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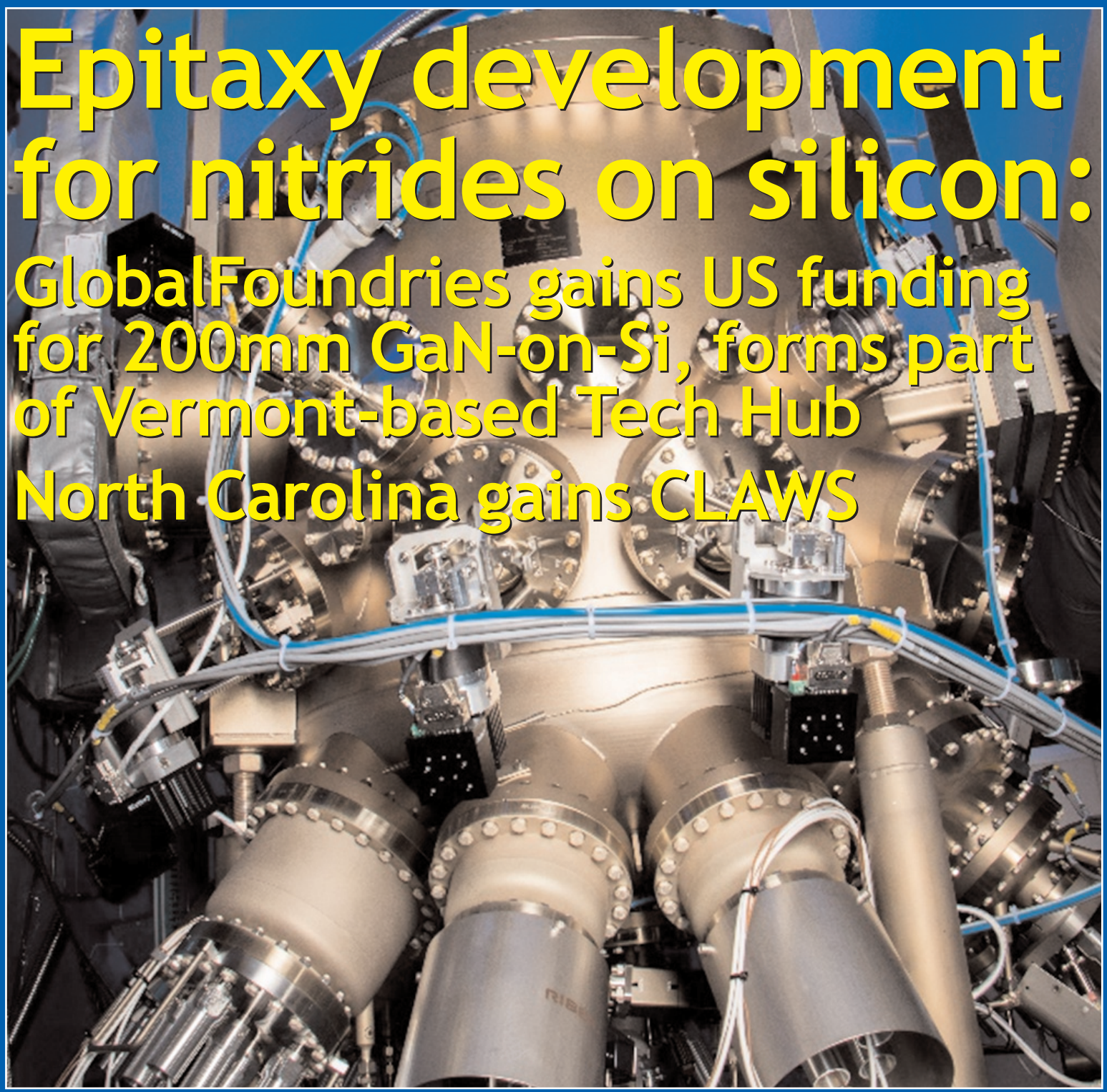

Epitaxy development for nitrides on silicon:

GlobalFoundries gains US funding for 200mm GaN-on-Si, forms part of Vermont-based Tech Hub

North Carolina gains CLAWS

Coherent gains $1bn SiC investment • News from ECOC 2023
Soitec opens SmartSiC plant • First 8” SiC fab for Hong Kong

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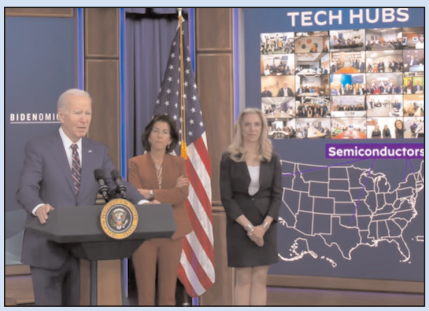
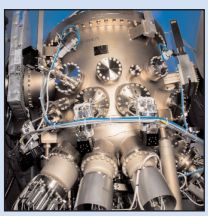
p12 HKSTP has signed an MoU with Shanghai-based J2 to establish Hong Kong's first 8" SiC wafer fab.



p19 A consortium led by University of Vermont and GlobalFoundries has been designated as one of 31 Tech Hubs by the US Department of Commerce.

p27 ELEMENT 3–5 has unveiled its ACCELERATOR 3500K for the mass production of AlN epitaxial thin films as a starting layer on silicon, sapphire or SiC.



Cover image: Riber's new MBE 49 GaN system is a fully automated mass-production platform that is targeted at competing with MOCVD for depositing gallium nitride on 200mm silicon wafers. **p28**

editorial

Building on silicon for WBG electronics

The transition of the power electronics industry from silicon to silicon carbide (SiC) continues, with Japan's Mitsubishi Electric and automotive supplier DENSO investing $1bn in the SiC substrate manufacturing business of US-based Coherent (see page 10), French silicon-on-insulator substrate maker Soitec inaugurating its SmartSiC wafer production plant (page 11), Shanghai-based J2 Semiconductor agreeing to establish Hong Kong' first 200mm SiC wafer fab (page 12), Germany's Infineon winning a multi-year contract to supply silicon and SiC power semiconductor chips and modules to South Korea-based Hyundai Motor Group (page 14), and US-based onsemi completing the expansion of its SiC fab in South Korea (page 13).

However, the cost-of-living crisis for consumers is slowing growth in electric vehicle sales, leading some established auto-makers to postpone launches of their new EV models, while US-based EV maker Tesla's dominant market share is now being eroded by an increasing number of lower-cost rivals. onsemi's forecast of slowing SiC chip sales growth for fourth-quarter 2023 and a consequent drop in its share price highlights an inevitable pitfall of rapid technology transitions, manufacturing investments and occasional mismatches in supply versus demand as auto parts makers work through inventories.

Longer-term development of wide-bandgap (WBG) semiconductor technology more generally is being boosted by the US Department of Defense's award of $39.4m to create a Microelectronics Commons regional innovation hub 'Commercial Leap Ahead for Wide-bandgap Semiconductors' (CLAWS), led by North Carolina State University and joined by N.C. A&T State University, as well as Wolfspeed, Coherent, General Electric, Bluglass, Adroit Materials and Kyma Technologies (see page 16). This will address not only silicon carbide and gallium nitride but also ultra-wide-bandgap materials including diamond and gallium oxide for microelectronics applications.

More specifically, the high-volume manufacturing of gallium nitride on silicon wafers is being boosted by a consortium 'Advancing Gallium Nitride (GaN) Technology in the Greater Burlington Area' (led by the University of Vermont and including GlobalFoundries) being designated as one of 31 Tech Hubs by the US Department of Commerce, unlocking the opportunity for up to $75m in federal grant funding for R&D (see page 18).

GlobalFoundries has also been awarded $35m in federal US funding by the Department of Defense to accelerate the manufacturing of GaN-on-Si at its facility in Essex Junction, near Burlington, Vermont (see page 19). The funding targets large-scale production for applications in 5G and 6G cellular communications infrastructure and handsets, automotive and industrial IoT, as well as power grids and other critical infrastructure.

The prospects for GaN-on-Si have prompted French molecular beam epitaxy deposition system maker Riber to develop the MBE 49 GaN, a variant of its MBE 49 system optimized for growth of gallium nitride on 200mm silicon substrates (page 28). Collaboration with CNRS-CRHEA has optimized the RF plasma source to combine growth speed and deposition uniformity, enabling MBE to compete with established MOCVD high-speed GaN growth.

Also aiming to improve on MOCVD in terms of high capacity is Germany's ELEMENT 3–5 with its Next Level Epitaxy technology. In this case, its new ACCELERATOR 3500K system targets the deposition of aluminium nitride single-crystal thin films on a silicon, sapphire or SiC substrate as a starting template layer for the growth of GaN-based devices (see pages 27 & 62).

Mark Telford, Editor

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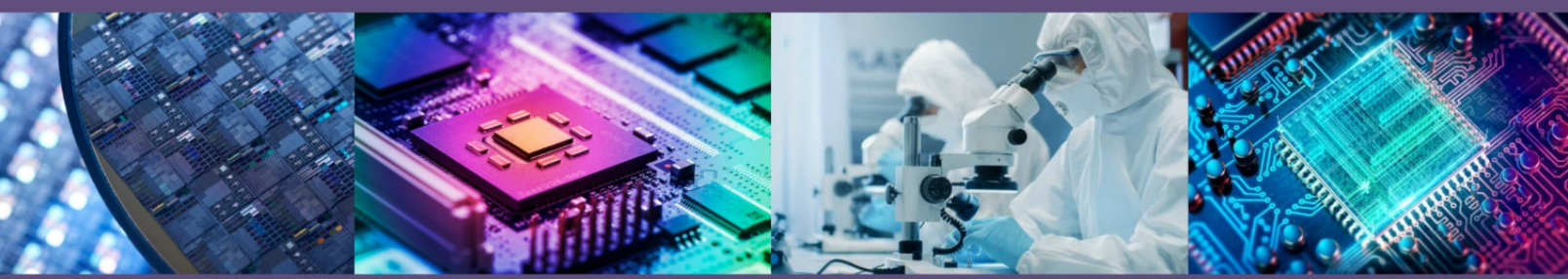

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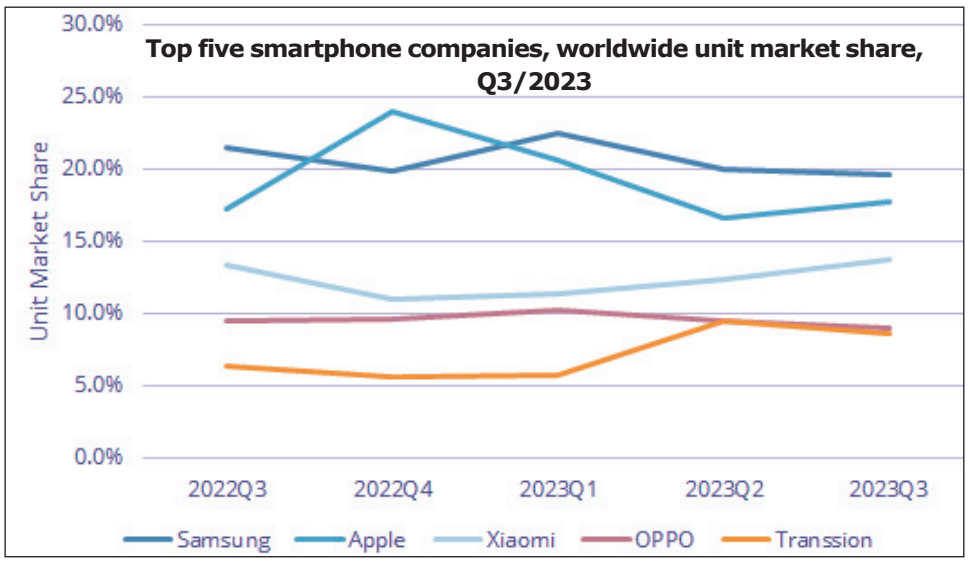
Smartphone shipments on track for recovery after only slight decline in Q3/2023

China shipments fall for tenth consecutive quarter

Worldwide smartphone shipments declined by 0.1% year-on-year to 302.8 million units in third-quarter 2023, according to preliminary data from the International Data Corp Worldwide Quarterly Mobile Phone Tracker. Although macro-economic uncertainties linger as markets struggle with soft demand, inflation and geopolitical tensions, healthy inventory and the slower pace of decline are encouraging some vendors to increase shipments.

"We are seeing a strong ramp up of shipments in emerging markets by vendors like Xiaomi and Transsion," notes Nabila Popal, research director with IDC's Mobility and Consumer Device Trackers. "While this is a good sign of approaching recovery, vendors must keep a close eye on sell-through to avoid falling into excess inventory again, as demand is still weak in many regions," he adds. "Meanwhile, on the other end of the spectrum, we see Apple growing in all regions except China, where it's facing renewed competition from Huawei as well as heightened macroeconomic uncertainties that are causing consumers who once used to rush for the latest iPhones to pause and think more carefully about their purchases."

China saw shipments fall for a tenth consecutive quarter, falling by 6.3% year-on-year in Q3/2023. Rising youth unemployment, the ongoing real-estate crisis and deflation have significantly dampened consumer spending and the broader macroeconomic environment in China.



Elsewhere, shipments in Europe, Japan and the USA fell by 8.6%, 5.3% and 1.1%, respectively. However, emerging markets like the Middle East and Africa (MEA), Latin America (LA) and Asia/Pacific (excluding Japan and China) saw Q3/2023 shipment growth of 18.1%, 8.2% and 1.3%, respectively.

"The continued growth in the high-end market feels counter-intuitive considering the economic challenges we are seeing across the globe," says Anthony Scarsella, research director, Mobile Phones. "Yet the high-end continues to flourish due to generous trade-in and financing options in many developed markets," he adds. "However, as consumers choose premium models, the refresh cycle will continue to extend. Superior build quality, increased storage, premium features, and longer support cycles drive buyers towards the high-end as these devices last well beyond most affordable models."

www.idc.com

Company	3Q23 Shipments	3Q23 Market Share	3Q22 Shipments	3Q22 Market Share	Year-Over-Year Change
1. Samsung	59.5	19.7%	65.0	21.4%	-8.4%
2. Apple	53.6	17.7%	52.3	17.2%	2.5%
3. Xiaomi	41.5	13.7%	40.5	13.4%	2.4%
4. OPPO	27.0	8.9%	28.9	9.5%	-6.5%
5. Transsion	26.0	8.6%	19.2	6.3%	35.0%
Others	95.1	31.4%	97.2	32.1%	-2.1%
Total	**302.8**	**100.0%**	**303.1**	**100.0%**	**-0.1%**

Top five companies, worldwide smartphone shipments, market share, and year-on-year growth, Q3/23 (preliminary results, shipments in millions of units).

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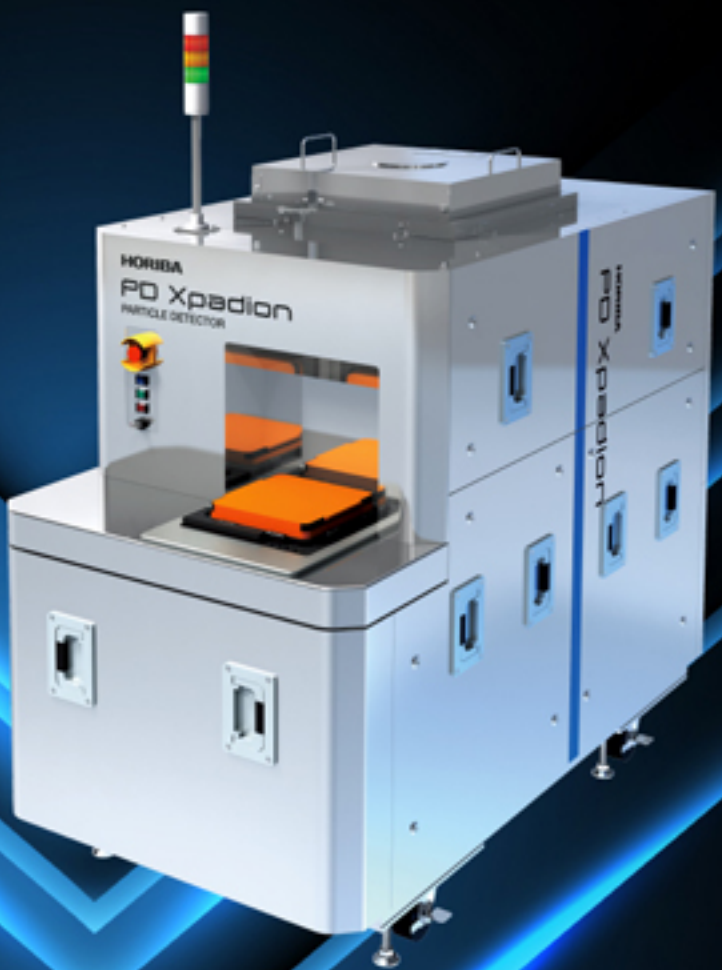

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CML completes acquisition of Microwave Technology

Price of $13.18m comprises $7.65m in cash and $5.53m in shares

UK-based CML Microsystems Plc, a designer and fabless manufacturer of mixed-signal, RF and microwave semiconductors for wireless communications applications, has completed its acquisition of Silicon Valley-based semiconductor firm Microwave Technology Inc (MwT).

Founded in 1982, MwT designs and manufactures gallium arsenide (GaAs)- and gallium nitride (GaN)-based monolithic microwave integrated circuits (MMICs), discrete devices, and hybrid amplifier products for commercial wireless communication, defense, space and medical (MRI) applications. It became part of the IXYS Corp, which was then acquired in 2018 by Chicago-based technology manufacturing company Littelfuse Inc. In 2019, MwT underwent a management buy-out from Littelfuse, while transitioning away from manufacturing to a fabless semiconductor model with a specific focus on MMICs. The business has 20 staff and operates from its sole location in Fremont, CA.

CML says that the acquisition expands its product portfolio, strengthens and enhances its support resources and increases its R&D capabilities, providing essential know-how and experience in system-level understanding, product manufacturing and packaging techniques. MwT's products are complementary to CML's existing range, and most of its focus and client concentration is within the USA. CML's board believes that there is a significant opportunity to increase its current market share by internationalizing MwT's products.

"Their dedicated and very experienced team will accelerate our multi-year growth strategy, enhancing the group's existing competencies, whilst the strong cultural synergies bode well for the combined businesses over the medium term," comments CML's group managing director Chris Gurry.

MwT's unaudited US GAAP results for 2022 recorded revenue of $6.5m and a pre-tax loss of $132,000 with net assets of circa $2.4m. The board expects that MwT will be earnings enhancing in its first full year of ownership within CML.

MwT's chairman Dr Nathan Zommer (previously MwT's majority shareholder) will join CML's board of directors in a non-executive capacity (subject to completion of normal regulatory due diligence checks).

The total sum payable for the acquisition is $13.18m (comprising $7.65m in cash and $5.53m in shares). The cash element, which is subject to customary post-completion adjustments, is payable in four tranches: $1.93m on completion, $1.17m on the six-month anniversary of completion, $2.65m on the first anniversary of completion, and $1.9m on the second anniversary of completion (with the latter three payments being subject to performance-related adjustments). The $5.53m share element is payable via the issue to the sellers of 864,349 new CML ordinary shares of 5 pence each, valued at a price of 440 pence per share, being the volume-weighted average price of CML's shares for the 30 days prior to the initial announcement of the transaction on 17 January, to be issued in three tranches: 592,010 shares on completion, 90,780 shares on the first anniversary of completion, 90,780 shares on the second anniversary of completion, and 90,779 shares on the third anniversary of completion.

www.mwtinc.com
www.cmlmicroplc.com

Altum RF signs MEV Elektronik as sales representative in Germany, Austria and Switzerland

Altum RF of Eindhoven, The Netherlands (which designs RF and millimeter-wave semiconductors for commercial and industrial applications) has announced a sales representative agreement with Germany-based MEV Elektronik Service GmbH (a distributor/stocking rep and manufacturers' representative for electronic components, modules and systems), covering customers in Germany, Austria and Switzerland, as the firm continues to expand its sales and technical resources.

MEV specializes in providing engineering and technical support for the electronic components, modules and systems that it distributes. It also offers expertise and relationships in the industrial automation, communications technology, aerospace & defense and medical industries.

"With a solid team of sales engineers, we feel confident MEV will effectively assist our customers with excellent technical, customer service and logistics support," says Altum RF's CEO Greg Baker.

"Altum RF's technically advanced microwave and millimeter-wave products are an ideal addition to our line-card offering," comments Wiho Herkenhoff, manager marketing & quality assurance, MEV. "Altum RF's ongoing product development helps expand our product offering in the aerospace & defense, SATCOM and communications technology markets," he adds. "We are optimistic about this partnership and our future collaboration to support customers with optimal products for high-technology applications."

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DENSO and Mitsubishi Electric investing $1bn in Coherent's silicon carbide business

Business to operate as independent subsidiary of Coherent

Materials, networking and laser technology firm Coherent Corp of Saxonburg, PA, USA says that automotive supplier DENSO Corp of Kariya, Aichi prefecture, Japan and Tokyo-based Mitsubishi Electric Corp have agreed to invest an aggregate $1bn in its silicon carbide business. The transaction results from Coherent's strategic review process announced in May for the business.

DENSO and Mitsubishi Electric will each invest $500m in exchange for a 12.5% non-controlling ownership stake, with Coherent owning the remaining 75%. Prior to completion of the transaction, Coherent will separate and contribute the business to a subsidiary. Coherent will control and operate the business, which will continue to be led by Sohail Khan, Coherent's executive VP, New Ventures & Wide-Bandgap Electronics Technologies.

In connection with the transaction — which is expected to close in first-quarter 2024 — the business will enter into long-term supply arrangements with DENSO and Mitsubishi Electric that support their demand for 150mm and 200mm silicon carbide (SiC) substrates and epitaxial wafers.

"After a thorough review of strategic alternatives for our silicon carbide business, we determined that the creation of a separate subsidiary and the strategic investments from DENSO and Mitsubishi Electric, two leaders in SiC power devices and modules, is the best path forward to maximize shareholder value and position the business for long-term growth," says Coherent's chair & CEO Dr Vincent D. Mattera Jr. "The investments from our strategic partners will be used to accelerate our capacity expansion plans and help sustain our leadership position, while ensuring the development of a robust and scalable supply for the rapidly growing market for SiC-based power electronics, largely driven by the explosive growth of the global electric vehicle market," he adds.

"Through this investment, we will secure a stable procurement of SiC wafers, which are critical for BEVs, and contribute to the realization of a carbon-neutral society by promoting the widespread adoption of BEVs," says Shinnosuke Hayashi, president & chief operating officer, representative member of the board at DENSO.

"Demand for SiC power semiconductors is expected to grow exponentially as the global market for electric vehicles increases in line with the transition to a decarbonized world," says Dr Masayoshi Takemi, executive officer, group president, Semiconductor & Device, at Mitsubishi Electric. "To capitalize on this trend, we have decided to expand our SiC power semiconductor production capacity, including by constructing a 200mm wafer plant in the Shisui area of Kumamoto Prefecture," he adds. "We are delighted to strengthen our partnership with Coherent by investing in this new SiC company, which will provide us with a stable supply of high-quality SiC substrates essential for our increased supply capacity."

www.MitsubishiElectric.com/semiconductors
www.globaldenso.com
www.Coherent.com

Wolfspeed appoints board member Werner as chairman

Wolfspeed Inc of Durham, NC, USA — which makes silicon carbide materials & power-switching devices — says that Thomas Werner, a board member since 2006, has been elected the new chairman of the board. Werner succeeds Darren Jackson, who stepped down as chair after five years in the role. Jackson will continue to serve as a member of Wolfspeed's board. In addition, board member Stacy Smith will replace John Replogle as chair of the Governance and Nominations Committee.

"Tom is a proven innovator with vast experience in the energy and semiconductor industries, and will provide invaluable leadership as we further scale our operations to meet the growing demand for silicon carbide power devices," comments president & CEO Gregg Lowe.

"It is my honor to serve as Wolfspeed's board chair, and help Wolfspeed as it leads the transition from silicon to silicon carbide," says Werner. "Wolfspeed is on the cusp of truly changing the power electronics industry," he adds.

Werner has over 25 years of experience in semiconductor, disruptive technology and energy organizations. He previously served as chairman of the board of directors for SunPower Corp, a publicly traded manufacturer and marketer of high-efficiency solar cells and solar panels, after serving as CEO of SunPower for 18 years.

Smith is executive chairman of Kioxia Corp (formerly Toshiba Memory Corp), a flash memory company, and non-executive chair of the board at design and make technology firm Autodesk Inc. Prior to his board positions, Smith worked at Intel Corp for three decades in roles including group president of sales, manufacturing & operations, chief financial officer, chief information officer, and head of Europe Middle East and Africa.

www.wolfspeed.com

Soitec inaugurates plant for SmartSiC wafer production

Substrate maker aims to triple addressable markets by 2030

In the presence of Thierry Breton (European Commissioner for the Internal Market) and Roland Lescure (French Minister Delegate for Industry), engineered substrate manufacturer Soitec of Bernin, near Grenoble, France has inaugurated its new plant, which will have a 2500m^2 footprint and a final production capacity of 500,000 SmartSiC wafers per year.

Based on silicon carbide (SiC), Soitec says that it has developed its patented SmartSiC technology in response to the challenges of vehicle electrification. SmartSiC enables electric vehicles to achieve ranges above 500km, it is reckoned, compared with an average 350km using silicon insulated-gate bipolar transistor (IGBT) alternatives. Also, since each SiC substrate can be used 10 times, SmartCut reduces CO_2 emissions during wafer manufacturing by 70% compared with producing monocrystalline SiC substrates, the firm adds.

Development of the technology began in 2020 in partnership with CEA-Leti and has received financial support from the French state, the region, local authorities and the European Union. The new plant will lead to the creation of 400 direct jobs, while also adding to the 'French Silicon Valley' ecosystem.

"More than ever we are ready to establish our SmartSiC technology as a new standard in semiconductor materials for coming generations of electric cars," says CEO Pierre Barnabé. "This plant will enable us to meet growing demand for silicon carbide and achieve a 30% market share by 2030, while helping to make electric mobility more efficient and affordable. Completed in record time, it is the embodiment of our industrial performance and our future-facing strategy, based on the expansion of our product and technology portfolio," he adds.

"This is also an important day for our region, which is once again showing its dynamic and exemplary approach to industrial innovation, with technologies designed, developed, and manufactured within our ecosystem," continues Barnabé. "We will create jobs and continue to showcase French and European knowhow in global semiconductor markets."

The new plant should contribute to Soitec's strategy of sustainable growth towards a threefold expansion of addressable markets by 2030.

www.soitec.com

J2 and HKSTP to establish first SiC fab in Hong Kong

The Hong Kong Science and Technology Parks Corporation (HKSTP) has signed a memorandum of understanding (MoU) with mainland China-based J2 Semiconductor (Shanghai) Co Ltd to establish a global R&D Centre focusing on third-generation semiconductors at the Hong Kong Science Park, and to set up Hong Kong's first silicon carbide (SiC) 8-inch wafer fab.

The collaboration is jointly supported by the Innovation, Technology and Industry Bureau and the Office for Attracting Strategic Enterprises (OASES) with a view to sustain Hong Kong's innovation and technology ecosystem and promote new industrialization. HKSTP's CEO Albert Wong and J2 Semiconductor's co-CEO TY Chu formally signed the MoU, witnessed by bureau secretary professor Sun Dong; OASES director-general Philip Yung; Ms Lillian Cheong, Under Secretary for Innovation, Technology and Industry; HKSTP's chairman Dr Sunny Chai; and J2 Semiconductor's chairman Dr Robert Tsu.

"J2 Semiconductor is proactively building up the capacity, quality and competitiveness of Hong Kong's tech talent pool," says professor Sun Dong, Secretary for Innovation, Technology and Industry. "The project will also drive the development of related industries, including semiconductor equipment manufacturers, material suppliers, testing service providers, to develop a complete ecosystem to reinforce Hong Kong's position in the global semiconductor industry value chain," he believes.

