CapEx will be much more flexible and variable as we will be able to modulate how we invest in tools capacity to match our demand outlook."

Planned CapEx also does not include any CapEx for a new greenfield facility, e.g. the proposed fab in Saarland, Germany (announced in February 2023). "We will not begin another greenfield facility expansion until we have achieved our cash flow objectives from our facilities in the US," stresses Reynolds. "Given that outlook and the number of liquidity options at our disposal, we expect to maintain a minimum cash balance greater than $1bn for the foreseeable future and we will continue to evaluate that need as we complete our US facility expansion plan."

Wolfspeed targets positive EBITDA exiting fiscal year 2025 and operating cash flow breakeven shortly after that. The existing US capacity expansions can generate about $3bn in annual revenue with greater than 40% EBITDA margins.

"In combination with The JP, Mohawk Valley will be able to produce more than $2bn of device revenue in addition to the $400m of device capacity currently installed in our Durham device fab. In addition, with The JP online, we have the potential to grow the material substrate business to greater than $600m," says Reynolds.

"Our strong design-in and design-win trajectories this year, notwithstanding the current gyrations of the EV market, gives us confidence in the future and the longevity of silicon carbide, and we look forward to continuing our momentum, particularly at Mohawk Valley through the close of fiscal 2024 and beyond," concludes Lowe.

www.wolfspeed.com

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SemiQ starts known-good-die program for SiC portfolio

Screening elevates quality assurance and delivers consistent, repeatable performance of key parameters

SemiQ has begun a known-good-die (KGD) screening program that delivers high-quality, electrically sorted and optically inspected SiC MOSFET technology ready for back-end processing and direct die attachment.

SemiQ says that known-good-die ensures consistent electrical parameters, enabling customers to rely on repeatable performance for high end-of-line yield when building equipment such as high-voltage supplies, traction inverters, and power conditioning systems. Uniform die parameters also simplify the connection of multiple devices in high-power modules.

"Our known-good-die SiC MOSFETs from SemiQ provide important performance advantages, such as near-constant junction capacitance, low insertion loss, and high isolation needed for high-frequency applications," says Michael Tsang, VP, product engineering & operations. "Thanks to this program, customers can receive quality-assured dies that will streamline and improve productivity and deliver predictable and repeatable performance in high-efficiency applications."

The KGD program is active now and applies to the complete portfolio of SemiQ's QSiC 1200V SiC MOSFETs, ranging from 20mΩ to 80mΩ. This portfolio supports robust and efficient electrification across automotive, eMobility, renewable energy, industrial power, and other applications.

KGD devices are supplied post-singulation on a choice of carrier media including blue tape, pre-cured UV tape, and tape-and-reel to ease integration with customers' processes.

www.semiq.com/known-good-die

SemiQ partners with ClearComm Technical Sales to expand reach in North America

Strategic alliance to promote sales of SiC power semiconductors across Southeastern USA

SemiQ Inc of Lake Forest, CA, USA — which designs, develops and manufactures silicon carbide (SiC) power semiconductors and 150mm SiC epitaxial wafers for high-voltage applications — has announced a partnership with ClearComm Technical Sales of Huntsville, AL, USA, a specialist manufacturer's representative serving the computing, communication, industrial and consumer sectors across the Southeastern USA.

The strategic alliance will enhance SemiQ's presence and support in North America, particularly in North Carolina, South Carolina, Georgia, Tennessee, Florida, Mississippi, and Alabama.

ClearComm will serve as SemiQ's representative, providing expert technical sales support to customers seeking innovative semiconductor solutions. With an extensive network and a proven track record in the industry, ClearComm is positioned to promote SemiQ's portfolio of standard and custom SiC power semiconductors, including MOSFETs and diodes, in discrete, module, and known-good-die formats.

SemiQ provides SiC solutions for demanding applications including solar energy, electric vehicle (EV) charging, automotive, medical, and energy storage. By partnering with ClearComm, the firm aims to accelerate customer engagement in the southeastern USA, and ensure seamless access to its products and engineering support.

"ClearComm's extensive experience and technical expertise align perfectly with our commitment to delivering superior SiC solutions for ultra-efficient, high-performance, and high-voltage applications," says SemiQ's president Dr Timothy Han. "Together, we look forward to driving innovation and empowering customers with advanced SiC power semiconductor technologies."

"The SiC market is fast growing in high-efficiency, power applications and together ClearComm and SemiQ will provide customers with best-in-class SiC solutions and support," says Ken Erickson, principal at ClearComm.

www.SemiQ.com

Nexperia's 1200V SiC MOSFETs made available in D²PAK-7 SMD packages

SiC MOSFET range expanded to 17mΩ, 30mΩ, 40mΩ, 60mΩ, 80mΩ

Discrete device designer and manufacturer Nexperia B.V. of Nijmegen, The Netherlands (a subsidiary of Wingtech Technology Co Ltd) is now offering its 1200V silicon carbide (SiC) MOSFETs in D²PAK-7 surface-mount device (SMD) packaging, with a choice of 30mΩ, 40mΩ, 60mΩ and 80mΩ R_{DSon} on-resistance values.

Following Nexperia's release in late 2023 of two discrete SiC MOSFETs in 3- and 4-pin TO-247 packaging, this the latest offering in a series that will see the firm's SiC MOSFET portfolio swiftly expand to include devices with RDSon values of 17mΩ, 30mΩ, 40mΩ, 60mΩ and 80mΩ in flexible package options.

With the release of the NSF0xx120D7A0, Nexperia is addressing the growing market demand for high-performance SiC switches in SMD packages like D²PAK-7, which is becoming increasingly popular in various industrial applications including electric vehicle (EV) charging (charge pile, offboard charging),

uninterruptible power supplies (UPS) and inverters for solar and energy storage systems (ESS).

It is also further testimony to Nexperia's successful strategic partnership with Mitsubishi Electric Corp (MELCO), which has seen the two companies join forces to push the energy efficiency and electrical performance of SiC wide-bandgap semiconductors to the next level while additionally future-proofing production capacity for this technology in response to ever growing market demand.

As a critical performance parameter for SiC MOSFETs, R_{DSon} impacts conduction power losses. However, many manufacturers concentrate on the nominal value, neglecting the fact that it can increase by more than 100% as device operating temperatures rise, resulting in considerable conduction losses. Nexperia identified this as a limiting factor in the performance of many currently available SiC devices and leveraged the features of its innovative process technology to ensure that its new SiC MOSFETs offer what is claimed to be industry-leading temperature stability, with the nominal value of R_{DSon} increasing by only 38% over an operating temperature range from 25°C to 175°C.

Nexperia says that the tightest threshold voltage $V_{GS(th)}$ specification allows these discrete MOSFETs to offer balanced current-carrying performance when connected in parallel. Furthermore, low body diode forward voltage (V_{SD}) is a parameter that increases device robustness and efficiency, while also relaxing the dead-time requirement during freewheeling operation.

www.nexperia.com/sic-mosfets

SemiQ unveils 1200V half-bridge modules in S3 package

In Alfatec's booth (418, Hall 7) at Power, Control and Intelligent Motion (PCIM) Europe 2024 in Nuremberg, Germany (11–13 June), SemiQ Inc of Lake Forest, CA, USA — which designs, develops and makes silicon carbide (SiC) power semiconductors and 150mm SiC epitaxial wafers for high-voltage applications — is showcasing its latest SiC power solutions and its known-good-die (KGD) screening process (launched at the beginning of May).

SemiQ is debuting the latest addition to its QSiC family of high-speed-switching MOSFET half-bridge modules in S3 packages, which offer enhanced design flexibility and performance in current applications. Featuring industry-standard 62mm footprints and 26.3mm high, the new power modules address the size, weight and power demands of challenging applications, ranging from induction heaters, welding equipment and uninterruptible power supplies (UPS) to photovoltaic and wind inverters, energy storage systems, high-voltage DC–DC converters and battery charging systems for electric vehicles (EVs). They are available in 600A (GCMX003A120S3B1-N) and 400A (GCMX005A120S3B1-N) variants. Visitors can also see SemiQ's QSiC family of 1200V modules in SOT-227, half-bridge and full-bridge options.

Booth attendees can also learn more about the known-good-die (KGD) screening program and see SemiQ's MOSFET bare die on KGD UV tape array for the first time. The KGD process delivers high-quality, electrically sorted and optically inspected advanced SiC MOSFET technology ready for back-end processing and direct die attachment.

"With the expansion of our QSiC family, our goal is to offer a comprehensive, high-performance SiC portfolio across various sectors and offer customized solutions for cutting-edge designs," says president Dr Timothy Han. "Our continued dedication to rigorous testing and quality assurance, delivering unmatched reliability, is embodied in our new KGD program, which we will be demonstrating at the event."

www.semiq.com

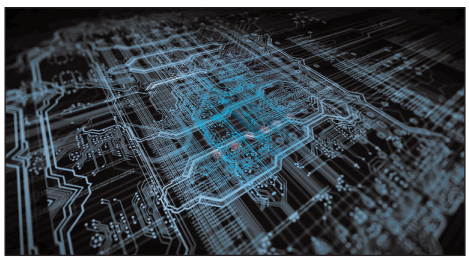
BAE Systems awarded $12m THREADS contract to boost effectiveness of RF-based applications

DARPA program aims to solve thermal challenges limiting electronic warfare systems

The Defense Advanced Research Projects Agency (DARPA) has awarded BAE Systems' FAST Labs R&D organization in Merrimack, NH, USA a $12m contract for the program THREADS (Technologies for Heat Removal in Electronics at the Device Scale).

The DARPA THREADS program aims to overcome the temperature limits at the transistor scale inherent to power-amplifying functions. With new materials and approaches to diffusing the heat that degrades performance and mission life for monolithic microwave integrated circuits (MMICs), THREADS aims to resolve the thermal management challenges of existing gallium nitride (GaN) devices.

Many military systems leverage radio frequency (RF) electronics and have historically operated at



powers well below their theoretical limits because the GaN transistors get too hot. Solving this challenge will improve the range of RF-based systems by nearly threefold, expanding engagement distances for warfighters.

"Excessive heat in electronics has been a long-standing challenge in the aerospace and defense industry," says Caprice Gray, director of Device Materials and Manufacturing Research at BAE Systems' FAST Labs. "With material and process enhancements, we are on the verge of overcoming this challenge and doing so will unleash the hidden potential in mission-critical electronic warfare and other RF-based systems."

BAE Systems will leverage its expertise and track record of developing and manufacturing advanced microelectronics for the program at its Microelectronics Center (MEC) in Nashua, NH. The MEC is an accredited DoD Category 1A Trusted Supplier and manufactures GaN and gallium arsenide integrated circuits in production quantities for critical Department of Defense programs.

Work on the THREADS program includes collaboration with Modern Microsystems, Penn State University, Stanford University, University of Notre Dame, and University of Texas at Dallas.

www.baesystems.com/en-us/

Power Integrations to acquire Odyssey

Transaction to close in July, transferring all key Odyssey staff to Power Integrations' technology organization

Power Integrations Inc of San Jose, CA, USA (which provides high-voltage integrated circuits for energy-efficient power conversion), has agreed to acquire the assets of Odyssey Semiconductor Technologies Inc of Ithaca, NY, USA, which develops high-voltage vertical power switching components based on proprietary gallium nitride (GaN) processing technology. The transaction is expected to close in July, after which all key Odyssey employees are expected to join Power Integrations' technology organization.

The acquisition supports Power Integrations' ongoing development roadmap for its proprietary PowiGaN technology, which is featured in many of the firm's product families including InnoSwitch ICs, HiperPFS-5 power-factor-correction ICs and the recently launched InnoMux-2 family of single-stage, multiple-output ICs. The company introduced 900V and 1250V versions of PowiGaN technology and products in 2023.

"Power Integrations has been at the forefront of GaN development and commercialization since we began shipping products with PowiGaN technology in 2018," says Dr Radu Barsan, VP of technology." We are executing on an ambitious roadmap that includes driving toward cost parity with silicon MOSFETs and expanding the voltage and power capabilities of PowiGaN. Our goal is to commercialize a cost-effective high-current and high-voltage GaN technology to support higher-power applications currently served by silicon carbide (SiC), at a much lower cost and higher performance enabled by the fundamental material advantages of GaN over SiC. The experience of the Odyssey team in high-current vertical GaN will augment and accelerate these efforts," he adds.

"As the first company to commercialize high-voltage GaN, Power Integrations continues to lead the industry in driving the technology forward in terms of cost, voltage and current, as well as the design of system-level products that take full advantage of the capabilities of GaN," comments Odyssey's co-founder & CEO Dr Richard Brown.

www.odysseysemi.com
www.power.com

Guerrilla RF acquires GaN device portfolio from Gallium Semiconductor

New RF GaN products to increase addressable market

Guerrilla RF Inc (GRF) of Greensboro, NC, USA — which develops and manufactures radio-frequency integrated circuits (RFICs) and monolithic microwave integrated circuits (MMICs) for wireless applications — has finalized the acquisition of the entire portfolio of gallium nitride (GaN) power amplifiers and front-end modules of Singapore-based Gallium Semiconductor, which designs and manufactures RF GaN products for 5G mobile communications, aerospace & defense, and industrial, scientific & medical (ISM) applications.

Guerrilla RF acquired all previously released components as well as new cores under development at Gallium Semiconductor. Additionally, all associated intellectual property (IP) has been transferred. By integrating the assets, Guerrilla RF aims to significantly enhance its ongoing efforts to develop and commercialize a new line of GaN devices tailored for wireless infrastructure, military and satellite communications applications.

Market analyst firm Yole Group forecasts that the RF GaN device market will double from $1.3bn in 2022 to $2.7bn by 2028, due mainly to double-digit expansion in three key market segments relevant to Guerrilla RF: telecom infrastructure (including 5G and point-to-point systems), military, and satellite communications, with projected compound annual growth rates (CAGRs) of 10%, 13% and 18%, respectively. Moreover, the GaN-on-SiC variants utilized in Gallium Semiconductor's designs are forecasted to dominate this market for the next decade.

"As the company continues to evolve as an RFIC and MMIC supplier, integrating GaN technology into our expanding portfolio is imperative," reckons Guerrilla RF's CEO & founder Ryan Pratt. "GaN represents a pivotal advancement towards offering comprehensive signal chains for our target markets. Prior to this acquisition, Guerrilla RF was already advancing GaN device development as part of its organic growth strategy. The acquisition of Gallium Semiconductor's portfolio significantly accelerates this strategic initiative. We anticipate this transaction will yield meaningful revenue with favorable margins in the near and long term," he adds.

"Merging these new products into Guerrilla RF's portfolio is expected to be fast and seamless," says Gallium Semiconductor's CEO Henk Thoonen. "Both companies share common foundry partners for GaN and GaAs products and target similar applications and market segments," he adds. "Guerrilla RF will inherit a diverse range of released and sampling products, encompassing simple, unmatched transistors to fully integrated asymmetric Doherty PAs. With rated peak power levels ranging from 5W to 400W, these products complement Guerrilla RF's existing portfolio of indium gallium phosphide (InGaP) heterojunction bipolar transistor (HBT) and gallium arsenide (GaAs) pseudomorphic high-electron-mobility transistor (pHEMT) amplifiers which are suited for power levels of 2W and below."

Guerrilla RF has already begun actively integrating these new components into its ordering system, with full portfolio integration anticipated by June.

www.guerrilla-rf.com/gallium-semi

Guerrilla RF completes $5m private placement equity financing and debt conversion

Maturity of $12m debt facility extended to January 2026

Guerrilla RF has completed a private placement equity financing, selling about 2 million shares of its common stock and accompanying warrants to purchase up to 2 million shares of its common stock. The aggregate offering price per share and accompanying warrant sold in the private placement to accredited investors was $2.50. The warrants have an exercise price of $2.50 per share and a term of five years.

The private placement resulted in aggregate net proceeds of about $2.9m to the company, after deducting fees and expenses for the transaction and a $1.5m reduction in outstanding debt as a result of debt converting into equity.

In connection with the capital raise, the firm's primary lender has extended the maturity of its $12m debt facility from April 2024 to January 2026, allowing Guerrilla RF to continue the execution of its strategic plan.

"We expect the funds from this capital raise should allow the company to reach EBITDA break-even, and support our working capital needs and R&D initiatives, as we accelerate our growth through new market penetration and capitalize on our strong competitive position," says founder & CEO Ryan Pratt.

www.guerrilla-rf.com

CNIPA validates EPC's GaN gate technology patent

China National Intellectual Property Administration previously validated E-mode GaN HEMT patent

Efficient Power Conversion Corp (EPC) of El Segundo, CA, USA — which makes enhancement-mode gallium nitride on silicon (eGaN) power field-effect transistors (FETs) and integrated circuits for power management applications — says that the China National Intellectual Property Administration (CNIPA) has validated the claims of EPC's patent 'Compensated gate MISFET and method for fabricating the same' (Chinese Patent No. ZL201080015425.X) for enhancement-mode GaN semiconductor devices.

The decision on 30 April follows a 2 April announcement from the CNIPA that confirmed the validity of key claims of EPC's Chinese patent 'Enhancement mode GaN HEMT device and method for fabricating the same' (Chinese Patent No. ZL201080015388.2). Both EPC patents were challenged by China-based gallium nitride-on-silicon (GaN-on-Si) power solutions firm Innoscience (Suzhou) Technology Co Ltd.

Chinese Patent No. ZL201080015425.X covers the fundamental design and configuration of EPC's proprietary enhancement-mode GaN field-effect transistors (FETs) with reduced gate leakage. Most industry participants employ the GaN gate technology covered by this patent, it is claimed.

"These are two of the foundational patents supporting our broad portfolio of innovations, and we are pleased that the CNIPA has again confirmed the validity of our valuable intellectual property," says EPC's CEO & co-founder Alex Lidow. "Quick, fair and efficient decisions such as these reinforce the confidence in legal systems that companies need to operate globally."

In May 2023, EPC filed complaints in the US federal court in Los Angeles and in the US International Trade Commission, asserting that Innoscience (Zhuhai) Technology Co Ltd and its affiliates infringe patents of its foundational patent portfolio, which include the US counterparts of EPC's Chinese Patent Nos. ZL201080015425.X and ZL201080015388.2. In response, Innoscience had petitioned CNIPA to invalidate the two Chinese patents.

www.innoscience.com
www.epc-co.com

Wise-integration and Leadtrend launch GaN system-in-package, targeting rapid consumer device charging

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 — and Leadtrend Technology Corp of Zhubei City, Hsinchu County, Taiwan (which designs analog and analog-digital mixed-mode IC designs) have released a GaN system-in-package (SiP) supporting consumer electronics applications.

The collaboration's targeted application is a 65W USB PD adapter for high-speed charging of smartphones, laptops and other devices. The LD966LGQALVE High Voltage Multi-Mode PWM Controller of Flyback with GaN integrated includes Leadtrend's silicon die flyback controller and Wise-integration's 650V e-mode gallium nitride (GaN) transistor die in a SiP. The SiP has passed 1000 hours of operating life tests (OLT).

"This SiP enables original design manufacturers (ODM) to develop a less expensive system with fewer components, a smaller printed circuit board and faster system development time," says Wise-integration's CEO Thierry Bouchet. "This collaboration also underscores Leadtrend's confidence in the breadth and depth of our GaN expertise and the quality of our products."

The LD966L is green-mode PWMIC built-in with brown-in/out functions of a QFN8X8 package. It minimizes the component count and circuit space, and reduces overall material cost for power applications. It features HV start, green-mode power-saving operation, soft-start functions to minimize power loss and enhances system performance.

The LD966LGQALVE evaluation board features an overall peak efficiency of 93.02% and a power density of 22.7W/in^3.

Wise-integration has optimized GaN capabilities to make power electronics technology both greener and more efficient with high-current, high-voltage breakdown and high switching frequency. Its WiseGan power-integrated circuit combines several power electronics functions into a single GaN chip for improved speed, efficiency, reliability and cost-effectiveness.

Wise-integration opened an office in Taiwan in 2022, and uses 650V GaN/Si technology from Taiwan Semiconductor Manufacturing Co (TSMC) in its 650V e-mode GaN transistor die with ESD protection.

www.leadtrend.com.tw
www.wise-integration.com

ETRI develops 3kV-class gallium oxide epilayer and device technologies

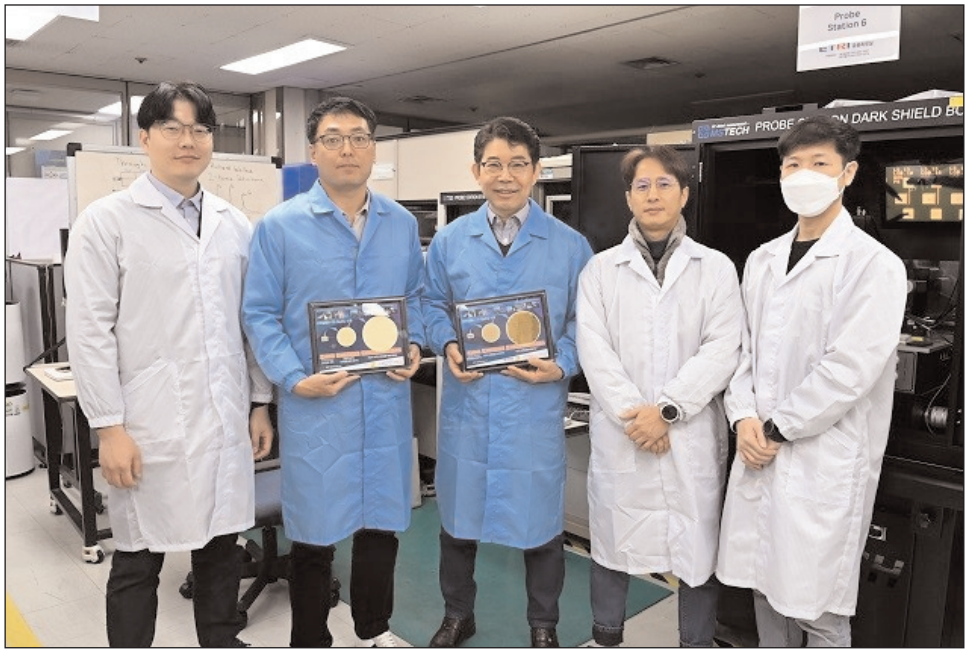
Focus on local technology rather than foreign dependency

Supported by South Korea's Ministry of Culture, Sports and Tourism, and in collaboration with the Korea Institute of Ceramic Engineering and Technology (KICET), South Korea's non-profit, government-funded Electronics and Telecommunications Research Institute (ETRI) has developed core material and device process technologies for gallium oxide (Ga_2O_3) power semiconductors, namely the first 3kV-class gallium oxide power semiconductor metal–oxide–semiconductor field-effect transistor (MOSFET) device developed in Korea.

Gallium oxide has been actively researched worldwide as a key material for next-generation power semiconductors. Japan and the USA have held technological superiority in this field, but ETRI reckons that its development has narrowed the gap.

The 3kV class is applicable to urban rail, subways and ultra-fast electric vehicle chargers. By incorporating gallium oxide 3kV-class power semiconductors into ultra-fast electric vehicle chargers, it is possible to significantly reduce charging times from the 30-minute range to less than 20 minutes.

As they are essential components used across national industries (including mobile and quantum communications, electric vehicles, solar and wind power generation, power transmission, defense, aerospace, and quantum computing), power semiconductor devices comprise one of South Korea's 12 national strategic technologies related to materials, components and equipment. However, currently more than 95% depend on imports from abroad. Localization of next-generation gallium oxide power semiconductor materials and device technologies therefore holds significant importance from the perspective of South Korea achieving self-reliance in national strategic technologies.



Dr Mun Jae-kyoung's research team.

The gallium oxide epitaxial layer technology developed by the research team involves a process of growing multiple layers of high-quality conductive thin films on a single-crystal substrate.

Dr Jeon Dae-woo's research team at KICET has localized the high-quality beta-Ga_2O_3 epitaxial growth technology using metal-organic chemical vapor deposition (MOCVD), which is expected to be used globally for mass production of large-diameter epitaxial wafers. As well as enabling the growth of epitaxial layers with thicknesses ranging from nanometers to microns, this technology also allows a wide range of adjustment in electron concentration. Consequently, this facilitates the development of power semiconductor devices with various voltage and current capabilities, bringing it closer to mass-production technologies.

Furthermore, the gallium oxide device process technology developed by the team presents a wafer-scale integration process technology for fabricating large-size power semiconductor devices. This technology encompasses the formation of micro-patterns on the epilayers of Ga_2O_3substrate, low-damage etching, deposition, and thermal processing.

Dr Mun Jae-kyoung's research team at ETRI has developed a superior performance 3kV-class MOSFET device using the epilayers directly developed by the KICET research team, rather than commercial epilayers on single-crystal wafer imported from Japan.

In particular, a new epitaxial structure capable of reducing leakage current to the level of picoamperes (pA) was developed. Furthermore, the achievement includes the development of new device and process technologies that significantly enhance the breakdown voltage to exceed 3kV.

The localization of gallium oxide power semiconductor technology is given paramount importance for enhancing next-generation global competitiveness and preempting new markets, especially in a context where most wide-bandgap

Gallium oxide epiwafer for high-efficiency power semiconductor (left) and power semiconductor MOSFET (right) (size: piece → 2-inch → 4-inch).

(WBG) power semiconductor technologies, such as gallium nitride (GaN) and silicon carbide (SiC), currently rely on overseas sources.

The research team states that the development of gallium oxide epilayers and power semiconductor MOSFET technologies can cut manufacturing costs to one-third to one-fifth compared with existing power semiconductors. This cost reduction through localization enables South Korea to take a leading position in the high-value-added industry of next-generation power semiconductors, the team reckons.

Moreover, gallium oxide semiconductors exhibit superior material properties, enabling them to withstand higher voltages. This not only allows a reduction in the size of power semiconductor devices by 50% or more, facilitating miniaturization, but also improves power conversion efficiency. Consequently, the performance of power semiconductor devices can be enhanced by more than tenfold, increasing the price competitiveness of these devices more than 20-fold compared with existing power semiconductors.

The research team explained that gallium oxide power semiconductor devices could not only enhance power conversion efficiency but also significantly reduce the size of inverter and converter systems to less than one-tenth of their existing dimensions.

It is anticipated that applying these devices to high-power industries, such as power transmission and distribution networks, high-speed railways, data centers, quantum computers, and electric vehicles, will substantially boost energy-saving effects.

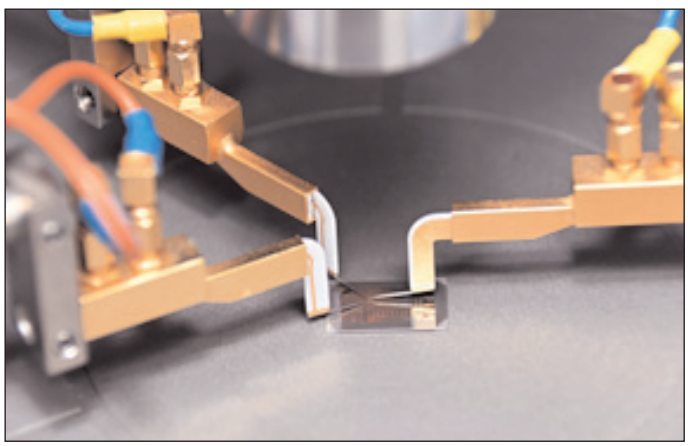
Focus on commercializing 4-inch Ga_2O_3 power MOSFET process using plating process

ETRI is currently focusing on the world's first development and commercialization of a 4-inch gallium oxide power semiconductor MOSFET device process using a plating process with a thickness of 4μm. Thus, it is expected that the acquisition of mass-production technology for gallium oxide power semiconductors, utilizing domestically developed 4-inch large-area epitaxial materials and device process technologies, will also be possible in near future.

According to a 2023 report by Japan's Yano Research Institute, the global power semiconductor market will grow to about KRW49 trillion by 2030, with the gallium oxide market reaching KRW1.7 trillion.

"The localization of gallium oxide epitaxial wafers, which are key components of next-generation power semiconductors, will enable a reduction in the epitaxial wafer cost, which are over 40% of the manufacturing costs of domestic power semiconductors and achieve material independence," says Dr Jeon Dae-woo, a senior researcher at KICET.

"We anticipate the timing for the integration of gallium oxide power semiconductors into systems to be further accelerated," says Dr Mun Jae-kyoung, the project general manager at ETRI. "We plan to be the first in the world to commercialize kilovolt-class gallium oxide power semiconductor MOSFET devices."



Ga_2O_3 power semiconductor MOSFET device developed jointly by ETRI and KICET.

www.etri.re.kr

SUNY Poly receives extra $4m for Semiconductor Processing to Packaging Research, Education, and Training Center

Empire State Development grant to combine with $16m from $44m investment in SUNY Poly announced in November

New York Governor Kathy Hochul has announced that State University of New York Polytechnic Institute (SUNY Poly) is the recipient of a $4m Empire State Development (ESD) Grant. The new funding — combined with an additional $16m investment in SUNY Poly's College of Engineering announced by Hochul in November — will support the establishment of a $26.5m Semiconductor Processing to Packaging Research, Education, and Training Center in the NY CREATES Quad C building on SUNY Poly's campus, which is also occupied by Semikron Danfoss.

The center's goal is to increase the number of graduates across advanced manufacturing disciplines by 10% in the next four years.

Lieutenant Governor Antonio Delgado, as well as State and local officials, were on campus to celebrate the announcement, as the center will be a one-stop shop for semiconductor manufacturing. It will also offer highly specialized educational opportunities that align with the needs of the region's burgeoning tech industries and prepare students for high-demand jobs.

Semiconductor and supply chain companies Wolfspeed, Danfoss, Micron, Indium, Marquardt Switches, Menlo Micro and NoMIS Power, along with NY CREATES, will be collaborating with SUNY Poly, as well as Working Solutions — the Workforce Development Board of Utica, Fulton Montgomery Community College, Mohawk Valley Community College and Onondaga Community College to establish a curriculum with wraparound services for jobs in the industry that includes device processing for power electronics, optoelectronics and clean energy applications, as well as their unique packaging needs.

New York State's Lieutenant Governor Antonio Delgado at SUNY Poly for the announcement of the new funding.

"Our new Semiconductor Processing to Packaging Research, Education, and Training Center will have a transformational impact on individual lives and families, the Mohawk Valley, New York State, and beyond," reckons SUNY Poly's president Dr Winston Soboyejo. "We look forward to working with our partners to meet the workforce needs of the rapidly growing semiconductor industry — and to helping students access the education they need to benefit from the opportunities associated with the unprecedented growth and innovation happening here."

Wolfspeed, Danfoss, Micron, Indium, Marquardt Switches, Menlo Micro and NoMIS Power, along with NY CREATES, will be collaborating with SUNY Poly The center will allow for both silicon device processing and packaging as well as SiC, GaN, AlN and their alloys, and gallium oxide

SUNY Poly's Semiconductor Processing to Packaging Research, Education, and Training Center is being established to prepare the future semiconductor workforce by providing deep theoretical knowledge and hands-on experience, ensuring that students develop a full understanding of the packaging, processing and testing workflow, as well as the attention-to-detail needed to produce devices with the required yield and performance functionality. The center will allow for both silicon device processing and packaging as well as silicon carbide (SiC), gallium nitride (GaN), aluminium nitride (AlN) and their alloys, and gallium oxide (Ga_2O_3) devices.

In addition to educating and training traditional engineering students, SUNY Poly – through the center – will also provide several workforce development training and upskilling opportunities for industry partners and their employees, as well as those seeking to gain entrance into the semiconductor workforce. Some of these opportunities for career enhancement will include non-credit-bearing professional certificates and micro-credentials along with credit-bearing stackable micro-credentials.

The $4m ESD Capital Grant will be used primarily to fund metrology equipment for the center, which will have 5000ft^2 of cleanroom space. The center will also have two classrooms that can seat 30 students each, in addition to office space for scientists, postdocs, and students.

www.sunypoly.edu

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Diamond Quanta emerges from stealth mode with lab-grown diamond technology

AKHAN founder Adam Khan launches new diamond-based semiconductor venture

After being founded in January by Adam Khan, Diamond Quanta of Palo Alto, CA, USA has announced its official launch out of stealth mode, aiming to capitalize on the properties of diamond to deliver advanced solutions in power electronics and quantum photonic devices.

Khan's work in diamond technology spans advances across a spectrum of applications. He was previously founder, chairman & CEO of AKHAN Semiconductor, innovating lab-grown diamond for a range of applications. In advanced diamond materials synthesis, he has contributed to breakthroughs in doped polycrystalline diamond research, and spearheaded design and fabrication techniques for a range of optics, photonic and semiconductor component applications. Joining Khan at Diamond Quanta is Tae Sung Kim Ph.D., who will lead photonics and fab engineering efforts.

Diamond Quanta claims to have achieved a breakthrough in lab-grown diamond fabrication with its 'Unified Diamond Framework', which facilitates true substituent doping. This innovative technique is said to seamlessly integrate new elements into the diamond's structure, imparting novel properties without disrupting its crystalline integrity. As a result, diamond — traditionally known for its insulating properties — is transformed into a high-performance semiconductor capable of supporting both negative (n-type) and positive (p-type) charge carriers.

This level of mobility is indicative of a very clean, well-ordered diamond lattice, and effective passivation of scattering centers due to the successful implementation of co-doping strategies that mitigate defect impacts on carrier transport.

Moreover, the doping process refines the existing diamond structure by amending dislocations, enhancing the material's conductivity. These advances are said to not only preserve but enhance the diamond structure, avoiding common pitfalls like significant lattice distortion or the introduction of trap states that typically decrease mobility. Consequently, this makes the diamond not just an excellent semiconductor material but a more stable and efficient one, it is claimed, capable of outperforming other materials traditionally used in high-power and high-temperature environments.

The exceptional thermal conductivity and high electrical breakdown strength of these advanced diamond semiconductors make them suitable for deployment in environments where high power density and extreme temperatures are prevalent. From the demanding operational conditions of aerospace engineering and automotive industries to the rigorous power requirements of AI data centers and high-performance consumer electronics, the firm's diamond technology offers what is claimed to be unparalleled resilience and efficiency.

As industries such as aerospace and automotive increasingly rely on advanced materials to enhance the performance and safety of their applications,

This level of mobility is indicative of a very clean, well-ordered diamond lattice, and effective passivation of scattering centers due to the successful implementation of co-doping strategies that mitigate defect impacts on carrier transport

Diamond Quanta says that its diamond semiconductors can be applied to these sectors. Simultaneously, in AI data centers, where managing thermal loads while maintaining high computational throughput is crucial, the technology provides a robust solution that aligns with the industry's vision for durable and energy-efficient 'chips for AI'. Diamond Quanta reckons that these capabilities ensure that its diamond-based systems are not only positioned to meet the existing demands of high-power applications but are also scalable for the future needs of technology across various critical sectors.

"Industries like electronics, automotive, aerospace, energy and more have been looking for a semiconductor technology that can handle the growing strains that come with the evolving needs of their technological expansion," says founder & CEO Adam Khan. "Our technology does not simply offer an alternative material to industries looking for semiconductor efficiency improvements; we are introducing a brand-new material that is set to redefine the standards of performance, durability and efficiency," he claims.

Diamond Quanta's background is characterized by transforming theoretical models into tangible technologies. The firm has filed patent applications for and made technical journal submissions related to its advanced diamond power and photonic semiconductor technology, which introduces a new diamond material that improves upon the efficiency and durability capabilities of lab-grown diamonds in semiconductor applications. Diamond Quanta has also submitted to numerous technical journals, with publication expected this summer.

www.diamondquanta.com

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Enkris and Incize form strategic partnership

Formal collaboration aims to make GaN-on-Si technology the mainstream standard for wireless infrastructure

Pure-play gallium nitride (GaN) epitaxial wafer foundry Enkris Semiconductor of Suzhou, Jiangsu, China and Incize of Louvain-La-Neuve, Belgium — which began as a spun off from Université catholique de Louvain (UCLouvain) in 2011 — have signed a memorandum of understanding for in-depth strategic cooperation on modeling, simulation and testing of GaN-on-Si epitaxial technology for wireless communication applications.

Since 2019, Enkris and Incize have been working closely to raise the quality standards of GaN-on-Si epiwafers to meet the demands of wireless communication applications. The firms have now decided to formalize their partnership to further expand and strengthen their strategic collaboration to push more products onto the market.

As material epitaxy technology has developed, GaN-on-Si wireless devices have made significant progress. However, GaN-on-Si technology entails greater losses of signal power, which limits the frequency and power characteristics of GaN HEMT-on-Si, presenting a bottleneck to it becoming the mainstream technology.

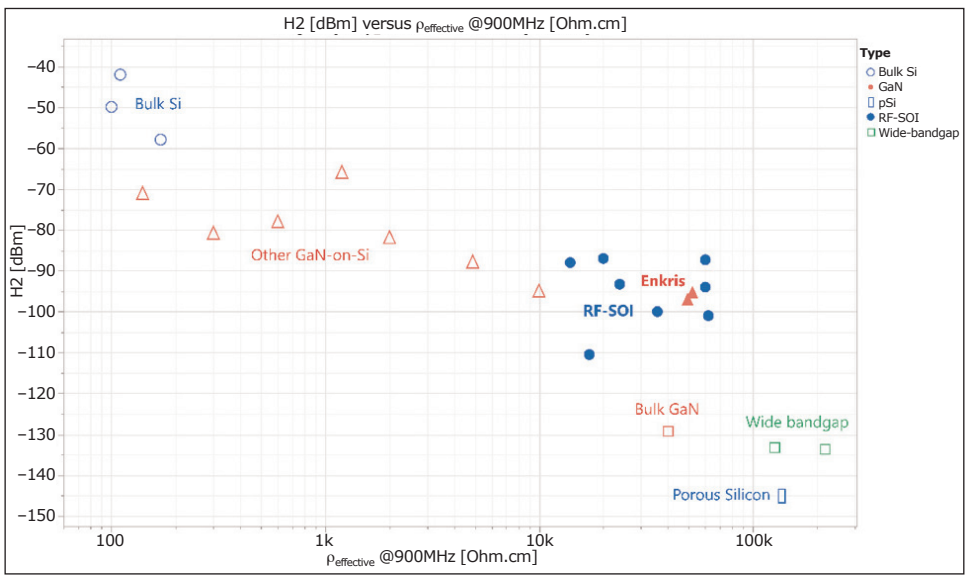
Because Enkris' GaN-on-Si wafers incorporate its buffer optimization, which significantly improves the wireless communication performance, this leads to a comparable RF loss with that of RF-SOI. This can pave the way for GaN-on-Si technology to become the mainstream standard for wireless infrastructure, says the firm.

Founded in 2014, Incize addresses wireless communication applications, from materials, devices, and circuits to the system level, with experience in simulating, testing and modeling. Customers span wafer manufacturers, foundries, fabless IC design companies, and IDMs. "Advocating for the revitalization of the European semiconductor ecosystem, Incize also provides high-quality services to all its customers around the world," says Incize's founder & CEO Dr Mostafa Emam. "For front-end companies to design better wireless communication chips, it is critical to innovate and upgrade the substrates and the underlying technology and [Incize] is willing to actively participate in and help the innovation efforts of wafer manufacturers, such as Enkris. Enkris has become a major player in the epiwafer manufacturing of III-V materials in a record time and has a deep culture of R&D, which aligns perfectly with our experience and service portfolio at Incize," he adds.

Enkris' founder & CEO Dr Kai Cheng and Incize's founder & CEO Dr Mostafa Emam agree the memorandum of understanding.

"Enkris has now made great progress in both the sales client side and the production supply chain side cum technology side in terms of GaN-on-Si epi wafers for different applications, among which the wireless communication applications comprise a highly demanding and promising market," says Enkris' founder & CEO Dr Kai Cheng. "It is pleasing to reinforce the already existing collaboration between Enkris and Incize and advance a step further towards a long-term collaboration that shall promote the next generation of GaN-on-Si technology, together with a new generation of wireless communication devices," he adds. "Incize has advanced test equipment professional processes, and component modeling team resources. Such a partnership shall provide Enkris with the opportunity to experiment with deep innovation in materials and epiwafers".

www.incize.com
http://en.enkris.com



Benchmark plot of second harmonic distortion (more negative values are better) showing Enkris GaN-on-Si (solid triangles) compared with other GaN-on-Si providers (open triangles) as well as with RF-SOI technology (solid circles).

Aehr receives order from new customer for FOX-NP multi-wafer test & burn-in system

To be used for engineering, qualification and small-lot production of SiC power MOSFETs

Semiconductor production test and reliability qualification equipment supplier Aehr Test Systems of Fremont, CA, USA has received an initial customer order for a FOX-NP wafer-level test and burn-in system, multiple WaferPak Contactors, and a FOX WaferPak Aligner to be used for engineering, qualification and small-lot production wafer-level test and burn-in of their silicon carbide devices.

The customer is a multi-billion-dollar per year global semiconductor company with locations across Europe, Asia and the Americas that serves various industries including automotive, industrial, mobile and consumer applications. The FOX-NP system, including the FOX WaferPak Aligner and initial WaferPaks, are scheduled to ship over the next few months.

The FOX-NP system is configured with the new Bipolar Voltage Channel Module (BVCM) and Very High Voltage Channel Module (VHVCM) options that enable new advanced test & burn-in capabilities for silicon carbide power semiconductors using Aehr's proprietary WaferPak full-wafer Contactors.

"After working with the Aehr team and our technology solutions over an extended period of time, they [the customer] felt secure in our ability to aid them in achieving these goals," says president & CEO Gayn Erickson. "A key feature in their selection of our FOX solution is its proven ability to cost-effectively implement their target burn-in and stabilization requirements, including 100% traceability and proof that every device on the wafer is burned in for the needed test duration," he adds.

"This customer currently has a wide range of automotive products and is entering the silicon carbide market to address several applications that include automotive, industrial and electrification infrastructure. Key capabilities of our solution include our ability to scale from engineering and qualification and small-lot production with the FOX-NP system to large-scale production with the FOX-XP with Automated WaferPak Aligner. They have told us that they plan to transition to our FOX-XP multi-wafer test and burn-in systems for high-volume production. Aehr's FOX-P technology facilitates a seamless transition from engineering to high-volume production with 100% compatibility between systems," he adds.

Aehr's FOX-NP wafer-level test and burn-in system.

This customer currently has a wide range of automotive products and is entering the silicon carbide market to address several applications

"This customer sees the enormous opportunity for silicon carbide power devices in industrial and power applications. William Blair forecasts that, in addition to the 4.5 million six-inch-equivalent wafers that will be needed to meet the demand for electric vehicle-related silicon carbide devices in 2030, another 2.8 million wafers are needed to address industrial, solar, electric trains, energy conversion and other applications in 2030. The cost of ownership of our solution proves to be more cost-effective and efficient for these devices than package part burn-in after the die are packaged. This is a strong testimony of the advantage of wafer-level burn-in as a better alternative to package part burn-in," Erickson continues.

"The FOX family of compatible systems including the FOX-NP and FOX-XP multi-wafer test and burn-in systems and Aehr's proprietary WaferPak full-wafer contactors provide a uniquely cost-effective solution for burning in multiple wafers of devices at a single time to remove early-life failures of silicon carbide devices, which is critical to meeting the initial quality and long-term reliability of the automotive, industrial and electrification infrastructure industry needs."

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

www.aehr.com

UK's EPSRC grants Cardiff $11m to lead compound semiconductor research and manufacturing hub

Hub to capitalize on manufacturing opportunity identified in UK's national semiconductor strategy

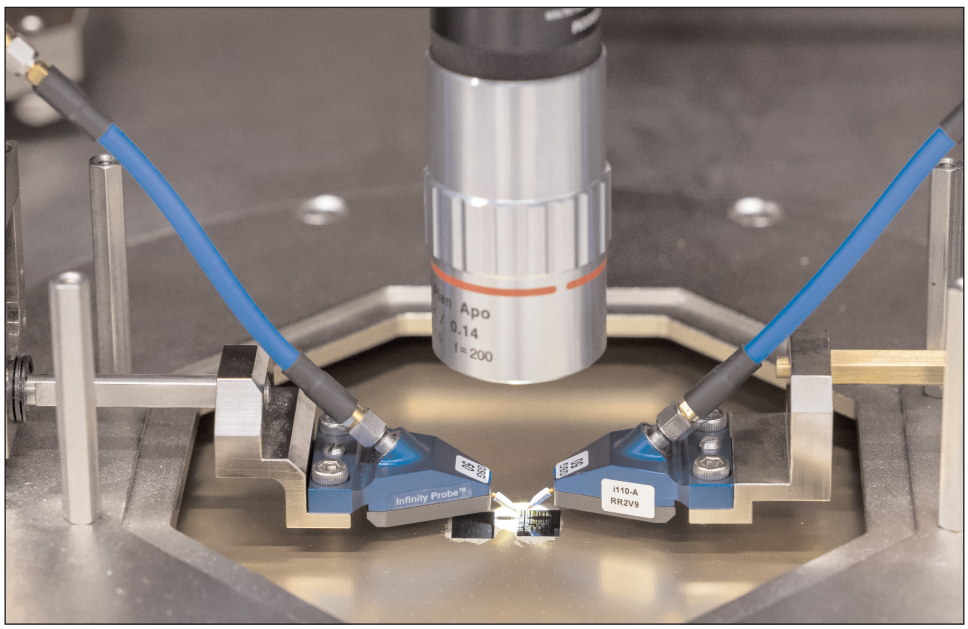
As one of five new hubs supported by the UK's Engineering and Physical Sciences Research Council (EPSRC), Cardiff University is to receive funding to lead a hub that aims to capitalize on the opportunity of compound semiconductor manufacturing identified in the UK's national semiconductor strategy.

The researchers will develop energy-efficient optoelectronics for use in key emerging technologies such as quantum, the 6G network, sensors for autonomous vehicles (AVs), the Internet of Things (IoT) and satellite communications.

A key driver for the hub will be to expand the environmental benefits of compound semiconductors by carrying out research in an environmentally friendly way, developing new manufacturing processes and creating new devices that are energy efficient along the way.

"This award is an endorsement of our vision to establish the UK as the primary global research and manufacturing hub for compound semiconductor (CS) technologies, expanding and extending the CS Cluster here in South Wales that our previous EPSRC Manufacturing Hub initiated," says professor Peter Smowton, the Cardiff hub lead and managing director of Cardiff University's Institute for Compound Semiconductors. "Supported by new start-ups and inward investment into our region, the hub will be at the very heart of the cluster, ensuring we can continue to develop CS technologies which enable our connected world, our health, our security and protect the environment," he adds. "The time is right for a step-change in CS manufacturing."

The five manufacturing research hubs are supported by the EPSRC (part of UK Research and Innovation) with an investment of £55m, with each hub receiving £11m. Partner contributions, cash and in-kind, takes the total support committed to the new hubs to £99.3m.



Characterization of a GaN-based microwave monolithic integrated circuit in labs at Cardiff University's Translational Research Hub.

The hubs aim to address a wide range of challenges in commercializing early-stage research within different manufacturing sectors by reducing waste, finding alternatives to expensive or environmentally damaging materials, and speeding up processes.

Working with industry partners, the researchers will also explore different pathways to manufacturing, including production scale-up and integration within the wider industrial system.

Advances in environmental sustainability across manufacturing processes are also a focus of the hubs, which hope to bolster the economy though efficiencies such as reducing waste, emissions and pollution, and lowering production costs.

"Given the scale and importance of the UK's manufacturing sector, we must ensure that it is able to benefit fully from advances made across the research and innovation ecosystem," says EPSRC executive chair professor Charlotte Deane. "With their focus on innovation and sustainability, the advances made by the hubs will benefit specific sectors, the wider manufacturing sector and economy, as well as the environment."

Cardiff University researchers will also support the Sustainable Chemicals and Materials Manufacturing hub led by the University of Oxford and the Advanced Metrology for Sustainable Manufacturing hub led by the University of Huddersfield.

The remaining hubs announced include:

- the MediForge Hub led by the University of Strathclyde;
- the Manufacturing Research Hub in Resource-Enabled Sustainable Circular Automation Manufacturing (RESCu-M) led by the University of Birmingham.

www.cardiff.ac.uk/institute-compound-semiconductors
www.compoundsemiconductorhub.org

Canada's NSERC awards grants worth $1.1m to research gallium extraction

NOSM University to develop more efficient mining of gallium using microbes

Two researchers at Northern Ontario School of Medicine (NOSM) University and Laurentian University have been awarded funding from grants administered through the Natural Sciences and Engineering Research Council of Canada (NSERC) Alliance Missions program. One project studies how gallium can be mined more efficiently while the second project focuses on the extraction of critical minerals from tailings ponds.