"The plan of establishing J2 Semiconductor's R&D Centre in the Science Park will promote Hong Kong's R&D and advanced manufacturing capabilities of third-generation semiconductor devices," says HKSTP's chairman Dr Sunny Chai. "J2 Semiconductor brings the core technology and expertise to Hong Kong in advanced chip design, fabrication process and semiconductor product development, which is an important milestone in the development of microelectronics industry in Hong Kong. As one of Hong Kong's flagship innovation and technology platforms, we provide high-quality infrastructure and facilities as well as a vast network of partners, which will continue to promote Hong Kong's microelectronics R&D capabilities and strengthen Hong Kong's position as an international I&T hub," he adds.

With professor Sun Dong, Secretary of Innovation, Technology and Industry Bureau (last row, middle), Philip Yung, general director of OASES (first from left), Ms Lillian Cheong, Under Secretary for Innovation, Technology and Industry (first from right), Dr Sunny Chai, chairman of HKSTP (second from left), Dr Robert Tsu, Chairman of J2 Semiconductor (second from right), Albert Wong, CEO of HKSTP (first row, left) and TY Chu, co-CEO of J2 Semiconductor (right) sign the MoU.

J2 Semiconductor will invest an estimated HK$6.9bn into the project, with plans to start volume production in the next couple of years. The targeted annual production capacity of 240,000 SiC wafers in 2028 should generate more than HK$11bn annually and create more than 700 jobs in Hong Kong. "The project will assist in the early completion of the localization of the new energy vehicle supply chain and drive the long-term development and prosperity of the semiconductor industry in Hong Kong," reckons the firm's chairman Dr Robert Tsu.

J2 Semiconductor aims to meet the strong demand for domestically produced automotive chips from the China automotive industry. It mainly provides high-performance silicon carbide devices focused on automotive, power conversion and communications. J2 Semiconductor says that its SiC technology can be applied to applications such as electric vehicles, as well as related infrastructure such as charging stations, smart grids and energy storage.

Aiming to build an ecosystem that now involves more than 200 microelectronics-related companies, HKSTP has established an extensive network of microelectronics hardware infrastructure, including the Sensor Packaging and Integration Laboratory (Sensor Lab), Heterogenous Integration Lab (HI Lab) and the Hardware Lab, which can support the end-to-end process of design, prototyping and pilot production of chip-related equipment and systems as well as products. The Microelectronics Centre in Yuen Long Innovation Park is set to begin operation in 2024, supporting HKSTP's infrastructure to accelerate microelectronics R&D pilot production, creating opportunities for upstream and downstream enterprises in the industry chain.

The establishment of the J2 Semiconductor facilities in Hong Kong is expected to create a greater level of synergy and knowledge exchange. Currently, five universities in Hong Kong are ranked among the top 100 universities in the world, with over 100 university researchers engaged in microelectronics research. In this year's Budget Speech, the HKSAR Government announced its plan to establish a Microelectronics Research and Development Institute to strengthen collaboration with universities, R&D centers and companies in the industry, and further accelerate the '1 to N' translation of R&D outcomes and bolster industry development.

www.j2semi.com
www.hkstp.org

onsemi completes expansion of SiC fab in South Korea

Full annual capacity to exceed 1 million silicon carbide wafers

Power semiconductor IC supplier onsemi of Phoenix, AZ, USA has completed expansion of its silicon carbide (SiC) fabrication facility in Bucheon, South Korea (claimed to be the world's largest SiC wafer fabrication plant). At full capacity, the plant will be able to manufacture more than 1 million 200mm SiC wafers per year. To support the ramp in SiC manufacturing capacity, onsemi plans to hire up to 1000 local staff over the next three years to fill the mostly highly technical positions (a more than 40% rise on the present workforce of about 2300.

Silicon carbide devices are a critical component for power conversion in electric vehicles, energy infrastructure and high-power EV chargers. The rapidly growing demand for these products has created a surge in demand for SiC chips, with demand outpacing supply for the foreseeable future. The expansion of the Bucheon fab addresses the pressing need for additional production capacity, allowing onsemi to continue to provide supply assurance for its customers and strengthen its position in intelligent power solutions.

Construction of the new 150mm/200mm SiC fab line along with the utility building and adjacent parking garage began in mid-2022 and was completed this September. Expansion of the 150mm/200mm SiC epi and wafer fab emphasizes onsemi's focus on building out its vertically integrated silicon carbide manufacturing supply chain at brownfield locations. The Bucheon SiC line is starting with the production of 150mm wafers and will be converted to 200mm in 2025 upon qualification of the 200mm SiC process.

onsemi's leadership was joined by a delegation of dignitaries led by Vice Governor for Economy of the Gyeonggi-Do Taeyoung Yeom; followed by Bucheon City Mayor YongEek Cho; National Assembly delegates; and Bucheon Chamber of Commerce and Industry chairman JongHuem Kim. Also in attendance were representatives from local communities, customers, suppliers and the semiconductor industry.

"The 150mm/200mm SiC wafer fab in Bucheon is critical to the continued success of our fully integrated SiC supply chain, enabling us to support the acceleration of electrification globally," says onsemi's CEO Hassane El-Khoury. "The last five years have shown what extraordinary performance our Bucheon team is capable of, and what we can achieve when we work together with governmental agencies."

www.onsemi.com

ST launches 32-pin, dual-inline, molded, through-hole package silicon carbide power modules

STMicroelectronics of Geneva, Switzerland has released the ACEPACK DMT-32 family of silicon carbide (SiC) power modules in a 32-pin, dual-inline, molded, through-hole package for automotive applications. Targeted at systems such as on-board chargers (OBC), DC/DC converters, fluid pumps and air conditioning, they are said to deliver advantages including high power density, very compact design, and simplified assembly. ST says that the product family enhances flexibility for system designers by presenting a choice of four-pack, six-pack and totem-pole configurations.

The modules contain 1200V SiC power switches that leverage ST's second- and third-generation SiC MOSFET technology, ensuring low $R_{DS(on)}$ values. The devices deliver efficient switching performance with minimal dependence on temperature to ensure high efficiency and reliability at converter system level.

Leveraging ST's proven, robust ACEPACK (Adaptable Compact Easier PACKage) technology, the modules reduce overall system- and design-development costs while ensuring reliability. The package technology features a high-performance aluminium nitride (AlN) insulated substrate for what is claimed to be excellent thermal performance. There is also an integrated NTC sensor that provides temperature monitoring for thermal protection.

The first product in ACEPACK DMT-32, introduced now with ramp-up to volume production from fourth-quarter 2023, is M1F45M12W2-1LA. In addition, the M1F80M12W2-1LA, M1TP80M12W2-2LA, M1P45M12W2-1LA, M1P80M12W2-1LA and M1P30M12W3-1LA are sampling now with ramp-up to volume production from first-quarter 2024. Pricing is dependent on configuration.

www.st.com/acepack-dmt-32

Infineon signs multi-year agreement to supply power semiconductors to Hyundai/Kia

Hyundai/Kia to fund manufacturing capacity build-up and reservation

Infineon Technologies AG has signed a multi-year agreement to build and reserve manufacturing capacity to supply silicon carbide (SiC) as well as silicon (Si) power semiconductor modules and chips to South Korea-based Hyundai Motor Company and Kia Corp until 2030. Hyundai/Kia will support the capacity build-up and capacity reservation with financial contributions.

"Infineon stands as a valued strategic partner, boasting steadfast production capabilities and distinct technological prowess within the power semiconductor market," comments Heung Soo Kim, executive VP & head of the Global Strategy Office (GSO) at Hyundai Motor Group. "This partnership not only empowers Hyundai Motor and Kia to stabilize its semiconductor supply but also positions us to solidify our leadership in the global EV market," he adds.

"As a trusted partner, we are proud to advance our long-term partnership with Hyundai/Kia," says Peter Schiefer, president of Infineon's Automotive Division. "We contribute premium products of high quality, our system knowledge and application understanding combined with continued investments in manufacturing capacity to address the increasing demand for automotive power electronics."

From left to right: Jason Chae (VP of the Semicon Strategy Group at Hyundai Motor Company), Heung Soo Kim (executive VP & head of Global Strategy Office at Hyundai Motor Group), Peter Schiefer (president of Infineon's Automotive Division), Peter Schaefer (executive VP, sales, marketing and distribution of Infineon's Automotive Division).

Infineon's power semiconductors are key enablers for the transition to electro-mobility. This transition will lead to strong market growth for power semiconductors, especially those based on wide bandgap materials like SiC. With the significant expansion of its fabrication plant in Kulim, Malaysia, Infineon is building what it is reckoned will be the world's largest 200mm SiC power fab, strengthening its role as a high-volume supplier to the automotive industry. In line with Infineon's multi-site strategy, the Kulim facility will complement the firm's existing manufacturing capacity in Villach, Austria, and further capacity expansions in Dresden, Germany.

www.infineon.com/mobility

Infineon completes acquisition of GaN Systems

Infineon Technologies AG of Munich, Germany has closed its acquisition (announced on 2 March) of GaN Systems Inc of Ottawa, Ontario, Canada (a fabless developer of gallium nitride-based power switching semiconductors for power conversion and control applications) for US$830m, funded from existing liquidity in an all-cash transaction. All required regulatory clearances have been obtained and GaN Systems is now part of Infineon.

"GaN technology is paving the way for more energy-efficient and CO_2-saving solutions that support decarbonization," notes Infineon's CEO Jochen Hanebeck. "The acquisition of GaN Systems significantly accelerates our GaN roadmap and further strengthens Infineon's leadership in power systems through mastery of all relevant power semiconductor technologies," he reckons.

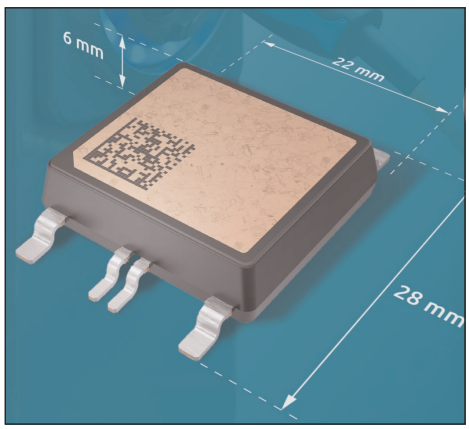
Infineon now has a total of 450 GaN experts and more than 350 GaN patent families, which is reckoned to expand its position in power semiconductors and speed up time-to-market. Both companies' complementary strengths in IP and application understanding as well as a well-filled customer project pipeline put Infineon in a position to address various fast-growth applications.

www.gansystems.com

Nexperia and KYOCERA AVX Salzburg to co-produce 650V SiC rectifier module for power applications

In a deepening of their existing, long-term partnership, Nexperia B.V. of Nijmegen, the Netherlands (a subsidiary of Wingtech Technology Co Ltd) and Austria-headquartered automotive electronic component maker KYOCERA AVX Components (Salzburg) GmbH are to jointly produce a new 650V, 20A silicon carbide (SiC) rectifier module for high-frequency power applications ranging from 3kW to 11kW power stack designs, aimed at applications such as industrial power supplies, electric vehicle (EV) charging stations, and on-board chargers.

Since space-saving and weight reduction are key requirements for manufacturers of next-generation power applications, the compact footprint of the new SiC rectifier module is expected to help to maximize power density, reducing the amount of required board space and lowering the overall system cost. Thermal performance is optimized using a combination of top-side cooling (TSC) and an integrated



negative temperature coefficient (NTC) sensor which monitors the device temperature and provides real time feedback for device or system-level prognosis and diagnosis. The rectifier module has a low-inductance package to enable high-frequency operation and has been qualified to operate with a junction temperature of up to 175°C.

"This collaboration between Nexperia and KYOCERA AVX combines cutting-edge silicon carbide semiconductors with state-of-the-art module packaging and will allow Nexperia to better serve the market demand for power electronic products which offer exceptionally high levels of power density," says Katrin Feurle, senior director of Nexperia's SiC Product Group. "The release of this rectifier module will represent the first step in what is envisaged as a long-term SiC partnership between Nexperia and KYOCERA AVX," she adds.

"We are delighted to further extend our successful partnership with Nexperia into the production of silicon carbide modules for power electronics applications," comments Thomas Rinschede, deputy VP at KYOCERA AVX Components' Sensing & Control Division. "Nexperia's manufacturing expertise combined with KYOCERA module know-how make a compelling offering for customers looking to achieve higher power densities using wide-bandgap semiconductor technology."

Nexperia expects samples of the new SiC rectifier modules to be available in first-quarter 2024.

www.nexperia.com/sic_diodes

US DoD awards $39.4m for NC State-led 'CLAWS' Microelectronics Commons regional innovation hub

Commercial Leap Ahead for Wide-bandgap Semiconductors to involve N.C. A&T State, Wolfspeed, Coherent, GE, Bluglass, Adroit and Kyma

North Carolina State University has been awarded $39.4m from the US Department of Defense to serve as the leader of a regional innovation hub in wide-bandgap semiconductors.

The regional hub 'Commercial Leap Ahead for Wide-bandgap Semiconductors' (CLAWS) also includes one university partner, N.C. A&T State University, as well as six industry partners: Wolfspeed, Coherent Corp, General Electric, Bluglass, Adroit Materials and Kyma Technologies Inc.

The funding is part of $238m invested through the 'Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act' for the establishment of eight Microelectronics Commons regional innovation hubs spread across the USA, as announced on 20 September by Deputy Secretary of Defense Kathleen Hicks.

"NC State is honored to lead a Microelectronics Commons regional innovation hub to use our breadth and depth of expertise to create better wide-bandgap semiconductors that are so important for our nation's defense," says chancellor Randy Woodson. "We're thankful for the work of those who developed and passed the 'CHIPS and Science Act' that supports these regional hubs, and for the regional partners who will collaborate on future research and discovery in this critical high-tech sector."

As well as wide-bandgap semiconductors (offering higher voltage and temperature capacity than silicon chips, for applications in power electronics, as well as RF and wireless devices for communications and radars, as well as photonic devices for sensing, communications, artificial intelligence and future quantum technology applications) the hub will also explore next-generation ultra-wide-bandgap materials with even greater voltage and temperature capabilities, including diamond and gallium oxide electronics.

"Leveraging NC State's expertise through campus resources like PowerAmerica and the FREEDM Systems Center alongside traditional strengths in electrical and computer engineering as well as computer science should help make this leap ahead for wide-bandgap semiconductor technology a reality," believes Mladen Vouk, vice chancellor for research & innovation at NC State.

"The effort is focused on 'lab to fab' capability for wide-bandgap semiconductors and is about building capability to make them here in the USA and help ensure domestic supply," says John Muth, Distinguished Professor of Electrical and Computer Engineering and the primary investigator on the award.

"The hub has a nucleus of members that are building this capability, but we will also have hub affiliates and future partners that will be able use the equipment and capability of the hub for Department of Defense-funded and commercial projects."

The hub will also enhance the ability to perform a wide range of fundamental research that is core to the university's science and extension mission, Muth added.

"The technologies hold the potential to enable future electric vehicles, power grid technologies, 5G/6G, quantum technologies and artificial intelligence applications," says Fred Kish, MC Dean Distinguished Professor of Electrical and Computer Engineering and the director of the new hub. "They are also important for national security applications by providing energy efficiency, size, weight, power and performance advantages in critical application areas including weapons systems, warfighter outfitting, position/navigation/timing, biotechnical and medical, materials processing, displays, and a host of additional defense needs."

NC State will work with hub partner N.C. A&T State University and community colleges to build technical expertise in semiconductors across the state, Muth adds.

https://ece.ncsu.edu/people/fakish
www.freedm.ncsu.edu

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University of Vermont–GlobalFoundries consortium designated a Tech Hub

Advancing Gallium Nitride Tech Hub eligible for $50–75m in funding

A consortium led by the University of Vermont (UVM) — and including GlobalFoundries, the Vermont Agency of Commerce and Community Development, and the Vermont State College System — has been designated as one of 31 Tech Hubs by the US Department of Commerce's Economic Development Administration (EDA), unlocking the opportunity for up to $75m in federal grant funding to further research in semiconductor technology.

'Advancing Gallium Nitride (GaN) Technology in the Greater Burlington Area' was selected by the Tech Hubs program from nearly 400 applications. The aim of the program is to "strengthen US economic and national security by catalyzing technology-based regional growth that enables the industries of the future to start, grow and remain in regions across our country," according to the EDA's announcement of the designation, which corresponded with a live event hosted by President Biden on 23 October.

The EDA designation paves the way for the consortium to apply for Phase II of the program, which will culminate in award implementation grants totaling $50–75m to each of 5–10 Tech Hubs.

"Investment in American innovation and supply chain independence is essential to our nation's economic security and global competitiveness. We appreciate the Biden Administration and Congress for investing in this area, and the EDA for recognizing the important role small, more rural states like Vermont will have," said Governor Phil Scott.

The goal of the Vermont Tech Hub is to build and sustain a successful ecosystem for advancing GaN and other semiconductor innovations and, in the process, to grow the economy and economic vitality of the region and the state.

US President Joe Biden, joined by Secretary of Commerce Gina Raimondo and Director of the National Economic Council Lael Brainard, announces the Tech Hubs program at the Eisenhower Executive Office Building on 23 October.

"GlobalFoundries looks forward to deepening our partnership with UVM, working together to realize the full potential of high-volume manufacturing of GaN on silicon chips, and to driving US leadership in this emerging technology," says Ken McAvey, VP & general manager of GlobalFoundries Vermont.

"The CHIPS and Science Act has proven to be a successful catalyst for renewed enthusiasm, collaboration and investment in US semiconductor manufacturing, and the Tech Program will be a critical vehicle for advancing new technologies through development and into the marketplace."

The estimated global demand for GaN and related semiconductor solutions is growing, and the technology invites significant potential uses and offers advantages over existing semiconductor technology — adding speed, power and efficiency. GaN has the potential for many applications, including high-frequency radio communications, power electronics, automotive electronics, aerospace applications, high-performance medical imaging equipment, and consumer electronics.

"EDA Tech Hub designation is an important step in our plan to build a successful innovation economy for Vermont — in the area of semiconductor materials and advanced chip design," says Kirk Dombrowski, UVM vice president for Research and Economic Development.

Signed into law in August 2022, the CHIPS and Science Act authorized $10bn in funding for the Tech Hubs Program. EDA has received $500m (5%) of the authorized dollar amount and has designated 31 Tech Hubs and awarded 29 Strategy Development Grants.

At its core, the Tech Hubs Program is an economic development initiative designed to drive technology- and innovation-centric growth by strengthening a region's capacity to manufacture, commercialize and deploy critical technologies. The consortium's regional vision is focused on the tech ecosystem that will emerge with the next generation of high-power, high-speed chips based on GaN. The northeast region has the partnerships, technology leaders, and research capacity to become a global leader in this technology, it is reckoned.

The Tech Hub designation follows a week after the launch of UVM's new Device Characterization Lab, a partnership with GlobalFoundries with funding from the US Department of Education aimed at driving semiconductor research and preparing students for key roles within the field.

www.gf.com
www.uvm.edu

GlobalFoundries gains $35m US Government funding to accelerate 200mm GaN-on-Si chip production

Fab in Essex Junction, Vermont to move closer to large-scale production for aerospace & defense, cellular communications, industrial IoT and automotive applications

GlobalFoundries (GF) of Malta, NY, USA (which has operations in Singapore, Germany and the USA) has been awarded $35m in federal funding from the US government to accelerate the manufacturing of its gallium nitride (GaN) on silicon semiconductors at its facility in Essex Junction, Vermont. The funding brings GF closer to large-scale production of GaN chips, whose ability to handle high voltages and temperatures enable "game-changing" performance and efficiency in 5G and 6G cellular communications for infrastructure and handsets, automotive and industrial Internet of Things (IoT), as well as power grids and other critical infrastructure.

With the $35m in funding awarded by the Department of Defense's Trusted Access Program Office (TAPO) GF plans to purchase additional tools to expand development and prototyping capabilities, moving closer to at-scale 200mm GaN-on-Si manufacturing. As part of the investment, GF plans to implement new capabilities for reducing the exposure of GF and its customers to supply chain constraints of gallium, while improving the speed of development, assurance of supply and competitiveness of US-made GaN chips.

The funding builds on years of collaboration with the US government — including $40m in support from 2020–2022 — that leverages GF's Vermont team and their 200mm semiconductor manufacturing experience, and applies it to GaN-on-silicon manufacturing.

The federal funding "will solidify our state's position as a leader at the forefront of manufacturing next-generation chips," reckons Senator Peter Welch. "It's critical we support investment in this industry here in Vermont and in the US — both for our local economic growth and for our national security," he adds.

"This strategic investment continues to strengthen our domestic ecosystem of critical dual-use commercial technologies, ensuring they're readily available and secure for DoD utilization," says The Honorable Christopher J. Lowman, Assistant Secretary of Defense for Sustainment." In concert with key partners, we're proactively shaping the future of our defense systems," he adds.

"GaN on silicon is an ideal technology for high-performance radio frequency, high-voltage power switching and control applications for emerging markets, and it's important for 6G wireless communications, industrial IoT, and electric vehicles," says president & CEO Dr Thomas Caulfield. "GF has a longstanding partnership with the US government, and this funding is critical to move GaN-on-silicon chips closer to volume production. These chips will enable our customers to realize bold new designs that push the envelope of energy efficiency and performance of critical technologies we rely on every day."

GF's facility in Essex Junction, Vermont, near Burlington, was among the first major semiconductor manufacturing sites in the USA. Currently, about 1800 GF staff work at the site. GF-made chips are used in smartphones, automobiles, and communications infrastructure applications around the world. The facility is a DMEA-accredited Trusted Foundry and manufactures secure chips in partnership with the US Department of Defense, for use in some of the nation's most sensitive aerospace & defense systems.

www.gf.com

Innoscience ships 300 millionth InnoGaN chip

Company increases sales of GaN devices 500% year-on-year

Innoscience (Zhuhai) Technology Co Ltd of Suzhou, China says that, as of August, it has shipped more than 300 million of its InnoGan gallium nitride chips, helping customers to achieve small size, high energy efficiency, and low-loss product design.

This is in response to market demand across multiple applications in the consumer sector — fast charging, mobile phones, LEDs — as well as automotive LiDAR, data centers, and renewable energy and energy storage systems, which has seen analysts such as TrendForce in its 2023 GaN Power Semiconductor Market Analysis Report, state that "the global GaN power device market will grow from US$180m in 2022 to US$1.33bn in 2026, with a compound annual growth rate of 65%".

In November 2017, Innoscience started up the world's first 8-inch GaN-on-Si mass-production line, adopting the integrated device manufacturer (IDM) whole industry chain model, and launched its first low-voltage GaN power device in May 2018. By June 2019, Innoscience's 650V high-voltage GaN device had passed JEDEC approval and, subsequently, Innoscience has been the only firm that simultaneously mass produces both high-voltage and low-voltage GaN.

Since its 2019 entry into the fast-charging market, Innoscience's 650V parts have been adopted in 30–120W designs by leading brands including ASUS, Anker, Nubia, Baseus, Greenlink, and Flash.

In 2020, Innoscience's 100V low-voltage GaN was used by Hesai in mass-production LiDAR designs, allowing lasers to achieve image transmission in a shorter time.

In March 2021, the Tencent x Nubia Red Magic mobile phone 6Pro was released, equipped as standard with the industry's first 120W Black Rubik's Cube GaN fast charger, which is based on Innoscience's 650V chip. With adoption by Oppo, Vivo, Lenovo and other manufacturers, it has become an industry trend for mobile phones to be equipped with GaN fast charging as standard.

March 2021 saw the official start of mass production of Innoscience's bi-directional conduction chip V-GaN, which is claimed to be the only GaN chip that can be applied to high-voltage side load switches, smartphone USB/wireless charging ports with built-in OVP protection, multi-power supply system switch circuits and other scenarios: one V-GaN replaces two silicon MOSFETs in load switching applications, yielding a smaller and more efficient solution. In October 2021, Innoscience scored another industry first, as OPPO used its self-developed bi-directional conduction VGaN IC as the internal power switch in its latest smartphone. Other mobile-phone makers such as Realme, OnePlus, Lenovo, and Motorola have also adopted VGaN for charging protection.

In May 2022, Shounuo released the world's smallest 45W/65W PD car charger, using Innoscience's 40V low-voltage INN040FQ043A.

Then in July, Anker and Innoscience jointly released the first 65W full-GaN fast charger. This uses GaN power chips at both the AC and DC ends for the first time, taking system power density and efficiency to a new level.

In October 2022, Innoscience achieved mass production of GaN products targeting industrial power supplies — again an industry first — improving energy conversion efficiency and reducing system energy consumption.

In November, Innoscience's INN100W032A won the IIC World Electronics Achievement Award. The gate charge of this product is only 20% of a traditional silicon MOSFET, and its Ciss is only 40% of its silicon counterpart. It can be widely applied in motor drive, Class D, data-center, communication base-station and other product fields. This January, Innoscience launched the SolidGaN ISG3201, a 100V highly integrated half-bridge drive packaged solution, further improving the overall system performance of 48V power supplies for data-center module power supplies, motor drives, class D power amplifiers, photovoltaic inverters and light hybrid electric vehicles.

The move to GaN as the premium power semiconductor technology is driven by both new GaN products and market demands. As an example, in April, Innoscience's IATF 16949 automotive-grade low-voltage parts expanded from industrial to automotive applications, with use in autonomous vehicle LiDAR systems.

Then in July Innoscience began to apply GaN in renewable energy, reducing the size and improving the efficiency of photovoltaic modules.

By the end of August, Innoscience had mass produced 54 different types of high-voltage GaN chips (650–700V) and 20 types of medium/low-voltage GaN chips (30–150V). Products span three chip categories: wafers, discrete devices and integrated solutions.

"We are just at the start of the GaN story. The first applications were all in consumer, but GaN is undoubtedly the key to reducing costs and increasing efficiency in the industrial field as well," says Dr Denis Marcon, Innoscience's general manager, Europe. "According to automotive industry forecasts, GaN may enter the automotive market already this year, penetrating applications such as low-power OBC and DC–DC applications in 2025," he adds. "With such rapid growth in market demand, the reliability of devices, price competitiveness and stable supply in large quantities are now the major concerns of users. Based on an advanced Innoscience 8-inch GaN-on-Si IDM manufacturing platform, Innoscience's current production capacity has reached 15,000 wafers per month, providing tremendous advantages in scale, reliability and cost."

www.innoscience.com

Innoscience signs MEV Elektronik as European distributor

MEV offering InnoGaN and integrated SolidGaN devices including technical support

Gallium nitride-on-silicon (GaN-on-Si) power solutions firm Innoscience (Zhuhai) Technology Co Ltd of Suzhou, China has signed a pan-European distribution agreement with Germany-based MEV Elektronik Service GmbH.

Founded in December 2015 with main investment from CMBI, ARM, SK and CATL, Innoscience first established a mass-production 8-inch wafer line for gallium nitride-on-silicon (GaN-on-Si) devices in Zhuhai National Hi-Tech District in November 2017, then inaugurated a new facility in Suzhou in September 2020. The firm now claims to be the largest integrated device manufacturer (IDM) fully focused on GaN technology. Innoscience delivers GaN power devices that can be used in applications including cloud computing, electric vehicles (EV) and automotive, portable devices, mobile phones, chargers and adapters.

MEV is a distributor/stocking representative and manufacturers' representative that employs 20 engineers to support customers in Germany as well as in Central and Eastern Europe, and has an in-house laboratory where the technical solutions can be developed in partnership with customers. It also focuses on logistics and services that are tailored to meet individual customer's needs, and builds partnerships with customers and suppliers.

"GaN has applications everywhere, so we need distribution partners who can offer high levels of technical support," says Dr Denis Marcon, Innoscience's general manager, Europe. "MEV is a very well-established company and we are sure that existing and new customers will find the expertise they need within MEV's extensive FAE and logistics teams," Marcon adds.