"The work of both Dr Tharmalingam and Dr Scott are vital to ensuring Canada plays a leading role in a net-zero world, while supporting economic growth, environmental rehabilitation, and job creation," says Viviane Lapointe, Member of Parliament for Sudbury. "Critical minerals represent a generational opportunity for Sudbury and our net-zero future."

Extracting gallium

Tharmalingam, assistant professor at NOSM University, was awarded $600,000 by NSERC to support his research project 'A microbial sponge to mine the critical mineral gallium'.

The recent global semiconductor shortage has highlighted the need for alternative sources of gallium. China currently controls about 80% of the world's supply.

While gallium is not found naturally as a mineral, it exists in trace amounts in tailings ponds — the waste products from mining processes. However, existing methods for extracting gallium from these sources are expensive and inefficient.

Tharmalingam's project, conducted in collaboration with Dr Vasu Appanna, co-founder of Biomine Ltd and a professor at Laurentian University, aims to develop a new and eco-friendly solution for gallium extraction.

(From left): Dr Tammy Eger, Chris Granger of Glencore, Dr Corey Laamanen, Dr John Ashley Scott, Sudbury MP Viviane Lapointe, Dr Sujeenthar Tharmalingam, Dr David Marsh, and Dr Lynn Wells at the announcement of the NSERC grant. Laurentian University photo.

Building on their previous work, the research team will focus on more efficiently mining gallium using microbes.

The NSERC Alliance grant will help to develop a new microbial-based technology to collect gallium from tailings ponds in a clean and cost-effective manner. The project brings together Tharmalingam's expertise in molecular biology, microbiology and gene editing with Biomine's experience in developing custom-tailored eco-friendly microbial solutions.

It is reckoned that this research has the potential to revolutionize gallium mining by developing a sustainable process that provides a steady supply of this critical mineral.

"The significance of gallium in electronics manufacturing is underscored by the recent semiconductor shortage," says Tharmalingam. "Our main objective is to pioneer an innovative microbial-based method to extract gallium from mining tailings, providing an environmentally friendly and economically viable solution to satisfy the increasing global need for this vital semiconductor material."

Making the most of tailings ponds

Dr John Ashley Scott, full professor at Laurentian University's Bharti School of Engineering, leads the project 'Microalgal biosorption of critical minerals from mining related tailing ponds — recovering key metals to better protect aquatic systems and water supplies', which will receive $530,990 from NSERC plus in-kind contributions from industry partner Glencore's Sudbury Integrated Nickel Operations (Sudbury INO). Dr Corey Laamanen serves as project co-investigator.

The project will use naturally occurring micro-algae bioprospected from mining sites in Northern Canada to remove critical minerals such as copper, nickel and cobalt from mining effluents using natural biosorption processes. It will also investigate metals recovery from the biomass and beneficial uses of the remaining biomass, e.g. a soil ameliorant to aid in land rehabilitation.

The value to the critical minerals industry is that this low-cost approach will help with managing operational ponds and maximizing recovery of critical mineral resources. It can also act as a sustainable safeguard for protecting water supplies for regional communities, by continuing to 'mop up' metals and maintain post-closure legacy ponds to high standards to ensure long-term environmental protection, not just now but for future generations.

"This project may open up new opportunities for industry and environmental protection that simply haven't been developed yet," says Scott.

www.nosm.ca

Riber's Q1 revenue up 20% year-on-year

Order book rises 4% to €34.4m

For first-quarter 2024, molecular beam epitaxy (MBE) system maker Riber S.A. of Bezons, France has reported revenue of €4.5m, up 20% on €3.7m a year ago.

MBE systems revenue was €2m (comprising billing for one machine), up 6% on €1. 9m a year ago.

Services & Accessories revenue has risen by 35% from €1.8m to €2.5m.

Of total revenue, 71% came from Europe, 21% from Asia and 8% from North America.

Order book up 4% year-on-year

The order book totaled €34.4m at the end of March, up 4% from €33.1m at end-March 2023, highlighting the compound semiconductor market's strength in both R&D and industrial production.

Specifically, orders for MBE systems are up by 5% from €26.7m to €27.9m, comprising 10 machines (including seven production systems).

The Services & Accessories order book remained level at €6.5m.

Full-year outlook for 2024

Given its existing orders and the opportunities that are expected to open up for its systems and services & accessories, Riber forecasts further growth in revenue and earnings for 2024.

The firm will provide a full-year revenue forecast at the end of first-half 2024.

www.riber.com

EPIR orders second Riber MBE 32 MCT research system

Delivery in 2025, for HgCdTe device development and production

Riber says that EPIR Inc of Bolingbrook, IL, USA has ordered its second MBE 32 MCT research system (just two months after delivery of the first), for delivery in 2025, to further strengthen its capacity for the development and production of advanced materials.

EPIR is a subsidiary of Sivananthan Laboratories Inc and a privately owned company specializing in developing HgCdTe (MCT — mercury cadmium telluride) semiconductors, used primarily in high-performance infrared detection and imaging devices, particularly in the defence sector.

EPIR has been involved in research into HgCdTe materials and related technologies since 1997. The firm has been able to develop a customized material growth technology, made possible by Riber's MBE 32 MCT system. Due to its complexity and the high degree of stability needed, the epitaxy process requires the use of identical machines to ensure consistent development of production capacity. Riber says that EPIR's decision to acquire a second MBE 32 MCT system is an endorsement of the quality and reliability of the machine.

The MBE 32 range has been in existence for 40 years, with several hundred systems installed worldwide. Among the wide range of materials that can be processed, the epitaxial growth of mercury-containing compounds represents one of the most complex challenges in terms of MBE thin-film deposition, Riber notes.

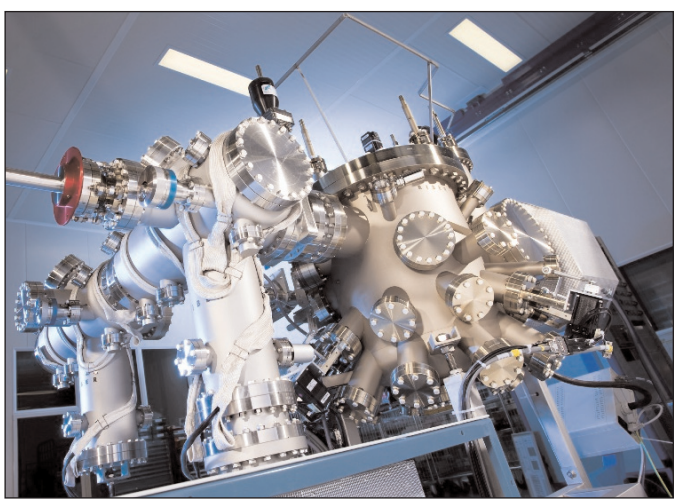
www.epir.com

Riber wins US order for Compact 21 research MBE system

System to be used for development of III–V materials and devices for microelectronics and photonics

Riber has received an order from a US customer for a Compact 21 research MBE system, for delivery in 2024, to be used for the development of III-V semiconductor materials and devices for microelectronics and photonics.

The system will enable the laboratory, which is already equipped with Riber machines, to enhance its versatility by adding a new ultra-high-vacuum (UHV) chamber to its existing lines, and to multiply its processes or share its equipment with other research groups.



The Compact 21 will provide users with enhanced safety, reliability and ease of use by incorporating new-generation evaporators developed by Riber, as well as a range of instruments including the EZ CURVE in-situ control device and Crystal XE process control software.

www.riber.com

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Aixtron grows Q1 revenue and profit jump year-on-year

Additional SiC customer gained from the 'top-five'

For first-quarter 2024, deposition equipment maker Aixtron SE of Herzogenrath, near Aachen, Germany has reported revenue of €118.3m (near the top of the €100–120m guidance range). This was down 45% on last quarter's record €214.2m but up 53% on €77.2m a year ago (although the latter was reduced by delays in the issue of export licenses, pushing €70m worth of shipments out of the quarter).

On a regional basis, 58% of revenue came from Asia (up from 47% a year ago, almost doubling from €36.2m to €68.6m), 32% from Europe (up from 28%, growing by 77% from €21.6m to €38.2m) and 10% from the Americas (down from 25%, shrinking by 41% from €19.4m to €11.5m).

Of total revenue, 79% came from equipment sales (up from 73% a year ago), growing 65% year-on-year from €56.3m to €93m, driven largely by systems for applications in silicon carbide (SiC)- and gallium nitride (GaN)-based power electronics. The remaining 21% of total revenue came from after-sales (consumables, spare parts and services).

Of the equipment revenue, metal-organic chemical vapor deposition (MOCVD)/chemical vapor deposition (CVD) systems for making GaN- and SiC-based power electronics devices comprised 45% and 17%, respectively, and 62% collectively (€57.7m, up 59% on €36.3m a year ago).

Growth was driven by further technical advances to the G10-SiC CVD system for the production of silicon carbide-based power electronics, which have already been confirmed by numerous customers and will be implemented in systems already delivered in the course of the year. Aixtron has hence been able to win further new customers in the SiC segment, in particular an additional customer from the 'top-five' SiC manufacturers (meaning that three of the top-five SiC-players now rely on the G10-SiC for their 200mm volume ramp), as well as a large volume order from China and several customers in Japan.

In addition, gallium nitride-based power electronics continue to expand into new application areas, with the new G10-GaN MOCVD system (launched in September 2023) proving very popular among both new and repeat customers, based on performance and cost per wafer.

MOCVD systems for making LEDs (including micro-LEDs) comprised 21% of equipment revenue (up from just 12% a year ago), almost tripling year-on-year from €6.9m to €19.6m. R&D activities in the micro-LED segment continue to be highly dynamic, which has led to increased demand for Aixtron technology and orders from numerous customers.

MOCVD systems for making other optoelectronics devices (telecoms/datacoms and 3D sensing lasers for consumer electronics, solar, and wireless/RF communications) comprised 11% of equipment revenue (down from 23% a year ago), falling year-on-year from €13m to €10m, mostly comprising systems for producing lasers for optical data communications.

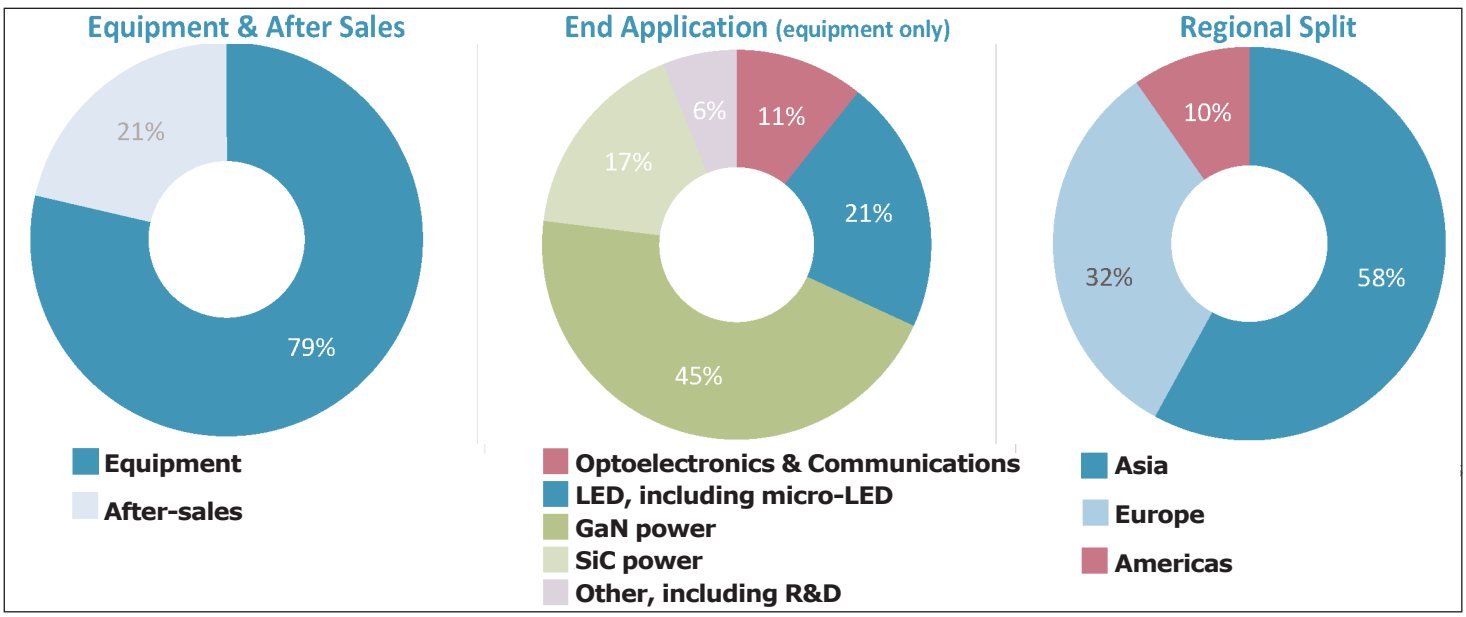
Investing in R&D and staffing

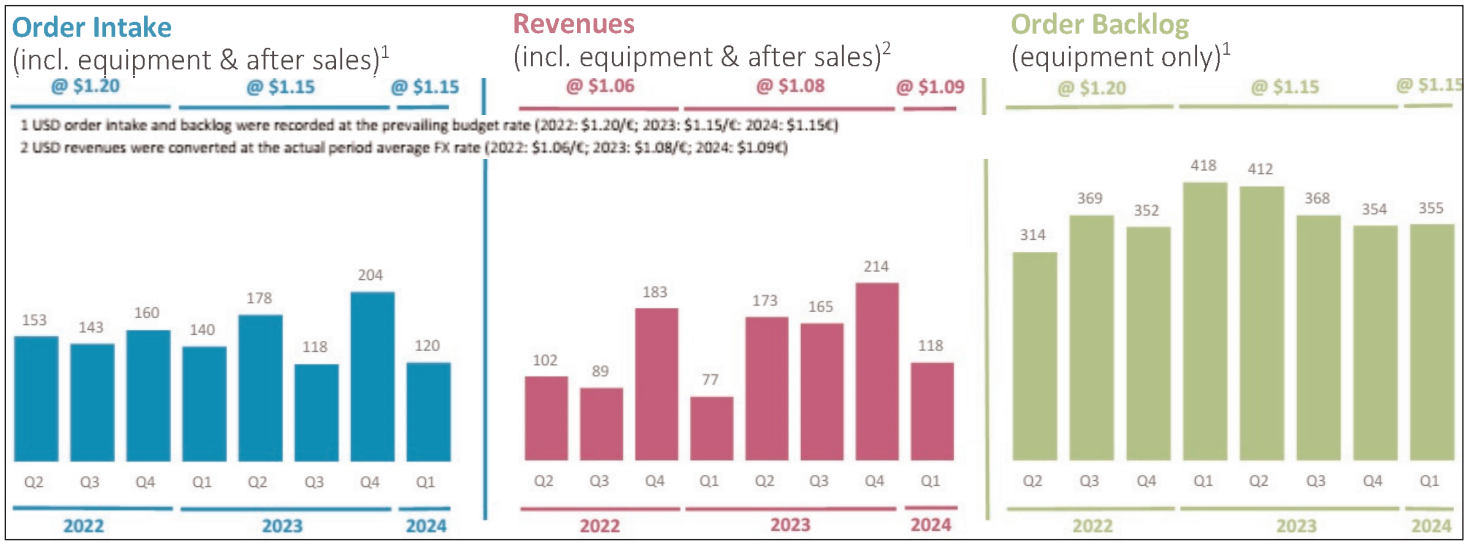
Gross margin was 37%, down from 46% last quarter and 40% a year ago, and below the 43–45% guidance for full-year 2024. However, this corresponds to the strong revenue and the change in product mix, plus fixed-cost effects.

Operating expenses have risen from €27.6m a year ago to €33.8m. This was due partly to R&D spending rising by 19% from €19.2m to €22.9m, following €27.9m last quarter. As well as implementing further improvements to its new G10 product family, Aixtron is simultaneously already investing in future tool generations.

Accordingly, full-time equivalent staffing has grown further, by 16% year-on-year from 974 to 1132.

Also, after breaking ground in





Q4/2023, work on the new Innovation Center in Herzogenrath is on schedule and within budget. Involving an investment of about €100m, Aixtron is creating a new cleanroom where it will work with customers on the development and testing of the next generation of systems.

Year-on-year increase in profit

In Q1/2024, operating profit (earnings before interest and taxes, EBIT) was €9.9m (EBIT margin of 8%), almost tripling from €3.5m (5% EBIT margin) a year ago.

Net profit was €10.8m (€0.10 per share), more than tripling from €3.5m (€0.03 per share) a year ago.

CapEx and inventory building still exceeding cash generation

Operating cash flow was €7.4m (up from €5.8m a year ago). Capital expenditure (CapEx) was €25.7m (up from just €3.9m).

Free cash flow was hence –€33.1m, compared with €1.9m a year ago. This was due mainly to investments related to the Innovation Center, plus a further increase in inventories of €41.4m (from €394.5m to €436.4m) in preparation for a correspondingly high business volume in the following quarters.

Cash and cash equivalents (including other current financial assets) have correspondingly fallen further, from €327.5m a year ago and €181.7m last quarter to €148.5m.

However, underlining the firm's financial strength, the equity ratio has risen further, from 72% a year ago and 75% last quarter to 76%.

At the Annual General Meeting on 15 May, the Executive Board and the Supervisory Board are proposing a dividend payout of €45m from accumulated profit for 2023, i.e. €0.40 per entitled share (up from 2022's €0.31 per share).

Balanced order intake across all end markets — strong momentum from micro-LED

Order intake was distributed relatively evenly across all addressed end-markets and amounted to €120.3m, down 41% on €204.5m last quarter and 14% on €139.9m a year ago.

There was strong new momentum from business with systems for micro-LED applications, which accounted for 37% of equipment order intake. This was boosted by the continued development activities of micro-LED customers, who are continuing to invest in development and pilot lines for the commercialization of micro-LED technology.

Equipment order backlog at the end of March was €355m, down 15% on €417.9m a year ago but roughly stable with €353.7m last quarter.

Full-year growth guidance confirmed

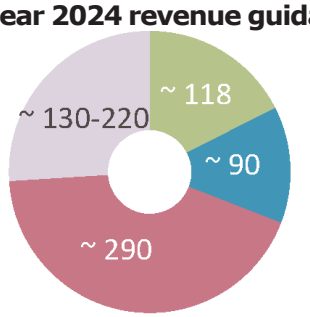
Based on the current corporate structure, the estimated development of the order intake, and the budget exchange rate of $1.15/€), Aixtron's executive board has confirmed that, for full-year 2024, it expects revenue of €630–720m, gross margin of 43–45% and EBIT margin of 24–26%. Second-quarter 2024 revenue should be €120–140m.

"Our recent technological achievements in SiC have further strengthened our position in this area and helped us to win new customers and follow-up orders. These successes are the result of our continuous work on innovative solutions that not only meet our customers' needs but exceed their expectations," says Aixtron's CEO & president Dr Felix Grawert. "We are committed to long-term partnerships with our customers, with whom we work together on the innovations of the future. The Gold Supplier Award from the leading micro-LED player BOE HC SemiTek is further proof of the success of our strategy," he adds.

"Our strategy's success is rooted in a long-term perspective," says chief financial officer Dr Christian Danninger. "We persistently invest in innovative solutions that address current technological challenges, whether it's electrification, energy efficiency, or fast data transfer with growing volumes."

www.aixtron.com

Full-year 2024 revenue guidance



Lumileds selling Lamps and Accessories business to First Brands Group

Lumileds to focus on LEDs and micro-LEDs for automotive, general illumination, display and flash markets

LED product and lighting maker Lumileds of San Jose, CA, USA has agreed to sell its Lamps and Accessories business for $238m to First Brands Group LLC (a global automotive parts maker that serves the worldwide automotive aftermarket). Under First Brands, the Lamps and Accessories business will continue to expand its global offerings and position its products and brands in the automotive accessories sector. The sale is expected to close in second-quarter 2024.

"The automotive OEM lighting go-to-market synergies and conditions that made the union of Lumileds and Philips automotive lighting business so compelling nearly a decade ago have changed as transportation manufacturers have adopted LEDs as their standard light source and traditional automotive light sources have transitioned to primarily an automotive aftermarket business," says Lumileds' CEO Steve Barlow. "Our Lamps and Accessories and our LED businesses are industry leaders in their respective markets and will be free to focus on the ongoing growth of their unique brands, channels, and customers."

As part of the acquisition, Lumileds automotive lamps factories in China, Germany and Poland will transfer with the Lamps and Accessories business. Lumileds will retain its factories and sites in The Netherlands, USA, Malaysia, Singapore, Germany and Jiaxing, China.

www.lumileds.com

Luminus unveils 4-in-1 red-green-blue-lime color-mix LEDs

Luminus Devices Inc of Sunnyvale, CA, USA has launched a series of 4-in-1 RGBL (red-green-blue-lime) LEDs designed for stage and architectural lighting systems that require high-output color mixing with high color-rendering index (CRI).

With minimal spacing between individual emitters, the 4-in-1 RGBL LED delivers what is claimed to be unmatched color mixing capabilities, providing lighting designers with an extensive palette. The Lime (570nm dominant wavelength) channel replaces the cool white LED used in the traditional 4-in-1 LED to enlarge the color space while improving brightness.

The LEDs have what is claimed to be best-in-class lumen output at maximum current while maintaining a high CRI of over 85, ensuring brilliant illumination across the entire color temperature range of 3000–8000K. All channels can be driven up to 3A and 100% DC, allowing high lumen output with uncompromised reliability.

"Luminus is committed to providing the best LED solutions to the entertainment and stage lighting markets," says senior business line director Yves Bertic." Our new 4-in-1 RGBL LED technology allows our customers to design or upgrade fixtures with high lumen output and excellent reliability," he adds. "Leveraging Luminus' ceramic-based converted green technology for the Lime channel, this product can be driven at very high current and delivers unmatched performance, setting a new standard in the 40W color-mix market".

www.luminus.com/products/color/color-mix

Luminus adds improved version of SST-08-UV LED

Adding to its high-power UV-A LED series, Luminus Devices has introduced the SST-08H-UV as the improved version of its SST-08-UV.

The new LED is said to have exceptional cost-effectiveness and compact size. Despite its small stature, it delivers a significant impact due to its efficiency and ability to be driven at a current of 1A. This combination makes it suitable for UVA customers seeking to maximize their UVA-based systems' optical output per dollar.

Designed to meet the demands of a wide range of applications, the SST-08H-UV offers peak wavelength options including 365nm, 385nm, 395nm and 405nm, ensuring precise spectral output for optimal performance. In addition, it features a robust, sulfur- and corrosion-resistant package, making it suitable for demanding environments. Finally, its industry-standard 3.5mm x 3.5mm package allows easy integration into existing systems, and a wide viewing angle of 130° provides uniform illumination across various applications.

Luminus says that the versatility of the SST-08H-UV makes it suitable for a broad range of applications, including horticulture, curing inks, coatings and adhesives, photocatalytic air and water purification, medical and analytic instrumentation, diagnostics, fluorescence imaging, disinfection and anti-microbial applications, torch and flashlight illumination, odor removal, and insect traps.

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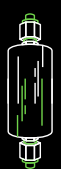
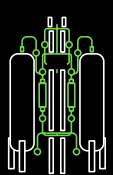
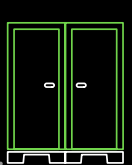


Point-of-Use Purifiers



Frame-Mounted Purifiers



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Mojo Vision demos micro-LED advances at Display Week

Single-panel RGB at 6350 pixels per inch developed for AI-powered smartglasses

At SID Display Week 2024 in San Jose (14–16 May), Mojo Vision Inc of Saratoga, CA, USA — which is developing and commercializing micro-LED display technology for consumer, enterprise and government applications — announced advances in display technology, including demonstrating a monolithic red, green and blue (RGB) panel with 4μm pixel pitch, representing a density of 6350 pixels per inch (ppi).

The firm is also demonstrating a technology enhancement that substantially improves brightness and reduces power consumption by up to 5x compared with a traditional LED structure.

Mojo says that the demonstrations represent another step in its micro-LED development progress as it drives the technology towards commercialization.

Display technology for AI-powered smartglasses

Mojo developed a monolithic RGB panel with 4μm pixels and 1.3μm sub-pixels using its proprietary quantum dot (QD) and integration processes. Designed to enable slim smartglass form factors, the compact display addresses existing consumer pain points such as high ambient viewing, size, weight and battery life. With 6350ppi, this single-panel micro-LED display is claimed to set a new standard, as augmented-reality (AR) glasses currently on the market offer ~4000ppi or less.

"As the XR industry continues to push for smaller, less obtrusive form factors, we need to get to smartglasses that look and feel just like the eyeglasses that most people wear today," says CEO Nikhil Balram. "But functionality and features like brightness, resolution, field of view and integration of AI are also critical. Today's smartglasses are starting to include AI in the form of audio input and output, but visual interaction with AI will be an important enhancement to the user experience, for true AI glasses," he adds.

"Over half of the brain's cortex is devoted to visual processing, and the possibility of incorporating rich AI with visual feedback into future smartglasses will create captivating new products," continues Balram. "The 4μm pixel size in Mojo's monolithic RGB panels is critical to enabling a lightweight, compact, energy-efficient and bright display, which will be key to making glasses fully 'smart' without sacrificing visual-appeal and comfort."

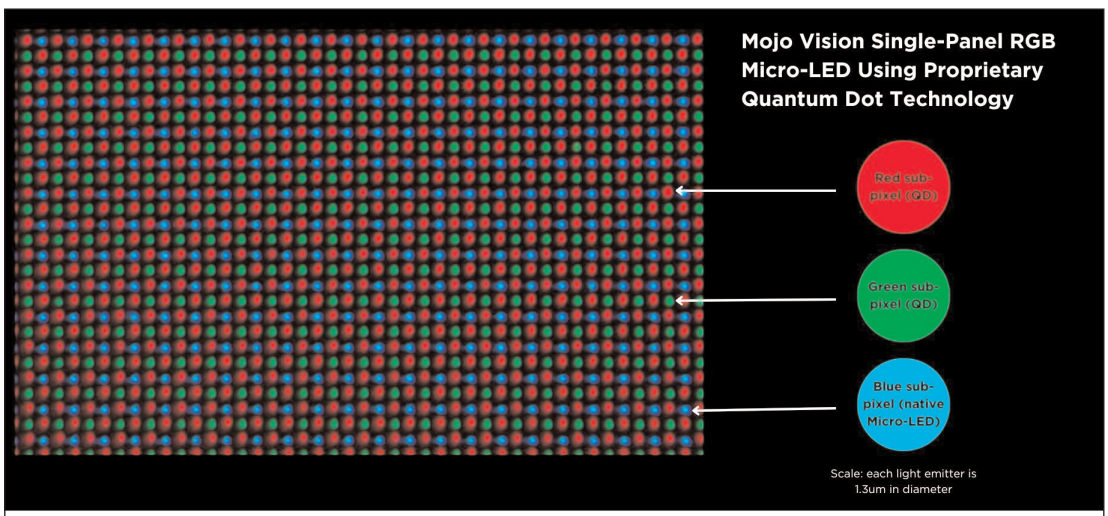
Brightness enhancement and power reduction using Micro-Lens-Array

Mojo is also demonstrating the substantial performance enhancements made possible through its use of ultra-small LEDs. LEDs naturally disperse light in many directions, leading to wasted light. Less than 7% of an LED's output enters the AR optics and reaches the human eye for visual processing. By using an MLA with lenses that can be substantially larger than tiny LEDs, Mojo's displays can deliver up to five times as much light to the human eye, resulting in a robust increase in brightness and energy efficiency, it is claimed.

Mojo is demonstrating this enhancement by placing an MLA with 3μm pitch on top of blue LED and red QD arrays with 1.3μm sub-pixels, and showing side-by-side comparisons of the brightness with and without the MLA. This is reckoned to be a significant milestone in creating a commercially scalable, high-performance and reliable full-color micro-LED display.

"Mojo is advancing human interaction with technology by creating the world's smallest and densest micro-LED displays," comments Society for Information Display's president Dr Achin Bhowmik, who is a member of Mojo Vision's board of directors. "As smartglasses with compelling AI features gain popularity, the market is primed for the next generation of displays," he adds. "Mojo's advancements will provide significant benefits to manufacturers as they incorporate micro-LED into the next generation of product."

www.displayweek.org



Raw image (captured through a microscope) demonstrating successful integration of red, green and blue (RGB) sub-pixels into a first-of-its-kind single panel (illuminated from below using blue LED) using Mojo Vision proprietary high performance Quantum Dot (QD) technology.

Aledia exceeds 32% EQE for sub-1.5µm micro-LEDs

Firm reaches 99% DCI P3 color gamut

Aledia S.A of Echirolles, near Grenoble, France (a developer and manufacturer of 3D micro-LEDs for display applications based on its large-area gallium nitride nanowires-on-silicon platform) has announced a series of technical advances that, it claims, set new standards for performance, efficiency and display quality.

Record energy efficiency and sustainability

Aledia says that it has set a new benchmark for small-sized micro-LEDs (<1.5µm), achieving an external quantum efficiency (EQE) of over 32%, leading to a wall-plug efficiency (WPE) of 320mW of visible light output per watt of electrical power input.

As well as a high EQE enabling a larger portion of electricity to be converted into visible light (reducing energy consumption and extending device battery life), Aledia claims that superior WPE illustrates the ability of its micro-LEDs to provide bright, vivid displays while consuming significantly less power, establishing a new paradigm for eco-friendly display technologies that do not compromise on performance.

Enhanced image quality for AR

Moreover, the technology's advances in native red, green and blue (RGB) directionality and pixel size reduction can benefit augmented reality (AR) applications. By reducing pixel size to 2µm, Aledia can significantly enhance the resolution and compactness of micro-LED displays. This is crucial for AR devices, where space and image clarity are paramount. Innovations in native RGB directionality ensure that each color channel precisely aligns, producing sharper, more vibrant images for AR.

Setting new standards in color fidelity

Aledia has also claimed a milestone by reaching a 99% Digital Cinema Initiatives (DCI) P3 color gamut. The DCI P3 color space is known for its wider spectrum compared with traditional RGB, enabling a broader range of colors that bring more depth and realism to digital displays. Aledia says that this advance in color fidelity for micro-LED technology enhances its capability to deliver what is claimed to be unparalleled image quality, ensuring vibrant and lifelike visuals across a variety of applications, from consumer electronics to professional display solutions.

"These technological advances have the potential to profoundly impact various markets and pave the way for new applications and user experiences," reckons chief technology officer Philippe Gilet.

www.aledia.com

Porotech partners with GIS to commercialize AR products with micro-LED micro-displays

Partnership for mass producing micro-LED and optical/touch module solutions for augmented-reality products

Fabless micro-LED company Poro Technologies Ltd (a spin off from the Cambridge Centre for Gallium Nitride at the UK's University of Cambridge that has developed porous GaN material and has an R&D center in Hsinchu, Taiwan) has partnered with General Interface Solution Holding Ltd (GIS, a provider of integrated touch and display module solutions with investment from the Foxconn Technology Group) as it enters the augmented reality (AR) area by investing in optical components and optical modules for micro-display applications.

The partnership aims to expedite production of bright, high-pixel-density, small and low-cost AR products for consumer applications. GIS's proprietary technologies in optical components and modules combined with Porotech's technologies in PoroGaN microLED-on-silicon (μLEDoS), Dynamic Pixel Tuning (DPT) technology for micro-display platform targets the commercialization of AR products including glasses, head-up displays (HUD) and head-mounted displays (HMD).

Enabled by partnering with Hon Hai Technology Group (Foxconn), Powerchip Semiconductor Manufacturing Corp (PSMC) and now with GIS, mass producing Porotech's micro-display is a step towards commercialization of AR products for consumer applications. GIS's strength in mass manufacturing of optical components and modules will deliver next-generation AR products.

Both Porotech and GIS highlight the immense potential of micro-display AR solutions for consumer markets. The partnership represents a commitment to capitalize on manufacturing precision with what is reckoned to be unparalleled product performance for high-volume and low-cost AR products.

www.gis-touch.com
www.porotech.com

Porotech selects ClassOne's Solstice single-wafer platform for development and manufacture of GaN products

Solstice's plating capabilities to help advance GaN products for micro-LED micro-displays

Porotech has selected the Solstice single-wafer platform of ClassOne Technology of Kalispell, MT, USA (which manufactures electroplating and wet-chemical process systems for ≤200mm wafers) for the development and manufacture of gallium nitride products for applications requiring silicon wafer substrates.

The devices being developed by Porotech target ultra-high-density and energy-efficient micro-LED micro-displays for augmented reality (AR) applications, wearables, and smart devices. To pursue these micro-LED applications, Porotech is leveraging its proprietary technologies: its PoroGaN GaN-on-silicon materials platform and Dynamic Pixel Tuning (DPT) micro-LED-on-silicon (μLEDoS) technology, which can be engineered to produce light at wavelengths across the visible spectrum.

ClassOne's Solstice single-wafer system.

"Porotech is tackling mass-production challenges with partners in the μLEDoS supply chain, integrating wafer manufacturing, hybrid bonding, IC design, packaging and assembly solutions. ClassOne's Solstice plating technology provides a reliable and efficient foundation for the development of key process steps that will support the route to improved yields through utilization of larger silicon wafer sizes," says Porotech's CEO Tongtong Zhu. "We look forward to working with the team at ClassOne to bring the industry-leading performance benefits of PoroGaN and DPT to display applications in the next few years," he adds.

"We're excited to participate in the development and growth of Porotech's breakthrough, game-changing micro-LED technology and to help drive these solutions toward mass production and high-volume manufacturing," comments ClassOne Technology's CEO Byron Exarcos.

www.classone.com/solstice

Kubos adds $2m investment to double red micro-LED efficiency for AR/VR displays

Investors include Martin Lamb, Drew Nelson and Geoff Haynes, plus Development Bank of Wales, FOV Ventures and S4C Digital Media

Micro-LED material technology company Kubos Semiconductors Ltd (which was spun out of the UK's University of Cambridge in 2017) has raised $2m to accelerate development of its cubic-phase gallium nitride (GaN) technology, which is said to be able to double the efficiency of red micro-LEDs. This brings total funding to $5.5m and will enable Kubos to enter the micro-LED display market within three years through IP licensing. According to analyst Spherical Insights and Consulting, the global market for micro-LED displays will grow from $1.35bn in 2022 to $14.97bn by 2032. Kubos says that its technology can enable clearer, brighter, more efficient displays to be manufactured for augmented-reality and virtual-reality (AR/VR) applications.

Kubos secured support from three experienced veterans of the UK compound semiconductor industry and three strategic investors. Martin Lamb, Drew Nelson and Geoff Haynes have a combined tenure of over 100 years in compound semiconductor materials development. Strategic investors are the Development Bank of Wales, FOV Ventures, and S4C Digital Media.

"The strategic investor group that we have assembled brings vital insight into how the metaverse, digital content and AR/VR products drive display and micro-LED requirements," says Kubos' CEO Caroline O'Brien.

Martin Lamb, formerly CEO of Wafer Technology (acquired by IQE plc in 2000) and an angel investor with several successful exits, was instrumental in the formation of Kubos and an early investor and has guided and shaped the team. He has served as chairman since its inception and will continue in this role. Drew Nelson OBE, president of compound semiconductor epiwafer and substrate maker IQE plc of Cardiff, Wales, UK (having founded and grown the business before stepping down as CEO in January 2022) has invested in Kubos and joins the board of directors. Also participating in this investment round is GaN expert Geoff Haynes, who in 2008 co-founded GaN Systems (acquired by Infineon in 2023 for $830m) to address the power semiconductor market.

The Development Bank of Wales has a track record of supporting breakthrough technologies and compound semiconductor businesses. FOV Ventures is focussed on spatial computing, and S4C Digital Media plays a key role in the delivery of digital content to consumers. This investor group brings experience and knowledge that is said to touch on all aspects of the AR/VR opportunity that Kubos aims to exploit.

"Kubos' proprietary technology has the potential to improve the user experience for lighting and displays and accelerate the adoption of micro-LEDs across a wide range of applications," comments Dr Carl Griffiths, fund manager in the Technology Venture Investments team at the Development Bank. "We are proud to be working with this exciting company of highly acclaimed engineers and scientists, and to have helped them re-locate to Wales to make use of the compound semiconductor expertise and infrastructure in the region."

www.kubos-semi.com

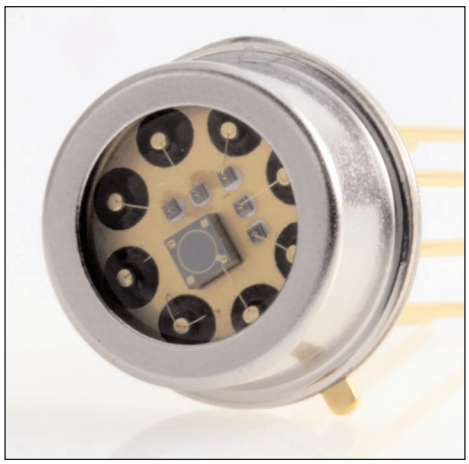
Marktech unveils multi-chip packages with InGaAs photodiodes and multiple LED emitters

MTMD142345PDT38 co-packages 1040nm, 1200nm, 1300nm, 1460nm and 1550nm LEDs with 600–1750nm SWIR detection

Marktech Optoelectronics Inc of Latham, NY, USA, a designer and manufacturer of optoelectronics components and assemblies — including UV, visible, near-infrared (NIR) and short-wave infrared (SWIR) emitters, detectors, and indium phosphide (InP) epiwafers — has unveiled its new multi-chip packages with indium gallium arsenide (InGaAs) photodiodes and multiple LED emitters.

Marktech says that its visible, NIR and SWIR emitters combined with its IR detectors (InGaAs photodiodes) are suitable for many analytical, medical, aerospace and industrial sensing applications. Specifically, multiple LED light sources and the appropriate photodiode detector can allow improved signal-to-noise ratio and detection speed in spectrometry, fluorescence microscopy and other optical analytical methods.

NIR and especially SWIR wavelength light can penetrate deeper into human tissue than visible light due to the reduced photon scattering at these wavelengths, enabling the capture of deep tissue chemical composition information. Marktech's MTMD142345PDT38 multiple SWIR wavelength emitter-detector span



1040nm, 1200nm, 1300nm, 1460nm and 1550nm peak wavelength LEDs combined with the firm's InGaAs photodiode for SWIR detection in the 600–1750nm range, suiting infrared spectroscopy.

Also, a silicon detector can be added to the package when UV and visible LED light needs to be monitored or detected. Marktech can even co-package silicon carbide (SiC) photodiodes with 235nm or 255nm LEDs for deep UVC applications where solar blindness is required.

The co-packaged emitters are individually addressable. Multiple chip products are available in TO can and hermetic SMD packages.

The firm says that the new LED light sources, multiple wavelength LED emitters, have several advantages over singular packaged LEDs and older, conventional light sources, including:

- rapid variation of light power output and wavelength;
- reduced part count, circuitry and design complexity;
- more compact designs for wearables;
- reduced power and heat and improved life-time and response time (no warm-up);
- elimination of moving parts; and
- high emission stability.

The specific combinations of emitters and detectors can be tailored or 'mixed and matched' to an application's specific light source and detection requirements.

"We can assemble virtually any combination of deep UVC to MWIR wavelength LEDs with our InGaAs, silicon, SiC, or other detectors in various packages, demonstrating our adaptability to meet specific OEM design needs," says chief technology officer Vincent Forte.

www.marktechopto.com/led-emitters/multiwavelength

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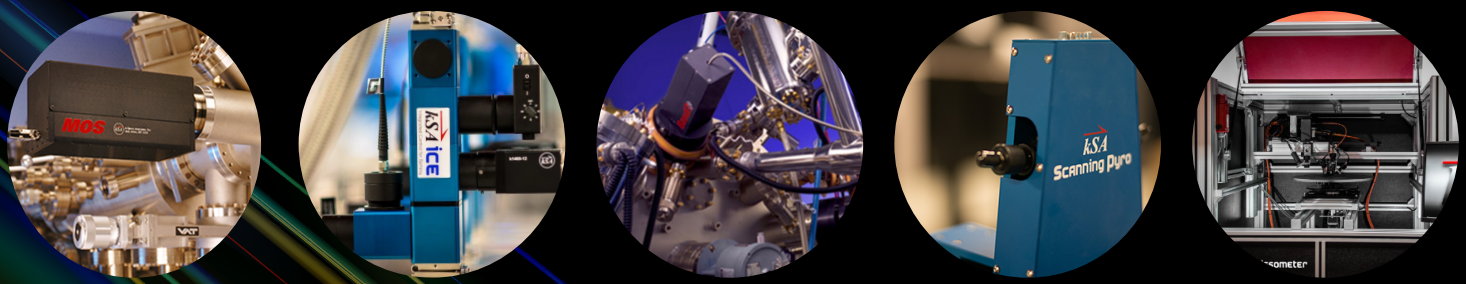

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BluGlass highlights progress in March quarter

MoU signed with Applied Energetics; GaN DFB performance data released; $10.17m raised to speed and scale visible laser delivery

For the three months ended 31 March (fiscal Q3/2024), 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 given an update, including the following highlights.

MoU with Applied Energetics

BluGlass and US-based advanced defence and dual-use photonics company Applied Energetics Inc are collaborating under a memorandum of understanding (MoU) on the development of advanced laser systems for next-generation military and commercial applications. Applied Energetics has complementary laser technology, specializing in ultrashort pulse (USP) optical systems spanning ultraviolet to infrared wavelengths for the US Department of Defense, defence primes, and intelligence community.

The collaboration will leverage BluGlass' full suite of gallium nitride (GaN) products, including its distributed feedback (DFB) lasers, for use within Applied Energetics' advanced dual-use laser systems.

"This collaboration combines our highly complementary laser technologies and capabilities to address innovative new market segments where neither company can compete individually," says CEO Jim Haden. "Laser technology is increasingly playing a larger role within modern military and national security strategies, where application size, weight and power are critical. Brighter, better-performing visible lasers have the potential to significantly reduce these key parameters in next-generation solutions while also unlocking a new era of exploratory technologies," he adds. "While this collaboration is in its infancy, our work with Applied Energetics has numerous commercial and technical benefits, further strengthening our presence within the US government and intelligence communities, and advancing our next-generation product roadmap."

CLAWS Hub development

BluGlass says that it delivered all quarterly milestones under its Microelectronics Commons' Commercial Leap Ahead for Wide Bandgap Semiconductors (CLAWS) Hub contract, and is on track or ahead of schedule on all metrics. The firm has made substantial progress against many of next quarter's deliverables spanning operational, single-mode, and DFB milestones. BluGlass has met yearly single-mode electro-optical performance metrics across core 405nm, 420nm and 450nm wavelengths, and continues to work on refinements.

As part of its development activity with the CLAWS Hub, BluGlass has also improved the performance of its 450nm blue GaN DFB lasers. Together with development partner the University of California Santa Barbara (UCSB), BluGlass has improved the side-mode suppression ratio of its DFB lasers by 100% since Photonics West 2023 at the end of January 2023, exhibited power output over 100mW from a single diode, and operated at single-frequency over a wide range of current densities. The firm has also reduced operating voltages by 27% over the same period – a key factor in device reliability, thermal management, and wavelength stability.

BluGlass delivered all quarterly milestones under its Microelectronics Commons' CLAWS Hub contract

Visible GaN DFB lasers comprise compact, single-frequency laser light sources that are said to meet the unique requirements of next-generation technology, such as quantum sensing and navigation, advanced robotics, underwater and space communications, and biomedical applications. While DFBs are commonly used in non-visible wavelengths, they are not commercially available in the near-ultraviolet (UV) and visible spectrums.

"Our recent breakthroughs in GaN-based DFB lasers offer a game-changing solution for emerging quantum sensing, navigation, and communication needs, as well as critical next-generation defence and aviation applications. Visible DFB lasers offer multiple advantages for these emerging technologies, providing precise stable wavelengths and high-power narrow spectral width," says Haden. "They also address a key challenge for quantum computing, which currently utilize large laser systems with significant power and space requirements. Thousands of GaN DFB lasers are processed simultaneously on one 2-inch wafer, potentially paving a way for quantum computers to scale-up in volume production as well as scale-down in size," he adds. The company has published an updated white paper on BluGlass' latest DFB laser performance data, which is available to download at www.bluglass.com/laser-diodes.

Intellectual property

BluGlass has secured the rights to license key DFB fabrication IP, entering an agreement with development partner the UCSB Solid State Lighting and Energy Electronics Consortium (SSLEEC) to obtain the rights to two patents. These patents protect laser design, microfabrication techniques, and specialized optical structures for high-performance GaN DFB lasers for use in wavelengths spanning UV to green.

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Customer engagement

BluGlass shipped multiple laser orders from new and repeat customers during the quarter. BluGlass says that it is in various stages of engagement with multiple potential customers and remains focused on converting these opportunities into new orders and custom projects. The firm is also pursuing large revenue-generating contracts, applying for specialist projects as part of the broader ME Commons initiative and engaging with potential partners on tender applications.

Secured $10.17m to speed laser delivery

BluGlass strengthened its balance sheet during the quarter, raising $10.17m to fast-track the production and delivery of its visible lasers to fulfil new and existing contracts, invest in additional fab equipment, and working capital. A well-supported placement to sophisticated investors raised $4.3m at $0.037 per share in March, and a share purchase plan on the same terms contributed $5.87m in April. Each new share is inclusive of one free attaching option, exercisable at $0.046 and expiring on 28 February. For every attaching option exercised, shareholders receive an additional piggyback option.

Financials

March-quarter revenue of $795,000 comprised payments under the NCSU contract, laser orders, and foundry services for a European wafer developer.

R&D expenses were $2,863,000 (comprising $2,829,000 for laser diode product development and $34,000 for RPCVD development), inclusive of salaries, materials, and fabrication costs. Payments to related parties were $101,000, encompassing chair and non-executive director fees. Cash at the end of the quarter was $3,277,000, following a $4.3m placement. The cash balance excludes the $5.87m raised via a share purchase plan, received in April.

Outlook

BluGlass says that it continues to gain traction within the highly constrained GaN laser market, building its novel architecture capability to address evolving market needs. The firm is making in-roads with its next-generation product development as part of its CLAWS Hub activity, and is collaborating on complementary technology solutions with laser pioneer Applied Energetics. These partnerships align with BluGlass' technical and commercial roadmaps, enabling it to further differentiate its visible laser offering from larger competitors, bring innovative new products to market quicker, and build industry credibility, it is reckoned.

BluGlass will continue to execute on its growth strategy in fiscal Q4/2024, expanding revenue-generating partnerships, progressing sales and qualification of its direct-to-market GaN lasers, and bringing its vertically integrated fab up to speed.

www.bluglass.com.au

Blue laser maker NUBURU enters medical device market

Purchase order for BlueScan from Ireland-based Blueacre

NUBURU Inc of Centennial, CO, USA — which was founded in 2015 and develops and manufactures high-power industrial blue lasers — has received a purchase order for its BlueScan solution from Blueacre Technology of Dundalk, Ireland (which was founded in 2005 to provide contract manufacturing solutions to the medical device industry). The BL laser will be integrated by Blueacre with scan head optics to produce a versatile welding system for the manufacture of precision medical devices.

The order is an extension of the NUBURU's market focus on the electric vehicle (EV) industry, next-generation computers, consumer electronics and communication (3C) device manufacturing, and medical devices. The blue laser addresses the need for a non-contact, high-speed process with low-to-no defects for manufacturing batteries and electric vehicles by replacing slower methods like ultrasonic and resistance welding, which represent multi-billion-dollar equipment spent today due to their high cost of operations. It can work with copper, aluminium, titanium and stainless steel, facilitate the manufacture of EV batteries, and address the tens of thousands of welds in an electric vehicle.

"Blue wavelength light is absorbed better by metals than infra-red sources. Blue, therefore, reduces the heat input into the material, reducing the risk of heat damage to critical medical components," says Blueacre's managing director & owner David Gillen. "We are excited to add blue lasers to our range of equipment," he adds.

"Our focus remains on providing world-class solutions to our customers' most challenging processes. These solutions are critical when welding disparate materials in a precision environment like medical device manufacturing," says NUBURU's CEO Brian Knaley. "Blueacre will prove to be a world-class partner in this important market segment of medical device manufacturing, which is indicatively worth $6bn according to AMPOWER 2022."