"We like to partner with leading suppliers, and Innoscience is the largest 8-inch GaN-on-silicon wafer supplier in the world, with two fabs that are already delivering discrete and integrated GaN solutions," comments MEV's marketing manager Wiho Herkenhoff. "We are excited to offer InnoGaN and integrated SolidGaN devices including technical support to our customers, and to show them the high levels of efficiency that these new parts enable a power conversion system to achieve."

www.mev-elektronik.com
www.innoscience.com

CGD's ICeGaN HEMTs awarded 'Best Demo' at Innovation Zone of TSMC's Europe Tech Symposium

Cambridge GaN Devices aiming to extend portfolio in near future

Cambridge GaN Devices Ltd (CGD) — which was spun out of the University of Cambridge Department of Engineering's Electrical Power and Energy Conversion group in 2016 and designs, develops and commercializes power transistors and ICs that use GaN-on-silicon substrates — says that its ICeGaN GaN HEMT system-on-chip (SoC) was awarded 'Best Demo' at the Innovation Zone of the 2023 Europe Technology Symposium of Taiwan Semiconductor Manufacturing Co (TSMC).

CGD's ICeGaN technology, which has entered high-volume production for global customers using TSMC's GaN process technology, is bringing the complexity of a typical external driving circuit into the GaN HEMT, monolithically integrated. This concept reduces the component count at the PCB level and is said to significantly improve the robustness and reliability of the power transistor and the whole system, while enabling the user to couple it with a gate driver of choice. This concept is easily scalable to higher power and voltages, which CGD is actively pursuing. ICeGaN is claimed to be an industry first: GaN eMode HEMTs can be driven like a silicon MosFET. Recognizing the differentiation that it brings to the market, ICeGaN was voted 'Best Demo' by visitors to the Innovation Zone, TSMC's showcase for start-up customers' cutting-edge products at its largest annual event in Europe.

"CGD recognizes TSMC's leadership in high-voltage GaN – we believe that they have the most mature and reliable process in the industry, which is why we chose to have our proprietary ICeGaN technology SoCs made there. Consequently, we are also delighted to win TSMC's prestigious award for innovation," says CEO & co-founder Giorgia Longobardi. "Innovation is one of CGD's key values, and we aim to achieve a leadership position through technology. The award is also a very real demonstration of the success that our two companies are achieving in bringing game-changing, innovative GaN technology to the market," she adds.

"TSMC is excited to cooperate with CGD to deliver its easy-to-use 650V ICeGaN GaN transistors in high volume to companies working on diverse applications worldwide," says TSMC Europe's general manager Paul De Bot. "We look forward to close collaboration with them in the field of GaN power semiconductor technology."

ICeGaN H2 single-chip eMode GaN HEMTs — CGD's second-generation of 650V GaN ICs recently launched on the market — have demonstrated record low losses in No Load–Light Load operations, which is key for many consumer and industrial applications. Together with the H1 portfolio, CGD has demonstrated what is claimed to be the highest efficiency and reliability in the entire range 65W to 3kW, both at the TSMC European event and in several conferences worldwide. CGD aims to extend its portfolio in the near future.

ICeGaN includes a monolithically integrated GaN interface circuitry within the power transistor chips. This simplifies their use, enabling them to be driven like a silicon MOSFET, without the need for special gate drivers, complex and lossy driving circuits, a negative voltage supply or external clamping components. This design results in devices that are said to be extremely rugged and reliable, while achieving the highest performance among available eMode GaN technologies.

www.camgandevices.com
www.tsmc.com

Power Integrations' PowiGaN used in solar car race

Team aCentauri's power converter based on 750V InnoSwitch3-EP IC

Power Integrations Inc of San Jose, CA, USA, which provides high-voltage integrated circuits for energy-efficient power conversion, is providing PowiGaN gallium nitride (GaN) technology, expert design support, and financial sponsorship for Team aCentauri in the 3000km Bridgestone World Solar Challenge, which begins in Darwin on 22 October with 38 entrants and is expected to conclude in Adelaide on 29 October after crossing the Australian Outback.

"After studying Power Integrations' extensive list of reference designs, Team aCentauri asked us to help them design a power converter based on the 750V InnoSwitch3-EP with PowiGaN technology," says Trevor Hiatt, director of marketing at Power Integrations. "With our IC and expert design support, the team not only boosted energy efficiency to 95.7% while the system operates at maximum power but also improved efficiency by more than 50% while the system drives light loads – which is most of the time."

www.power.com

Transphorm launches first JEDEC-standard top-side-cooled surface-mount TOLT GaN transistor

Transphorm Inc of Goleta, near Santa Barbara, CA, USA has introduced the SuperGaN TOLT FET.

With an on-resistance of 72mΩ, the TP65H070G4RS transistor is claimed to be the industry's first top-side-cooled surface-mount GaN device in the JEDEC-standard (MO-332) TOLT package. The TOLT package offers flexibility of thermal management where system requirements do not allow for the more conventional surface-mount devices with bottom-side cooling. The thermal performance of the TOLT is similar to that of the widely used, thermally robust TO-247 through-hole packages and delivers the added benefit of highly efficient manufacturing processes enabled by SMD-based printed-circuit-board assembly (PCBA).

Currently available to sample, the TP65H070G4RS leverages Transphorm's robust, high-performance 650V normally-off d-mode GaN platform, which is claimed to offer improved efficiency over silicon, silicon carbide and other GaN offerings via lower gate charge, output capacitance, crossover loss, reverse recovery charge, and dynamic resistance. The SuperGaN platform advantages — combined with the TOLT's better thermals and system assembly flexibility — results in a high-performance, high-reliability GaN solution for customers seeking to bring to market power systems with higher power density and efficiency at an overall lower power system cost.

Transphorm says it is engaged with multiple global partners for high-power GaN, including lead customers in server and storage power, a global leader in the energy/micro-inverter space, an innovative manufacturer of off-grid power solutions, and a leader in satellite communications.

"Surface-mount devices such as the TOLL and the TOLT offer various benefits such as lower internal inductance as well as simpler board mounting during manufacturing. The TOLT adds to that more flexible overall thermal management with through-hole-like thermal performance by using top-side cooling," says Philip Zuk, senior VP business development & marketing. "These devices are commonly found in mid- to high-power system applications for key market segments including high-performance computing (server, telecom, AI power), renewables and industrial, and electric vehicles, some of which our GaN technology already powers today."

The robust 650V SuperGaN TOLT device is JEDEC qualified. Because the normally-off d-mode platform pairs the GaN HEMT with an integrated low-voltage silicon MOSFET, the SuperGaN FETs are said to be easy to drive with commonly used off-the-shelf gate drivers. They can be used in various hard- and soft-switching AC-to-DC, DC-to-DC and DC-to-AC topologies to increase power density while reducing system size, weight and overall cost.

www.transphormusa.com/en/docu

Transphorm launches 650V SuperGaN FETs in TOLL packages with on-resistances of 35mΩ, 50mΩ and 72mΩ

Transphorm has introduced three 650V SuperGaN FETs in TOLL packages with on-resistances of 35mΩ, 50mΩ and 72mΩ. Transphorm's TOLL package configuration is industry standard, so the SuperGaN TOLL FETs can be used as drop-in replacements for any E-mode TOLL solution. The new devices also offer Transphorm's proven high-voltage dynamic (switching) on-resistance reliability that is generally lacking in leading foundry-based E-mode GaN offerings, it is claimed.

Currently available to sample, the three 10mm x 12mm surface-mount devices (SMDs) support higher-power applications operating within an average range of 1–3kW. These power systems are typically found in high-performance segments such as computing (AI, server, telecom, data center), energy and industrial (PV inverters, servo motors), and other broad industrial markets which, collectively, have a current global GaN total addressable market (TAM) of $2.5bn. The FETs are said to be optimal solutions for today's rapidly expanding AI systems that rely on GPUs requiring 10–15 times the power of traditional CPUs.

Transphorm's high-power GaN devices are already widely supplied to leading customers who use them to power in-production high-performance systems including data-center power supplies, high-power gaming PSUs, UPSs, and micro-inverters. These applications can also be supported by the TOLL devices, as can electric-vehicle-based DC-to-DC converters and on-board chargers, with the underlying SuperGaN die already automotive (AEC-Q101) qualified.

Because the normally-off D-mode platform pairs the GaN HEMT with a low-voltage silicon MOSFET, the SuperGaN FETs are said to be easy to drive with commonly used off-the-shelf gate drivers. They can be used in various hard- and soft-switching AC-to-DC, DC-to-DC and DC-to-AC topologies to increase power density while reducing system size, weight and overall cost.

www.transphormusa.com

Element Six selected for US Department of Defense LADDIS program

Large Area Device-quality Diamond Substrates targeted at RF & power electronics for harsh-environment military applications

CVD-based synthetic diamond materials firm Element Six of Oxford, UK (E6, part of the De Beers Group) has been selected as a performer for the LADDIS (Large Area Device-quality Diamond Substrates) program, set up by the United States Defense Advanced Research Projects Agency (DARPA).

LADDIS aims to develop new ways of fabricating device-quality diamond substrates with ultimate applications that include radio-frequency and power electronics to operate in the harsh environments of military applications.

As a pioneer of demonstrating and synthesizing electronic-grade single-crystal CVD diamond, E6 will use its expertise in the development of large-area single-crystal diamond substrates, leveraging its developed large-area synthesis platform, to realize diamond substrates measuring 50mm in diameter. E6 first developed electronic-grade CVD diamond as an integral part of the European Council for Nuclear Research (CERN) Large Hadron Collider monitoring systems, used in the experiments that enabled the discovery of the Higgs Boson Particle. In addition, by combining this electronic-grade intrinsic diamond with solving the challenge to achieve very high boron doping ($>5x10^{20}cm^{-3}$), E6 — in collaboration with ABB — demonstrated >4keV diamond Schottky diodes. Since then, E6 has invested in the development and manufacturing of single-crystal diamond and has registered over 2000 patents in 40 countries.

In addition to its facility in Santa Clara, California, USA, E6 has also built and commissioned what was believed to be the world's largest operating single-crystal diamond factory, in Portland, Oregon.

"Element Six has a 20-year track record of introducing disruptive single-crystal diamond-enabled solutions to the market, helping to unlock a range of new applications in sensing, optics and semiconductors," says chief technologist Dr Daniel Twitchen. "We are looking forward to leveraging our expertise, alongside Raytheon and E6's long-term academic partner professor Martin Kuball, to further develop this world-leading diamond semiconductor technology."

Diamond-based semiconductors have the potential for unprecedented power density, speed and performance; but there is a lack of industrial-size single-crystal diamond wafers that are needed to commercialize device. By working with its network of partners as part of the LADDIS project, Element Six aims to overcome these challenges.

E6 has already successfully demonstrated the scaled synthesis of polycrystalline diamond with diameters greater than 100mm. These are already being adopted in passive thermal management applications of high-power-density silicon (Si) and gallium nitride (GaN) semiconductor devices, used for example in satellite communications, electronic warfare (EW) and telecom infrastructures.

The LADDIS program has partnered E6 with aerospace & defense manufacturer Raytheon of Arlington, VA, USA, which makes high-power GaN RF devices for defense applications, and Martin Kuball, professor of Physics at the UK's University of Bristol, who has pioneered the thermal characterization techniques that can be used to assess the produced material of the group's synthesis work.

www.e6.com

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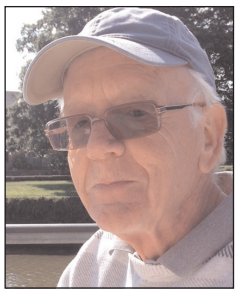
GaN Systems' co-founder Haynes joins QPT as advisor

GaN industry veteran endorsing qGaN module technology prior to Series A funding round

Power electronics company Quantum Power Transformation (QPT) of Cambridge, UK (which was founded in 2020) says that Geoff Haynes, who co-founded GaN Systems Inc of Ottawa, Ontario, Canada (a fabless developer of gallium nitride-based power switching semiconductors for power conversion and control applications) is joining its team as an advisor.

QPT's technology "solves the thermal and RF problems that GaN is now facing that currently form an insurmountable major barrier for the widespread use of GaN in high-power, high-voltage, hard-switching applications," says Haynes. "I visited the company's laboratory and was so impressed with its solutions that I am joining the company as an advisor to help them rapidly deploy this technology to the market. With it, GaN can now operate at the high frequencies needed to deliver significant power savings and open up applications worth billions as it provides a far superior performance and efficiency than silicon carbide," he adds.



Geoff Haynes.

Haynes is a "world authority on GaN and knows the challenges that it currently faces that limit its use," comments QPT's founder & CEO Rob Gwynne. "He immediately understood how our solutions and patents unlock the next phase in the evolution of GaN to become the enabling technology of choice for power electronics," he adds. "Having him join and effectively putting his name behind QPT's qGaN solutions is an incredible endorsement not only for customers but also for our upcoming Series A funding round."

GaN transistors can quickly transition from on to off at 1–2ns instead of 20–50ns for silicon and SiC transistors, notes QPT. However, achieving maximum performance is challenging in many high-voltage, high-power applications without significant RF interference issues or overheating.

QPT says that its qGaN module solution enables the GaN transistors to be run at their full potential of up to 20MHz with nanosecond switching to deliver better operational precision. The firm's technology in a variable-frequency drive (VFD) enables motors to be driven at up to 99.7% efficiency at peak load with hardly any decrease in efficiency at lower loads. This is a challenge for conventional designs today, says QPT, where the efficiency can drop off rapidly at lower loads. In addition to superior efficiency, the higher converter frequency significantly reduces the size and weight of the power electronics by 10x or more as well as reducing the manufacturing costs due to the removal of expensive filters that are normally required to protect the motor. Application areas include heat pumps, industrial motors, HVAC systems and electric vehicles.

www.gansystems.com

Tokyo University of Agriculture and Technology and Taiyo Nippon Sanso achieve high-speed growth of high-purity gallium oxide films by MOVPE

Development could lead to practical application of mass-production technology for β-Ga_2O_3 power devices

Tokyo University of Agriculture and Technology's professor Yoshinao Kumagai and assistant professor Ken Goto of the Institute of Engineering's Division of Applied Chemistry and assistant professor Shogo Sasaki of the FLOuRISH Institute — in collaboration with Junya Yoshinaga, Guanxi Piao and Dr Kazutada Ikenaga of Taiyo Nippon Sanso Corp Innovation Unit's CSE Department and Dr Yuzaburo Ban, fellow of Taiyo Nippon Sanso CSE Ltd — have achieved high-speed growth of high-purity β-gallium oxide (β-Ga_2O_3) thick films using the metal-organic vapor phase epitaxy (MOVPE) method, which has been considered difficult.

Beta-phase gallium oxide (β-Ga_2O_3) is attracting attention as an important semiconductor for next-generation power devices, which are essential for increasing the efficiency of power control and conversion systems. This achievement is expected to lead to the practical application of mass-production technology for β-Ga_2O_3 power devices.

The research results have been published online on 28 September in the paper 'High-speed growth of thick high-purity β-Ga_2O_3 layers by low-pressure hot-wall metalorganic vapor phase epitaxy' in the journal Applied Physics Express (APEX).

https://doi.org/10.35848/1882-0786/acf8ae

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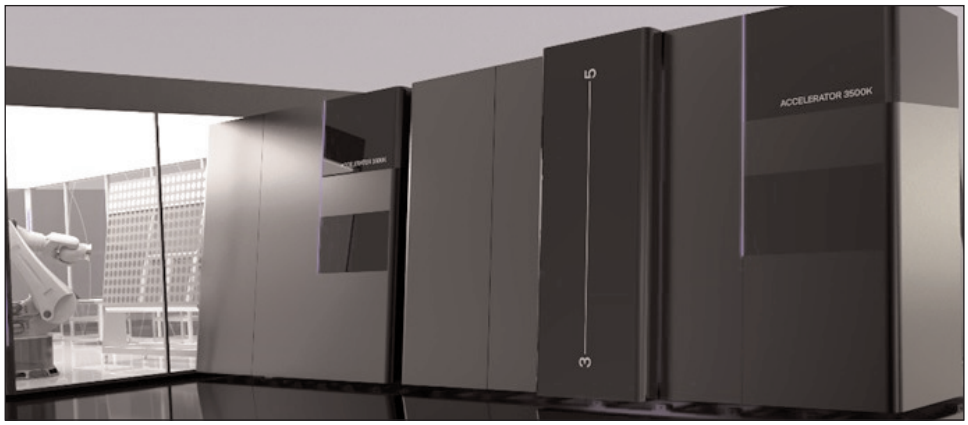
ELEMENT 3–5's novel ACCELERATOR 3500K provides single-crystal AlN for mass production

ELEMENT 3–5 GmbH says that its innovative Next Level Epitaxy (NLE) technology enables the reduction of the total manufacturing cost, energy and environmental impact of light-emitting diodes (LED), high-electron-mobility transistor (HEMT) for high-power applications, and life-time expanding layers in batteries.

The Baesweiler (Germany)-based company has unveiled its ACCELERATOR 3500K for the mass production of aluminium nitride (AlN) epitaxial thin films as starting layer on silicon, sapphire or silicon carbide (SiC).

The ACCELERATOR 3500K is said to represent a paradigm shift in the production of wide-bandgap semiconductors. The epitaxy system follows a modular design and is for the first time in-line ready — it includes the carrier loading, substrate cleaning followed by growth of single-crystal AlN layers.

"The ACCELERATOR 3500K lives up to its' name. The system accelerates the production on the customer side significantly. It is equipped with combined plasma sources and ion gun enabling the fabrication of AlN layers characterized by single-crystal quality at processing temperatures below 300°C that enable a 90% saving in energy consumption," says



ELEMENT 3-5´s ACCELERATOR 3500K.

ELEMENT 3–5's managing director Dr Volker Sinhoff. "Additionally, its wafer carrier is designed to accommodate 35 x 300mm, 70 x 200mm, 135 x 150mm or 300 x 100mm wafers during each processing cycle, making a tenfold increase in capacity compared to a conventional metal-organic chemical vapor deposition (MOCVD) reactor. Compared with the MOCVD process the incorporation efficiency of the molecules is distinctly higher (from 35% to >80%), which leads to significantly reduced consumable costs. In addition, metal-organic compounds and toxic gases are avoided completely. All in all, an advantageous solution for the user to enter new markets like micro-LEDs for displays or in mature markets like GaN LED and GaN power (HEMT).

The mini- and micro-LED boom is just getting started and we expect a steep rise in the HEMT market in the future, supported by our Next Level Epitaxy," he adds. "Customers anticipate even greater performance while also guaranteeing cost-effectiveness. We provide customers with the ability to take the pole position with the help of our cutting-edge technology."

ELEMENT 3–5 says that it is setting a new epitaxy standard, enabling the customer to have a completely new option: single-crystal layer qualities, superior layer homogeneity, and stable thickness repeatability paired with over 70% reduced productions costs, reduced CO_2 footprint and MOCVD capacity increase is included for free.

www.element3-5.com

Riber's MBE 49 GaN aims to compete with MOCVD for 200mm gallium nitride on silicon

MBE 49 production system optimized in collaboration with CRHEA

Riber S.A. of Bezons, France — which makes molecular beam epitaxy (MBE) systems as well as evaporation sources — says that it continues to improve and develop its system portfolio with the advent of the MBE 49 GaN, a mass-production machine dedicated to growth the growth of gallium nitride (GaN).

Riber highlights the latest order for an MBE 49 production machine for III–nitride applications (GaN, AlN), announced on 3 October, in the context of a particularly competitive ecosystem with metal-organic chemical vapor deposition (MOCVD).

"This order results from significant research and development work to optimize our 200mm MBE 49 production machine in order to meet the production challenges of advanced GaN- and AlN-based optoelectronic components," says Dr Jean Louis Guyaux, Riber's chief technology officer. "It also confirms the relevance of our partnership initiated in 2018 with CNRS–CRHEA [Centre de Recherche sur L'Hétéro-Epitaxie et ses Applications – Centre National de la Recherche Scientifique] in Sophia Antipolis, France [which specializes in epitaxial growth of wide-bandgap semiconductor materials] through the development of a joint laboratory. Riber is delighted with the excellent results of this collaboration and the exceptional performance achieved with the MBE 49 GaN, which is generating real interest from the scientific and industrial community worldwide," he adds. "Developing a technology that is ahead of its time on the market has required Riber to combine strategic vision with a willingness to invest in a bold and ambitious R&D program," comments CNRS–CRHEA director Philippe Boucaud. "CRHEA was a pioneer in GaN growth by MBE. It was therefore natural for it to make a long-term commitment to Riber, taking a significant risk on 200mm GaN by MBE... This [the MBE 49 GaN] is a remarkable success in the context of an exemplary partnership between CNRS and Riber."

The MBE 49 GaN is a fully automated production platform, compatible with ammonia and nitrogen plasma, that enables the production of high-quality optoelectronic and electronic devices, including UV LEDs, micro-LEDs, RF components, and N^+ GaN ohmic contacts.

In particular, the MBE 49 GaN is a suitable for producing high-quality GaN layers on silicon with improved voltages, considerably reduced RF losses and higher throughput with the required diameters, says Riber. Advantages of MBE for GaN processing are said to include in particular a lower growth temperature than MOCVD, excellent p-doping quality, enhanced by the use of a valve cell, and excellent process control due to integrated in-situ instrumentation. The work carried out by the joint Riber/CRHEA laboratory has enabled the RF plasma source to be optimized to combine growth speed and deposition uniformity.

The joint Riber/CRHEA laboratory gives the community the opportunity to evaluate the structural, optical and electronic qualities of epiwafer demonstrators, up to 200mm. It also opens its doors to all users wishing to see the machine in operation.

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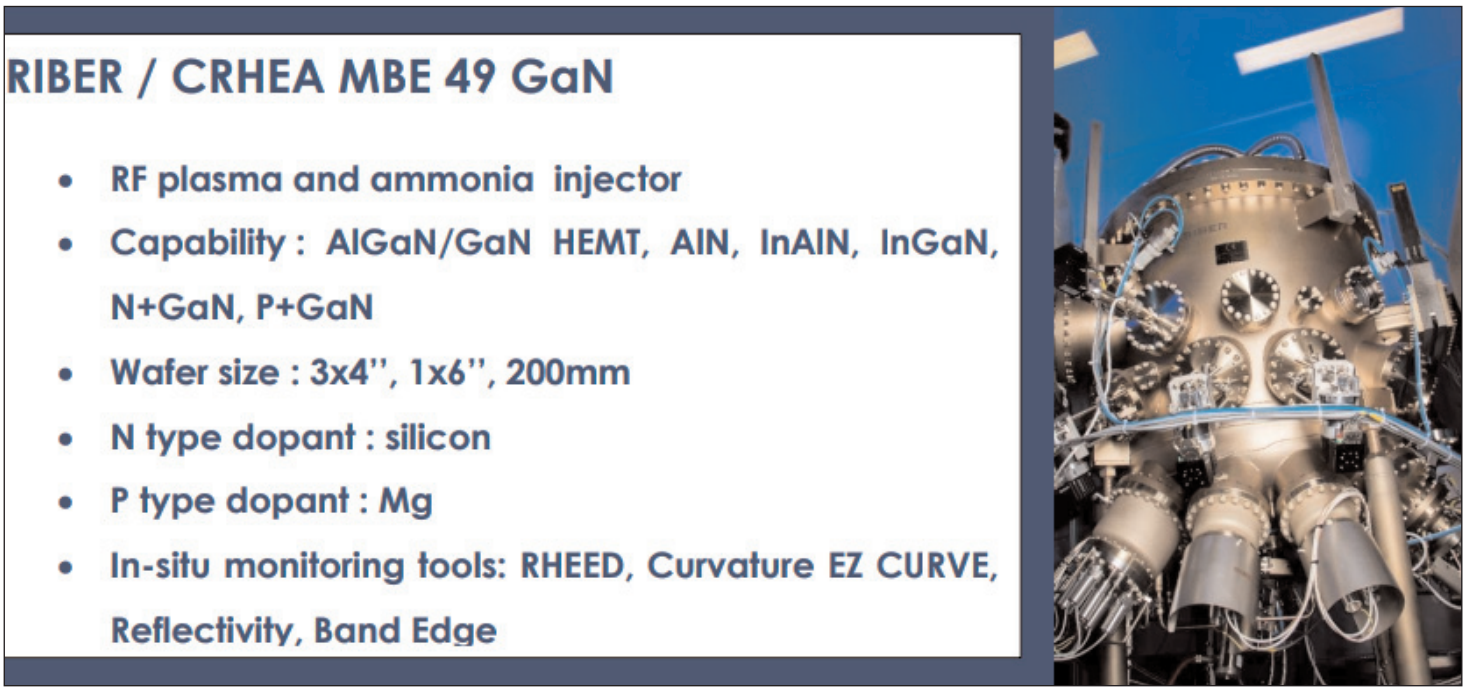

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Aehr almost doubles revenue year-on-year

Growth driven by production wafer-level burn-in products for SiC

For its fiscal first-quarter 2024 (to end-August 2023), semiconductor production test and reliability qualification equipment supplier Aehr Test Systems of Fremont, CA, USA has reported revenue of $20.6m, up 93% on $10.7m a year ago.

On a non-GAAP basis, net income was $5.2m ($0.18 per diluted share), up from $1.3m ($0.05 per diluted share) a year ago.

"We finished the first quarter with solid revenue and non-GAAP net income, the strongest first quarter in our history, which has historically been our seasonally softest quarter," notes president & CEO Gayn Erickson.

Cash provided by operations was $3.9m. During the quarter, total cash, cash equivalents and short-term investments rose from $47.9m to $51m.

"We had record shipments of our FOX WaferPak full-wafer Contactors in both revenue and units and are very pleased with the continued stream of new designs we are seeing. Our new design volume has tripled over the last nine months as we are seeing more electric vehicles coming online with their own specific device design for inverters and onboard chargers," says Erickson.

"We have now received customer acceptance of both configurations of our new fully automated FOX WaferPak Aligner, which allows hands-free operation of WaferPak handling and alignment and is available either as a standalone unit or in full integration with the FOX-XP system. We recognized revenue for two standalone WaferPak Aligners in the first quarter and received customer acceptance and sign off on two fully integrated WaferPak Aligners with the integrated FOX-XPs in September. These acceptances and the associated revenue recognition are a great way to start our second quarter and pave the path for revenue recognition immediately upon future shipments of these products," continues Erickson.

"Additionally, we announced last month our sixth customer for silicon carbide wafer level burn-in. This new customer is a US-based multi-billion-dollar semiconductor supplier that serves several markets, including automotive, computing, consumer, energy, industrial, and medical markets. After conducting a detailed financial evaluation of Aehr and Aehr's FOX family of products, including multiple onsite visits to Aehr's application lab, this new customer purchased an initial FOX-NP system, WaferPak Aligner, and multiple WaferPaks for engineering, qualification, and small-lot production of their silicon carbide power devices. This system is configured with our new Bipolar Voltage Channel Module (BVCM) and Very High Voltage Channel Module (VHVCM) options that enable new advanced test and burn-in capabilities for silicon carbide power semiconductors. This customer has indicated that, as their production capacity increases, they intend to quickly move to our FOX-XP multi-wafer test and burn-in systems for high-volume production.

"Including this newest customer, our last two announced customers have selected our systems primarily for applications other than electric vehicles including industrial, solar and commuter electric trains. This further extends our application space beyond the opportunity we see in silicon carbide for traction inverters and onboard and offboard chargers for electric vehicles. These applications expand our market opportunity to include what William Blair forecasts will be an additional 2.8 million 6"-equivalent wafers needed per year by 2030 for applications beyond the 4.5 million 6"-equivalent wafers per year it forecasts will be needed just for electric vehicles."

Our last two announced customers have selected our systems primarily for applications other than electric vehicles

"We continue to see increased interest from prospective new customers for our solutions for silicon carbide wafer level burn-in," says Erickson. "In the last few weeks, we have attended two international conferences in Europe and met with more than a dozen companies that are not currently using our solutions, in addition to meeting with all six of our current silicon carbide customers. These face-to-face meetings included multiple meetings with one of the market leaders in silicon carbide with whom we have been doing a significant automotive qualification of wafer-level burn-in for well over two years. This benchmark and qualification process has made even more progress in the last few months with a very large number of wafers being run at our facility and multiple meetings and reviews of the data. We continue to feel confident that this customer will move forward with us using the FOX-XP multi-wafer solution for their high-volume needs, including initial purchase orders and system shipments within this fiscal year. In the next few weeks, we also plan to meet with a significant number of potential new customers as well as end users in Asia, as we are seeing increasing activities and opportunities heating up there."