Blueacre's purchase order for the BlueScan solution follows a successful Phase II contract award by the National Aeronautics and Space Administration (NASA) through its Small Business Innovation Research (SBIR) to advance blue laser power transmission technology as a unique solution to dramatically reduce the size and weight of the equipment needed for Lunar and Martian applications.

www.blueacretechnology.com

www.nuburu.net

NUBURU wins second NASA contract for blue laser space technology

Demonstration to show the feasibility of reducing size and weight of power beaming equipment on Moon and Mars

NUBURU Inc of Centennial, CO, USA — which was founded in 2015 and develops and manufactures high-power industrial blue lasers — has been awarded an $850,000 Phase II contract by the US National Aeronautics and Space Administration (NASA) to advance blue laser power transmission technology as a unique solution to dramatically reduce the size and weight of the equipment needed for Lunar and Martian applications. The contract builds on NUBURU's Phase I Small Business Innovation Research (SBIR) announced in August 2023.

NUBURU's blue power beaming technology is a rethinking of the electrical power grid for the unique Lunar and Martian environments – eliminating the need for transporting heavy copper or aluminium wires, which are neither economically nor logistically practical. The blue power beaming technology approach unlocks the dynamic distribution of power to moving rovers, temporary or permanent stations, and even remote habitats. NUBURU's blue laser architecture enables a low size, weight and power (SWaP) design, clear visibility aiding navigation, efficient direct diode technology, and advanced direct-bandgap solar cell technology for high electrical efficiency.

This technology solution is directly aligned with the mission goal of NASA's Artemis program, which aims to return humans to the moon permanently. The need has been outlined in NASA's Moon to Mars Objectives in Lunar Infrastructure Goal 1.

In the initial phase I project, NUBURU demonstrated the scientific, technical and commercial feasibility of its technology. During the Phase II program, the firm aims to scale up the power, range and performance of the blue laser power beaming technology. This program will demonstrate the technology with hundreds of watts of power delivered at kilometer-scale range. Furthermore, NUBURU aims to advance its high-brightness laser source with a next-generation technology capable of extending the technology range to tens of kilometers on the lunar surface.

"This second NASA contract is a testament to the innovative nature of our blue power beaming technology, which has the potential to revolutionize power management challenges facing NASA, other space operators, and many commercial enterprises today," says NUBURU's chief executive officer & chief technology officer Brian Knaley. "Our upcoming innovation, powered by NUBURU's state-of-the-art blue laser technology, is set to significantly decrease the size and weight of necessary equipment to meet routine mission demands," he adds.

"In addition to Lunar applications, blue laser power beaming has terrestrial applications, including remote power solutions, disaster relief, and DoD contested logistics," continues Knaley. "NUBURU's unique high-brightness technology has additional applications in industrial, medical and defense markets that benefit from this SBIR program funding and megamarkets like e-mobility, consumer, electronics, aerospace, healthcare, defense, energy, and industrial applications."

NASA's SBIR program funds the research, development and demonstration of innovative technologies that have significant potential for successful commercialization. The SBIR program is designed to drive these technologies to market in a three-phase process, ultimately resulting in commercialization and deployment. This Phase II effort will be a significant step forward towards validating the blue laser power beaming technology at a scale critical for commercial success, NUBURU reckons.

www.nasa.gov/sbir_sttr
www.nuburu.net

Lumentum awarded Platinum EcoVadis Medal for second consecutive year

Firm stays top for sustainability performance; increases environmental score by 10 points

Lumentum Holdings Inc of San Jose, CA, USA (which designs and makes optical and photonic products for optical networks and lasers for industrial and consumer markets) has received the EcoVadis Platinum Medal for the second consecutive year, representing the highest level of recognition for sustainability performance. Lumentum remains in the top one percent of companies assessed by EcoVadis in the past year, increasing its overall score from 78 points to 80 points. In the environmental category, the firm increased its score by 10 points from last year. Medals are awarded based on the percentile rank of a company compared with the performance of all rated companies.

"This achievement reflects our efforts to integrate sustainable practices across all of our operations," says Lumentum's president & CEO Alan Lowe. "We are dedicated to pushing the boundaries of what is possible, driving both technical innovation and operational advancements that serve our customers and create a positive impact on our planet and communities," he adds.

"We have continuously improved our sustainability efforts every year and it is a major accomplishment to be recognized among the elite top one percent for our environmental initiatives for two consecutive years," says Misha Rozenberg, senior VP of global operations and chief quality officer.

Some of Lumentum's key environmental commitments and recent accomplishments include:

- Achieve net-zero greenhouse-gas (GHG) emissions from global operations (Scope 1 and 2) by 2030. In fiscal year 2023, GHG emissions fell by 25%, compared with fiscal 2022.
- Increase percentage of renewable electricity for global operations year over year. Lumentum doubled the percentage of renewable energy sourced for its global operations from 31% to 61% in fiscal 2023.
- Divert 90% of non-hazardous waste by fiscal year 2027. 70% of non-hazardous waste was diverted from landfill in fiscal 2023.

As a global standard for business sustainability ratings, the EcoVadis assessment evaluates 21 sustainability criteria across four core categories: Environment, Labor & Human Rights, Ethics and Sustainable Procurement. More than 100,000 companies globally have been rated by the organization.

EcoVadis' business sustainability ratings are based on international sustainability standards such as the Ten Principles of the UN Global Compact, the International Labour Organization (ILO) conventions, the Global Reporting Initiative (GRI) standards and the UN Guiding Principles on Business and Human Rights.

EcoVadis previously recognized Lumentum with a Platinum Rating in 2023, a Gold Rating in 2022, and a Silver Rating in 2021. The organization will be planting a tree on behalf of Lumentum to celebrate its achievement, through its partnership with One Tree Planted, a non-profit organization focused on global reforestation.

www.ecovadis.com
www.lumentum.com/en/company/sustainability
https://onetreeplanted.org

ESA awards €0.5m to Phlux, Airbus and Sheffield University to develop free-space optics satellite terminals

Phlux's 1550nm APDs to aid reliable communications at 2.5Gbps, and 10Gbps longer term

Sheffield University spin-off Phlux Technology (which designs and manufactures 1550nm avalanche photodiode infrared sensors), Airbus Defence and Space, and The University of Sheffield have embarked on a €500,000 project to build more efficient free-space optical communications (FSOC) satellite terminals.

Funded by the European Space Agency (ESA) in a first phase that runs until the end of September 2025, the project's medium-term goal is to achieve reliable 2.5Gbps communications with low Earth orbit (LEO) satellites at 1550nm wavelength. These satellites orbit the earth at heights of up to 2000km (1200 miles). A longer-term aim is to produce links that will operate at 10Gbps.

Phlux Noiseless InGaAs avalanche photodiodes (APDs) are used as infrared sensors in FSOC receivers and are expected to deliver 6dBm more sensitivity than traditional indium gallium arsenide APDs operating at 1550nm. This means that they can detect much lower signal levels, enabling faster and higher-bandwidth links with low latency to be developed. Also, adequate performance can be maintained for longer periods because link integrity is maintained over a wider angle as the satellite passes overhead.

A key technical challenge with realising FSOC is that the infrared signals used to transmit data are diffracted as they pass through the troposphere (the atmospheric layer closest to Earth). Variations in our atmosphere's air temperature, humidity and turbulence cause fluctuations in the intensity and angle of incidence of the infrared signal. This makes the beam wander over the signal detector area, limiting performance. This issue is being addressed by developing a large-area, high-sensitivity APD to produce a wider receptor.

A radiation-hard detector module being developed in this project has other potential applications including space debris monitoring, greenhouse gas detection, and space navigation.

"This project is an endorsement of the value of our patented APD technology developed at The University of Sheffield," says Phlux's CEO Ben White. "With more than an order-of-magnitude improvement in sensitivity over traditional devices, we offer the enabling component that makes other technology breakthroughs possible. Higher-performance FSOC links are a perfect example," he adds.

"The availability of APD products at 1550nm for optical communication with sensitivities close to those of fibered low-noise optical amplifiers could be a game changer for the development of cost-effective laser terminals and optical ground-stations," comments Ludovic Blarre, who is leading Airbus Space Systems' optical communication roadmap. "This will be an enabler for the rapid development of optical communication in satellites for direct-to-earth applications and inter-satellite links with data rates below 10Gbps. Our team is delighted to work with Phlux Technology and the University of Sheffield towards this goal and to carry out irradiation tests on their patented APD technology," he adds.

"This is a very challenging and exciting project that will provide opportunities for our team to extend our patented technology to an exciting new application in FSOC," says professor Chee Hing Tan of the University of Sheffield. "Working with ESA, we hope to provide a disruptive technology that will accelerate the adoption of satellite-to-ground FSOC."

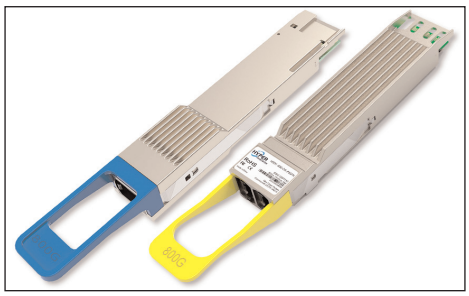
As demand for bandwidth grows beyond the capabilities of radio frequency systems, the FSOC market will rise at a compound annual growth rate (CAGR) of 31.3% to $4.8bn by 2031, forecasts analyst firm Allied Market Research.

www.phluxtechnology.com

Hyper Photonix announces general availability of 800G DR8 optical transceivers

Optical transceiver designer and manufacturer Hyper Photonix Ltd of Bellevue, WA, USA has announced general availability (GA) of its 800G DR8 products, which leverages the power of its patented Hyper Silicon silicon photonics platform, demonstrating the scalability of its 400G DR4 product line.

Hyper Photonix 800G optics are available in QSFP-DD112 and OSFP-112 form factors and 500m to 10km reach, and they are compatible with NVIDIA/Infiniband and Ethernet ecosystems. With completion of comprehensive qualification testing, the 800G products are now in mass production at the company's high-volume automated manufacturing facility. Hyper Photonix says that the milestone underscores its commitment to delivering reliable, high-performance, cost-optimized, next-generation transceivers worldwide and bridging the gap in global optical interconnect supply and surging AI/ML-driven demand.



Hyper Photonix's 800G DR8 optical transceiver.

"Operators of large AI clusters started to transition from using multi-mode fiber transceivers to longer-reach single-mode fiber modules, including DR8," comments Dr Vladimir Kozlov, CEO & chief analyst at LightCounting. "Demand for single-mode 800G transceivers is likely to exceed our forecast in 2024 and triple in 2025. Large customers are concerned about the limited manufacturing capacity of their current suppliers and starting to qualify new vendors. It is great timing for the Hyper Photonix announcement," he adds.

"Built on the Hyper Silicon platform, these transceivers offer performance, reliability and capacity tailored to the demands of hyperscale data centers," says Hyper Photonix's CEO Xavier Clairardin. "The cost- and power-optimized design makes the QSFP-DD112 and OSFP-112 transceivers ideal for Ethernet and Infiniband AI/ML applications."

Looking ahead, Hyper Photonix is expanding its portfolio of parallel single-mode optics further. The firm will announce additional 800G and 1.6T products later this year, including the highly anticipated linear pluggable optic (LPO) and active optical cable (AOC) configurations, further solidifying its position as an industry leader in high-speed optical interconnects.

www.hyperphotonix.com

Pilot Photonics secures €2.5m in funding from the European Innovation Council to develop key technologies for CPO scaling

Pilot Photonics of Dublin, Ireland — which produces laser light sources and III-V photonic integrated circuits (PICs) for communications, automotive and space applications — has secured €2.5m from the European Innovation Council (EIC) to develop, integrate and commercialize key technology blocks relevant to a coherent co-packaged optics (CPO) solution to overcome future scaling challenges in the data center.

The explosion in data processing due to the adoption of AI/ML is putting further pressure on data-center networks and in large computing arenas. New architectures are emerging to tackle this problem but already scaling challenges are appearing and new innovations will be needed to overcome them.

Supported by the EIC funding, Pilot Photonics aims to mature a number of its patented technologies including comb lasers, ring resonator IQ modulators and comb-enhanced DSP algorithms. These innovations are relevant to both pluggable and CPO architectures and can help to unlock coherent communication inside the data center. They enable data center switches at 204.8T and beyond as well as longer-reach CPO systems at 10km (LR) distances or more.

"The low-hanging fruit for scaling CPO, namely power splits and coarse wavelength multiplexing, is already taken," says Pilot Photonics' founder & CTO Dr Frank Smyth. "This project recognizes that continued densification of the interconnects is required for future cloud and AI/ML network scaling. It develops key enabling technologies such as comb laser technology to densify the wavelength grid and ring resonator IQ modulators to increase the information spectral density."

Pilot Photonics presented at the Optical Fiber Communication conference (OFC 2024) in San Diego, CA, USA (26-28 March), where it provided details of the development program and discussed its other technologies, including its fast tunable low-linewidth laser and integrated comb laser technologies.

www.pilotphotonics.com

US investing $71m to advance US solar manufacturing and development

As part of President Biden's Investing in America agenda, the US Department of Energy (DOE) has announced a $71m investment (including $16m from the President's Bipartisan Infrastructure Law) in research, development and demonstration projects to grow the network of domestic manufacturers across the US solar energy supply chain.

The selected projects will address gaps in the domestic solar manufacturing capacity supply chain, including equipment, silicon ingots and wafers, and both silicon and thin-film solar cell manufacturing. The projects will also open new markets for solar technologies such as dual-use photovoltaic (PV) applications, including building-integrated PV and agrivoltaics.

These efforts complement and strengthen the Biden–Harris Administration's goal to rapidly deploy clean energy to help achieve net-zero emissions by 2050.

"The Biden–Harris Administration is committed to building an American-made solar supply chain that boosts innovation, drives down costs for families, and delivers jobs across the nation," says US Secretary of Energy Jennifer M. Granholm.

Silicon Solar Manufacturing and Dual-Use Photovoltaics Incubator funding program

DOE selected three projects for the Silicon Solar Manufacturing and Dual-Use Photovoltaics Incubator funding program, which will support the development of technologies to bring silicon wafer and cell manufacturing onshore. This investment will enable new solar companies to prove out their technologies, with the goal of being eligible to apply for capital to scale-up manufacturing, accelerating their path to commercialization.

Seven additional projects will advance dual-use PV technologies to harness their potential to electrify buildings, decarbonize the transportation sector, and reduce land-use conflicts.

The ten selected projects are:

- Re:Build Manufacturing (Nashua, NH): $1.9m;
- Silfab Solar Cells (Fort Mill, SC): $5m;
- Ubiquity Solar (Hazelwood, MO): $11.2m;
- Appalachian Renewable Power (Stewart, OH): $1.6m;
- GAF Energy (San Jose, CA): $1.6m;
- Noria Energy Holdings (Sausalito, CA): $1.6m;
- RCAM Technologies (Boulder, CO): $600,000;
- The R&D Lab (Petaluma, CA): $1m;
- Silfab Solar WA (Bellingham, WA): $400,000;
- Wabash (Lafayette, IN): $1.6m.

Funding for program 'Advancing US Thin-Film Solar Photovoltaics'

Thin-film PV technologies, such as cadmium telluride (CdTe) and perovskites, have potential advantages over incumbent silicon technology, such as less energy-intensive manufacturing, lower manufacturing costs, simpler supply chains, and greater lifetime energy yield.

Of the eight projects that the DOE has selected for the Advancing US Thin-Film Solar Photovoltaics funding program, four will address opportunities to improve efficiency, reduce costs, and bolster the supply chain for CdTe systems.

DOE's Solar Photovoltaics Supply Chain Review identified CdTe as an opportunity to expand domestic production of solar panels. Improving the ability to use and recover materials efficiently when building and recycling panels is a promising approach to strengthen domestic CdTe PV competitiveness.

Four other projects will prove out innovative tandem PV devices that pair established PV technologies like silicon and copper indium gallium diselenide (CIGS) with perovskite thin-film PV technology that is nearing market readiness and could be manufactured in the USA. One project leverages the USA's trade partnership with Canada to increase the supply of tellurium in the USA.

The selected projects are:

- First Solar (Tempe, AZ and Perrysburg, OH): $6m;
- Cubic PV (Bedford, MA): $6m;
- Tandem PV (San Jose, CA): $4.7m;
- Swift Solar (San Carlos, CA): $7m;
- 5N Plus (Montreal, Canada): $1.6m;
- First Solar (Tempe, AZ and Perrysburg, OH): $15m;
- Brightspot Automation (Boulder, CO): $1.6m;
- Tau Science (Redwood City, CA): $2.1m.

Details of 'Advancing US Thin-Film Solar Photovoltaics' program

The Advancing US Thin-Film Solar Photovoltaics funding program awards $44m for research, development, and demonstration projects on two major thin-film photovoltaic (PV) technologies. Projects aim to help to enable domestic manufacturing of affordable solar hardware, increase the portion of solar hardware value kept in the US economy, and promote American leadership of thin-film PV technologies.

The US Department of Energy (DOE) Solar Energy Technologies Office (SETO) announced the funding opportunity on 12 September 2023 and announced selections on 16 May.

Projects will de-risk tandem thin-film technologies that include perovskite materials. Projects will also support innovation in cadmium telluride (CdTe) production by improving efficiency and reducing costs, making CdTe systems more affordable and improving competitiveness of the domestic CdTe industry. Advancement of thin-film technologies presents an opportunity to strengthen the domestic solar supply chain and reduce reliance on foreign imports.

This funding program supports an equitable transition to a decarbonized electricity system by 2035 and

facilitates secure, robust and reliable integration of solar electricity into the nation's energy grid.

Selectees

Topic 1: Promoting Research & Development toward Industrial Manufacturing of Early-Stage Perovskite Tandem Photovoltaics (PRIMES Perovskite Tandem PV)

● Cubic PV (Bedford, MA): $6m (plus $1.5m awardee cost share) for project 'Scaling Perovskite-Silicon Tandems Toward Reliable Commercial Product' (principal investigator: Adam Lorenz).

This project aims to design perovskite-silicon tandem PV modules that can be fabricated using robust manufacturing methods and remain durable after exposure to heat and light. The team will use a four-terminal device configuration, which allows for optimization of the perovskite device layer without changing the silicon layer. By closely monitoring the devices throughout the perovskite layer fabrication process, the team can quickly and specifically identify the effects of any changes and ensure the final process will create reproducible, durable devices.

● First Solar (Perrysburg, OH): $6m (plus $1.5m awardee cost share) for project 'High-Performance Tandem Modules Based on Wide-bandgap $FAPbI_3$ Perovskites and Narrow-bandgap CI(G)S Bottom Cells' (principal investigator: Le Chen).

This project aims to design tandem perovskite and copper indium gallium diselenide (CIGS) PV modules with 27% efficiency that can be easily manufactured. The team will maximize the efficiency of the perovskite layer and optimize the properties of the CIGS layer to best complement the perovskite layer. They will also scale up these devices from mini-module size and perform durability tests to ensure that these devices are stable over time and practical to manufacture.

● Swift Solar (San Carlos, CA): $7m (plus $1.8m awardee cost share) for project 'PIPPIN: Perovskite-Silicon Tandem Solar Cells from Prototype to Production' (principal investigator: Rohit Prasanna).

This project is developing durable, high-efficiency perovskite-silicon tandem PV modules where the perovskite layer is fabricated using vapor deposition, a promising method for high-volume manufacturing. The team will incorporate measurements throughout the manufacturing process to improve process control and reproducibility while testing the durability of their modules to ensure that they can reliably operate for decades in the field.

● Tandem PV (San Jose, CA): $4.7m (plus $2m awardee cost share) for project 'STACKED: Stability and Characterization of Hole-Transporting Layers Key to Enabling Outdoor Durability' (principal investigator: Colin Bailie).

Ultraviolet (UV) light from the sun can cause significant damage to perovskite PV devices, but existing simulated outdoor durability testing does not adequately account for its effects. This project aims to engineer new layers to add into perovskite PV devices that can filter out UV light and increase durability under high temperatures. The team will perform enhanced durability testing on tandem perovskite-silicon devices with these new layers to ensure that they are stable and retain their high efficiency in outdoor conditions.

Topic 2: Improving the Market Potential of Advanced Cadmium Telluride Photovoltaics (IMPACdTe PV)

● 5N Plus (Montreal, Quebec): $1.6m (plus $0.4m awardee cost share) for project 'Upstream Extraction of Tellurium from Copper Concentrates' (principal investigator: Frederic Belanger).

A major barrier to increasing CdTe PV module production is the availability of the element tellurium (Te), which currently has very limited supply. Most Te is obtained from ore extracted for copper mining, but the existing processing methods only extract 3–4% of the available Te in this ore, with the rest being discarded during other processing steps. This project aims to increase Te supply by developing an innovative extraction method that will recover more Te from the copper ore earlier in the process. This method will also extract toxic elements like antimony and arsenic, making the copper mining process more environmentally friendly.

● Brightspot Automation (Boulder, CO): $1.6m (plus $0.4m awardee cost share) for project 'Lifecycle Reliability Testing of CdTe Solar Panels' (principal investigator: Andrew Gabor).

This project aims to develop an imaging method to detect damage to in CdTe PV modules in the field. The team will design, build and test a non-invasive, high-throughput imaging tool using photoluminescence, which works by shining light onto the PV panels and measuring light that shines back in response. The team will develop artificial intelligence software to correlate specific types of defects with changes seen in the photoluminescence data from the imaging tool. Automated defect detection will reduce investment risks, lower financing and insurance costs, improve system performance, and inform panel end-of-life decisions.

● First Solar (Perrysburg, OH): $15m (plus $27m awardee cost share) for project 'High-Density Interconnect Technology for CdTe PV Modules' (principal investigator: Rui Shao).

This project aims to increase CdTe PV module efficiency using an innovative three-dimensional design for electrical contacts in the PV cell. While this design has shown promise in smaller-scale experiments, this project will demonstrate that this design for electrical contacts can be scaled up for use in high-volume manufacturing to create more efficient, reliable, cost-effective CdTe modules.

● Tau Sciences (Redwood City, CA): $2.1m (plus $0.5m awardee cost share) for project 'MANTIS: From Multiscale Analysis to Next Generation Thin Film Module Inspection Systems' (principal

investigator: Gregory Horner).

This project is developing a new non-contact inspection technology to detect defects in CdTe PV modules, enabling site owners to detect problems, quantify the potential impact, and respond accordingly. Information gained through defect detection methods can also increase investor confidence in CdTe PV plants. The team will develop two different imaging techniques that measure how PV panels respond to electrical current and infrared light, then correlate these responses to specific defects.

www.energy.gov/eere/solar/solar-energy-technologies-office

MN8 orders 457MW of First Solar modules

170MW of Series 6 Plus bifacial modules and 287MW of Series 7 modules for projects in northeastern and southern USA

First Solar Inc of Tempe, AZ, USA says that MN8 Energy LLC has placed orders for 457MW of its cadmium telluride (CdTe) thin-film photovoltaics (PV) modules, including 170MW of its Series 6 Plus bifacial modules and 287MW of its Series 7 modules, to power projects in the northeastern and southern USA.

Founded as Goldman Sachs Renewable Power in 2017, MN8 owns and operates a 3.2GW portfolio, delivering renewable energy to over 40 corporates, 70 government entities, and 20 utilities. MN8 previously transacted with First Solar in its acquisition of the 123MW American Kings Solar project in California.

"We are pleased to continue our relationship with First Solar, building certainty and resilience into our development pipeline," says MN8's chief operations officer David Fernandez. "By executing these agreements, MN8 demonstrates strong support for developing a robust domestic supply chain for the US renewable industry that upholds the highest environmental, sourcing and manufacturing standards. Furthermore, we're thrilled to be collaborating with a partner that shares our commitment to responsibly and domestically produced solar, strengthening our industry's social license to operate," he adds.

"MN8 joins a growing number of renewable energy companies that are choosing certainty, competitiveness, and responsible solar by choosing First Solar," says First Solar's chief commercial officer Georges Antoun. "We thank MN8 for its trust and look forward to expanding this relationship."

First Solar, which exited 2023 with 6GW of annual US nameplate capacity, is the largest solar manufacturer in the Western Hemisphere. Its investments in US manufacturing are also believed to make it the most significant enabler of American jobs among solar manufacturers. According to a recent study commissioned by First Solar, existing operations supported an estimated 16,245 direct, indirect and induced jobs in 2023, representing about $1.6bn in annual labor income. As First Solar grows to an expected 14GW in annual US nameplate capacity in 2026, the company is forecast to support an estimated 30,060 direct, indirect, and induced jobs across the USA. The study projects that every direct job that First Solar supports in 2026 will support 7.3 jobs nationwide.

In addition to expanding its footprint in Ohio to over 7GW of annual nameplate capacity this year, First Solar expects to invest over $2bn in new manufacturing facilities in Alabama and Louisiana, which are expected to come online in 2024 and 2025, respectively. Additionally, First Solar is on track to commission about $450m in R&D innovation infrastructure in Perrysburg, Ohio, in second-half 2024.

https://mn8energy.com

Birch Creek orders 547MW of First Solar's Series 6 Plus Bifacial modules

US firm Birch Creek strengthening its domestic content strategy

First Solar is to supply 547MW of its Series 6 Plus Bifacial CdTe thin-film PV modules to renewable energy company Birch Creek Energy of St. Louis, Missouri, which develops, finances and owns utility-scale solar and storage projects across the USA.

The relationship with First Solar will "enable certainty of module supply for a critical part of our development pipeline," expects Birch Creek's CEO Dan Siegel. "By choosing to buy our modules from First Solar, we are strengthening our domestic content strategy with a trusted partner that delivers a competitive product," he adds.

"Birch Creek's decision to partner with us is a validation of our technology and competitiveness, and the value of pricing and supply certainty," says First Solar's chief commercial officer Georges Antoun. "We look forward to building on this relationship."

www.birchcreekenergy.com

Micro-LED IP plateaus after seven years of exponential growth

Over $12bn has been spent by the micro-LED industry, including $3bn by Apple before its exit, says Yole Développement.

Apple effectively pioneered the micro-LED industry, thrusting it into the spotlight back in 2014 with the acquisition of micro-LED startup Luxvue. However, in February, Apple pulled the plug on its smartwatch micro-LED project despite a decade-long investment totaling $3bn, reports market analyst firm Yole Group in 'Micro-LED Display Intellectual Property Landscape 2024'.

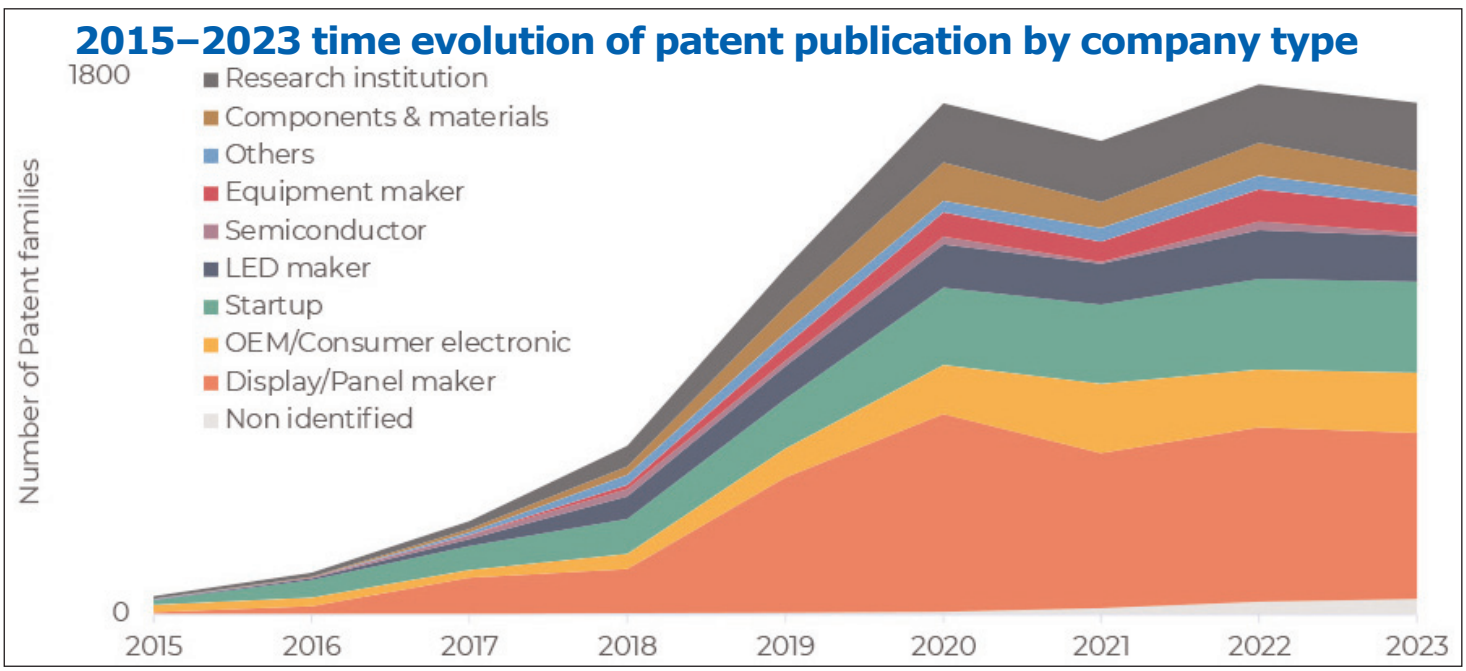
"With approximately $7bn poured into micro-LED development by various entities independently of the Apple ecosystem, the industry has gathered enough momentum to persist in its endeavor to establish micro-LED as a credible, top-tier display technology capable of rivaling OLED [organic light-emitting diode] and LCD [liquid-crystal display] across multiple sectors, including automotive and augmented reality," believes Eric Virey Ph.D., principal analyst, Display, at Yole Group.

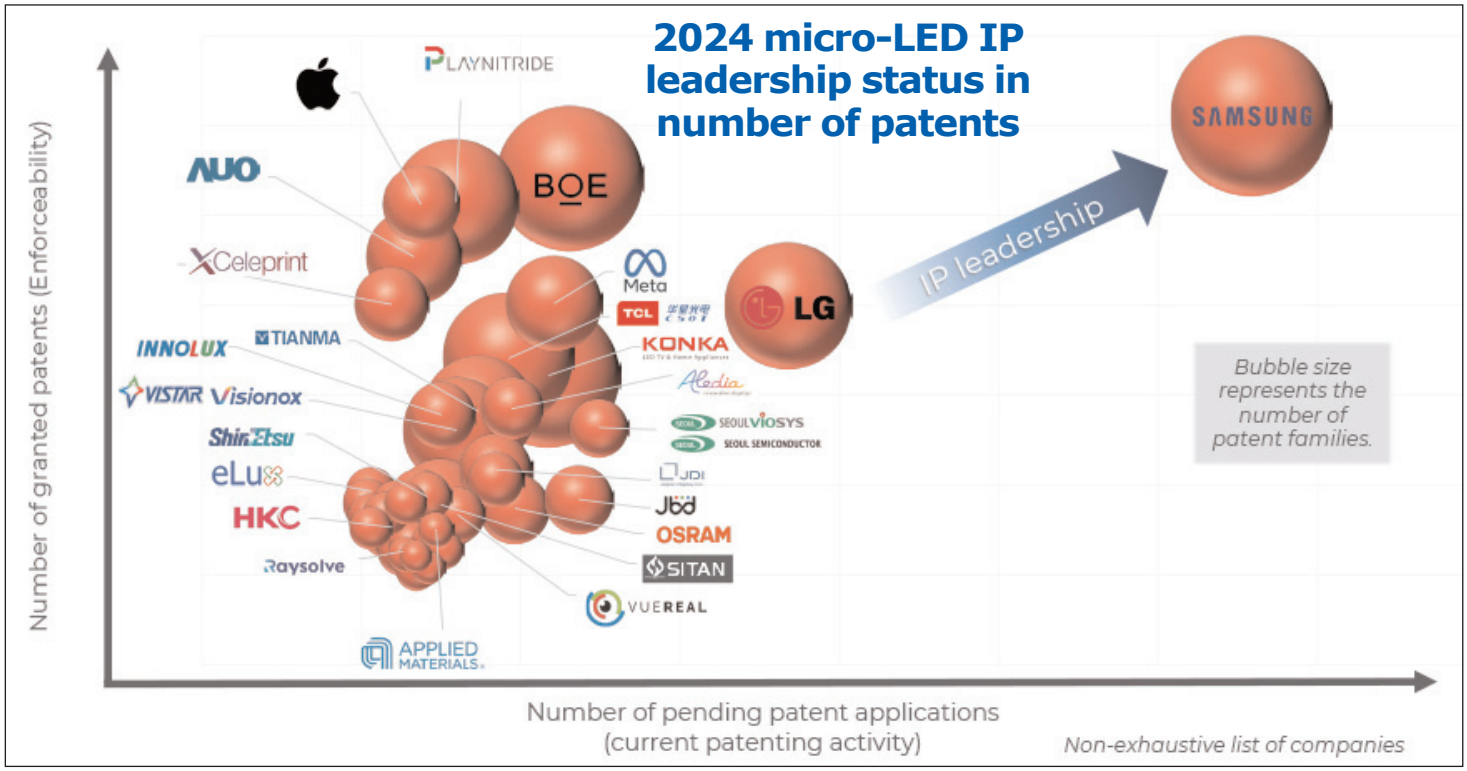
After seven years of rapid expansion, activity surrounding micro-LED intellectual property has stabilized since 2021 and reached a plateau. While some organizations are scaling back, others are ramping up their efforts. Chinese firms currently lead in this domain, with South Korea holding a strong second position.

Samsung has emerged as a formidable leader in the micro-LED industry's IP landscape, with prominent Chinese display manufacturers BOE and TCL CSOT also exerting significant influence. Additionally, Tianma and Vistar (the micro-LED-focused spin-off from OLED producer Visionox) are steadily gaining traction in terms of both quality and quantity. Meanwhile, startup PlayNitride has maintained a high level of activity throughout 2021–2023 and continues to compete alongside established display manufacturers.

"Primarily, Chinese companies tend to focus their patent coverage within the country. However, when considering the breadth of geographic coverage, startups such as Aledia and X-Display are notable," says Virey. "Since the 2021 edition of this report, over 370 newcomers have entered the scene, with a majority hailing from China and Korea. These newcomers are highly active and accounted for 20% of the new patent families published during the 2021–2023 period."

Following the trend set by equipment makers since 2018, many material companies have entered the race in the last three years. Nearly 20 patent families have changed hands during this period, with Samsung, LG





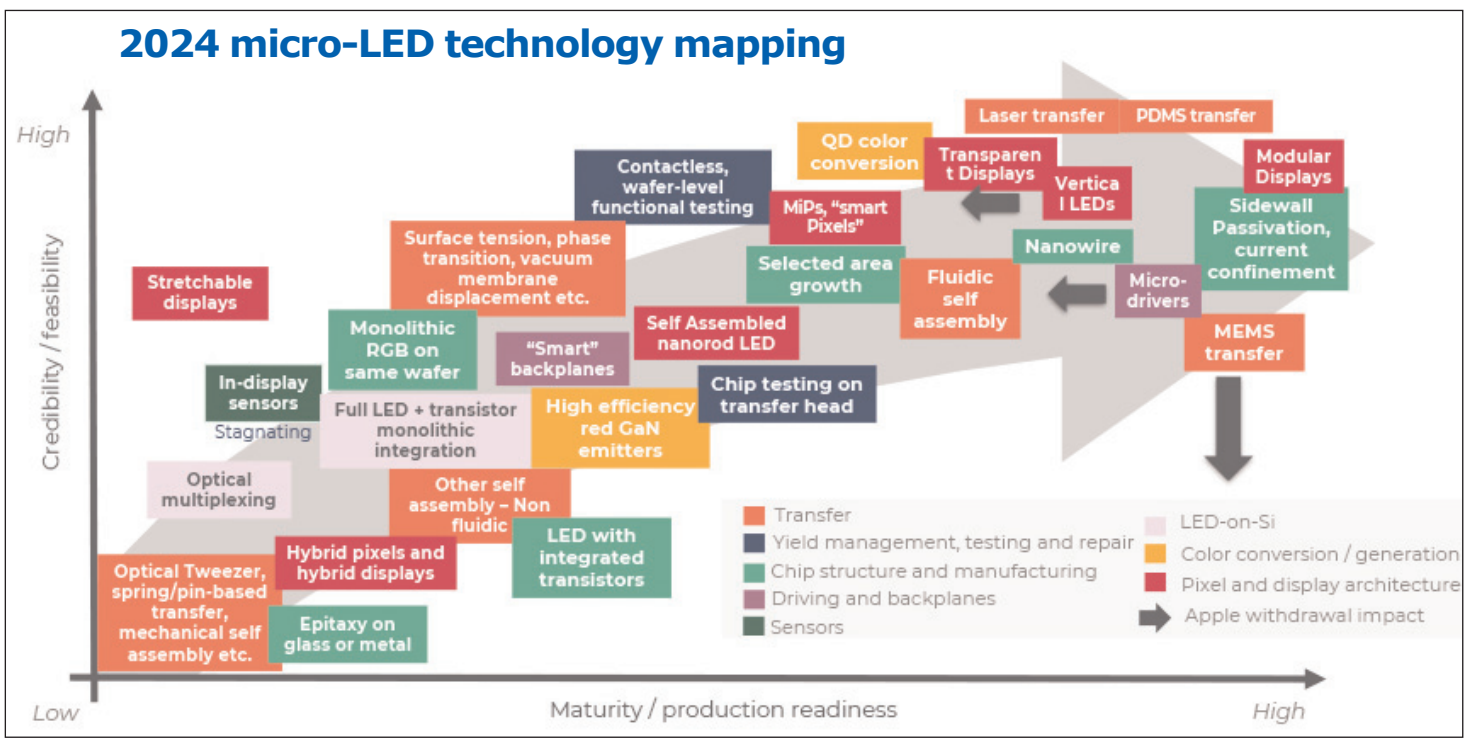
and others acquiring patents from companies such as Intel and Ultra Display.

While some patents may lack originality, overall technology is advancing, with recent patents showing increased maturity and addressing final-stage challenges. Multi-step transfer processes, predominantly using laser and stamp methods, are becoming widespread, alongside a resurgence of fluidic self-assembly. However, the departure of Apple may signal a decline in MEMS-based transfer due to cost concerns.

There's a surge in creativity, particularly from Chinese players proposing innovative transfer methods. Improvements in chip and backplane architectures are crucial for enhancing transfer and interconnectivity, with designs focusing on breakage resilience.

The MiP (micro-LED in package) concept and related display architectures are gaining momentum, along with growing interest in micro-drivers. Patents are also exploring transparent and flexible displays, tiling, and modular displays. However, efforts towards in-display sensors appear to be stalling temporarily. ■

www.yolegroup.com/product/report/microled-ip-for-displays-2024



III–nitride ultraviolet photonic circuits on silicon

Researchers demonstrate system comprising monitor, LED, modulator, and photodetector.

Nanjing University of Posts and Telecommunications in China has reported on progress toward ultraviolet (UV) photonic integrated circuits (PICs) using III–nitride epitaxial layers on silicon substrates [Jiabin Yan et al, IEEE Transactions on Electron Devices, vol.71, issue 5 (May 2024), p3056].

The researchers integrated four diodes acting as monitor, light-emitting diode (LED), modulator, and photodetector (PD) coupled together on one level via a 50μm-wide gallium nitride waveguide (WG). The epitaxial layers of indium gallium nitride (InGaN) and aluminium gallium nitride (AlGaN) were applied by metal-organic chemical vapor deposition in a sequence typical for laser diode fabrication with waveguide and cladding layers (Figure 1).

The researchers see prospects for UV microscopy, biosensing, and on-chip data communication. The team comments: "Our integration scheme based on the epitaxial III–V on silicon is feasible for realizing a compact, low-cost, and low-complexity PIC system."

The III–nitride layers are necessary to access and transmit UV light since silicon absorbs such radiation almost completely as UV photon energies are much higher than silicon's bandgap energy. However, for

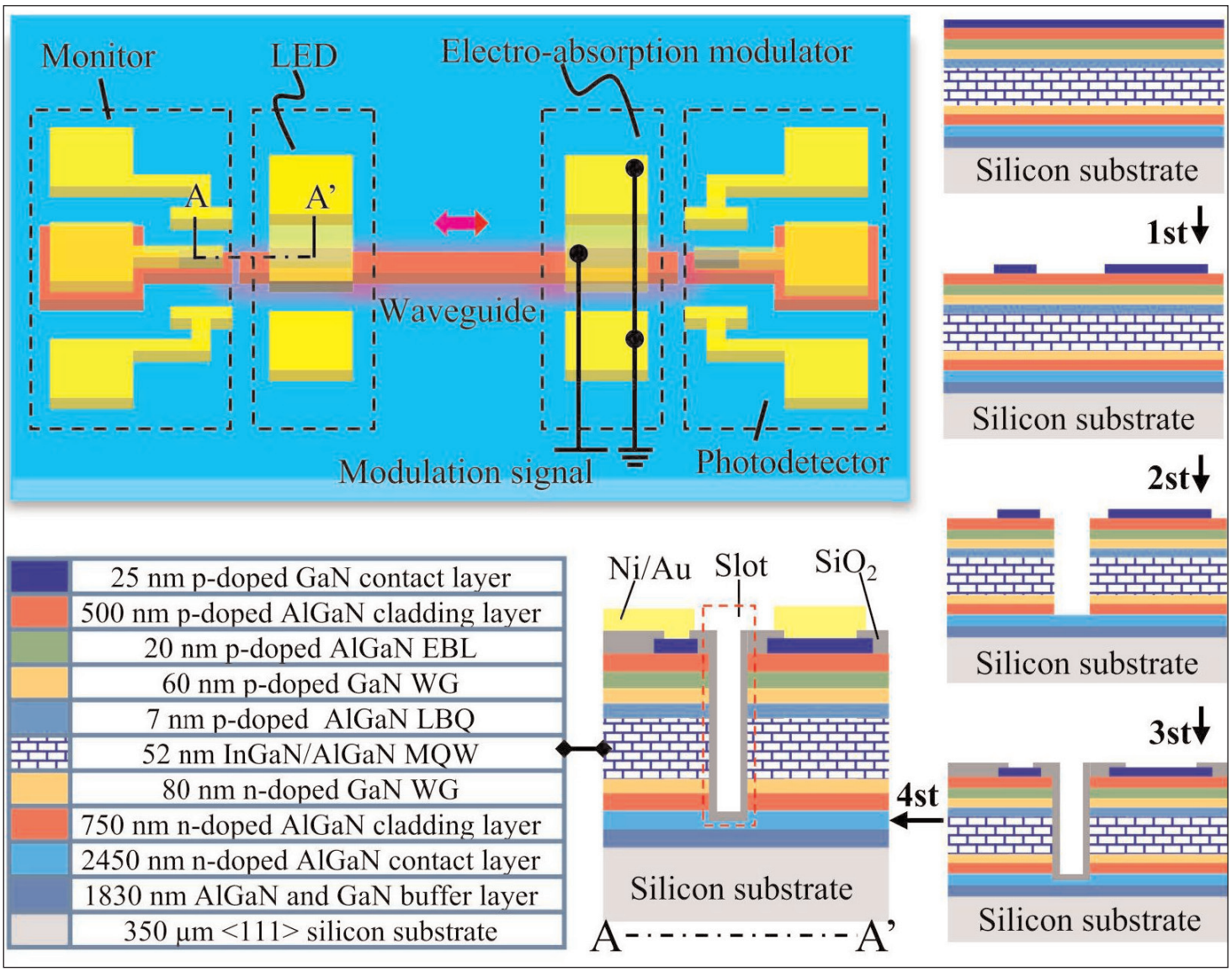


Figure 1. UV optoelectronic integrated chip scheme and associated fabrication steps.

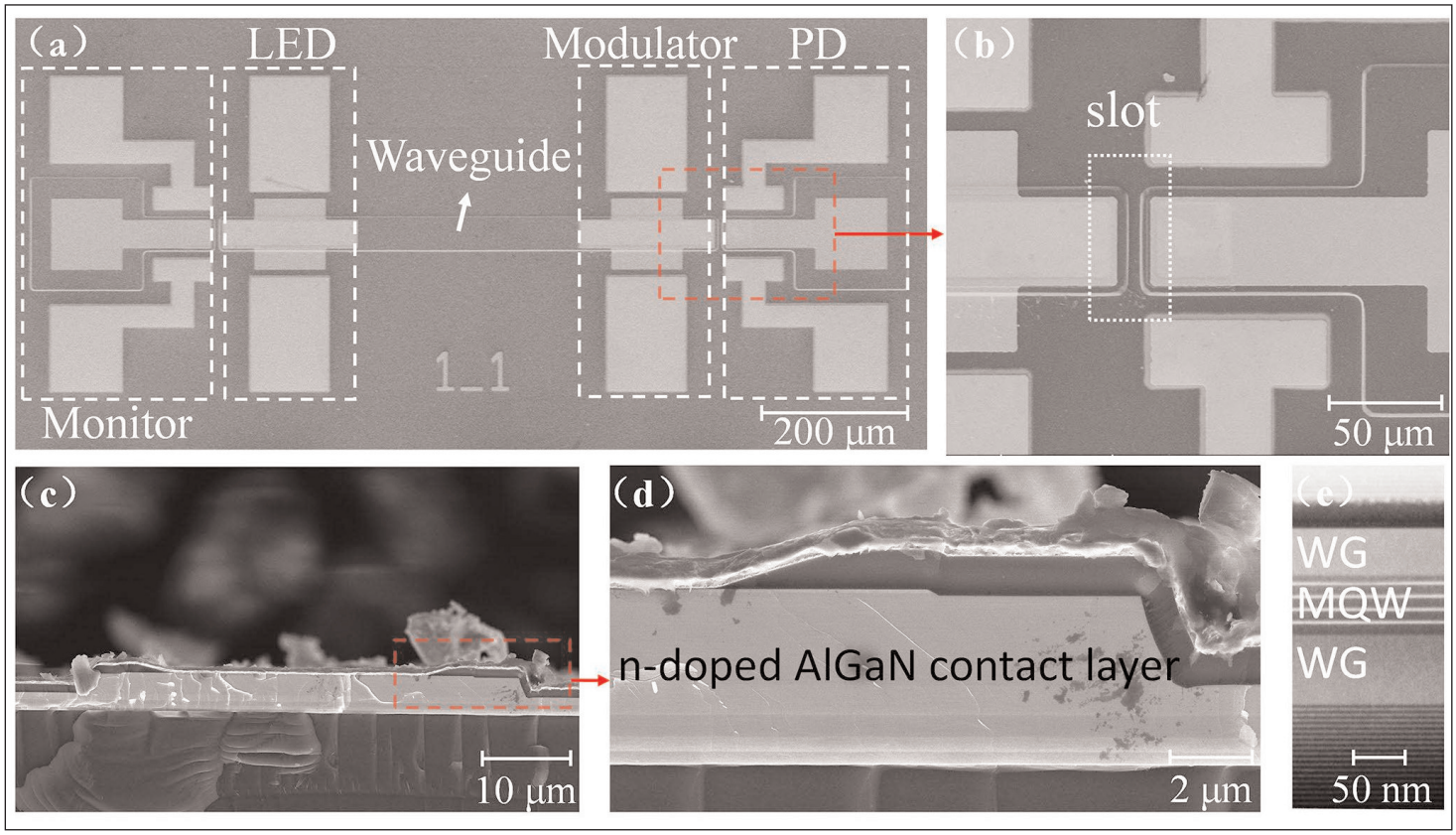


Figure 2. Scanning electron microscope (SEM) images: (a) Complete PIC. (b) Slot region between modulator and photodetector. (c) Waveguide modulator. (d) Waveguide edge. (e) Waveguide layers.

thermal and cost considerations a silicon substrate provides higher thermal conductivity than more expensive alternatives like sapphire.

The researchers comment: "Although the data transmission rate via the modulator is currently severely limited, the PIC chip has potential prospects for audio transmission and sensor applications."

The active layer of the structure consisted of four InGaN multiple quantum wells (MQWs) separated by AlGaN barriers. The last quantum barrier layer (LBQ) of the MQW sequence was p-doped. The epitaxial structure included an electron-blocking layer (EBL) to prevent losses from electrons overshooting the MQW and recombining non-radiatively in the hole injection layers.

The monitor and photodetector were separated from the main waveguide by slots etched down to the n-type cladding layer.

The etching for the PIC (Figure 2) used inductively coupled plasma (ICP) consisting of hydrogen chloride and boron trichloride in two steps: first to pattern the p-type contact layers, and then down to the n-cladding/contact layers to form the mesa and slot structures. Electrical isolation was provided by 100nm silicon dioxide (SiO_2) applied by plasma-enhanced chemical vapor deposition. The electrode consisted of nickel/gold (Ni/Au).

Table. Key parameters of the on-chip components.