"We are also in extensive engagements with multiple gallium nitride suppliers, including companies that also supply silicon carbide devices," continues Erickson. "Gallium nitride is similar to silicon carbide in that both of these semiconductor compounds are considered wide bandgap semiconductors that are able to withstand high-voltage applications more directly than silicon. Gallium nitride semiconductor mat-

erial has characteristics that make it optimal for lower power converter applications such as consumer power converters, solar micro-inverters, and industrial motor controllers, compared with silicon carbide that is optimal for higher power/higher voltage applications such as traction inverters in electric vehicles, trucks, trains, and converters used in charging infrastructure and storage. The gallium nitride market is another potential growth driver for our wafer-level solutions, particularly for automotive and photovoltaic applications where burn-in appears to be critical for meeting the initial quality and reliability needs of those markets. This fiscal year, while we do expect to recognize some revenue for systems, WaferPaks and Aligners for gallium nitride applications, we continue to expect a significant majority of our revenue to come from silicon carbide."

"In addition to these power semiconductor applications, we continue to be excited about the current application of silicon photonics devices for fiber-optic transceivers used in data centers and data and telecommunication networks, as well as the major market opportunity we see with the upcoming application of silicon photonics integrated circuits for use in optical chip-to-chip communication," says Erickson. "As we've previously announced, we received a first order from a current major silicon photonics customer for a new configuration of our FOX-XP multi-wafer test and burn-in system for use in very high-power silicon devices, and we expect to receive orders for additional production systems as they increase production of these devices. While we believe that it will likely be several years before we will potentially see significant revenue generated from this optical chip-to-chip communications market, we are working with some of the leaders in silicon photonics to ensure that we have the products and solutions available to meet their needs for this potentially significant market application."

"In conclusion, we are encouraged by the continued positive momentum we are seeing for silicon carbide in electric vehicles and are also excited about the expanding growth opportunities we are seeing in several additional markets with current and prospective customers."

Order bookings for fiscal first-quarter 2024 were $18.4m. Order backlog was $22.3m. Effective backlog, which includes all orders received since the end of fiscal Q1, is $24m.

"We are off to a very good start to our fiscal year," says Erickson. For the fiscal year to end-May 2024, Aehr is reiterating its prior guidance for total revenue of at least $100m (up 50% year-on-year) and GAAP net income of at least $28m (up by more than 90% year-on-year).

www.aehr.com

Mojo Vision almost doubles Series A round to $43.5m

Funding to drive micro-LED development and commercialization

Six months after an initial Series A close of $22.4m, Mojo Vision Inc of Saratoga, CA, USA — which is developing and commercializing micro-LED display technology for consumer, enterprise and government applications — has announced a final close of its $43.5m new Series A investment round to advance its micro-LED display technology across applications and bring it to commercialization.

The funding round is led by long-time investors New Enterprise Associates (NEA) and Khosla Ventures, and new investor Vanedge Capital, with participation from Shanda Grab Ventures, Dolby Family Ventures, Advantech Capital, Liberty Global Ventures, Drew Perkins, Fusion Fund, Open Field Capital and Knollwood Investment Fund.

"Mojo Vision has shown tremendous momentum as it has expanded its focus on micro-LED development over the past year," says CEO Nikhil Balram. "The funding round drew remarkable interest from investors and exceeded our expectations, with our final figure doubling the amount of our initial raise in this round."

The funding follows several company milestones including demonstrating the world's highest-density (14K ppi) true red micro-LED micro-display and successful light-up of the first-ever 300mm blue GaN-on-silicon micro-LED array wafer.

"Micro-LED displays are vital for high-performance, energy-efficient screens required in the next generation of AR/VR headsets, smart wearables, and even automotive applications," says Vanedge Capital's managing partner and new Mojo Vision board member Moe Kermani. "Mojo Vision's pioneering advancements in core micro-LED technology, display design, and manufacturing, places them in a strong position to dominate the market," he comments.

The micro-LED market is expected to see substantial growth, with estimates indicating 51.7 million units will be shipped by 2030. Mojo Vision developed proprietary High Performance Quantum Dot (HPQD) technology to engineer what is claimed to be the world's smallest and most efficient RGB pixels. The technology is expected to significantly improve the performance of augmented reality (AR) and mixed reality (XR) advanced displays.

"We are thrilled to further our investment in Mojo Vision, having been with the company from the very start," says Shanda's chairman & CEO Tianqiao Chen. "This successful funding round signals the industry's and venture community's shared belief in the potential of their pioneering work in advanced displays," he adds.

Mojo Vision developed what as claimed to be the world's smallest, densest micro-LED display for dynamic content in 2019. The firm's micro-LED technology delivers tiny pixels with ultra-high brightness, high efficiency, and a slim form factor.

"Mojo Vision developed a world-class AR display the size of a grain of sand and is now extending that same technology across the industry for the next generation of displays," says Mojo Vision's co-founder & chairman Drew Perkins.

www.mojo.vision

GE Licensing, Current Lighting, Savant and Seoul Semiconductor enter into patent license agreement

Seoul Semiconductor acquires license to PFS patent portfolio

GE Licensing (GEL), Current Lighting Solutions LLC, Savant Systems Inc and South Korean LED maker Seoul Semiconductor Co Ltd (SSC) have entered into a patent license whereby SSC has acquired a license to a PFS (also known as KSF) patent portfolio for all application fields widely licensed by the LED industry.

Seoul Semiconductor says that, due to this collaborative agreement, it has emerged as the unique beneficiary of GEL's PFS patent portfolio for all applications, such as display, lighting and automotive. The impact of this agreement in the emerging electric vehicle sector should be especially critical, where the parties expect the benefits of in-vehicle displays and lighting containing PFS to significantly reduce power consumption.

"We are pleased to welcome SSC back to the ranks of our PFS licensees, so that we can both focus on innovating and creating LED products that are critical to the world," says GE Licensing's president Patrick Patnode.

"Seoul Semiconductor, as a company that respects intellectual property rights, values the patent portfolios of GE Licensing, Current Lighting and Savant," says Chung H. Lee, founder of Seoul Semiconductor and Seoul VioSys. "The rights granted today in this license agreement further strengthens Seoul Semiconductor's second-generation patent portfolio of 18,000 patents and significantly enhances our ability to move products to the market," Lee adds.

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ams OSRAM to raise €2.25bn to cover financing needs until 2025/26

Financing of €1.9bn comprises €800m in rights issue, €800m in senior unsecured notes and €300m via asset-level financings in fall/winter, followed in 2024 by €350m via debt instruments

To strengthen its balance sheet long-term for structural growth (targeting 'investment grade' profile by 2026), ams OSRAM GmbH of Premstätten, Austria and Munich, Germany plans to secure a total of €2.25bn through the combination of a capital increase, new corporate bonds, and other financing instruments.

"Firstly, we have sharpened our strategy towards structural growth. Secondly, we are cleaning-up our semiconductor portfolio by exiting non-performing businesses. Thirdly, we are making our organization efficient and accountable," says CEO Aldo Kamper. "The foundation for 're-establishing the base' of ams OSRAM is having a solid and sustainable capital structure. With the holistic financing plan we present today, we aim to put our balance sheet on a solid footing, such that we can fully concentrate on executing our strategy for growth, higher profitability and monetizing innovation."

The financing follows a multi-stage plan: A rights issue of €800m (expected this fall/winter 2023/24) will be combined with an issuance of senior unsecured notes in € and US$, which are expected to raise a total of about €800m. The volume of the capital increase, approved at an extraordinary general meeting (EGM) of shareholders meeting in Premstätten on 20 October, is underwritten by the banks HSBC, Morgan Stanley and UBS. In addition, ams OSRAM expects to execute certain asset transactions — such as sale & lease-backs of corporate assets, to keep overall borrowing cost lower in a high-interest environment — in winter 2023/24 to raise a further €300m. The total financing package is expected to be completed in 2024 with an additional €350m in a mix of debt instruments, such as unsecured notes, bi-lateral debt facilities, or other instruments — the mix will be subject to market conditions.

"Our comprehensive plan consists of new equity to reduce gross and net debt as well as new senior notes to refinance additional outstanding debt with a well-balanced maturity profile," says chief financial officer Rainer Irle. "We will also use additional financing instruments, such as sale & lease-back transactions, with the aim of bringing the company on track to reach a healthy investment-grade leverage."

The financing plan creates a base for the strategic realignment of ams OSRAM, which is focusing its semiconductor portfolio on its profitable core business with intelligent sensor and emitter components. The firm hence aims to expand what it claims is its leading position in the relevant automotive, industrial and medical sectors. This will be complemented by selected offerings for the consumer electronics markets, such as micro-LEDs. The Automotive & Specialty Lamps segment continues to be an important part of the group after its portfolio was cleaned up and is delivering sustainable double-digit adjusted EBIT margins.

The new strategy and the associated efficiency program 'Re-establish the Base' aim to align the group with the focused semiconductor portfolio and to strengthen profitability with expected run-rate savings of about €150m by the end of 2025. ams OSRAM says that it is well on the track to achieve this. The organizational adjustments to strengthen accountability and to make the set-up leaner (e.g. reducing from four to three business units) are close to being fully implemented. Preparations are progressing for the exit of the passive optical components business, which is no longer part of the core business. Initial talks with interested parties are promising, says the firm. Potential proceeds from a sale of the non-core semiconductor portfolio could also be used to reduce leverage.

Placement and later repurchase of treasury shares

ams OSRAM intends to sell its entire self-held 12.86 million of treasury shares prior to the start of the rights issue. Under Austrian corporate law, the treasury shares are not entitled to subscription rights in the event of a capital increase. Essentially, the sale is a technical measure to avoid automatic dilution. Consequently, ams OSRAM intends to repurchase treasury shares in the market after execution of the rights issue to cover outstanding obligations under its long-term incentive programs. Details of this public share buyback program will be determined by the management and the Supervisory Board and communicated in due time.

Senior unsecured notes

The firm plans to issue senior unsecured notes (a mix of €, US$ and potentially staggered maturities) totaling about €800m in 2023. The new issuance is interlinked with the rights issue. Any new bond issuance could also be combined with a tender offer for the outstanding senior notes to optimize the debt structure and interest costs and allow existing bondholders to roll over their risk exposure.

Assets transactions to optimize borrowing cost

In view of the increased interest rate level compared with 2020, the company plans asset transactions including, for example, selling certain company assets and subsequently

leasing them back. The implicit borrowing costs of such transactions are typically lower compared with straight debt financing and thus will be designed to optimize overall borrowing costs under the planned financing package. These transactions are planned to amount to €300m. Further details will be published once contracts have been signed.

Extension of revolving credit facility and OSRAM Licht minority share holdings

ams OSRAM's core relationship banks are expected to extend the currently undrawn €800m revolving credit facility (RCF) by one year to September 2026. The RCF mainly serves as a backstop for the outstanding put options of the OSRAM Licht AG minority shareholders. The put options (including compounded interest) stood at €748m as of 30 June, representing about 17% of total shares outstanding.

State funding or grants

The firm has received confirmation for grants and support by state entities showing confidence in its innovation and industrialization power — e.g. funding from the IPCEI (Important Project of Common European Interest) and the Malaysian Investment Development Authority (MIDA) — and will continue to apply under eligible schemes globally. All governmental grants combined, the firm expects a high triple-digit million EUR amount of support until 2033. Such support is typically tied to certain milestones that need to be achieved per scheme. These fundings allow the company to accelerate the related technology developments, as they typically support R&D expenditures or partially cover investments in property, plant & equipment and are reflected in the company's business plans.

Pro-forma equity ratio at about 30% after implementing complete financing plan

Upon completion of all financing measures, ams OSRAM will have strengthened its balance sheet, with an expected pro-forma equity ratio (i.e. the ratio of equity to total assets) of about 30% (compared with 18% in June) and a smoother debt maturity profile. The financing would result in a pro-forma group leverage ratio (as of second-quarter 2023) below 2x, defined as net debt/adjusted EBITDA. The firm will work towards fulfilling all requirements for achieving investment grade over time.

Change in Supervisory Board

After Dr Wolfgang Leitner resigned from the firm's Supervisory Board in early September due to personal reasons, the EGM on 20 October also elected Arunjai Mittal to the board in a by-election. With over 30 years of experience in the industry, Arunjai is expected to further strengthen the technology and industry expertise of the Supervisory Board.

www.ams-osram.com

ams OSRAM adds 0.33" DLP-compatible LEDs to OSTAR Projection Power range

LE xx P1MS/AS LEDs produce up to 880lm on projector level in four-channel configuration

ams OSRAM GmbH of Premstätten, Austria and Munich, Germany has added four new LEDs to its family of OSTAR Projection Power products. The new LEDs are said to produce superior optical performance in projection equipment that is based on a 0.33" DLP (Digital Light Processing) imager.

Available now in production volume, the new OSTAR Projection Power LE xx P1MS/AS LEDs have a very close etendue match with the 0.33" DLP imager.

The new LEDs are available in Blue (LE B P1MS-EQET-23), Amber (LE A P1MS-RQRU-2), Deep Blue (LE D P1MS-ETFQ-R) and Converted Green (LE CG P1AS-TPTS-A) colors. When used in a typical four-channel configuration, these OSTAR Projection Power LEDs produce an output of 880lm on projector level. This is 5% brighter than the next best 0.33" DLP-compatible LEDs available from competitors, according to internal ams OSRAM tests.

The OSTAR Projection Power LE xx P1MS/AS LEDs are supplied in a compact package with a footprint of just 6.8mm x 7.6mm. The package has a copper metal-core PCB with isolated solder pad, making thermal system design easier and reducing the cost of thermal components.

The thermal performance of the OSTAR Projection Power LE xx P1MS/AS also supports very high current density and brightness — 6.6A/mm^2 for the Blue, Deep Blue and Converted Green LEDs, and 4.5A/mm^2 for Amber.

In multi-channel configurations, the LEDs support serial connection with a low forward current, enabling the use of a simpler, lower-cost LED driver.

"More vivid colors and sharper contrast in products such as home theatre projectors are now possible thanks to the high brightness of the latest OSTAR Projection Power LEDs and their excellent etendue match with 0.33" DLP imagers," says senior marketing manager Tony Tam.

The new OSTAR Projection Power LE xx P1MS/AS LEDs are suitable for other applications as well as projectors, including endoscopes, 3D scanners, and machine vision equipment.

www.ams-osram.com/applications/industrial/projection-display

NS Nanotech awarded $1m grant from NSERC to develop nanoscale LEDs and lasers

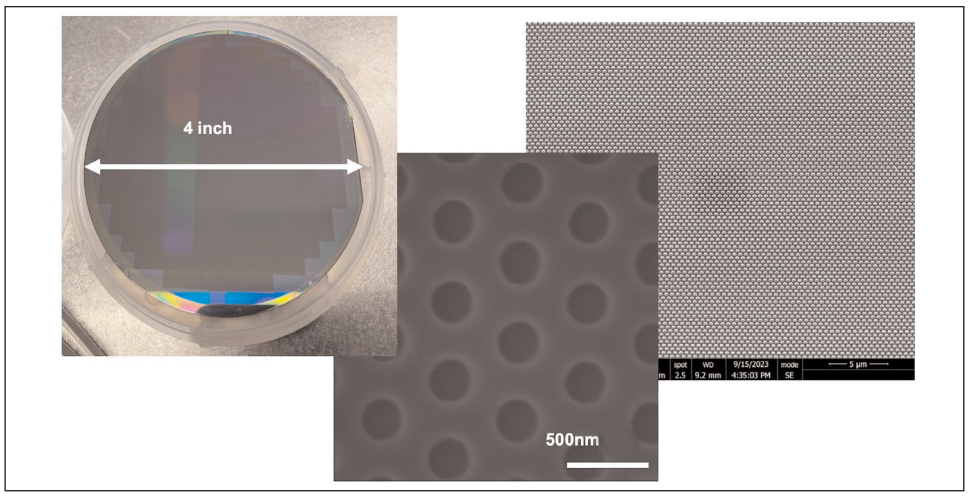
Collaboration with McGill University to help grow NS Nanotech's Canadian R&D operations

NS Nanotech Canada Inc in Montréal, Québec (founded in November 2022) has been awarded a two-year Alliance Grant from the Natural Sciences and Engineering Research Council of Canada (NSERC) for research into the development of nanoscale light-emitting diodes (LEDs) and lasers. NSERC and parent firm NS Nanotech Inc of Ann Arbor, MI, USA (founded in 2017) have committed a total of CDN$1m in funding and in-kind contributions. The firm co-applied for the grant with professor Songrui Zhao of McGill University in Montréal.

NS Nanotech scientists are collaborating with researchers in professor Zhao's laboratory in the Department of Electrical and Computer Engineering to fabricate a new generation of nanoscale gallium nitride (GaN) LEDs. Zhao holds numerous patents and is advancing the state of the art in molecular beam epitaxy (MBE) and other foundational technologies designed to enable orders-of-magnitude improvements in costs and efficiency over existing LEDs.

"We appreciate this substantial support from the Canadian government for the groundbreaking work initiated by professor Zhao and McGill University in the fast-moving worlds of nanotechnology, LEDs and lasers," says Seth Coe-Sullivan, CEO & co-founder of NS Nanotech. "Together we are on a mission to develop the world's first efficient submicron-scale nano-LEDs that will have the potential to disrupt the $120bn global display market."

NS Nanotech Canada's R&D Centre (opened in March) is leveraging exclusive licenses to a portfolio of patents owned by the University of Michigan and McGill University to develop the world's first efficient submicron-scale nano-LEDs and nano-lasers. Commercialization of the laboratory technologies should help to enable next-generation displays for TVs, mobile phones, smart watches, augmented-reality glasses, and other applications including disinfection with ultraviolet light.



Researchers at McGill University and NS Nanotech Canada utilized a standard deep ultraviolet (DUV) optical lithography process on a 4-inch wafter (left) to create a patterned mask (center), enabling uniform growth of submicron-scale gallium nitride nanowires on an optically patterned substrate for the first time. (Source: NS Nanotech Canada).

This summer, the combined team successfully fabricated nanowires on semiconductor wafers, demonstrating the potential for growth of nanoscale LEDs using standard commercial manufacturing processes. It was the first time that a deep ultraviolet (DUV) lithography process had been utilized to grow uniform GaN nanowires on an optically patterned substrate.

"Our collaboration with NS Nanotech's R&D Centre is accelerating our laboratory work developing an entirely new way of creating light-emitting diodes through growth of nanostructures on semiconductor materials," says Zhao. "The NSERC Alliance Grant will help enable additional breakthroughs that our combined team expects to deliver over the next two years."

The NSERC Alliance Grant is the latest milestone in the joint R&D program. Senior students from Zhao's lab have been collaborating with NS Nanotech scientists since early 2023 following the incorporation of NS Nanotech Canada Inc. In March, NS Nanotech received matching funding from McGill University's I&P Partnership Program to support its work with the scientists in Zhao's lab. Also, in September, NS Nanotech Canada opened its first office adjacent to the McGill campus.

"McGill University and Montreal are emerging as important centers of advanced high-technology research, development and commercialization," reckons NS Nanotech Canada's chief operating officer Derrick Wong. "Academic–industrial collaborations like ours will be an important means of ensuring that groundbreaking semiconductor technologies move successfully 'from lab-to-fab' and into commercial markets."

www.nsnanotech.com
www.mcgill.ca/research/innovation/industry/partnership-program

Luminus' new Gen 6 COBs reach 150lm/W at 3000K CCT and 90CRI

LM-80 testing confirms DLC premium lumen maintenance

Luminus Devices Inc of Sunnyvale, CA, USA — which designs and makes LEDs and solid-state technology (SST) light sources for i llumination markets — has announced the launch and immediate availability of its Generation 6 chip-on-board (COB) LEDs with what is claimed to be industry-leading efficacy exceeding 150 lumens per Watt (lm/W) at a correlated color temperature (CCT) of 3000K and a color rendering index (CRI) of 90, with the highest reaching over 184lm/W at a junction temperature of T_j=85°C.

The use of traditional nitride phosphors in the Gen 6 COBs is said to deliver high reliability and an expanded operating range as well as chromaticity stability over temperature, current and time. The COBs are suitable for lighting applications including retail, hospitality, residential, commercial, museum, and high- and low-bay lighting. Special color options, such as Sensus below the black-body curve for whitening warm color temperatures, AccuWhite color rendering to 97 CRI typical, and hospitality color points are all available.

With light-emitting surface (LES) sizes that range from 4mm to 32mm available in a full range of color temperatures and CRIs, the COBs can be used effectively for both indoor and outdoor applications. LM-80 testing confirmed that the parts are capable of achieving Design Lights Consortium (DLC) premium lumen maintenance, requiring greater than 90% lumen maintenance for over 36,000 hours of operation.

"Luminus products don't distort measurement conditions to achieve these results but rather deliver this performance at industry-standard operating conditions," says COB product line director Dave Davito.

The product line is now available through Luminus' authorized distributors with only a six-week lead time and volume available immediately.

www.luminus.com/products/

Luminus launches SST-12 high-power white LED for directional lighting

Compatibility with round-shaped optics aids brightness and color uniformity within beam spots, and provides tighter beam angle and longer beam distance

Luminus Devices has announced the immediate availability of the SST-12, a high-power white LED featuring a patented round emitter that is claimed to set a new standard in directional lighting by significantly enhancing the quality and brightness of beam spots. Compared with square-shaped emitters, the SST-12's round emitter offers advantages: its compatibility with typically round-shaped optics results in superior brightness and color uniformity within beam spots, and it provides a tighter beam angle and longer beam distance, making it a suitable choice for a wide range of directional lighting applications.

Available now through Luminus' authorized distributors, the SST-12 LEDs are specially designed for directional lighting applications, catering to both portable lights and architectural directional lighting needs. Notably, the high color rendering index (CRI) version, SST-12-WxH, has a CRI of greater than 95. With a typical efficacy of 116lmW at an injection current of 0.35A and a junction temperature (T_j) of 85°C (3000K), the SST-12-WxH LED is targeted at interior directional light fixtures such as spotlights, track lights, task lights, wall washers, and more.

"As the SST white LEDs have been very popular in directional lighting applications across multiple markets, we continue optimizing our SST LED sources to not only enhance the optical performance but also deliver the superior quality of light for the end customers," says senior business line director Yves Bertic.

www.luminus.com/products/white

SuperLight Photonics secures seed funding in investment round with DeepTechXL and oost NL

Wideband laser University of Twente spin-off to develop light sources for medical, industrial, automotive safety and data exchange applications

SuperLight Photonics of Enschede, the Netherlands — a spin-off from the University of Twente that is developing a wideband laser light source for measurement and detection applications — has completed a seed investment round led by DeepTechXL in collaboration with regional development agency Oost NL (operating on behalf of the Province of Gelderland, the Province of Overijssel, and the Ministry of Economic Affairs & Climate). SuperLight Photonics reckons that it will hence be able to further develop its platform technology into unique products and (sub)systems.

The wideband laser is based on the patented platform technology of founder Haider Zia, who was previously a researcher at the University of Twente, specializing i n integrated and nonlinear optics. The firm says that, by using colors in light to transmit information, the technology has numerous potential applications, such as creating 3D images of eyes for opticians or aiding dermatologists in detecting skin cancer. Beyond the medical sector, laser technology can be used, for example, to detect small cracks in oil or gas pipelines or to enhance optical safety sensors in smart cars.

"We aim for a swift market entry, relying on the robust photonics ecosystem in the Netherlands and Twente," says CEO Cees Links. "In the coming years, SuperLight Photonics is poised for significant growth, market establishment, and further scaling. We eagerly anticipate market responses to our upcoming product launches at the PIC Summit Europe photonics event on 7–8 November in Eindhoven," he adds.

"We are delighted with our two new investors, both active within the Dutch photonics ecosystem. Their deep knowledge and extensive networks, both nationally and internationally, are an invaluable addition," comments chief technology officer Dr Haider Zia. "They support the continued development of new knowledge within our photonics applications, emphasizing our commitment to technological advancement," he adds.

"The unique technology aligns with our goals of achieving societal objectives such as faster, more cost-effective data generation and disease detection. In the long run, it could also contribute to more energy-efficient data exchange," says DeepTechXL partner Ron Maurer.

"Through Innovatiefonds Overijssel, a fund of the Province of Overijssel managed by Oost NL, we can contribute to the solid establishment and growth of a unique photonics company," reckons Jacob Issa, investment manager Tech at Oost NL. "Ultimately, this technology can make a substantial contribution to critical challenges of our time in various sectors. Through further connections and collaborations with photonics companies in Twente, the Netherlands, and beyond, SuperLight Photonics can rapidly evolve in the coming years."

www.superlightphotonics.com
www.utwente.nl/en/tnw/lpno

Excelitas appoints new CEO and CFO

New leadership aims to accelerate profitable growth

Excelitas Technologies Corp of Waltham, MA, USA (which provides customized photonic solutions to OEMs) has appointed Ron Keating as its new chief executive officer and Ben Stas as chief financial officer.

Keating and Stas succeed former CEO David Nislick and former CFO Jim Rao, who have announced their retirements.

"Nearly 20 years ago, I joined Excelitas, the past 13 of which I had the privilege of serving as its CEO," said David Nislick. "Jim and I are both committed to ensuring a smooth transition and have committed time to support new leadership," adds Nislick, who will remain on the board as an independent director.

"Over the last 13 years, David and Jim have built Excelitas into a leading industrial technology company," comments Vinay Kumar, board member and partner of AEA Investors. "We have known Ron Keating and Ben Stas for over a decade and believe they can accelerate the success of Excelitas as it enters a new phase."

For the last nine years, Keating has been president & CEO of Evoqua Water Technologies, which he took public in 2017. In the last year, he successfully led the sale of Evoqua to Xylem.

Stas served alongside Keating at Evoqua as executive VP, chief financial officer and treasurer. The two also worked closely together at Kennametal, where they served in leadership positions before moving to Evoqua.

www.excelitas.com

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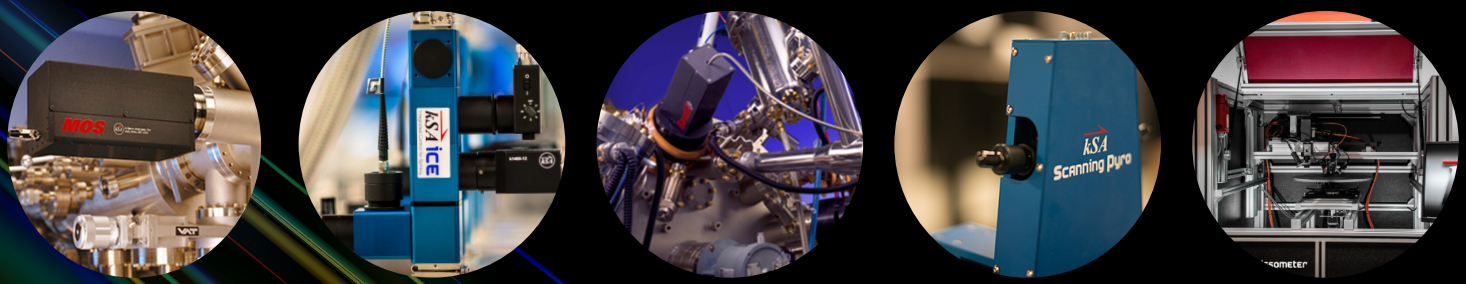

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LESSENGERS begins volume production of 800G AOCs and transceivers

Direct optical wiring technology targets AI/ML clusters and hyperscale data-center operations

LESSENGERS Inc of Seoul, South Korea, which provides optical components based on its patented direct optical wiring (DOW) technology, says that its new 800G transceiver product (800G OSFP SR8) will begin volume production in fourth-quarter 2023 and then begin shipping to customers.