Quantity	Component	Value	Unit
Output power	LED	0.53@20 mA	mW
3 dB bandwidth		64	MHz
Peak wavelength		385	nm
Modulation depth	Modulator	8.4	%
Modulation efficiency		0.05	dB/V
3 dB bandwidth		600	Hz
Responsivity	PD	112@-6 V bias	mA/W
Detectivity		9.3×10^{10}	$cmHz^{1/2}W^{-1}$
3 dB bandwidth		33	MHz
Optical loss	Waveguide	11	dB/mm

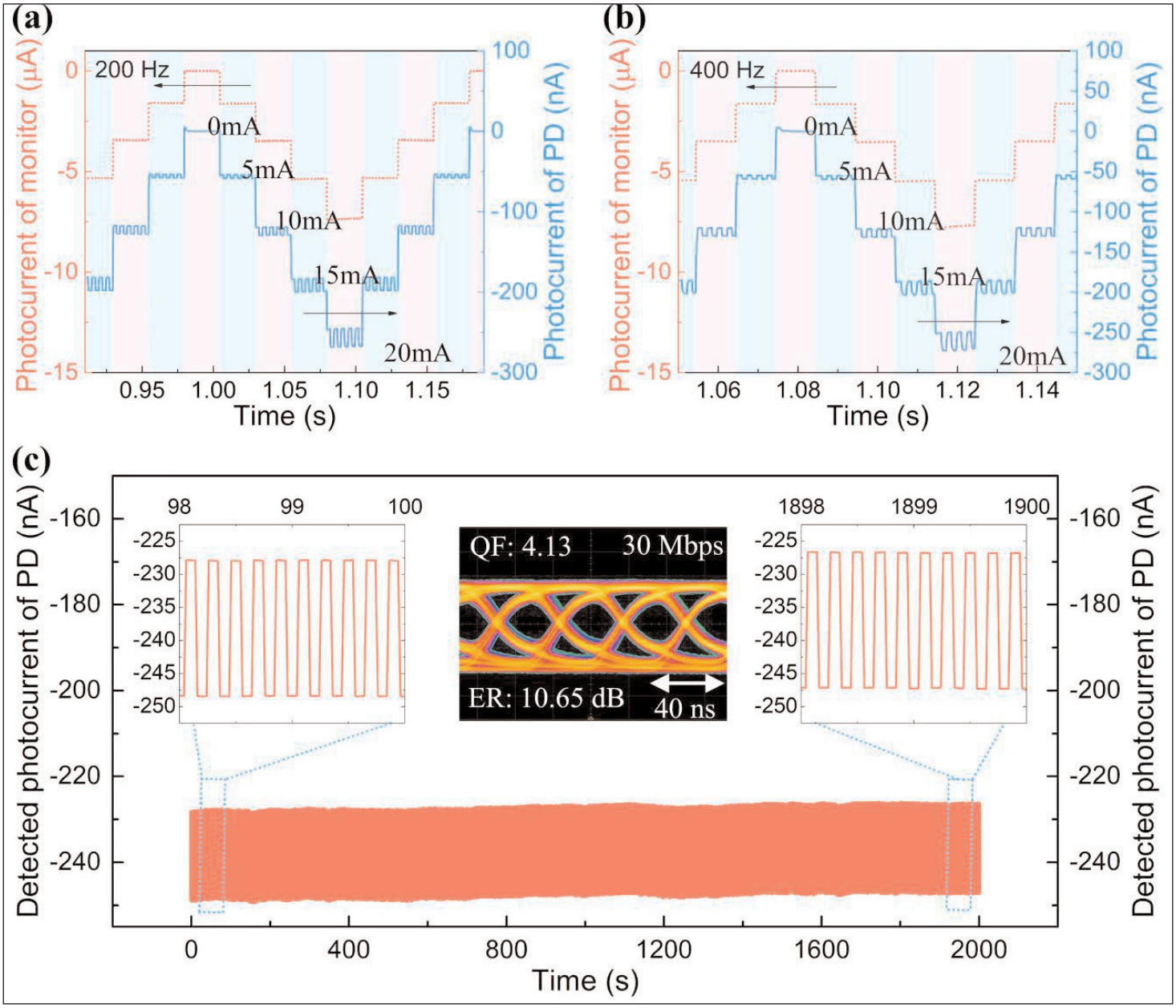


Figure 3. (a) Received photocurrent waveforms of monitor and photodetector due to multi-step current applied on LED and square signal of 200Hz frequency applied on modulator. (b) Received waveforms from multi-step current on LED and 400Hz on modulator. (c) Photodetector detection response to 5Hz modulation on modulator over 10,000 cycles. Inset: eye diagram using 30 megabits/second direct modulation on LED.

The waveguide optical loss was relatively high at 11dB/mm (Table d). The team put this down to absorption in the MQW layer and rough etched sidewalls. The researchers hope that smoother sidewalls could be achieved in the future. The narrower 3dB bandwidth of the modulation could be limited by a slow response of the electric field distribution under reverse bias voltage, the team reports.

The researchers performed a series of modulation tests on the PIC (Figure 3). The researchers suggest that direct and indirect modulation could be used simultaneously. "For example, a video signal can be transmitted using direct modulation via the LED, while a voice signal is transmitted using indirect modulation via the modulator," the team proposes.

While presently direct modulation allows higher data transmission rates, it suffers from nonlinear distortion, transient heating effects, and RC delays.

The team comments on the advantages of using a modulator: "First, the design of light source and modulator can be separated and more flexibility can be obtained. Second, multiple channels via individual modulators can share a single light source, thus reducing the size of the devices and the total power budget of the system. Moreover, by using direct and indirect modulations for a single light path, two types of data can be transmitted simultaneously or one of the modulations can encrypt the data transmission of another modulation signal." ■

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High-power 1.55µm CW laser diodes on silicon

Ion-cutting of a thin InP buffer layer onto a silicon substrate for III-V epitaxy.

Shanghai Institute of Microsystem and Information Technology, and University of Chinese Academy of Sciences, China, have reported high-power continuous wave (CW) operation of 1.55µm-wavelength laser diodes on silicon (Si) [Jialiang Sun et al, Light: Science & Applications, v13, p71, 2024]. The researchers claim records for both low threshold current (0.65kA/cm^2) and high CW operation temperature (120°C).

The team sees potential for laser integration with silicon and silicon-on-insulator (SOI) photonic technologies, along with mainstream Si electronics. In particular, the ion-cutting technique used created a thin 2µm indium phosphide (InP) buffer on silicon. The InP-on-Si (InPOS) substrates were then used for III–V epitaxy of 1.55µm lasers, avoiding traditional problems of lattice and domain mismatches that usually restrict performance to pulsed operation.

Even thinner buffers of InP (or other materials) could be realized for efficient light coupling into practical Si/SOI photonic deployment with complete opto-electronic data traffic systems connecting high-performance lasers with waveguides, modulators and photodetectors, CMOS electronics... The 1.55µm C-band is used for low-loss transmission in mid/long-haul communication, sensing, and light detection and ranging (LiDAR).

The InPOS substrate process (Figure 1) began with a 2-inch InP source, which was exposed to a co-implant of helium and hydrogen (He/H) ions, creating a damaged layer of the crystal a short distance below the surface. This layer was bonded to 4-inch high-resistance silicon.

The InP and Si surfaces were activated before bonding by a fast atom beam (FAB) of argon (Ar) for 1 minute. The wafers were bonded in vacuum with a bonding pressure of 5MPa. The applied InP was separated at the ion-damaged layer by 200°C annealing for 2 hours in nitrogen.

The remnants of the ion-damage at the InPOS surface were then removed using chemical mechanical polishing, leaving a smooth thin monocrystalline layer of InP on the silicon.

The InPOS was used as substrate for metal-organic chemical vapor deposition (MOCVD) growth of aluminium gallium indium arsenide (AlGaInAs) heterostructures for 1.55µm-wavelength laser devices (Figure 2). The active multiple quantum well (QW) region consisted of 5 $Al_{0.24}Ga_{0.05}In_{0.71}As$ wells separated by $Al_{0.44}Ga_{0.07}In_{0.49}As$ barriers.

The growth process was optimized for MOCVD on bulk InP, not InPOS. Hence, standard material characterizations, such as x-ray diffraction and surface roughness, showed reduced material quality compared with structures grown on bulk InP.

The surface roughness of the heterostructure on InPOS was 0.4nm, compared with 0.2nm on bulk InP, according to atomic force microscopy (AFM). The team comments: "The InPOS surface after epitaxial growth with an RMS roughness value of 0.4nm is smooth enough to facilitate the device fabrication without any pinholes, which is essential for high-performance lasing."

X-ray rocking curves from the InP (004) reflection showed a significant 2.88x increase in the peak width for the InPOS over bulk InP due to residual strain from the ion-cutting process. A small x-ray diffraction peak width indicates higher crystal quality. The MOCVD process only slightly altered the peak widths.

Photoluminescence measurements on the AlGaInAs structures (without cladding/contact layers) showed a 50% reduction in peak intensity for material on InPOS,

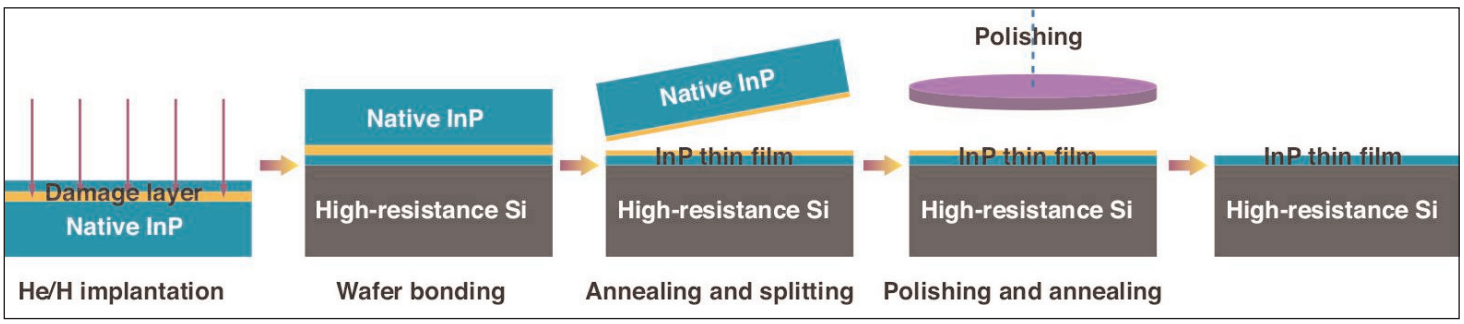

Figure 1. Fabrication of InPOS by ion-cutting.

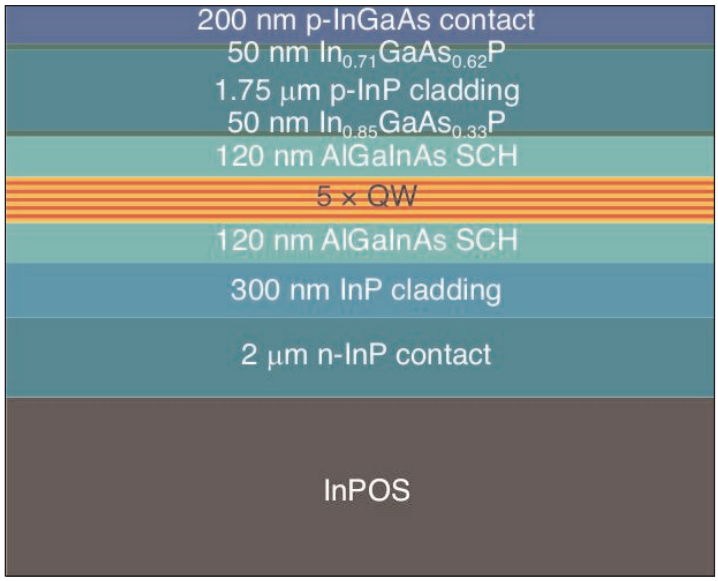

Figure 2. Laser epitaxial material structure.

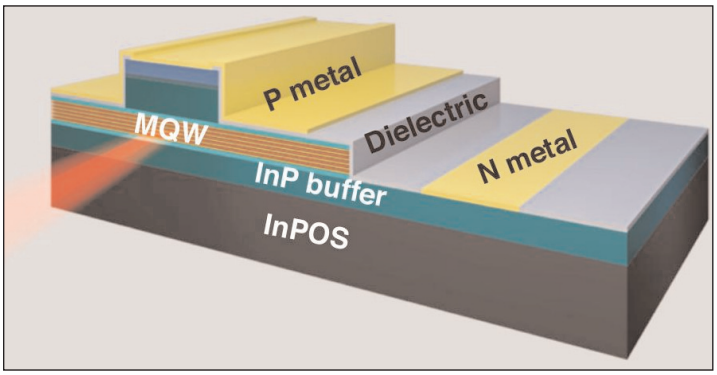

Figure 3. Ridge-waveguide laser scheme.

compared with bulk InP. The full-width at half maximum (FWHM) values were 67.5meV and 70.0meV for materials on InPOS and bulk InP, respectively.

Ridge-waveguide Fabry–Pérot (FP) laser structures were fabricated from the materials (Figure 3).

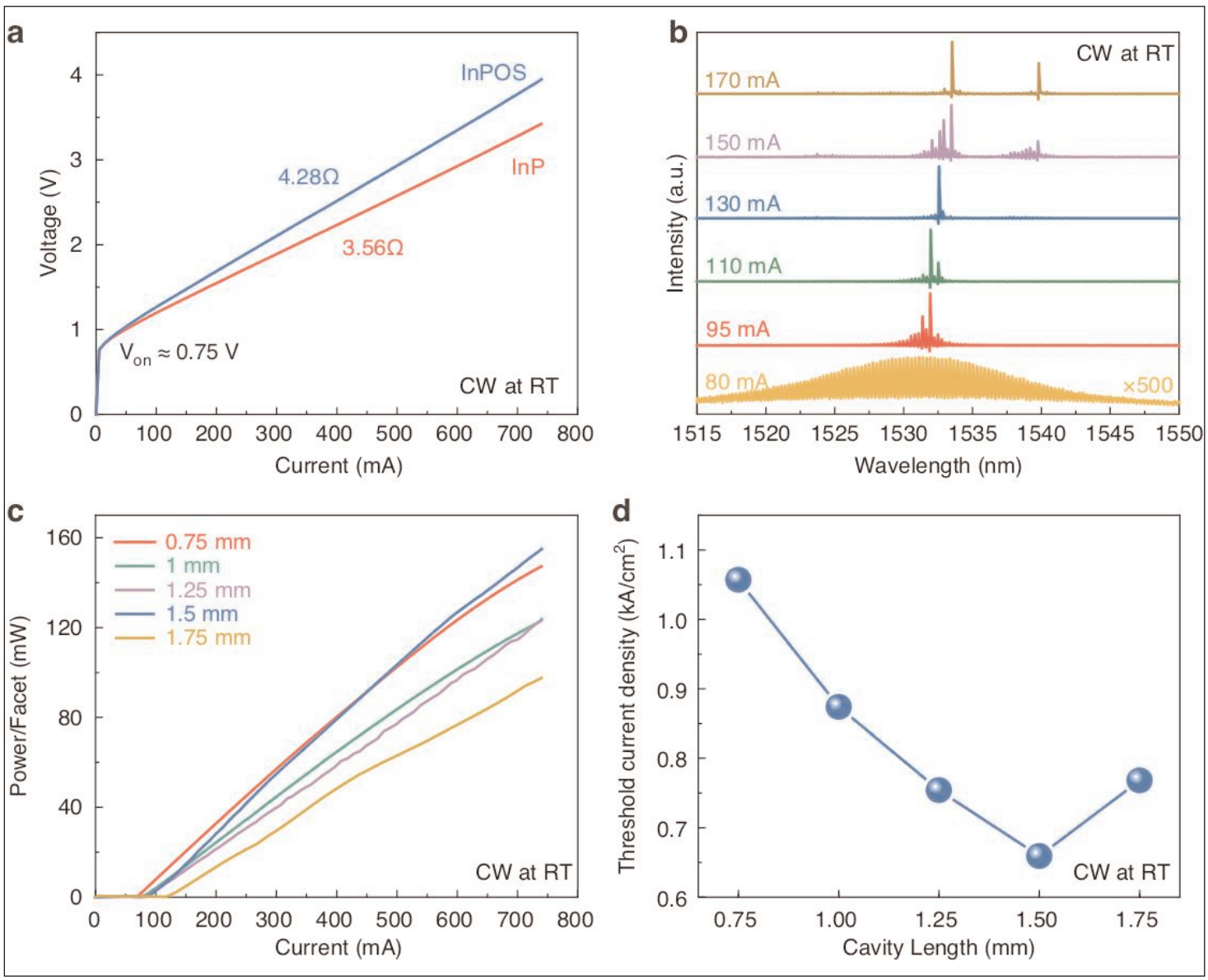

Figure 4. a Current–voltage behavior of as-cleaved lasers on bulk InP and InPOS with 8μmx1500μm ridge cavities. b Lasing spectra from InPOS laser. c Light output power versus current for laser on InPOS for various cavity lengths under CW operation. d Threshold current density (J_{th}) versus cavity length for lasers on InPOS.

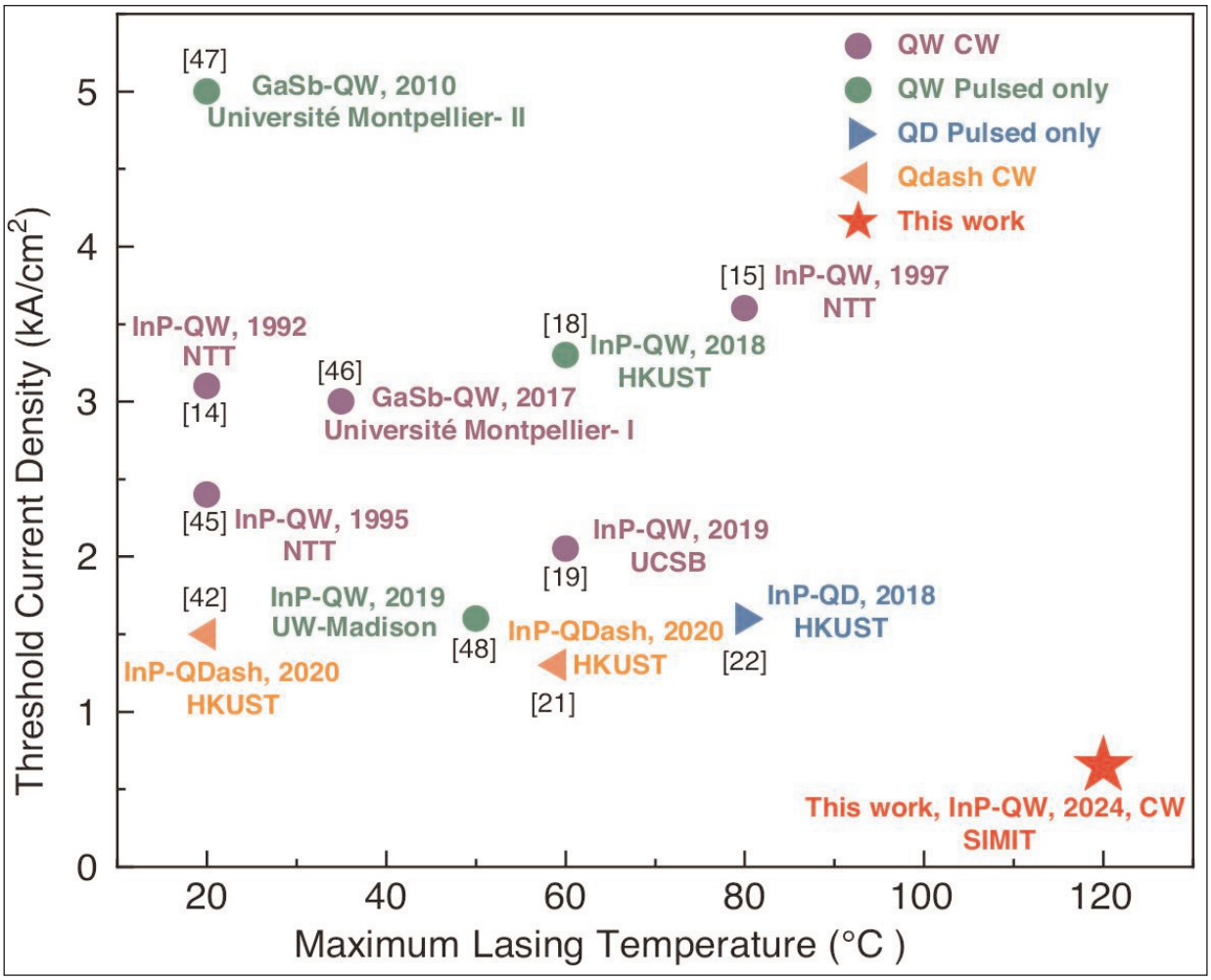

Figure 5. Historical evolution of 1.55μm-band lasers monolithically integrated on silicon by direct epitaxial growth in terms of threshold current density reduction and increase in maximum lasing temperature.

The lasers were tested at 20°C, 'room temperature' (RT), under CW operation (Figure 4). The turn-on voltage (V_{on}) was 0.75V for both the device types on bulk InP and InPOS substrates. Electrically, the InPOS devices had somewhat higher series resistance (4.28Ω). The higher resistance for the InPOS laser was attributed to the thinner InP layer (~2μm) through which the current had to travel from the N-electrode, reducing the cross-sectional area, compared with ~100μm for bulk InP.

The InPOS laser showed a decrease in J_{th} with increased cavity length up to 1500μm. An increase of J_{th} above that could be related to an improperly split facet in the 1750μm-long laser tested.

The researchers report (Figure 5): "The minimum J_{th} of 0.65kA/cm^2 was achieved with a cavity length of 1.5mm at RT under CW mode, which is the lowest J_{th} ever recorded for a silicon-based FP laser emitting at 1.55μm."

The threshold is only slightly higher than the lowest value of 0.6kA/cm^2 demonstrated by silicon-based 1.55μm lasers integrated by other methods.

The single-facet output power for the InPOS laser reached 155mW at 740mA injection without saturation. The laser on bulk InP only reached a slightly higher value of 164mW. The team point out in particular that their InPOS laser emits much higher power than a 22mW CW result reported by the Hong Kong University of Science and Technology (HKUST) in 2020 for a 1.55μm-wavelength electrically pumped lasers grown directly by MOCVD on V-grooved silicon.

Raising operating temperatures typically degrades the performance of semiconductor lasers. The InPOS laser was found to continue operating up to 120°C, while that on bulk InP only reached 115°C.

The team comments: "It is impressive that the laser on the InPOS can operate at a higher temperature of 120°C. To the best of our knowledge, 120°C is the highest operating temperature achieved to date for the silicon-based FP laser emitting at 1.55μm under CW mode."

Laser operation could be maintained for both InPOS and bulk InP devices at even higher temperature, up to the 130°C limit of the thermoelectric cooler (TEC), by adopting 2μs pulsed current injection to avoid self-heating (0.5% duty cycle).

The effect of self-heating was less prominent on InPOS lasers, compared with bulk InP, which the researchers attribute to the higher thermal conductivity of silicon (145W/m-K) compared with InP (68W/m-K). The threshold current reduction from adopting pulsed operation at 115°C was 20.7% for the InPOS laser, but for bulk InP it was 35.7%. ■

https://doi.org/10.1038/s41377-024-01389-2

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Reconstituted silicon wafers with III–V and silicon dies

A fab-compatible process enables the co-integration of III-V materials and silicon with no detectable impact on performance.

Imec in Belgium and Zhejiang University in China have reported on a fab-compatible indium gallium arsenide on indium phosphide (InGaAs/InP) to silicon (Si) wafer reconstitution (WARE) process [Gauri Karve et al, Jpn. J. Appl. Phys., v63, p04SP42, 2024]. The reported work was carried out on 200mm silicon wafers at Imec's facility. The team comments: "The method is compatible with the standard CMOS back-end-of-line and extendable to 300mm."

The researchers see a wide range of potential applications in photonics, RF, imaging, and sensing systems. The team also reports that it has used the technique to realize a micro-fluidic lab-on-chip solution.

The team points out that while compound semiconductors offer superior performance for light generation and RF handling, "high-performance silicon still remains the best candidate for required drivers in silicon photonics, read-out electronics for imagers, and beam-forming chips in RF."

Co-integration of III–V and silicon should also enable devices to be placed closer together, reducing the effects of parasitic structures, reducing operating power and lowering latency to boost data-handling rates.