DOW is a polymer-based air-clad waveguide technology that is particularly useful for optical interconnects in the data-center and high-performance computing (HPC) environments.

DOW connects active photonic devices such as laser diodes or photodiodes directly to the optical fiber, providing high-density and high-speed optical signal connectivity between switches, servers and other devices within the data center or high-performance computing clusters. This capability enables several operational efficiencies and economic benefits, such as:

- no active alignment — cost-competitive optical coupling;
- no use of multi-channel lens assembly — near-zero optical crosstalk;
- no air gap — dramatically lower reflection noise;
- high degree of freedom in heat sink design — much lower junction temperature.

These attributes are said to make the 800G OSFP SR8 and other products for high-speed active optical cables (AOCs) and transceivers high-performance, highly reliable and cost compelling, it reckoned.

"Demand for optical connectivity in AI clusters is accelerating innovation," notes Dr Vladimir Kozlov, CEO & founder of market analyst firm LightCounting. "New designs of pluggable and co-packaged optical engines rely on high-density parallel connectivity, which need new packaging and fiber-coupling methods. Direct optical wiring, developed by LESSENGERS, is a great example of such new approaches," he adds.

"The use of DOW technology enables us to achieve high-performance and low-noise optics by its nature, allowing us to streamline the production process flow with complete automation," says LESSENGERS' CEO Chongcook Kim.

http://lessengers.com

POET collaborates with Yuanjie for laser supply as optical engines enter volume production

Joint venture SPX to start production of 100G CWDM4, POET ONE, 100G LR4 and 200G FR4 optical engines

POET Technologies Inc of Toronto, Ontario, Canada — designer and developer of the POET Optical Interposer, photonic integrated circuits (PICs) and light sources for the data-center, telecom and artificial intelligence (AI) markets — is enabling its joint venture Super Photonics Xiamen (SPX) to ramp optical engines to high-volume production by utilizing the high-speed indium phosphide (InP) lasers of Yuanjie Semiconductor Technology Inc (YST), which was founded on 28 January.

"As we start ramping production of our optical engines, securing an additional reliable laser source that is well established in the industry with known good quality is of utmost importance to our business," says POET's chairman & CEO Dr Suresh Venkatesan. "Our partnership with YST has enabled POET and SPX to deliver reliable, high-performance optical engines to customers. SPX will start production of 100G CWDM4, POET ONE (a 100G single-chip TxRx engine), 100G LR4 and 200G FR4 optical engines using YST's directly modulated lasers (DMLs) this month and we expect to extend the collaboration to other products in the future," he adds.

"Our superior quality lasers and reputation for reliability will complement POET's Optical Interposer technology, which offers a unique and highly adaptable platform to module makers," comments YST's CEO & chairman Peter Zhang. "We will continue to collaborate with POET on high-speed optical engines while supporting SPX to ramp current products to high-volume production."

POET, SPX and YST will initially collaborate on 100G CWDM4, POET ONE, 100G LR4 and 200G FR4 transmitter products. All the design verifications and reliability testing of the optical engines is complete and all will be released to production during October. Current module customers for these products include ADVA, Beijing FeiYunYi (BFYY) and Fibertop, along with others whose names have not yet been disclosed.

www.poet-technologies.com

DustPhotonics unveils first merchant single-chip 800G DR8 photonic integrated circuit

Hyperscale data center and AI applications include immersion cooling and reduced-reach connectivity

At the European Conference on Optical Communication (ECOC 2023) in Glasgow, Scotland, UK (2–4 October), DustPhotonics of Modi'in, Israel — which was founded in 2017 and develops silicon photonics technology and solutions — announced what is claimed to be the industry's first merchant single-chip 800G DR8 photonic integrated circuit (PIC). In its booth, DustPhotonics also had multiple live demos of this product highlighting its operation in several applications.

The 800G PIC is a single-chip solution suitable for DR8 and DR8+ applications, providing eight optical channels independently modulated at 100Gb/s for an aggregate bandwidth of 800Gb/s. The chip is designed into a compact 7.5mm x 7mm package, enabling it to be used in industry-standard QSFP- and OSFP-style form factors. The device is suitable for reaches up to 2km in applications including hyperscale data centers and artificial intelligence (AI) and machine learning (ML) clusters.

The PIC includes on-chip lasers, incorporating DustPhotonics' patented L3C (low-loss laser coupling) technology, whereby off-the-shelf lasers from different manufacturers can be integrated with the PIC. This is said to allow advantages in product performance, cost, power and supply chain scalability.

DustPhotonics is demonstrating this device in multiple configurations including a traditional 800GBASE-DR8 application, an immersion cooling application, and a reduced-reach application. The immersion cooling demo showcases how this chip is suited to being immersed in a liquid coolant, since there is no free-space interface between the laser and PIC or at the fiber attach interface at the optical output of the chip. For the reduced-reach application, DustPhotonics is demonstrating a second, cost-optimized version of the product suitable for transceivers or active optical cables (AOCs) up to 100m, or for linear-drive pluggable optic (LPO) applications.

"We are seeing a lot of customer traction for this 800G application," says CEO Ronnen Lovinger. "We are well-positioned for the next phase of the company, which is to scale into high-volume manufacturing," he reckons.

"We have been encouraged by the growth of the 800Gb/s market, and we believe DustPhotonics single-chip PIC solution will help fuel adoption while easing some of the early supply chain constraints we are seeing in the industry," comments Vladimir Kozlov, founder & CEO of optical communications market research firm LightCounting.

The device is sampling to customers now and is expected to be in production by first-quarter 2024

www.ecocexhibition.com
www.dustphotonics.com

TRUMPF and KDPOF showcasing first 980nm multi-gigabit interconnect system for automotive systems

Partners implementing new IEEE Std 802.3cz standard in automotive optical datacoms

At the European Conference for Optical Communication (ECOC 2023) in Glasgow, Scotland, UK (1–5 October), TRUMPF Photonic Components GmbH of Ulm, Germany (part of the TRUMPF Group) — which makes vertical-cavity surface-emitting lasers (VCSELs) and photodiodes for the consumer electronics, datacoms, industrial sensing & heat treatment and automotive markets — and fabless semiconductor firm KDPOF of Tres Cantos, Madrid, Spain – a supplier of automotive gigabit connectivity over POF (plastic optical fiber) – showcased the first 980nm multi-gigabit interconnect system for automotive systems.

"After a long-term cooperation, it's great to have entered the stage where we can prove to end-users the true strength of 980nm optical interconnects," says Ralph Gudde, VP marketing & sales at TRUMPF Photonic Components.

Both companies aim to implement state-of-the art optical data communication standards and solutions for the automotive industry. Due to the push in the automotive sector towards autonomous driving, a large amount of data must be processed in cars. Consequently, optical interconnects are required to manage the data flow as a nervous system, connecting sensors and electronic brains, while tight electro-magnetic interference (EMI) requirements are met. As this trend is increasing, TRUMPF and KDPOF entered a strategic partnership as early as 2022 to combine their knowledge of components and networks for data communication. Now, significant progress is being made with the first implementation of the new standard IEEE Std 802.3cz (nGBASE-AU), consisting of a transceiver that integrates electronics, photonics and optics in a single IC component. Evaluation kits will soon become ready for OEMs to test.

"Automotive is a very demanding industry. The IEEE Std 802.3cz standard is therefore focusing on highly reliable conditions that enable lifetimes of 15 years and more, with low cost and high-volume implementations", notes Rubén Pérez-Aranda, KDPOF's chief technology officer. "Having suppliers like TRUMPF in the 802.3cz working group enriched the discussion with their deep manufacturing and design knowledge of VCSEL and photodiode components, which in turn enabled the production of a serious and dependable standard," he adds. "With our strategic partnership we are going one step further and are targeting optical networks to become an indispensable part of future cars."

Automotive applications require not only a much wider range of operating temperatures, reaching from minus 40°C up to +125°C but also a low interconnect length of less than 40m. For superior robustness against wear and random failures, the 980nm-wavelength VCSEL was approved as the new standard. Besides its performance characteristics, 980nm suits the existing OM3 fibers with low dispersion loss.

www.ecocexhibition.com
www.kdpof.com

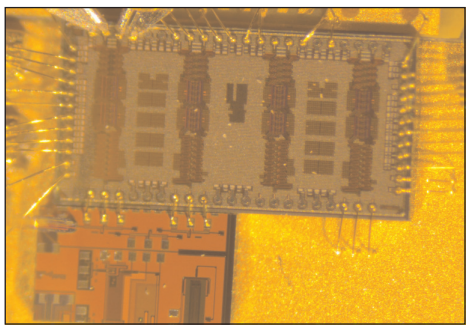
imec presents SiGe BiCMOS optical receiver achieving gross data rate of 200Gbps

Traveling-wave SiGe BiCMOS TIA combined and silicon photonics germanium photodetector

At the European Conference on Optical Communication (ECOC 2023) in Glasgow, Scotland, UK (2–4 October), researchers from IDLab, a team at Ghent University, Belgium from Leuven-based microelectronics research center imec, have presented an optical receiver achieving a gross data rate of 200Gbps. Their approach, combining a SiGe BiCMOS traveling-wave electronics integrated circuit and a silicon photonics germanium photodetector, offers not only speed but also scalability: two prerequisites for meeting exploding data-rate needs.

"Currently, the most performant optical datacom transceivers operate at speeds up to 800Gbps, using for example 8 x 100Gbps channels, but the field is envisioning doubling the channel capacity to 200Gbps to reduce the transceiver complexity, cost and power consumption while improving manufacturing yield," says Peter Ossieur, program manager for high-speed transceivers at imec's IDLab and professor at Ghent University.

Ossieur is leading a team of researchers working towards high-speed integrated circuits for photonics applications. His team has now achieved a gross data rate of 200Gbps by co-integrating a traveling-wave SiGe BiCMOS transimpedance amplifier (TIA) with a silicon photonics germanium photodetector.



Closeup of imec's SiGe BiCMOS optical receiver that achieves a gross data rate of 200Gbps

Aside from the speed, the use of mainstream SiGe BiCMOS makes the technology more scalable and therefore affordable. "An alternative to reach such speeds are InP electronics, which is a more expensive and less scalable technology," says Ossieur. "SiGe BiCMOS allows us to integrate more functionalities and the chips can also be manufactured at higher volumes."

If optical transceivers are to keep up with exploding data rates, all building blocks need to handle higher speeds. The team demonstrates their result in a setup with a silicon photonics Ge photodetector from imec's integrated silicon photonics platform (iSiPP), targeted at the telecom, datacom and medical diagnostics industries.

"The new optical receiver represents one of the many steps imec is taking to ready its silicon photonics platforms for demanding 200Gbps-and-beyond applications," says Joris Van Campenhout, fellow & program director optical I/O at imec. "These latest results represent one more data point showcasing the capability of imec's silicon photonics platform (iSiPP) to operate at lane rates of 200Gbps, a key requirement for upcoming pluggable and co-packaged optics," he adds.

The work received support through European Union's Horizon 2020 projects POETICS (No 871769) and NEBULA (No 871658).

www.ecocexhibition.com
www.imec-int.com

OIF's multi-vendor interoperability demonstrations at ECOC feature 39 firms

Demos span 400ZR+, co-packaging, CEI-112G & CEI-224G and CMIS

The Optical Internetworking Forum (OIF) says that, at the European Conference on Optical Communications (ECOC 2023) in Glasgow, Scotland, UK (2–4 October), a record 39 companies demonstrated innovation and collaboration across four sectors: 400ZR+ optics, co-packaging solutions, Common Electrical I/O (CEI) channels and Common Management Interface Specification (CMIS) implementations.

"This year's massive demo is a testament to the collective progress made by the industry," says Alphawave Semi's Mike Klempa, chair of the OIF Physical & Link Layer Interoperability Working Group. "With a focus on some of the most critical technologies driving industry progress, we will illustrate the exceptional strides OIF members have taken in fostering compatibility and facilitating innovation."

The live and static interoperability demos included:

- 400ZR+ Optics Demo: Exhibiting optical networking technologies that enable high-speed data transmission over extended distances, opening new horizons for data centers and telecommunication networks.

OIF says that its 400ZR project has played a pivotal role in facilitating the reduction of power and complexity for high-bandwidth data-center interconnects and promoting interoperability among optical module manufacturers. This year's public demonstration has been expanded to showcase progress including OpenZR+ and OpenROADM applications over a multi-span ROADM network.

The ECOC demo consists of a full implementation of 400GE across numerous DWDM networks using multiple vendors — module, router, open-line system and test equipment — all collaboratively demonstrating the realization of interoperability objectives for these projects.

- Co-Packaging Solutions Demo: Showcasing innovative approaches to integrating multiple chips within a single package, revolutionizing performance and power efficiency in electronic devices.

Initiatives to facilitate co-packaging solutions using interoperable electrical and optical interfaces feature efficiency in terms of power consumption and high-bandwidth edge densities. This year's interoperability showcase highlights the key multi-vendor elements essential for enabling co-packaging architectures.

Live demonstrations encompass the use of the External Laser Small-Form-Factor Pluggables (ELSFP) to power an optical link, all while being managed by CMIS. Additionally, various multi-vendor optical connectivity solutions are on display.

- Common Electrical I/O (CEI) Channels: Highlighting advancements in high-speed electrical interfaces, enhancing data-transfer rates and efficiency across various applications.

In 224G hardware interconnection application spaces and definitions, OIF has achieved an industry-first milestone of multi-vendor interoperability at 224G. It is also addressing and defining a low-power, low-latency 112G CEI specification for linear direct-drive optics. This initiative has resulted in the first multi-vendor interoperability showcase of an ecosystem dedicated to advancing these efforts. Live, in the booth, system, linear pluggable optics and test & measurement equipment vendors are collaboratively demonstrating the advantages of this technology.

The CEI-224G and 112G demonstrations showcase multi-party silicon supplier interoperability across a diverse array of long-reach (LR), medium-reach (MR) and very-short-reach (VSR) links that address many widely used applications.

- CMIS Implementations: Demonstrating management interfaces across diverse networking equipment, promoting streamlined control and management.

CMIS has established itself as the management interface of choice for next-generation pluggable modules, capable of managing both simple and advanced modules. It provides a well-defined mechanism to initialize and manage optical and copper modules in a standard way, while still providing the capability to provide custom functionality. This commonality makes integrating different host platforms easier for both the host and module vendors.

The live CMIS demos showed a variety of CMIS-managed modules in routers, switches and test gear from different vendors and showcased how CMIS is used to manage modules in real-world applications.

OIF member companies participating in the demo were Adtran; Alphawave Semi; Amphenol; Applied Optoelectronics Inc; Broadcom Inc; Cadence Design Systems Inc; Casela Technologies; Ciena; Cisco Systems; Coherent; Credo Technology Group; Eoptolink; EXFO; Fujitsu Optical Components; Hisense Broadband; Infinera; Juniper Networks; Keysight Technologies; Linktel Technologies; Lumentum; MACOM Technology Solutions; Molex; MultiLane Inc; NEC Corp; Nokia; O-Net Technologies; Precision Optical Technologies; Quantifi Photonics; Samtec; Semtech; Senko Advanced Components; Sicoya; Source Photonics; Sumitomo Electric Industries; Synopsys; Telefonica S.A.; VIAVI Solutions and Wilder Technologies. The interoperability demo was supported by participating companies Telefonica as the hosting consulting network operator and LightRiver as a host for technology-specific pre-demonstration integration testing.

www.oiforum.com

OpenLight partners with Spark to scale design services

Partnership cuts time to market and accelerates development of PICs

OpenLight of Santa Barbara, CA, USA (which launched as an independent company in June 2022, introducing the first open silicon photonics platform with heterogeneously integrated III-V lasers) has announced a strategic partnership with Spark Photonics of Waltham, MA, USA, which provides pure-play end-to-end integrated photonics design, layout and consulting services across silicon, silicon nitride, indium phosphide and lithium niobate platforms.

Spark will now offer design and layout services using the OpenLight process design kit (PDK) with the IPKISS design layout and simulation software suite of Luceda Photonics of Dendermonde, Belgium. The expansion of design services increases the number of designs that OpenLight can support at any one time on the Tower Semiconductor PH18DA process, reducing time to market for photonic integrated circuits (PICs) and expanding the silicon photonics industry's reach to drive advancements across applications.

"With the integration of industry-leading expertise and resources from OpenLight and Luceda coupled with best-in-class design services from Spark, we are fostering a new era for customers to tape in MPW engineering and production wafer run designs directly to Tower," says OpenLight's Dr Adam Carter. "This partnership empowers our customers to address distinct design needs, diversify their design portfolio, and resolve compatibility challenges."

The OpenLight PDK incorporates both active and passive components, enabling access to silicon photonics with heterogeneous integration. Mutual customers now have an array of choices from an EDA tool perspective to ensure first-time success in design verification and implementation.

"This partnership will play a pivotal role in our company's vision to grow the integrated photonics ecosystem," reckons Spark Photonics' CEO Dr Kevin McComber. "Working with OpenLight and Luceda positions us to meet the evolving needs of integrated photonics trailblazers. Customers stand to derive significant benefits from our collective capabilities, including reduced cost and faster turnaround," he adds.

"This collaboration enhances our long-term goal to enable cutting-edge PDK-based design services and meet the demands of diverse applications," says Luceda Photonics' chief technology officer Dr Pieter Dumon.

OpenLight recently introduced its Photonic Application Specific Integrated Circuits (PASIC) technology, which incorporates both passive and active components onto a single silicon photonics chip, resulting in significant improvements in performance and reliability. With the OpenLight PDK, customers can now design their own PASIC chips, offering greater flexibility and customization options.

OpenLight and Spark Photonics design and layout services are available now.

www.openlightphotonics.com
www.sparkphotonics.com

Hyper Photonix showcases transceivers at ECOC

Transceivers involved in interoperability demos by Ethernet Alliance

At the 49th European Conference on Optical Communications (ECOC 2023) exhibition in Glasgow, Scotland, UK (2–4 October), optical transceiver designer and manufacturer Hyper Photonix Ltd of Bellevue, WA, USA featured its latest products at the Ethernet Alliance booth, where it participated in a series of interoperability demonstrations.

Hyper Photonix showcased a range of optical transceivers including: 400GBASE-DR4, 400GBASE-ZR+, 400GBASE-DR4 in a QSFP112, and 800GBASE-DR8. These products, built upon the firm's Hyper Silicon platform, are the latest examples in high-performance optical transceiver technology specifically designed to cater to the growing demand of hyperscale data centers and AI/ML applications.

The interoperability demonstrations provided attendees with a first-hand look at the performance and capabilities of Hyper Photonix's optical transceivers. The firm states that the live demos underscored its commitment to advancing the field of optical communications and ensuring seamless compatibility with various network environments.

"Our 400G and 800G optical transceivers leverage the company's Hyper Silicon technology, which is designed in-house along with an advanced set of PDKs," says director of technology & strategy Brad Booth. "Our presence at ECOC in the Ethernet Alliance booth reflects our commitment to developing innovative solutions while collaborating with industry partners to showcase interoperability," he adds.

"Our range of high-performance silicon photonics transceivers are featured in this industry-wide, interoperability demonstration, highlighting our dedication to seamless integration with host switching platforms and test equipment," says CEO Xavier Clairardin. "This event exemplifies our ongoing efforts to drive innovation, foster collaboration, and contribute to the evolution of optical networking technology."

www.hyperphotonix.com

Coherent and Kinetic extend partnership to enable 100G services at network edge

Coherent Corp of Saxonburg, PA, USA and Kinetic by Windstream, a business unit of communications and software company Windstream that provides fiber-based connectivity, collaboration and security services across 18 states in the USA, have their existing partnership to enable 400G services has been extended to enable 100G services at the edge of the network, leveraging what is claimed to be the industry's first 100G QSFP28 0dBm digital coherent optics (DCO) transceiver.

The rapid growth of data traffic driven by enterprise and cloud networks, including the exponential growth of artificial intelligence (AI) and machine learning (ML) applications, is driving demand for next-generation transmission technology that enables service providers to efficiently expand the capacity of the transport network, note the firms. With the new high-power 100G transceivers from Coherent, Kinetic will be able to optically connect routers directly to access, metro and regional transport networks without additional intermediary interfaces, eliminating an entire layer of optical equipment.

"The 100G QSFP28 DCO transceiver with 0dBm output power is the industry's first, and it enables Kinetic to deploy 100Gbps coherent transceiver technology in the access aggregation networks efficiently and sustainably," says Matthias Berger, VP, coherent technology, at Coherent. "These benefits are achieved thanks to the transceiver's unique features, including Coherent's Steelerton digital signal processor (DSP) optimized for 100G, cost-efficient silicon photonics technology, high-power indium phosphide (InP) tunable lasers, and Flextune technology," he adds.

"We are pleased to expand our partnership with Coherent, which has been vital in accelerating the scale of our network in a sustainable way as we continue to deliver on our commitment to bring fiber connectivity to businesses and homes across rural America," says Kinetic's chief technology officer Jeff Austin. "Coherent's high-transmit-power 0dBm 100G QSFP28 DCO transceivers will add to the existing 0dBm 400G QSFP-DD DCO transceivers to enable Kinetic to deploy greatly simplified network architectures," he adds. "This will further accelerate the revolution in IP-over-DWDM networks to achieve efficiency and scale across our 18-state network, affording Kinetic a highly competitive operational model."

Kinetic validated the new 100G transceiver technology through a live network trial consisting of 820km transmission over 14 cascaded ROADM nodes. The live trial was achieved over a production link at 75% channel capacity carrying a mix of 10G, 100G and 400G signals from multiple technology generations. The 100G transceivers operated flawlessly end-to-end over the network, exceeding optical performance requirements and validating the IEEE electrical interface standard.

www.Coherent.com
www.ecocexhibition.com

Coherent's 200G PAM4 DFB-MZ laser wins ECOC Award for Most Innovative Product

Coherent says that its 200G four-level pulse amplitude modulation (PAM4) distributed-feedback laser and Mach–Zehnder modulator (DFB-MZ), combined monolithically in a photonic integrated circuit (PIC), has won the 2023 ECOC Exhibition Industry Award for Most Innovative Product in the category of Innovative Photonics Component.

The PIC enables 200G per lane in both re-timed and linear pluggable 800G and 1.6T transceivers. The 200G PAM4 DFB-MZ was first demonstrated at March's Optical Fiber Communications conference (OFC 2023) in San Diego, CA, USA (an industry first, it is claimed).

Coherent again gave a live demonstration of the 200G PAM4 DFB-MZ at the European Conference on Optical Communications (ECOC 2023) in Glasgow, Scotland, UK (2–4 October). This live demonstration showcases the DFB-MZ that transmits a 200G PAM4 signal over a 6km fiber.

"We have combined into one PIC the functional elements and integration experience of several of our most advanced devices, which are each breakthrough innovations on their own," says chief marketing officer Dr Sanjai Parthasarathi. "This PIC incorporates our knowledge from electroabsorption-modulated lasers, IQ modulators for coherent applications, and tunable lasers with Mach–Zehnder modulators. It will enable higher-performance, longer-reach PAM4 optical links."

Featuring a channel-specific chirp control that is said to provide excellent dispersion management, the DFB-MZ supports wavelength division multiplexing (WDM), including local area network (LWDM) and coarse (CWDM) wavelength plans. A cooled DFB-MZ supports LWDM for reach up to 10km. An uncooled DFB-MZ supports CWDM for shorter reaches.

www.ecocexhibition.com

Semtech and Coherent demonstrate 200G-per-lane differential driver with 200G DFB-MZ laser

Continued collaboration accelerates 200G-per-lane deployment with advanced optics

High-performance semiconductor, IoT system and cloud connectivity service provider has Semtech Corp of Camarillo, CA, USA has demonstrated its latest FiberEdge 200G PAM4 MZM driver driving the 200G DFB-MZ laser of materials, networking and laser technology firm Coherent Corp of Saxonburg, PA, USA.

Coherent conducted a live demonstration of Semtech's FiberEdge 200G PAM4 Quad MZM driver with Coherent's 200G DFB-MZ laser in Coherent's booth at the European Conference on Optical Communication (ECOC 2023) in Glasgow, Scotland, UK (2–4 October).

"We are very excited to continue our collaboration with Coherent as advanced lasers and optics get developed in the 200G-per-lane space," says Nicola Bramante, senior product line manager for Semtech's Signal Integrity Products Group. "This demonstration confirms once again the interoperability of state-of-the-art 200G lasers with Semtech's latest 200G-per-lane FiberEdge developments, ensuring superior linearity and signal integrity in 200G-per-lane Mach–Zehnder modulator-based applications, both in indium phosphide (InP) and silicon photonics. This enables rapid and scalable deployment of next-generation high-performing and reliable switches in data centers," he adds.

"Coherent continues to demonstrate its leadership in 200G-per-lane laser technology, which is a fundamental building block of 1.6T transceivers with up to 10km reach," says Coherent's chief marketing officer Dr Sanjai Parthasarathi.

The joint demonstration included a differentially driven DFB-MZ InP laser from Coherent and Semtech's PAM4 driver, demonstrating a path toward 1.6T and 3.2T optical transceiver deployments in data centers.

www.Coherent.com
www.semtech.com/optical

Sivers demos DFB laser arrays supporting 4 Terabit GPU-to-GPU communication for generative AI

CTO Andrew McKee also presents at ECOC conference

IC and integrated module supplier Sivers Semiconductors AB of Kista, Sweden says that, at the European Conference on Optical Communication (ECOC 2023) in Glasgow, Scotland, UK (1–5 October), its subsidiary Sivers Photonics of Glasgow, Scotland, UK showcased its range of custom III–V photonic devices at the exhibition, with a focus on CW-WDM MSA compliant 8-wavelength O-band CW DFB laser arrays (shown as part of a live demo).

Specifically, Sivers hosted a joint live demonstration with silicon photonics-based chip-to-chip optical connectivity firm Ayar Labs of Santa Clara, CA, USA, showcasing Sivers' 8-wavelength distributed feedback (DFB) laser array, integrated into the Ayar Labs SuperNova multi-wavelength optical source supporting 4 Terabit data communication.

This joint technology between the firms is said to be driving breakthroughs supporting generative AI applications. As foundational AI models have become larger and more complex, they require more GPU processing and memory capacity. Integrating optical I/O within the GPU package to communicate with the rest of the GPU cluster allows for efficient scaling of infrastructures to handle ever-growing AI demands. By using optical connections instead of electrical connections, power consumption can be reduced by up to 90% while allowing for 5–10x better communication within the AI cluster to increase utilization of all GPUs.

"Electrical communication in generative AI clusters is getting to its limit, with regards to speed, heat and capacity," notes Sivers Semiconductors' group CEO Anders Storm. "With Sivers laser array we will be able to allow for 5–10x better performance with up to 90% less power consumption to give generative AI clusters the performance needed," he adds. "With Sivers' lasers integrated in Ayar Labs SuperNova multi-wavelength optical source, we are working together to solve one of the main challenges for GPU-to-GPU communication to support the future revolution of generative AI applications."

In addition to its presence at the exhibition, Sivers Photonics' interim managing director & chief technology officer Andrew McKee presented 'Advances in InP Laser Arrays for Data Centre and Sensing Applications' on the Market Focus stage in the exhibition area.

McKee was also a speaker and panellist in the symposium 'PICs for Quantum Applications', presenting 'High Performance Laser sources for Hybrid PIC Quantum Applications'.

www.ayarlabs.com
www.sivers-semiconductors.com

Lumentum addresses surge in AI and ML data traffic with high-performance optical solutions at ECOC

Firm introduces InP-based 130+GBaud smart TROSA, 800G ZR+ and 0dBm 400G ZR+ transceivers

Lumentum Holdings Inc of San Jose, CA, USA showcased its latest solutions, conducting live demonstrations, and sharing industry perspectives at October's European Conference on Optical Communication (ECOC 2023) in Glasgow, Scotland, UK.

Product highlights included availability of a 130+GBaud smart transmitter receiver optical sub-assembly (TROSA), and live demonstrations of the new 800G ZR+ and 0dBm 400G ZR+ compact transceivers. These products address the growing need from cloud data-center operators for high-performance optical solutions that support the rapid influx of data traffic and increasing bandwidth requirements driven by new artificial intelligence (AI) and machine learning (ML) applications.

Also, senior principal engineer Brian Smith gave a Market Focus presentation 'The 6th Generation of Fiber Optic Communications: Carrier and Spatial Division Multiplexing (CSDM)', providing his insights on the next era of optical networking, which Lumentum introduced at its LITE 2023 Investor Event in March. The discussion complemented a recently published whitepaper on this topic, now available on the Lumentum website.

New and upcoming products

New optical solutions on display at the show included:

- 800G ZR+ and 0dBm 400G ZR+ compact transceivers, which are crucial components for connecting data centers, enabling IP over DWDM by directly plugging into switches and routers. Available in QSFP-DD and OSFP form factors and utilizing Lumentum's new 130+GBaud smart TROSA, the transceivers offer high output power and extended reach for metro and regional networks. Sampling will begin in December, with official release expected in 2024.
- InP-based 130+GBaud smart transmitter receiver optical sub-assembly (TROSA), which enables data rates of up to 800Gbps on a single wavelength, allowing for a seamless transition to faster network architectures that can support increasing data traffic from emerging AI and ML applications. Lumentum showcased this technology within the Lumentum 800G ZR+ demo. The product is available for sampling now, complementing the nano-iTLA, CDM and ICR optical components that are already available and being operated by multiple customers at up to 150Gbaud.
- M11 series, uncooled 980nm pump modules, which are compact, have low power consumption, comply with Telcordia GR-468-CORE standards, and offer wavelength selection for optimal spectrum control with high power output. They are well-suited for small-form-factor and pluggable EDFAs (erbium-doped fiber amplifiers), high-bit-rate and high-channel-count EDFAs, and CATV distribution. The M11 series pump modules are now available for purchase.

Live demonstrations

Lumentum also conducted and participated in live demonstrations with its latest optical solutions, including:

- 800G ZR+ and 0dBm 400G ZR+ transceivers: Lumentum is demonstrating its 800G ZR+ and 0dBm 400G ZR+ compact transceivers, highlighting the advantages of lower deployment costs for 400G and 800G networks, a simplified architecture, and interoperability through multiple sourcing options. They also support traditional carrier upgrade cycles to 400G routers.
- CPO/ELS technology: Lumentum's ultra-high-power 1310nm distributed-feedback laser (DFB) was demonstrated at over 400mW optical power ex-fiber at 25°C. These new ultra-high-power 13xx lasers will enable higher bandwidth for AI and ML applications by using co-packaged optics and external laser source solutions, as well as silicon photonics transceivers for the next generation of data centers.
- OIF 400ZR+ interoperability and CMIS demonstrations: At the OIF booth, Lumentum participated in OIF's 400ZR Interoperability demonstration through the integration of its 400ZR+ QSFP-DD and OSFP transceivers, which enable high-speed data transmission over long distances. The demonstration aims to show how optical module manufacturers are reducing power consumption and complexity in data-center interconnects, while promoting interoperability.

Lumentum also participated in the OIF's Common Management Interface Specification (CMIS) demonstration with its Open ZR+ and 400ZR QSFP-DD transceiver. CMIS has become the common, yet flexible, management interface that provides both host and module vendors an interoperable path for integration and feature development.

"As the technology landscape evolves at a breakneck pace and the relentless need for data-intensive applications persists, we've designed our products to support the increased level of efficiency and performance that's essential in this new era," emphasizes Wupen Yuen, president, Cloud and Networking, at Lumentum.

www.ecocexhibition.com
https://resource.lumentum.com/s3fs-public/technical-library-items/csdm-wp-oc-ae.pdf

Lumentum releases 2023 Corporate Sustainability Report

Third annual sustainability report highlights 25% year-on-year decrease in emissions, new employee development programs, and decrease in power consumption across multiple products

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 issued its fiscal 2023 Corporate Sustainability Report, highlighting its environmental, social and governance progress and achievements.

"I am extremely proud of the significant progress made on many of the company's sustainability goals, especially during a year with multiple acquisitions and new product introductions," says president & CEO Alan Lowe.

Highlights include:

Planet – Lighter Impact: Progress on Climate Goals During an Acquisition Integration Year: Lumentum continues to make substantial progress on its goal of achieving net-zero Scope 1 and 2 emissions by 2030, and remains committed to aligning its emission reduction targets with the Science-Based Targets initiative (SBTi).

- Achieved a 25% decrease in Scope 1 and 2 greenhouse-gas (GHG) emissions compared with fiscal 2022, despite the integration of two acquisitions and subsequent expansion in facility footprint.
- Doubled the percentage of renewable energy sourced for global operations, from 31% to 61% in fiscal 2023.
- Transitioned three additional sites to 100% renewable electricity, bringing the total to 11 sites.

People – Positive Impact: New Career Development and Diversity, Inclusion, Belonging (DIB) Programs: Lumentum says that it is committed to enabling its workforce to thrive, while fostering a diverse and inclusive culture where all employees feel welcomed and supported.

Among the new programs and initiatives established in fiscal 2023 to fulfill this commitment were:

- The introduction of four new Employee Resource Groups (ERGs) to create a diverse and supportive working environment.
- The launch of multiple new leadership development certificate programs in partnership with Duke University, including the Aspire Certificate Program that was completed by nearly 100 early career professionals around the world.
- An expanded Lumentum mentorship program, encompassing over 330 participants, to advance employee growth and retention.

Innovation – Breakthrough Impact: Significant Power Reduction Realized across Multiple Product Lines: Lumentum says that technology innovation is core to its commitment to improving the energy efficiency and power consumption of its products, while still enabling high-speed connectivity for customers and end users.

Newly designed products in fiscal 2023 included significant advancements such as:

- Wavelength-selective switch (WSS) TrueFlex products, which achieved 20–50% power reduction per switching capacity through innovative design improvements and functional integration.
- High-speed digital coherent optical data transmission modules used in internet backbone applications, which achieved a 79% reduction in relative power (W/Gb) usage (Gen 3 800G versus 100G).
- 200G PAM4 externally modulated lasers (EMLs), which were recognized in the 2023 Lightwave Innovation Reviews for providing innovative and cost-effective solutions that lower power consumption for the industry. The Lightwave award marks the second industry win for the company's EML products, following last year's award from the European Conference on Optical Communication (ECOC 2022) for the 'Data Center Innovation/ Best Product of 2022' award.

"It takes constant effort, over time, to enact lasting change when it comes to sustainability initiatives," notes Lowe. "We remain committed to consistently monitoring our progress and improving our processes year over year to achieve our long-term goals," he adds.

The report has been prepared in accordance with the Global Reporting Initiative (GRI) Standards for sustainability impacts, applies the standards of the Sustainability Accounting Standards Board (SASB), and references the United Nations Sustainable Development Goals (UN SDGs).

www.lumentum.com/en/company/sustainability

NREL sets efficiency record of 27% for a single-junction GaAs cell grown by D-HVPE

III-V cell efficiency boosted by using GaAs/ GaInAsP heterojunction

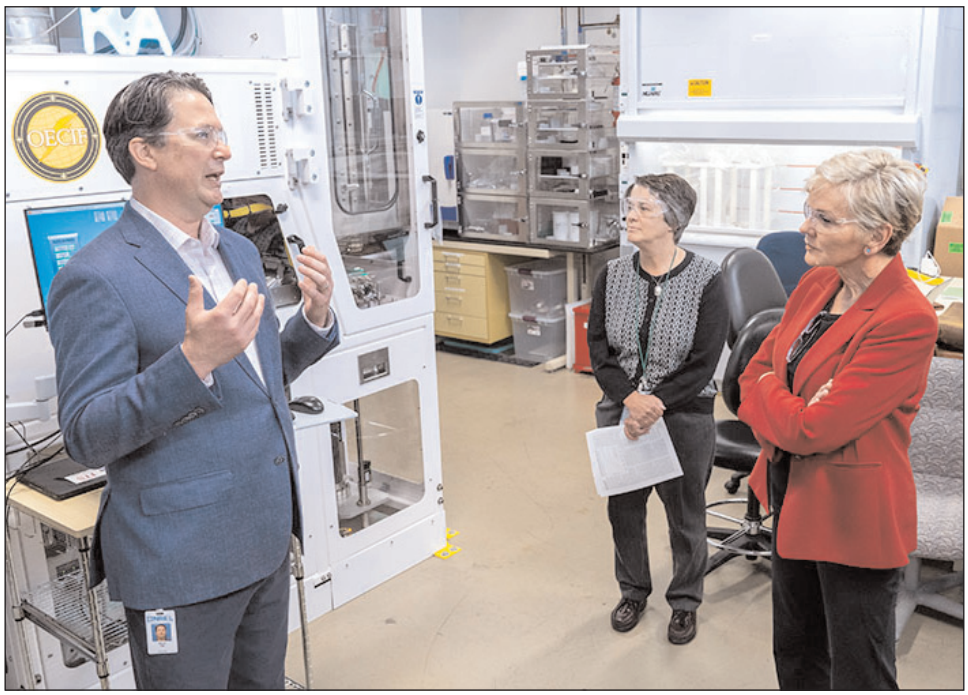
The US Department of Energy's (DOE's) National Renewable Energy Laboratory (NREL) says that it has been able to extract some extra efficiency out of its solar cells through careful design of the materials in the cell stack (Kevin Schulte, John Simon, Myles Steiner and Aaron Ptak, 'Modeling and Design of III-V Heterojunction Solar Cells for Enhanced Performance', Cell Reports Physical Science vol 4, issue 9, 20 September 2023, p101541).

Relying on both computational and experimental studies, the researchers grew a gallium arsenide (GaAs) heterojunction solar cell using dynamic hydride vapor phase epitaxy (D-HVPE) with a certified efficiency of 27%, a record for a single-junction GaAs cell grown using this technique.

The research is the latest effort by NREL researchers to make III-V solar cells more affordable for terrestrial applications rather than the more established space applications. D-HVPE offers the potential to be a lower-cost method of synthesizing these cells compared with incumbent techniques.

The research provides a roadmap to improving the performance of solar cells via optimization of the doping and bandgap of the emitter device layer to minimize the impact of defects on device efficiency. The results are theoretically applicable to materials beyond III-Vs that use heterojunctions such as silicon, cadmium telluride, or perovskites.

"With whatever method you choose to make them, solar cells will always contain some defects thanks to entropy. By using a heterojunction structure, with carefully designed emitter properties, you can minimize the adverse impact of these defects on efficiency, even though you haven't done anything to reduce their concentration," says Kevin Schulte of NREL's High-Efficiency Crystalline Photovoltaics group. "Furthermore, the relative efficiency improvement scales with defect concentration. While the baseline D-HVPE cell already had a high efficiency, a device that had a higher defect concentration would receive a higher relative efficiency boost using the methods described in the paper."



NREL senior scientist Aaron Ptak provides an overview of the D-HVPE lab to Secretary of Energy Jennifer Granholm (right) and Nancy Haegel, director of the National Center for Photovoltaics at NREL. (Photo by Werner Slocum, NREL).

Along with the GaAs base layer, the solar cell relied on an emitter layer of gallium indium arsenide phosphide (GaInAsP) to make up the heterojunction. Researchers modeled the effect of varying the zinc doping density and bandgap of the emitter layer, which is realized by varying the relative concentrations of gallium, indium, arsenic and phosphorus during layer growth, on cell efficiency. The modeling identified optimal choices for these two parameters that maximize device efficiency. The researchers then synthesized cells using the guidance of the modeling and achieved modelpredicted efficiency enhancements. The rear heterojunction solar cell that served as a baseline used an emitter consisting of GaInP and had a reported efficiency of 26%. By reducing the doping in the emitter and changing its composition from GaInP to the lower-bandgap GaInAsP, the efficiency increased to 27% even though the rest of the device was exactly the same.

The benefits of heterojunctions are generally known, although experimental demonstrations of III-V heterojunctions are limited to a handful of combinations, the researchers note. "We took this concept that was known but not quantified this way and mapped it out," Schulte says. "We showed the modeling matches what we see experimentally, showing that it is a powerful tool for solar cell design."

www.cell.com/cell-reports-physical-science/fulltext/S2666-3864(23)00338-7

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Germanium–tin MQW LEDs on 12-inch silicon substrate

Researchers claim the largest-diameter wafer so far opens way to mass production.

Researchers based in Singapore, China and the USA claim the first germanium–tin alloy (GeSn) multiple quantum well (MQW) light-emitting diodes (LEDs) on a 300mm (12-inch)-diameter silicon (Si) wafer [Shaoteng Wu et al, Photonics Research, v11, p1606, 2023]. The deployment on the largest-diameter wafers so far increases the potential for mass production and reduces manufacturing costs of complete integrated silicon photonic systems.

Ge and Sn both lie in the group-IV column of the periodic table, like silicon. This makes them potentially easier to integrate with mainstream Si-based electronics. However, these materials are not conducive to light emission, with the narrowest gap between the conduction and valence bands being indirect rather than direct. Some progress has been made in the GeSn alloy system in massaging the band structure so the direct and indirect gaps are more equal, boosting light-emission.

The researchers from Nanyang Technological University in Singapore, Institute of Semiconductors in China, Applied Materials Inc in the USA, and the National University of Singapore see potential for their work in the 2μm wavelength range (1900–2100nm) with appli-

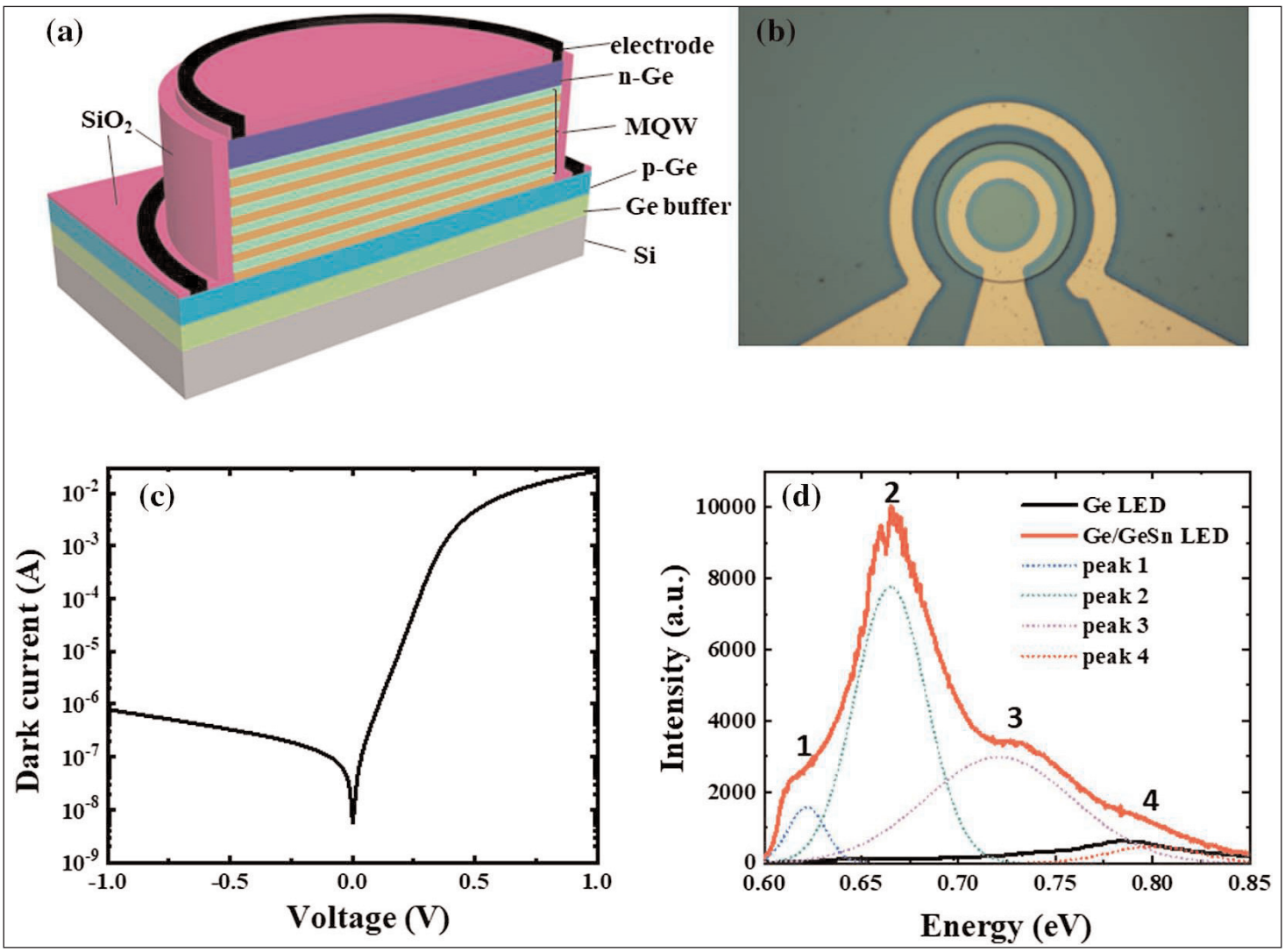

Figure 1. (a) Three-dimensional schematic of GeSn/Ge MQW LED; (b) top-view microscope image; (c) current–voltage characteristics; (d) room temperature electroluminescence spectrum, compared with Ge LED.

cations in biomedical and gas sensing (especially CO_2 sensors), and 3D light detection and ranging (LiDAR). Also, for optical communications, hollow-core photonic bandgap fibers (HC-PBGFs) have recently been found to have a lowest-loss window around 2μm.

The 300mm (12-inch) GeSn MQW on (001) Si wafers were produced on a commercial reduced-pressure chemical vapor deposition (RPCVD) system. The use of such a system opens the way to large-scale manufacturing.

The MQWs were grown on a 1.2μm Ge strain-relaxed buffer layer, between 200nm p- and n-type Ge contact layers. The buffer confined defects to near the Ge/Si interface. The wells consisted of 7.5nm $Ge_{0.92}Sn_{0.08}$ alloy, and the barriers 20nm Ge. The 15-period MQW structure was grown at less than 350°C.

The researchers comment: "The thin GeSn well layers were deliberately designed to provide better carrier confinement for excitons and to inhibit dislocation formation from strain relaxation."

The GeSn alloy was 0.0116% pseudomorphically strained, according to x-ray analysis.

Double-mesa LEDs were fabricated on the 300mm GeSn material (see Figure 1). The top mesa was formed through chlorine-based reactive ion etch (RIE) down to the p-Ge contact layer. The bottom mesa electrically isolated the devices by further RIE. The etched surfaces were passivated with 400nm plasma-enhanced CVD (PECVD) silicon dioxide

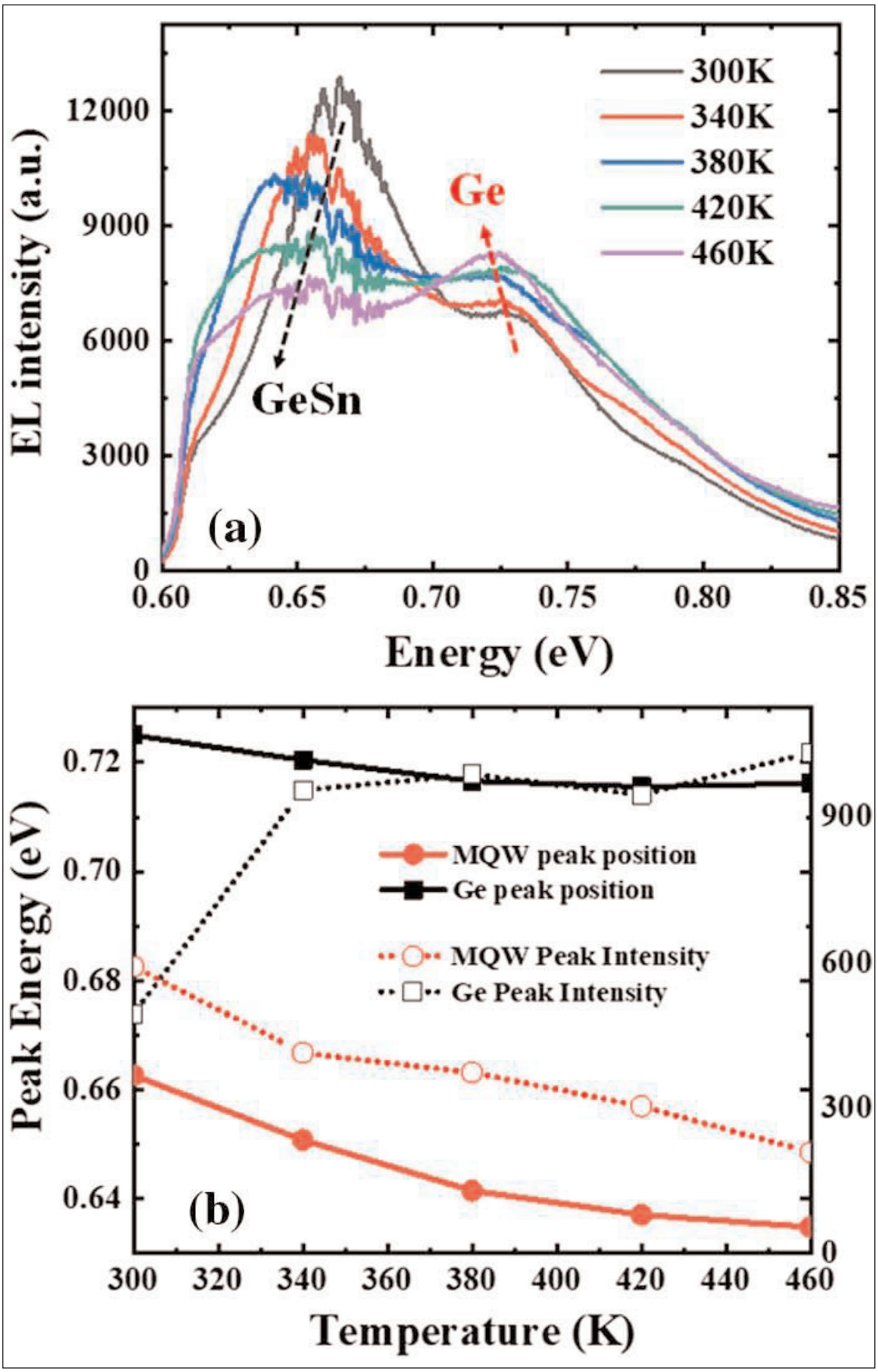

Figure 2. (a) EL spectra as function of temperature at 1900A/cm^2; (b) peak position and EL integrated intensity versus temperature.

(SiO_2). The titanium/gold electrodes were evaporated into windows fluorine-based reactive ion etched into the passivation.

The resulting devices demonstrated on/off current ratios ~10^4 for ±1V bias. The ideality factor was 1.36, relatively close to the 1 that is ideal for PN junctions. The dark current was 0.78μA (27.58mA/cm^2) at −1V.

"Due to the low threading dislocation densities (TDDs) from the pseudomorphic growth, the dark current density of our device is one of the lowest of GeSn photodiodes with similar Sn content," the team reports.

The EL spectrum for the device with 23mA injection showed four emission peaks, according to Gaussian fits. The dominant peak 2 energy was around 0.665eV, corresponding to a 1864nm wavelength. A comparison spectrum for a Ge LED (900nm intrinsic layer) had a peak at 0.785 (1578nm). The red-shift of the GeSn MQW structure was consistent with theoretical 1D Poisson–Schrödinger calculations that gave about 0.660eV as the bandgap for the GeSn MQW.

The researchers comment: "The emission of the GeSn LED covers a wide range from 0.65eV to 0.85eV (1458–2066nm), which covers the S, O, L, U and 2μm optical communication bands."

The integrated emissions of the GeSn MQW LED were 27.58x that of the p-i-n Ge LED comparison device. The researchers estimate the energy difference between the indirect L- and direct Γ-valley was reduced to 71.7eV in the GeSn alloy from 134.5eV in Ge. The reduced difference enables more electrons to be thermally excited into the Γ region, boosting the EL intensity exponentially.

The non-dominant peaks 1, 3 (0.723eV/1715nm) and 4 were attributed to the indirect band of the GeSn/Ge structure, the Ge direct band, and "Fabry–Perot modes between Ge-VS/Si and Ge/air interfaces or the Ge peak from the buffer Ge layer", respectively.

The intensity of the EL emission of the GeSn MQW LED increased approximately linearly between 35A/cm^2 and 1768A/cm^2. The MQW peak 2 red-shifted only slightly from 0.668eV to 0.664eV over the same current injection range. The Ge direct peak 3 red-shifted more significantly from 0.737eV to 0.718eV. The researchers point to a general view suggesting that EL peaks will red-shift when injection current increases due to Joule heating from electrical excitations. Band filling, widening the effective gap, can counteract this effect, perhaps explaining the minimal shift in peak 2.

The researchers also investigated the performance at increased ambient temperatures up to 460K (187°C) that would reflect potential thermal conditions for such devices in practical operation (Figure 2). Such temperatures are "higher than the maximum temperature in silicon integrated circuits," according to the team.

The bandgaps are expected to shrink at high temperature, resulting in an observed red-shift in the emission peak to lower photon energy. The MQW peak shifted by 27meV between 300K and 460K. The Ge peak is rather less affected.

In terms of measured intensity, the Ge peak increases somewhat, while the GeSn peak declined with increased temperature. Partly this can be explained by the MQW peak 2 moving towards the 0.610eV/2030nm measurement edge of the nitrogen-cooled linear indium gallium arsenide (InGaAs) detector array used to collect spectral data. For the Ge peak, the increased temperature increased the rate of excitation into the direct Γ region of the conduction band profile.

The researchers comment: "Due to the incorporation of Sn, GeSn is closer to direct-bandgap materials, resulting in reduced competition between direct-bandgap and indirect-bandgap luminescence. The non-radiative recombination due to the defects from non-equilibrium GeSn growth processes is dominant when the temperature increases. Thus, the method for enhancing the EL intensity of GeSn LEDs from increasing temperature perhaps is unrealistic, as it may occur only on very low Sn content (<4%) GeSn LEDs, which are inefficient." ■

https://doi.org/10.1364/PRJ.491763

Author: Mike Cooke

Fabricating 330ppi monolithic GaInN RGB pixels

Device development targets head-mounted displays and smart glasses.

Meijo University in Japan and King Abdullah University of Science and Technology (KAUST) in Saudi Arabia report on a monolithic stacked red–green–blue (RGB) gallium indium nitride (GaInN) micro-light-emitting diode (μLED) array with 330 pixel per inch (ppi) density [Tatsunari Saito et al, Appl. Phys. Express, v16, p084001, 2023].

The researchers see the potential for use of such devices in "head-mounted displays and smart glasses for virtual reality, augmented reality and mixed reality". The micron-level pixels needed for such displays would appear to preclude the use of mechanical assembly techniques, and necessitate the use of monolithic fabrication.

Although GaInN-based LEDs have suffered from severe efficiency problems for longer wavelengths, towards the red end of the visible spectrum there has been recent progress in this area. Further, red GaInN LEDs suffer less from impacts on efficiency from scaling to the smaller device sizes of μLEDs than the usual red LED material, aluminium gallium indium phosphide (AlGaInP).

Metal-organic vapor phase epitaxy (MOVPE) was used in two stages to grow the material for the RGB μLED arrays on GaN substrates (Figure 1). First, the blue and green layers were grown at Meijo, while the final red stage was produced at KAUST. The RGB layers were separated by tunnel junctions (TJs).