First, a 'pocket wafer' was constructed from silicon, using deep etch to create the pockets, followed by backgrinding of the wafer to leave 350–400μm thickness. This thickness was considered adequate for robustness in robot-handling scenarios.

The 'pockets' consisted of rectangular through holes in which various III–V/silicon epitaxial dies were placed before transfer and bonding to a final 200/300mm silicon wafer for subsequent processing. The dies could be chosen to be good quality, improving process yields. The pocket wafer was attached with temporary adhesive to a carrier wafer. The use of temporary glue helps to improve dielectric bonding yield and across-wafer uniformity of the reconstituted wafer, the team reports.

The researchers comment: "There are many possible implementations of this basic idea such as different materials for bonding III–V and silicon layers, sequence of processing, etc — each one with their pros and cons. Application-dependent technical specifications and cost constraints primarily drive the integration choices."

The III–V dies contained a PIN diode epitaxial structure of indium gallium arsenide lattice-matched to the indium phosphide substrate. A thin oxide cap was used to protect the device structure during transfer.

The InGaAs/InP, along with plain silicon and InP dies were singulated using 'stealth dicing', apparently referring to Hamamatsu's laser-based process, for which Hamamatsu Photonics owns the 'Stealth Dicing' trademark. Stealth dicing results in smoother sidewalls over mechanical saw processing.

The dies were put in the pockets using a pick-and-place tool — the 1cmx1cm InGaAs/InP dies were inserted

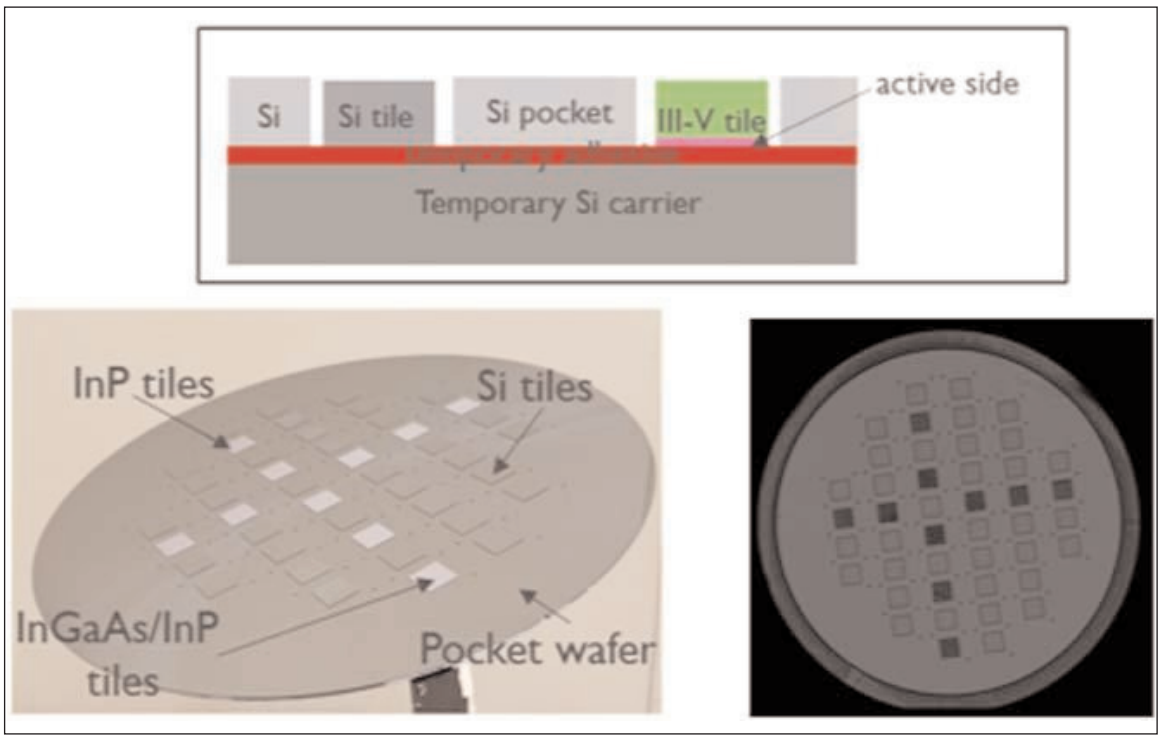

Figure 1. Carrier wafer populated with III-V and silicon tiles: (a) optical and (b) scanning acoustic microscope (SAM) images.

active side down (Figure 1). The team reports: "Using stealth dicing for III–V and silicon dies, and a die corner to silicon pocket alignment, a placement accuracy within ±10µm was achieved."

The researchers add: "The active III–V surface is exposed only at the end of the reconstitution flow, protecting the active side during the reconstitution steps."

The carrier wafer assembly was passivated with an ultra-thin oxide layer, then edge trimmed, and collectively thinned via grinding. The researchers worked with DISCO USA to optimize the grinding process, resulting in less than 3µm variation in thickness across the wafer.

The dies were bonded to the final silicon wafer using plasma-activated dielectric bonding with the back surface of the dies and pocket wafer being coated with 200mm of thermal oxide (Figure 2). Post-bond annealing was carried out in a dedicated bond chamber with the aim of improving yields over external furnace-based annealing. The temporary carrier was then removed and the adhesive cleaned away in a wet process.

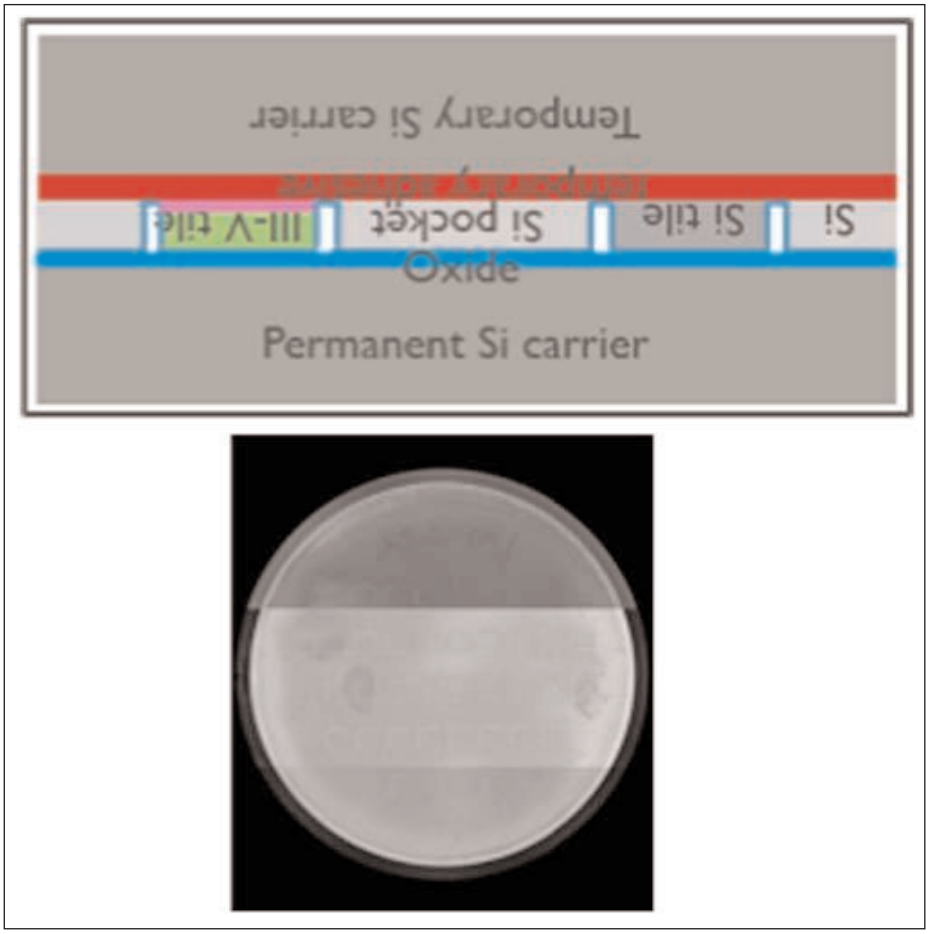

Figure 2. SAM image after dielectric bonding to permanent silicon carrier.

The researchers validated the process by fabricating circular PIN diodes of different radii on InGaAs/InP/Si coupons diced from the 200mm wafer alongside epitaxial InGaAs on InP material. The p- and n-electrodes consisted of non-annealed titanium/palladium/gold.

There was no significant impact of the InGaAs/InP/Si bonding process on diode dark-current performance, relative to the native InGaAs/InP diodes (Figure 3). The effects of sidewall recombination were essentially the same, as shown by the perimeter/area ratio for different radius devices. The ideality factor (n) was about 1.3 for both device species.

Using temperature variation, the researchers also extracted activation energies at various reverse biases. These results were also the same between the WARE and reference diodes.

The researchers comment: "These observations show that the wafer reconstitution process has no impact on the fabricated device performance." ■

https://doi.org/10.35848/1347-4065/ad32e2

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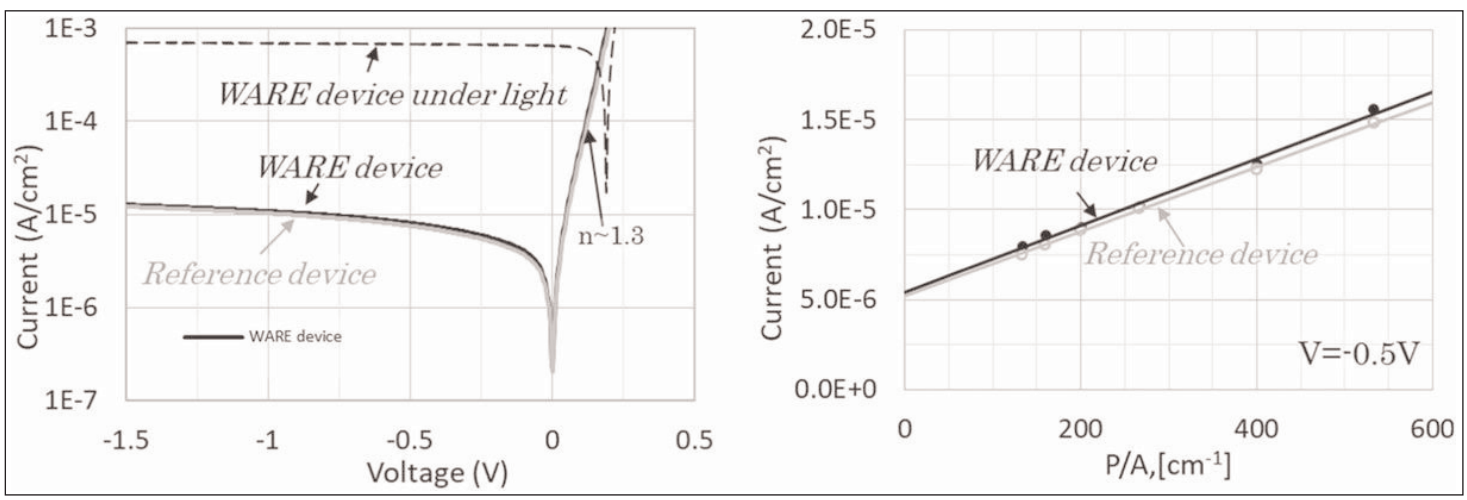

Figure 3. Typical normalized current versus voltage measurements (left) and normalized current versus device perimeter/area ratio (right) for reconstituted (WARE) and as-grown (Reference) devices.

HEMTs with 3C-SiC on 4H-SiC interfaces

Researchers claim fabrication of the first device on a little-studied structure.

Japan's National Institute of Advanced Industrial Science and Technology (NAIST) claims the first fabrication of high-electron-mobility transistors (HEMT) constructed using 3C/4H-polytype crystal heterostructures of silicon carbide (SiC) [Hiroyuki Sazawa et al, Appl. Phys. Lett., v124, p120601, 2024].

A two-dimensional electron gas (2DEG) has previously been found to form on the 3C-SiC side of a heterojunction with 4H-SiC grown with a carbon-face (Figure 1). This is similar to the aluminium gallium nitride (AlGaN) on GaN heterostructure often used as the basis for GaN HEMTs.

The 2DEGs in both cases arise due to the differences in the charge polarization properties of the chemical bonds. For the AlGaN/GaN structure a layer of bound positive charge forms in the AlGaN barrier, attracting a layer of electrons to the GaN side of the interface.

The 3C-SiC/4H-SiC has the bound charge in the 4H-SiC, and the 2DEG on the 3C-SiC side. Also, the 3C-SiC/4H-SiC has a larger conduction band offset of 0.93eV, compared with 0.38eV for Al0.3Ga0.7N/GaN.

The NAIST team sees potential for the 3C/4H-SiC HEMTs for high-power/high-frequency applications in high-power radars, broadband telecommunications, and high-resolution LiDAR. The electron saturation velocity in 3C-SiC can reach 2.5×10^7cm/s, comparable to the performance of GaN. High saturation velocities are important for increasing frequency performance of amplifiers.

Areas where SiC may have an advantage over GaN-based devices include growth quality and thermal conductivity.

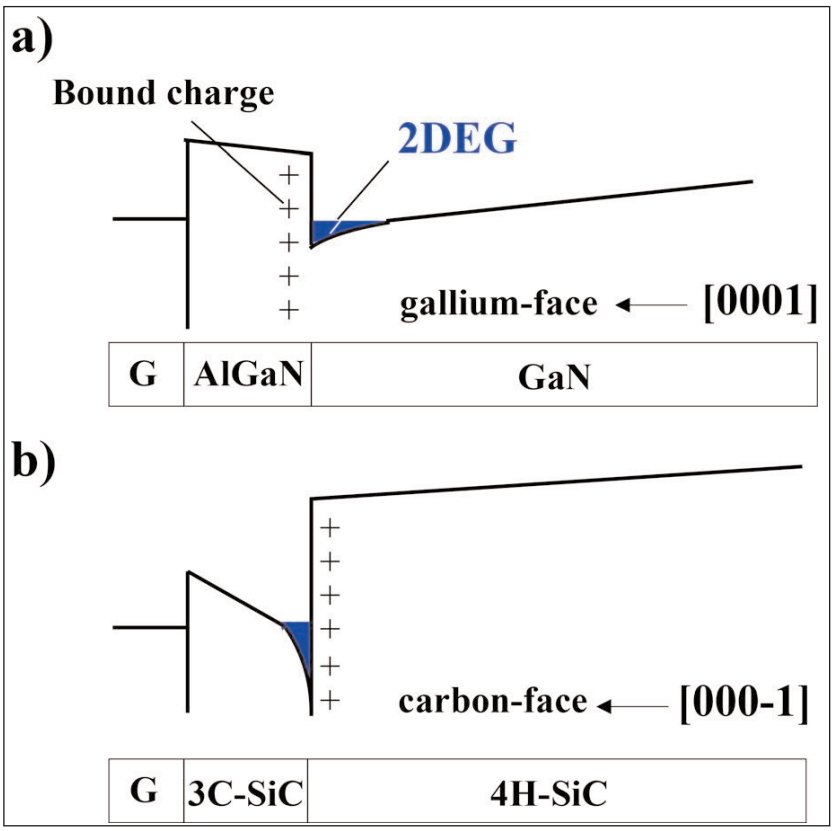

Figure 1. Schematic band diagrams for (a) AlGaN/GaN and (b) C-face 3C-/4H-SiC heterostructures.

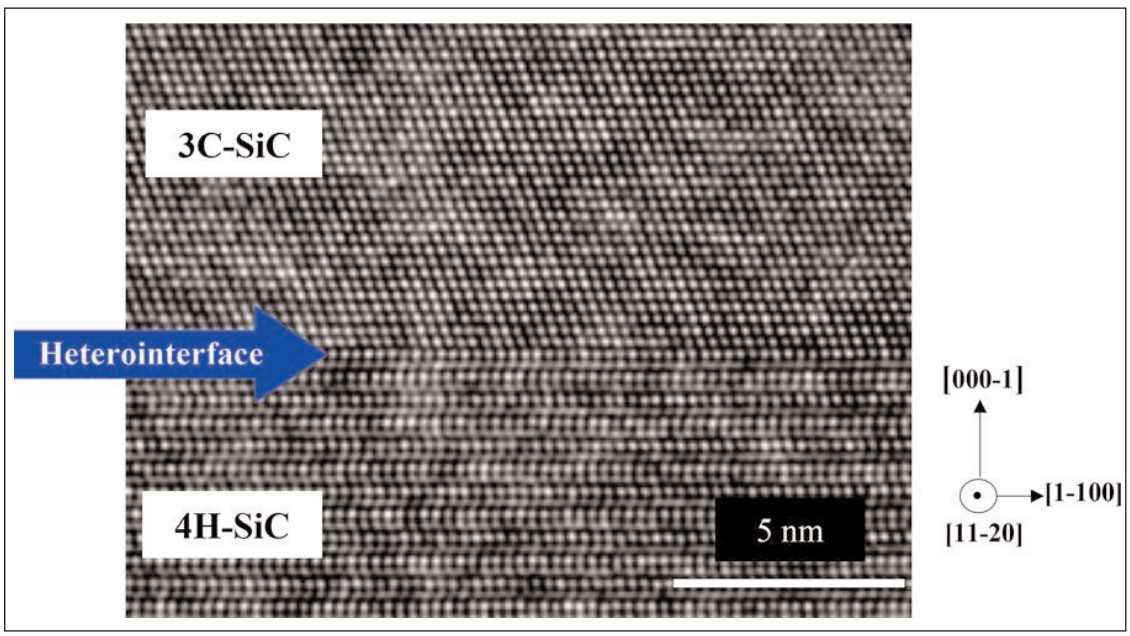

Figure 2. High-resolution transmission electron microscope image of C-face 3C/4H-SiC heterointerface.

The 3C/4H-crystal structures have much smaller lattice and thermal expansion mismatches than AlGaN/GaN, creating potential for higher-quality interfaces. The higher thermal conductivity of SiC is of advantage for management of high power densities in electronic systems.

Further, SiC is more compatible with silicon production processes such as gate oxidation and p-type doping through ion implantation.

The researchers used thermal chemical vapor deposition to create a 24nm 3C-SiC epitaxial layer on 12mmx12mm 4H-SiC substrates (Figure 2). The resistivity of the substrate was >10MΩ-cm.

Hall measurements found the mobility and sheet carrier density to be 586cm^2/V-s and 1.48x10^{13}/cm^2, respectively. The team reports that it has achieved mobility values up to 780cm^2/V-s, about half the value in GaN, in previous work on 3C/4H-SiC structures.

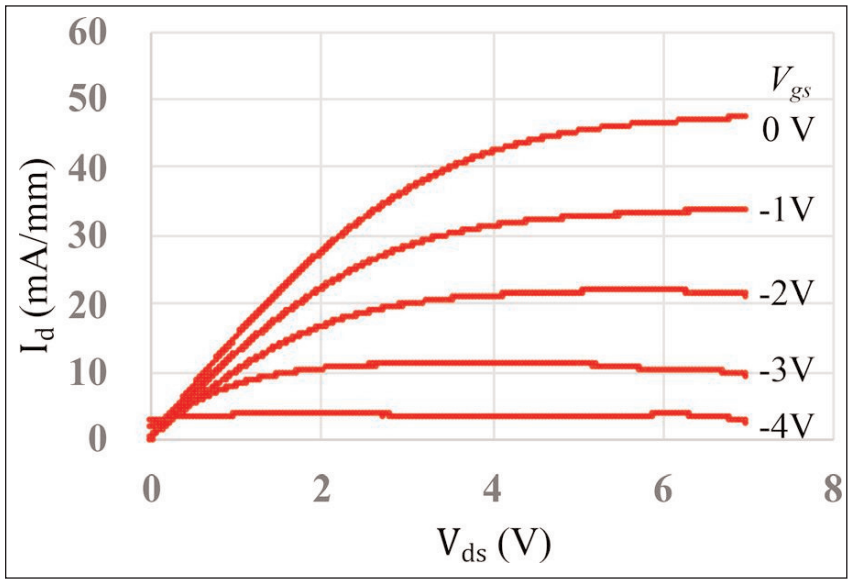

Figure 3. Drain current–bias (I_d-V_{ds}) characteristics of fabricated transistor at various gate potentials (V_{gs}).

Fabricated HEMTs featured a 200nm-high mesa, annealed nickel source/drain electrodes, and gold gate. The gate length was 10μm and the width 115μm. The gate was separated from the source and drain by equal spaces of 15μm.

The device was normally-on with a maximum drain current of 47.5mA/mm at 7V drain bias at zero gate potential (Figure 3). The extrapolated threshold voltage was –3.8V, although there was gate current leakage throughout the –4–0V gate potential test range. In the –1–0V gate potential range, the transconductance was 13.5mS/mm.

The researchers say that further work is needed on the blocking performance of the Schottky gate and on/off current ratio. In particular, "the measured current density for the SiC HEMT was one order of magnitude smaller than those for GaN HEMTs," the team reports.

The researchers see three main routes to improving performance to the current-density level achieved in GaN HEMTs:

1. Increasing the 2DEG by improving the 3C-SiC epitaxial layer quality;
2. Reducing the resistance of the ohmic contacts;
3. Decreasing the device dimensions. ■

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www.vacuumbarrier.com

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WEP (Ingenieurbüro Wolff für Elektronik- und Programmentwicklungen)
Bregstrasse 90,
D-78120 Furtwangen im Schwarzwald,
Germany
Tel: +49 7723 9197 0
Fax: +49 7723 9197 22
www.wepcontrol.com

12 Inspection equipment

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

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

13 Characterization equipment

J.A. Woollam Co. Inc.
645 M Street Suite 102,
Lincoln, NE 68508, USA
Tel: +1 402 477 7501
Fax: +1 402 477 8214
www.jawoollam.com

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

14 Chip test equipment

Riff Company Inc
1484 Highland Avenue, Cheshire,
CT 06410, USA
Tel: +1 203-272-4899
Fax: +1 203-250-7389
www.riff-co.com

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

15 Assembly/packaging materials

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

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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
Tel: +1 781 933 3570
Fax: +1 781 933 9428
www.vacuumbarrier.com

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20 Facility consumables

PLANSEE High Performance Materials
6600 Reutte,
Austria
Tel: +43 5672 600 2422
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
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USA
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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

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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

7–10 June 2024
LOPS 2024:
4th Edition of Annual Conference on Lasers, Optics, Photonics, Sensors, Bio Photonics, Ultrafast Nonlinear Optics & Structured Light
DoubleTree Resort by Hilton Hollywood Beach, Fort Lauderdale, FL, USA
E-mail: lopsannual@gmail.com
https://exceleve.com/photonoptics

9–14 June 2024
IEEE PVSC 2024:
52nd IEEE Photovoltaic Specialists Conference
Seattle, WA, USA
E-mail: Registration@ieee-pvsc.org
www.ieee-pvsc.org/PVSC52

11–13 June 2024
Power Conversion and Intelligent Motion (PCIM) Europe 2024
Halls 6, 7 and 9, Nuremberg Exhibition Center, Nuremberg, Germany
E-mail: pcim_visitors@mesago.com
https://pcim.mesago.com/nuernberg/en.html

Microwave Week

16–18 June 2024
RFIC 2024:
IEEE Radio Frequency Integrated Circuits Symposium
Washington DC, USA
E-mail: support@mtt.org
www.rfic-ieee.org

16–21 June 2024
IMS 2024:
2024 IEEE/MTT-S International Microwave Symposium
Washington DC, USA
E-mail: exhibits@horizonhouse.com
www.ims-ieee.org/about-ims/past-and-future-ims

16–20 June 2024
2024 IEEE Symposium on VLSI Technology and Circuits
Hilton Hawaiian Village Waikiki Beach Resort, Honolulu, HI, USA
E-mail: vlsi@vlsisymposium.org
www.vlsisymposium.org

9–11 July 2024
SEMICON West 2024
Moscone Center, San Francisco, CA, USA
E-mail: semiconwest@semi.org
www.semiconwest.org

17–21 July 2024
4th European School on Crystal Growth (ESCG4)
Jachranka near Warsaw, Poland
E-mail: escg4@unipress.waw.pl
https://eccg8.syskonf.pl/escg-4-about

advertisers' index

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

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

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

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

22–26 September 2024
ECOC 2024: European Conference on Optical Communication
Frankfurt am Main, Germany
E-mail: michelle.dampier@nexusmediaevents.com
www.ecocexhibition.com/future-dates

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

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

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

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

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

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

7–11 December 2024
70th annual IEEE International Electron Devices Meeting (IEDM 2024)
Hilton San Francisco Union Square Hotel, 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

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

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

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