The red layers were somewhat more involved than the relatively standard blue and green layers. The latter ➤

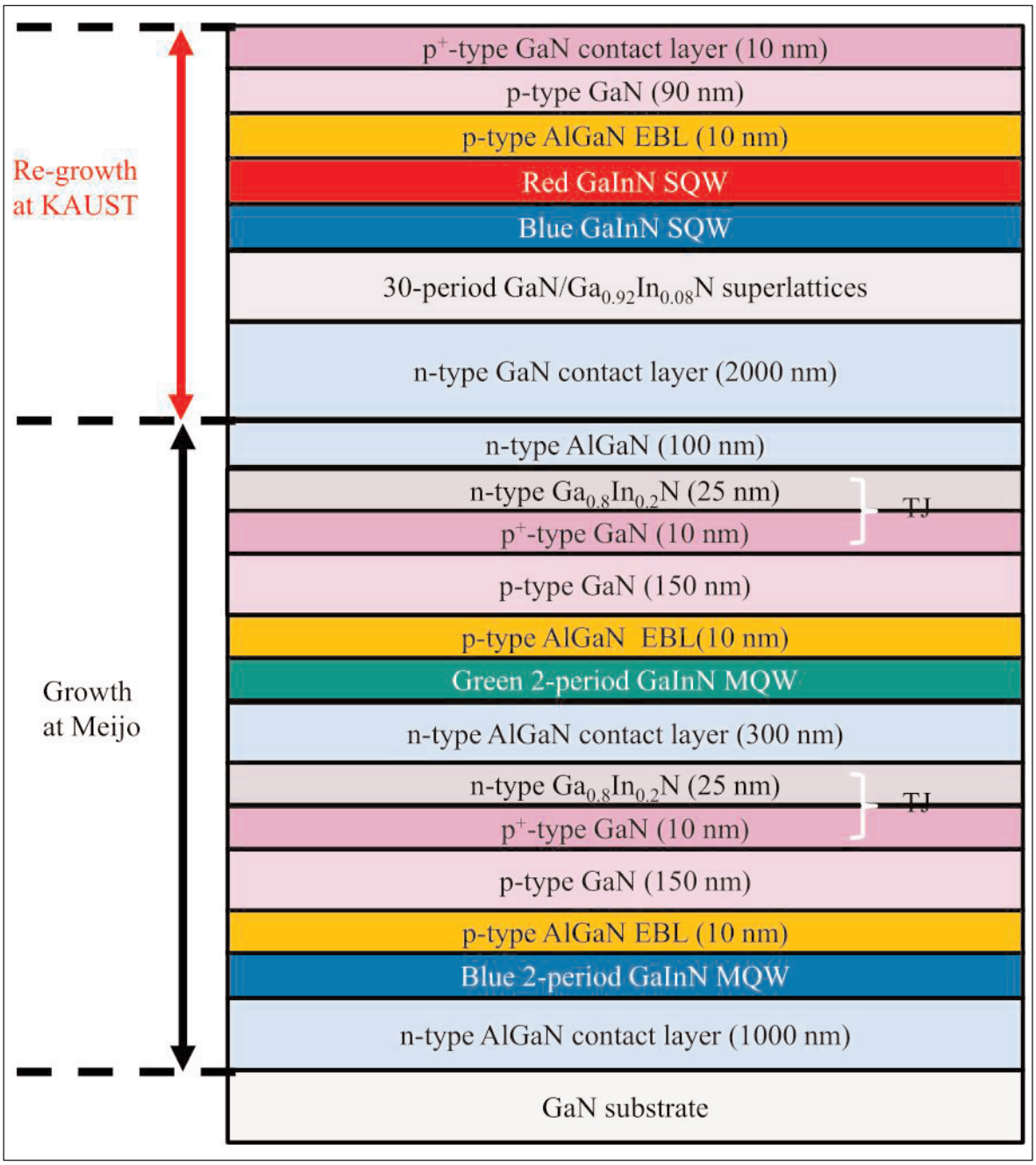

Figure 1. Schematic cross-section of LED multiple stacked structure.

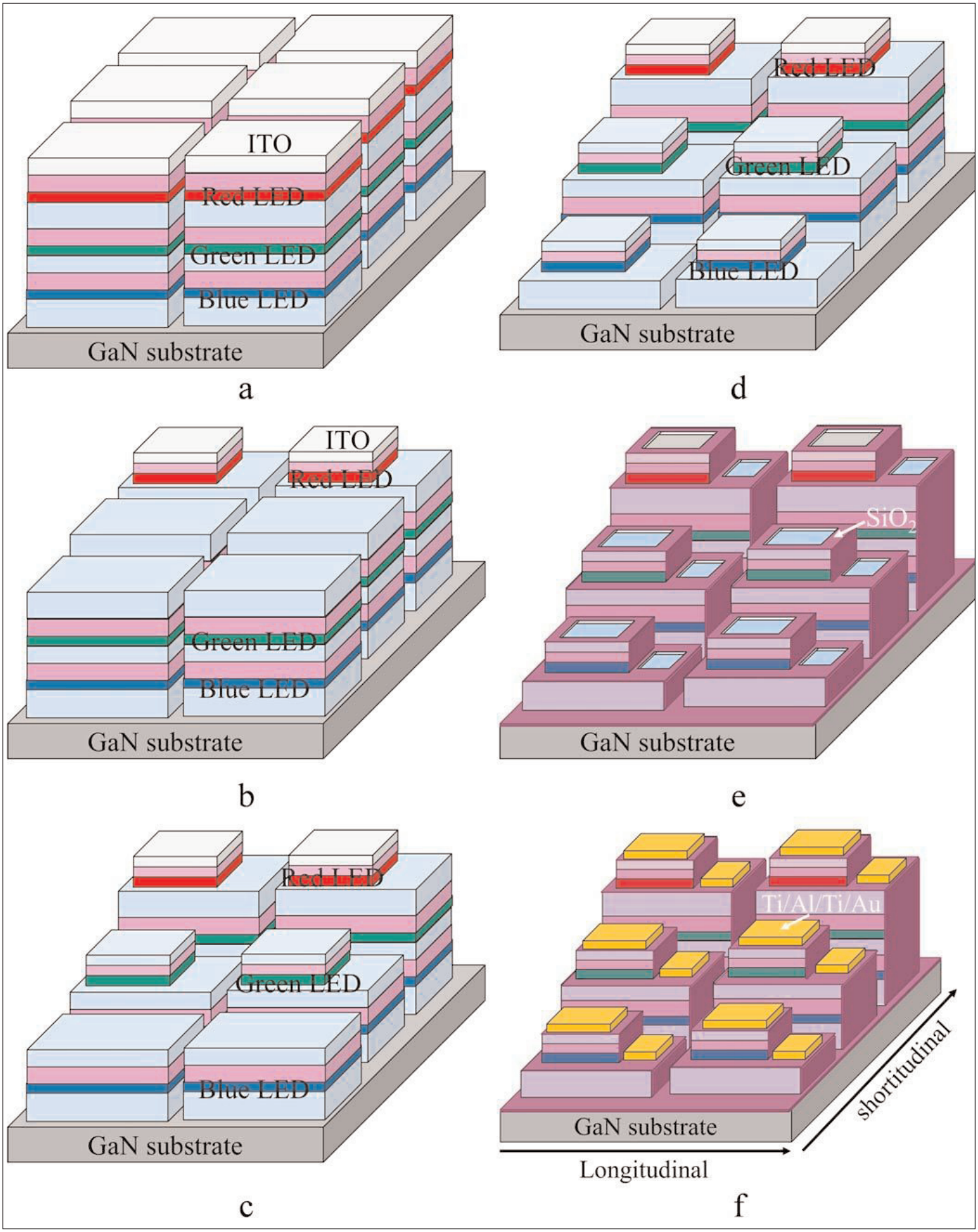

Figure 2. Schematic process flow of µLED array: (a) ITO p-type electrode formation and device separation by etching, (b) red µLED mesa fabrication, (c) green µLED mesa fabrication, (d) blue µLED mesa fabrication, (e) SiO_2 passivation film formation, (f) n-electrode formation.

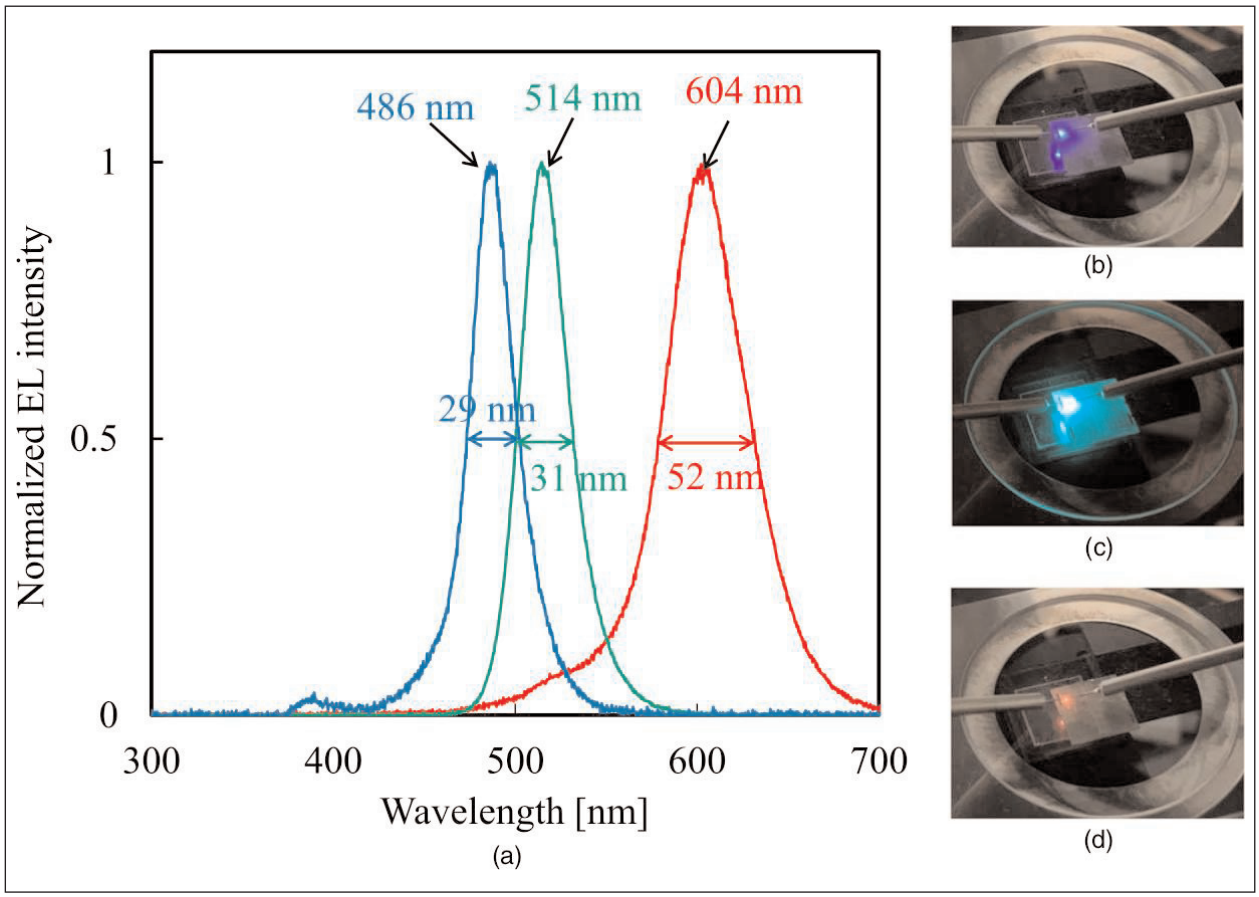

Figure 3. EL spectra of blue–green–red μLEDs; EL photos of (b) blue, (c) green and (d) red μLEDs with a digital camera.

used 2-period multiple quantum wells with suitable-indium-content GaInN alloys.

The red layers included a superlattice, and red and blue single quantum wells (SQWs). The researchers comment: "The blue GaInN superlattice and GaInN SQW inserted between the n-type GaN layer and the active layer in the red LED structure play a role in improving the emission efficiency of the red LED."

The researchers point out that the GaN substrate used was very expensive, and for production it would be necessary to move to a less expensive material, likely sapphire.

The material was fabricated into RGB pixels with a 330ppi density (Figure 2). The definition of the separate μLED structures was through inductively coupled plasma reactive-ion etch (ICP-RIE). The p-type layers of the TJs were activated through 30-minute annealing at 600°C.

The p-contacts consisted of sputtered indium tin oxide (ITO) transparent conductor, and metal electrodes of titanium/aluminium/titanium/gold (Ti/Al/Ti/Au). The n-electrode was Ti/Al/Ti/Au. Passivation was provided by sputtered silicon dioxide (SiO_2).

The μLEDs measured 73μmx20μm with 35μmx15μm device mesas.

The blue–green–red μLED electroluminescence (EL) spectra, collected from the substrate side with 50A/cm^2 injection, peaked at 486nm, 514nm and 604nm, respectively (Figure 3). The corresponding full-widths at half-maximum (FWHMs) were 29nm, 31nm and 52nm. The researchers say that these values are similar to those for separately fabricated devices.

The red and blue device spectra also had sub-peaks around 530nm (green) and 380nm (ultraviolet), respectively. The team comments: "In the future, it should be possible to eliminate the peak at 380nm wavelength from the blue active layer if the growth conditions are optimized by applying the AlN cap layers and lowering the growth temperature of the n-type AlGaN layer to the active layer of blue LEDs."

The red spectrum also featured a long tail on the short-wavelength side of the peak. "This is not observed when a monochromatic red LED is prepared under the same conditions," the researchers report, adding: "This could be because the red LED was stacked after the blue and green LEDs, and the optimal crystal growth conditions for the active layer of the red LED were different."

The turn-on voltages for the blue, green and red μLEDs were 2.8V, 3.2V and 3.2V, respectively, up to 1V greater than the corresponding bandgap energy drops for electrons recombining with hole states to generate photons. The researchers suggest that the smaller electrode areas in the μLEDs may suffer from increased contact resistance on p-type III–N layers.

While the light output power (LOP) from the green μLEDs almost reached 0.8μW at 10A/cm^2 injection, the red and blue LOPs were less than 0.2μW and 0.1μW, respectively. ■

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Author: Mike Cooke

GaN:AlN superlattice UVC LEDs boost light extraction

Australia's Silanna UV has achieved radiant flux of 17.4mW at 1A injection — a new record for a far-UVC LED grown on sapphire substrate.

Silanna UV in Australia reports on the use of gallium nitride:aluminium nitride (GaN:AlN) short-period superlattices (SPSLs) to improve the performance of far-ultraviolet-C (UVC) light-emitting diodes [Jordan Nicholls et al, Appl. Phys. Lett., v123, p051105, 2023]. The team claims a record radiant flux of 17.4mW for a far-UVC LED grown on sapphire.

Far-UVC light sources are sought for disinfection and sterilization efforts, such as those seen during the COVID-19 pandemic. The Silanna researchers comment: "The far-UVC wavelengths below 240nm are an extremely attractive option for this; light in this range has difficulty penetrating past the outmost layers of skin (the epidermis), and so exposure poses a reduced cancer risk."

Although AlGaN LEDs are seen as a route to low-cost, compact UVC sources, there are a number of challenges to overcome. In particular, as the aluminium content of AlGaN increases, the generated light becomes more difficult to extract, since the recombination process emits photons into transverse magnetic (TM), rather than transverse electric (TE), modes. The light is then predominantly emitted, therefore, parallel and not perpendicular to the device layers. A further problem for high-Al-content AlGaN is poor doping efficiency.

The light extraction problem is related to the ordering of the valence bands (Figure 1). In GaN, where light emission tends to be perpendicular to the device layers, the heavy-hole (HH) band is the highest energy level into which recombination of electrons from the conduction band predominantly takes place. In high Al-content AlGaN, by contrast, the crystal-field split-off hole (CH) band is the highest. Recombination into this band emits into TM modes.

The Silanna approach is to use SPSL structures to restore a HH mini-band, HH1, as the highest energy level, enabling TE light extraction. The SPSLs also ease doping efficiency problems. Rather than replace just one section of the device structure with an SPSL, the Silanna team used SPSLs almost throughout the entire epitaxial material layers.

The AlN:GaN short-period superlattice (SPSL) LED material was grown by plasma-assisted molecular beam epitaxy (PAMBE) on a 6-inch sapphire substrate (Figure 2). The material was pseudomorphically strained to the underlying 400nm AlN buffer.

The SPSLs consisted of alternating GaN and AlN layers. The thicknesses of these layers were varied to give different effective Al contents of the III–nitride material, and hence target wavelengths of the LEDs.

The 80nm/36-period recombination and 450nm

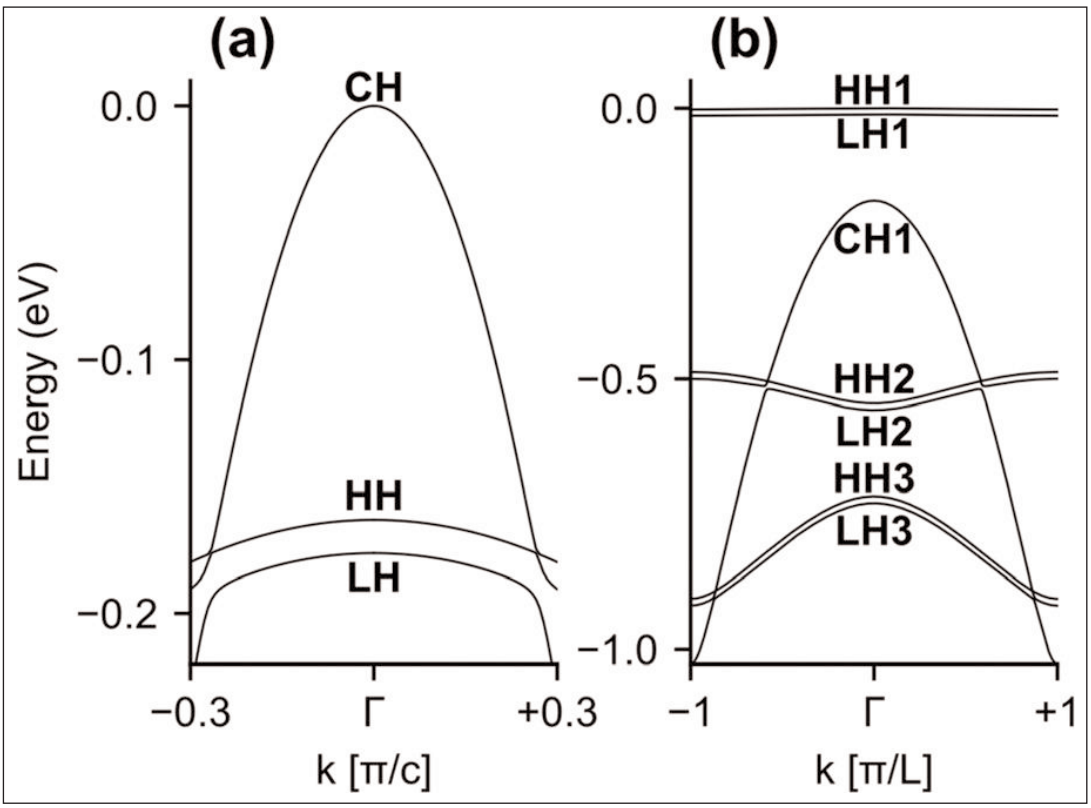

Figure 1. Valence-band energy–quasimomentum (E–k) diagrams along the c-axis, as calculated by 6x6 k.p theory for (a) bulk $Al_{0.8}Ga_{0.2}N$ and (b) 1:4 monolayer GaN:AlN short-period superlattice (SPSL) (period L).

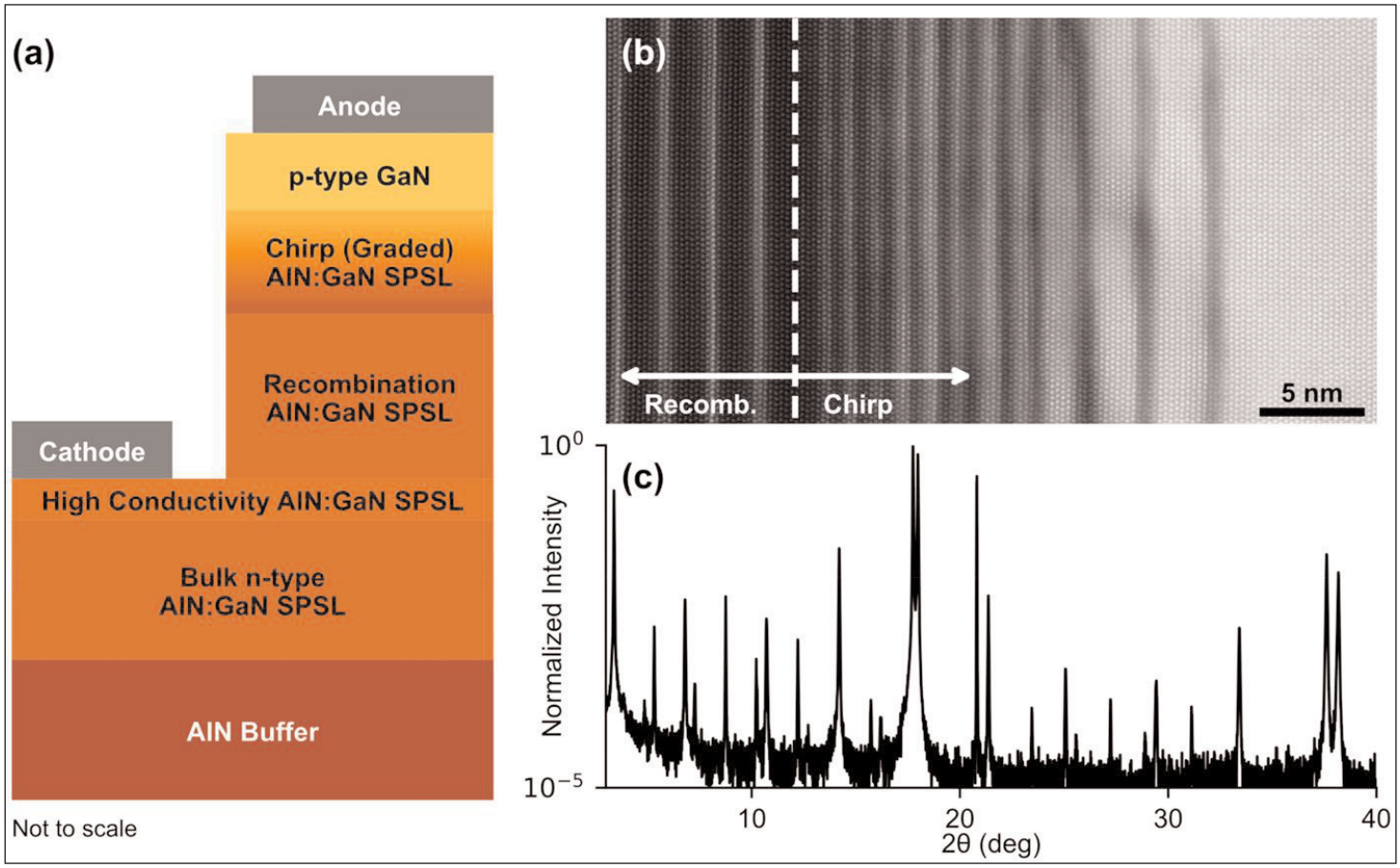

Figure 2. (a) Basic device structure of SPSL UV LEDs. (b) Transmission electron microscope image at interface between recombination and chirp regions. (c) X-ray diffraction x-2h scan of SPSL grown on AlN buffer.

bulk n-type regions of the device were separated by a 50nm high-conductivity region with a lower Al-content of 1:4 monolayers of GaN:AlN, giving an effective 80% Al over the 37 periods. The use of SPSL structure reduced the resistivity by a factor of three relative to values reported for bulk $Al_{0.8}Ga_{0.2}N$ material. The recombination/bulk regions had approximately 93–98% Al, targeting 229–240nm wavelengths.

The final regions of the device consisted of a 20nm chirped/graded layer transitioning with increasing GaN layer thickness to the 40nm p-type GaN cap layer.

The researchers comment: "The purpose of the chirp layer was to improve hole injection from the much lower-bandgap GaN into the SPSL recombination region. It also serves as an electron-blocking layer to limit electrons overshooting past the recombination layer."

The ionized acceptor concentration in the cap was of order $1x10^{19}/cm^3$. The ionized donor concentration in the high-conductivity SPSL layer was estimated at $8x10^{19}/cm^3$.

The material was fabricated into passivated mesa LEDs with titanium/aluminium contacts. The optoelectronic measurements were made using a 2-inch integrating sphere on the underside on the wafer.

The wavelength and power performance of the devices was uniform across the wafers. However, the electrical performance was less uniform. The team explains: "This is because the series resistance and, hence, the electrical characteristics are influenced by the etching and metallization processes, rather than solely the MBE growth process."

A wafer with 233±1nm-wavelength devices had a yield of 10,763 LEDs. For the inner 4-inches of the wafer, the wavelength standard deviation was just 0.16nm. The average optical power output at 20mA injection was 0.2W for this inner section. The standard deviation of the drive voltage at 20mA was less than 0.16V for the devices more than half an inch away from the edge of the wafer.

The researchers comment: "Given that we can produce a greater than 4-inch area of consistent performance, our MBE-grown SPSL LED approach is one of the most promising from a production throughput and yield prospective."

The team also packaged the 1mmx1mm singulated LEDs with electrostatic discharge protection from a commercial Zener diode shunt. The LEDs were thinned to 275μm before being packaged in AlN ceramic material. The measurements were made in a 6-inch integrating sphere (Figure 3).

A typical packaged device reached 0.55% wall-plug efficiency (0.55%) at 50mA injection. According to the team, only one other group has reported a higher WPE, of 0.63%, for a 234nm-wavelength LED.

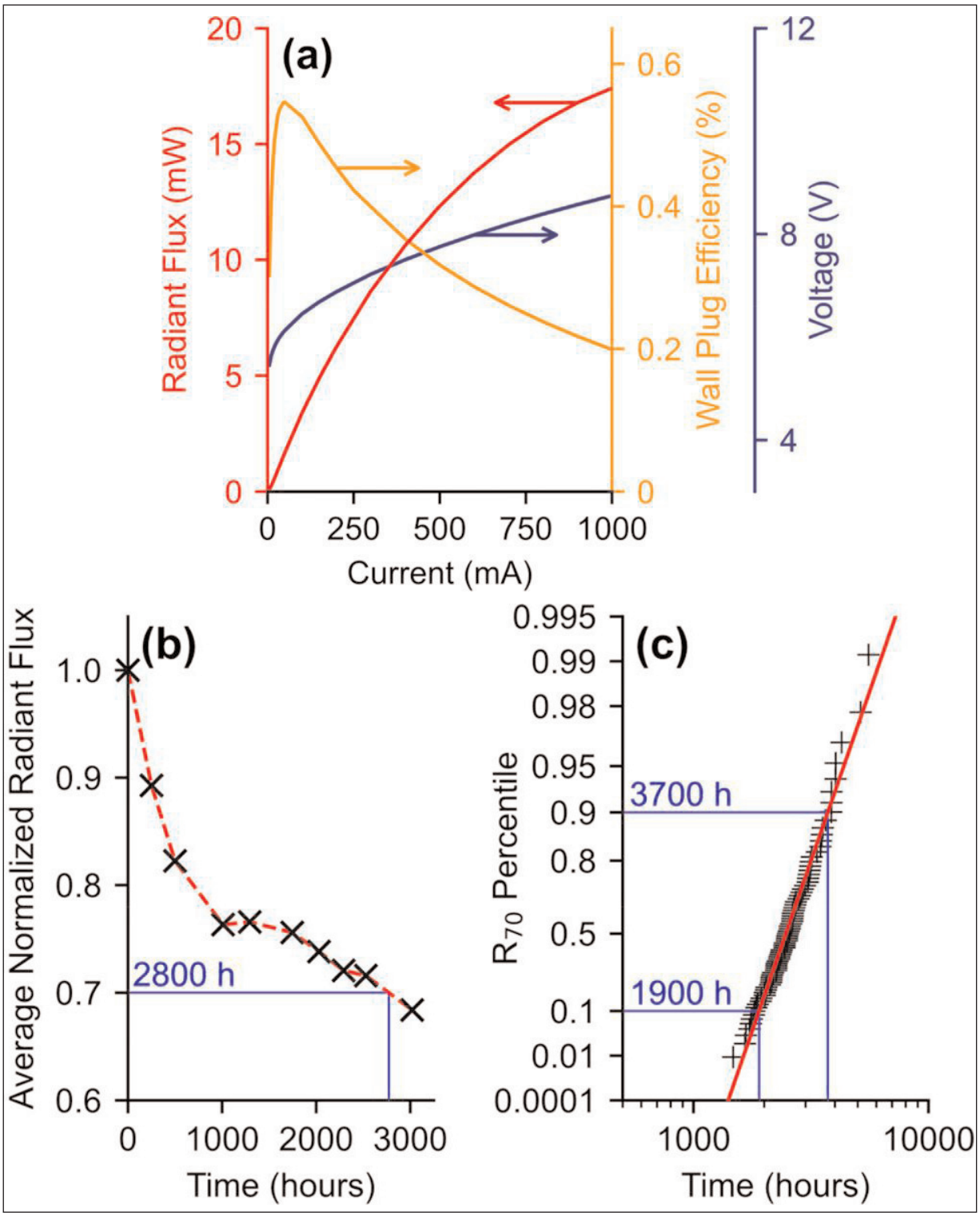

Figure 3. (a) Typical light output power, wall-plug efficiency, and voltage versus current injection for 236nm-wavelength device. (b) Lifetime performance for single device when operated at 20mA continuous current for 3000 hours, according to TM21 standard. (c) R70 percentiles for 80 packaged devices.

Radiant flux at the 0.55% peak efficiency was 1.7mW. The light output at 1A was 17.4mW. The researchers comment: "Although this is significantly beyond the intended drive current, this is the highest reported radiant flux for a far-UVC LED grown on a sapphire substrate."

Although similar powers can be achieved for devices grown on AlN substrates, these are more expensive and smaller diameter. "Our ability to achieve comparable performance while using the more cost-effective sapphire is, therefore, an important milestone toward viable commercialization of far-UVC LED technology," the team writes.

The lifetimes to 70% of the initial radiant flux (R70) were measured for 80 devices. A typical device had an R70 of 2800h, of which the researchers comment that "these are the longest-lived of any LEDs (which emit below 240nm) measured to date".

The team used normal operating conditions (25°C, 20mA current) as specified in the TM21 standard. Other groups use higher currents to speed the aging process, which makes a true comparison difficult. One other group using the TM21 standard achieved an R70 of 1500h, significantly less than for the Silanna UV device.

It is also suggested that using a burn-in period to weed out weak devices could extend the lifetime to 7000h. ■

https://silanna.com/

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Next Level Epitaxy for aluminium nitride thin films

Element 3–5 GmbH describes a novel approach for the mass production of semiconductor materials.

Aluminium nitride (AlN) epitaxial thin films have garnered significant attention due to their exceptional properties, rendering them highly suitable for a wide spectrum of devices such as quantum acoustodynamics, integrated photonics, lithium batteries, LEDs and high-frequency, high-power electronics.

To meet the demands of these applications, the team of experts at Element 3–5 GmbH has pioneered a groundbreaking methodology for the mass production of AlN epitaxial thin films, presenting a substantial leap in the domain of semiconductor fabrication. This innovative method is known as Next Level Epitaxy (NLE). In the context of NLE, a seamless integration of physical vapor deposition (PVD) and chemical vapor deposition (CVD) techniques has enabled epitaxial thin-film growth at surface temperatures below 300°C.

The NLE growth process shares a fundamental resemblance to the thin-film fabrication stages employed in the metal-organic chemical vapor deposition (MOCVD) process. However, in the case of NLE, a distinctive feature emerges as each of the fabrication stages (cleaning, nucleation, and growth) incorporates the use of various plasma sources. Designed, developed and manufactured at Element 3–5 GmbH, these proprietary plasma sources enable processing of 35 x 300mm, 70 x 200mm, 140 x 150mm or 300 x 100mm wafers at each cycle, leading to significant reduction of production costs compared with existing methods.

NLE-AlN epitaxial layers exhibit exceptional thickness uniformity over the wafer, a remarkably smooth surface (rms=0.3nm) and a low dislocation density ($<10^7 cm^{-2}$ within a 45nm AlN layer on sapphire). MOCVD-grown gallium nitride (GaN) on an NLE-AlN-coated flat sapphire wafer exhibits an impressive 002 x-ray rocking curve (XRC) full-width at half-maximum (FWHM) value of 77arcsec, measured within a GaN layer thickness of 2µm. Preserving GaN structural integrity is crucial for forming a vital two-dimensional (2D) electron gas in power transistors. An 8nm NLE-AlN layer on a partly processed high-electron-mobility transistor (HEMT), with mesa isolation and ohmic contacts, displayed a sharp interface and epitaxial growth confirmed by high-resolution transmission electron microscopy

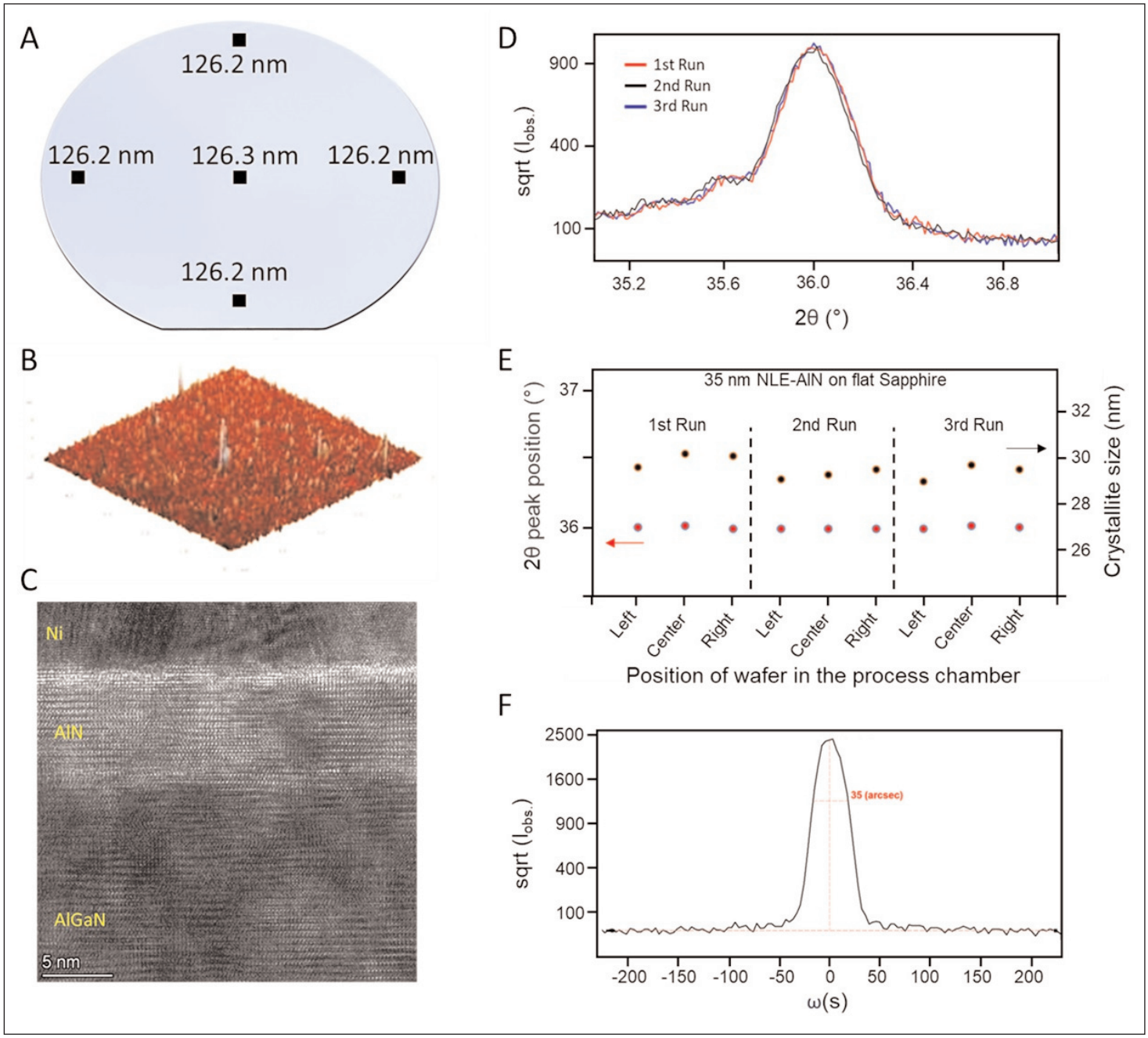

Figure 1. Characterization results of NLE-AlN films: (A) ellipsometry reveals consistent thickness across the entire wafer; (B) atomic force microscopy (AFM) height profile (1µm x 1µm) yields a root-mean-square (rms) value of 0.3nm; (C) HRTEM displays a uniform interface between NLE-AlN and AlGaN; (D) XRD measurement demonstrates a run-to-run reproducibility of the 2θ peak; (E) the 2θ peak position and crystallite size of NLE-AlN remain consistent across all chamber positions; (F) x-ray rocking curve (XRC) analysis reveals a 002 peak FWHM of 35arcsec.

(HRTEM) analysis, substantially reducing gate leakage current by three orders of magnitude.

Furthermore, a comparison was conducted between the growth of a light-emitting diode (LED) structure on NLE-AlN on a patterned sapphire substrate (PSS) and the same LED structure using a standard PSS-based process. While the NLE-AlN templates did result in a reduction of the growth time in MOCVD by 2.5 hours, it is noteworthy that the GaN crystal quality remained similar, with the 002 XRC FWHM peak measuring about 200arcsec for both the NLE-AlN templates and the standard templates, despite the NLE-AlN LED being 2µm thinner.

When subjected to photoluminescence analysis, a twofold reduction in standard deviation in intensity was observed for the NLE templates. In the realm of UV-C applications, the deposition of 2µm AlGaN with 60% aluminium content on NLE-AlN yielded x-ray diffraction (XRD) FWHM values of 780/1070arcsec for the 002/102 plane, whereas annealing a 150nm NLE-AlN layer improved these values to 50/350arcsec for the 002/102 planes. ■

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Recessing metal contacts for gallium nitride transistors

Researchers in Sweden have achieved low ohmic contact resistance together with low annealing temperature.

Researchers based in Sweden report low ohmic contact resistance (R_c) for recessed titanium/aluminium (Ti/Al) metal electrodes with a view to deployment in gallium nitride (GaN) high-electron-mobility transistors (HEMTs) and other transistors [Ding-Yuan Chen et al, Semicond. Sci. Technol., v38, p105006, 2023]. R_c values as low as 0.14Ω-mm were achieved with a low annealing temperature of 550°C.

The team from SweGaN AB, Chalmers University of Technology, Linköping University, Terahertz Materials Analysis Center, and Lund University, comment that their approach "provides a large process window without the requirement of precise control of the recessed etching depth."

Lowering R_c for HEMTs should reduce power losses, making for less heat and noise generation, while increasing power output and efficiency. The team sees their electron-beam evaporation process as being less complex than other recessed contact structures that regrow doped III–nitride material in metal-organic chemical vapor deposition (MOCVD) in the recess. Electron-beam evaporation is more favored in industrial production.

The researchers comment: "The formation of ohmic contacts requires deposition of ohmic metal stacks (Ti and Al in this work) followed by annealing to extract nitrogen from (Al)GaN, yielding compounds such as TiN, AlN and Al_xTi_yN. This process hence creates N-vacancies in the (Al)GaN, which act as donor-like dopants, resulting in a n-type region."

If the annealing temperature is too high (above ~800°C), the aluminium will melt, making smaller-size contacts difficult to manufacture.

The GaN HEMT wafers used in the study were supplied by SweGaN.

The material was grown on silicon carbide (SiC) by MOCVD, using SweGaN's QuanFINE buffer-free structure aimed at telecommunications (satellites, 5G base-stations,...) and high-power (electric vehicles,...) deployment.

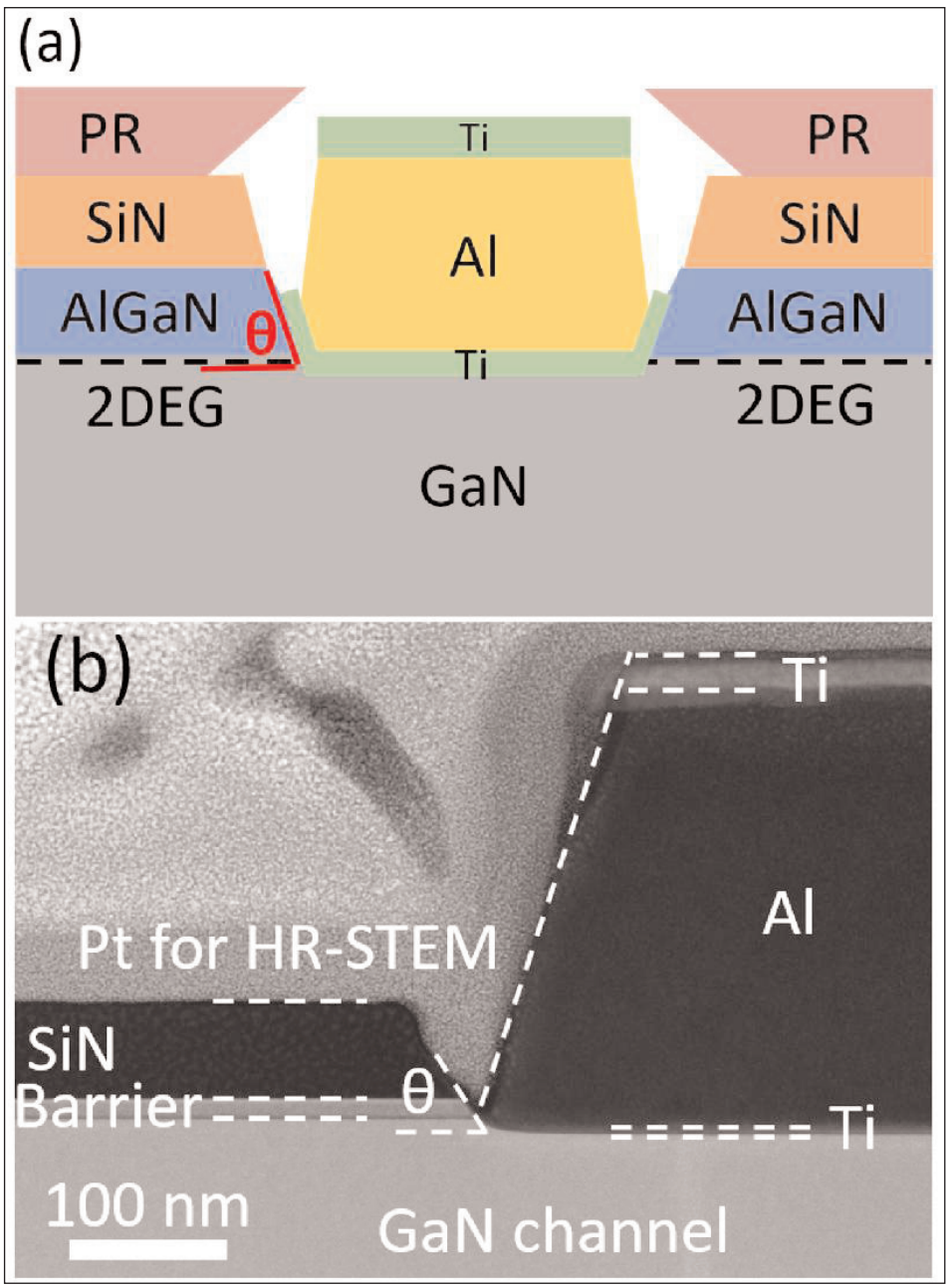

Figure 1. (a) Schematic of TLM structure. (b) High-resolution scanning transmission electron microscope (HR-STEM) cross-section of annealed TLM with 10°-tilted 3nm t_{Ti} on Epi II.

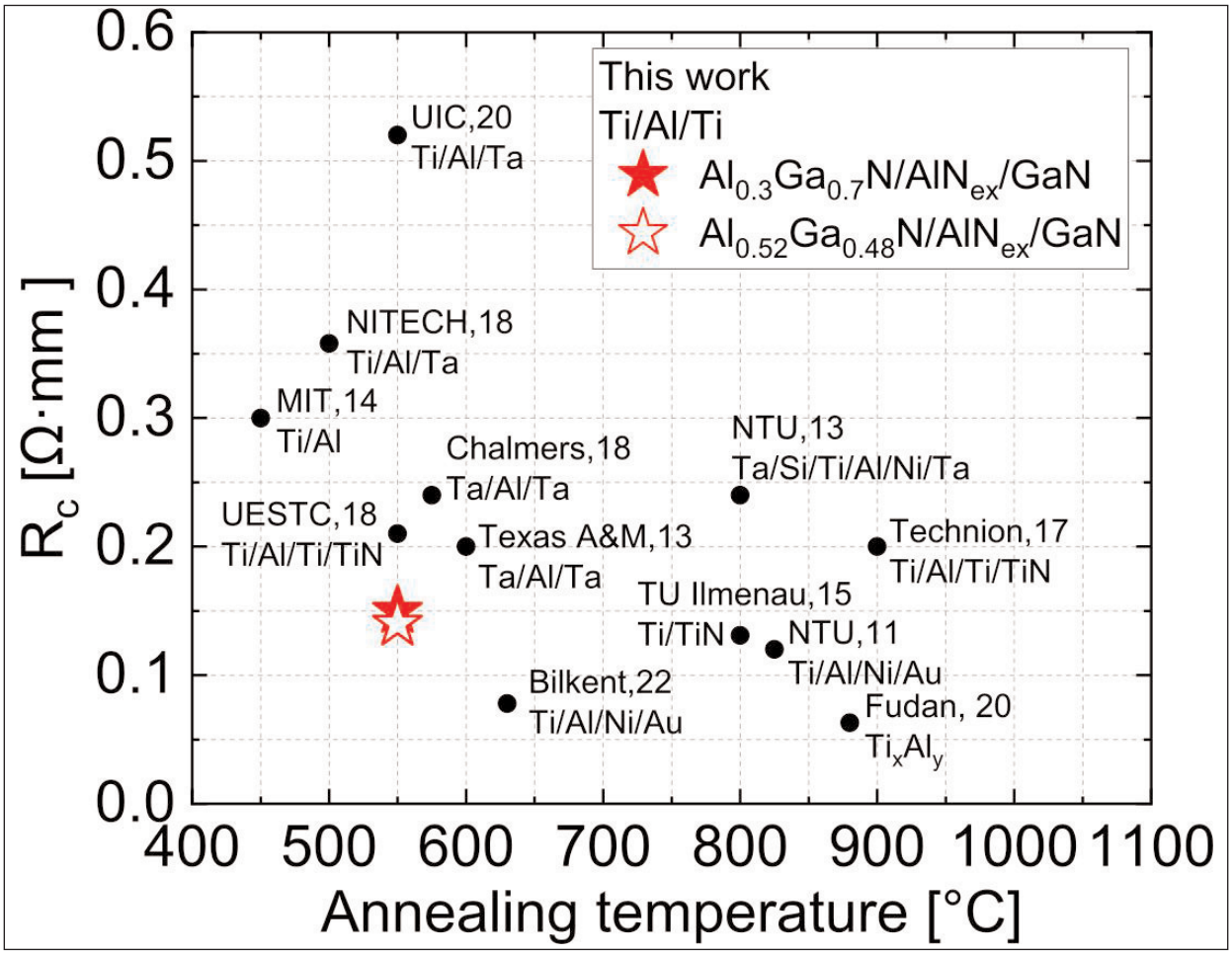

Figure 2. Benchmark of R_c versus annealing temperature on $Al_xGa_{1-x}N/GaN$ (x > 0.22) HEMT epi-structures.

"By removing the conventional thick doped buffer layer, we are able to bring the hot channel closer to the heat-sink SiC substrate, eliminate Fe-related deep traps, and shorten the production time," SweGaN explains on its website.

The HEMT epitaxial material was supplied in two forms: Epi I/II, consisting of 60/60nm AlN nucleation, 260/255m GaN channel, 1.5/1.2nm AlN spacer, 3.3/9.7nm $Al_{0.52}Ga_{0.48}N/Al_{0.3}Ga_{0.7}N$ barrier, and 1.4/2nm GaN cap, respectively. The respective sheet resistances, as measured through eddy currents, were 316 and 298Ω/❑.

The contact resistance of the proposed channel contact (Figure 1) was evaluated using fabricated transfer length method (TLM) structures on 16mm squares of the HEMT materials. First, silicon nitride (SiN) passivation was applied using low-pressure CVD. Electrical isolation was through mesa etching to ~120nm below the two-dimensional electron gas (2DEG) that constituted the channel.

The contact recess sidewall angle, θ, was controlled in turn by the photoresist (PR) profile angle. Key parameters for this were exposure dose, reversal baking temperature, and developing time. The recess for the contact was fabricated by inductively coupled plasma reactive-ion etch (ICP-RIE), using nitrogen trifluoride (NF_3) and chlorine (Cl_3) gases for removing the SiN and AlGaN/GaN layers, respectively. The recess etching continued to ~12nm below the 2DEG.

Native oxide was removed from the recessed sidewalls with buffered hydrofluoric acid and diluted hydrochloric acid, before electron-beam evaporation of the Ti/Al/Ti metal ohmic contact electrodes. The top Ti layer was 20nm. The other layer thicknesses were varied during the investigations. The width of the contact was 100μm, with the ohmic contact distance in the range 5–30μm.

The researchers comment: "The ohmic recess and the metallization are realized with the same resist, making the ohmic contact self-aligned to the recessed region. The first Ti layer was deposited with a 10° tilt and a low deposition rate of 0.05Â/sec to ensure good sidewall coverage and better thickness control, while the other two layers were deposited without tilt."

The structure was rapid thermal annealed at 550°C in 1 minute cycles until the measured contact resistance (R_c) saturated. Measurements were made with four-point probing.

The lowest R_c for Epi I was 0.14Ω-mm from electrodes with 3nm bottom Ti thickness (t_{Ti}) and 280nm Al (Figure 2). The θ angle was ~55°. The contact resistance remained below 0.25Ω-mm with θ in the range 50–60°. A similar electrode on the Epi II material yielded a R_c of 0.15Ω-mm.

The researchers believe that annealing at a slightly higher temperature, but still below the aluminium melting point, could reduce R_c further. ■

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www.umccorp.com

2 Bulk crystal growth equipment

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

3 Substrates

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

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

CS Microelectronics Co Ltd (Vital Materials subsidiary)
Gaofeng Park,
Wanzhou Economic-Technological Development Area,
Chongqing,
China 404040
Tel: +86 023-58879888
E-mail: csm_sales@vitalchem.com
www.cs-micro.com
Vital Materials is the world's leading producer of rare metals as well as the first Chinese manufacturer to deliver G11 rotary ITO target. Vital is also one of the world's three major supplier of infrared materials, a key supplier of compound semiconductor substrates, and a strategic partner of the world's largest thin film solar manufacturer.

Freiberger Compound Materials
Am Junger Loewe Schacht 5,
Freiberg, 09599,
Germany
Tel: +49 3731 280 0
Fax: +49 3731 280 106
www.fcm-germany.com

Kyma Technologies Inc
8829 Midway West Road,
Raleigh, NC, USA
Tel: +1 919 789 8880
Fax: +1 919 789 8881
www.kymatech.com

MARUWA CO LTD
3-83, Minamihonjigahara-cho,
Owariasahi, Aichi 488-0044, Japan
Tel: +81 572 52 2317
www.maruwa-g.com/e/products/ceramic

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

Sumitomo Electric Semiconductor Materials Inc
7230 NW Evergreen Parkway,
Hillsboro, OR 97124, USA
Tel: +1 503 693 3100 x207
Fax: +1 503 693 8275
www.sesmi.com

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

III/V-Reclaim
Wald 10, 84568 Pleiskirchen,
Germany
Tel: +49 8728 911 093
Fax: +49 8728 911 156
www.35reclaim.de

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
E-mail: sales@tecdia.com
www.tecdia.com

Wafer Technology Ltd
34 Maryland Road, Tongwell,
Milton Keynes, Bucks, MK15 8HJ, UK
Tel: +44 (0)1908 210444
Fax: +44 (0)1908 210443
www.wafertech.co.uk
Wafer Technology Ltd is a UK based producer of III-V materials and epitaxy-ready substrates offering the widest product range in the business.

Wafer World Inc
1100 Technology Place, Suite 104,
West Palm Beach,
FL 33407,
USA
Tel: +1-561-842-4441
Fax: +1-561-842-2677
www.waferworld.com

4 Epiwafer foundry

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

Intelligent Epitaxy Technology Inc
1250 E Collins Blvd,
Richardson, TX 75081-2401,
USA
Tel: +1 972 234 0068
Fax: +1 972 234 0069
www.intelliepi.com

IQE
Cypress Drive,
St Mellons,
Cardiff
CF3 0EG, UK
Tel: +44 29 2083 9400
Fax: +44 29 2083 9401
www.iqep.com
IQE is a leading global supplier of advanced epiwafers, with products covering a diverse range of applications within the wireless, optoelectronic, photovoltaic and electronic markets.

OMMIC
2, Chemin du Moulin B.P. 11,
Limeil-Brevannes, 94453,
France
Tel: +33 1 45 10 67 31
Fax: +33 1 45 10 69 53
www.ommic.fr

Soitec
Parc Technologique des Fontaines,
Chemin des Franques, 38190
Bernin, France
Tel: +33 (0)4 76 92 75 000
www.soitec.com

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

5 Deposition materials

Materion Advanced Materials Group
2978 Main Street,
Buffalo, NY 14214,
USA
Tel: +1 716 837 1000
Fax: +1 716 833 2926
www.williams-adv.com

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

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

Praxair Electronics
542 Route 303,
Orangeburg, NY 10962,
USA
Tel: +1 845 398 8242
Fax: +1 845 398 8304
www.praxair.com/electronics

Vital Thin Film Materials (Guangdong) Co Ltd (Vital Materials subsidiary)
18G, 18th Floor, Shenzhen Free
Trade Centre, No.111 Taizi Road,
Nanshan District,
Shenzhen, Guangdong, China 518067
Tel: (+86) 0755-21651348
sales@vitaltfm.com

www.vitaltfm.com
Vital Materials is the world's leading producer of rare metals as well as the first Chinese manufacturer to deliver G11 rotary ITO target. Vital is also one of the world's three major supplier of infrared materials, a key supplier of compound semiconductor substrates, and a strategic partner of the world's largest thin film solar manufacturer.

6 Deposition equipment

AIXTRON SE
Dornkaulstr. 2,
52134 Herzogenrath,
Germany
Tel: +49 2407 9030 0
Fax: +49 2407 9030 40
www.aixtron.com

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

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

FHR Anlagenbau Gmbh
(Vital Materials subsidiary)
Am Hügel 2, D-01458
Ottendorf-Okrilla,
Germany
Tel: +49 35205 520-0
E-mail: sales@fhr.de
E-mail: sales@vitalchem.com
www.fhr.biz
Vital Materials is the world's leading producer of rare metals as well as the first Chinese manufacturer to deliver G11 rotary ITO target. Vital is also one of the world's three major supplier of infrared materials, a key supplier of compound semiconductor substrates, and a strategic partner of the world's largest thin film solar manufacturer.

LPE S.p.A.
Via Falzarego, 8
20021 Baranzate (Mi), Italy
Tel: +39 02 383 41 51
Fax: +39 02 383 06 118
www.lpe-epi.com

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

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

Riber
31 rue Casimir Périer, BP 70083,
95873 Bezons Cedex,
France
Tel: +33 (0) 1 39 96 65 00
Fax: +33 (0) 1 39 47 45 62
www.riber.com

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

Temescal, a division of Ferrotec
4569-C Las Positas Rd,
Livermore, CA 94551,
USA
Tel: +1 925 245 5817
Fax: +1 925 449-4096
www.temescal.net

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

7 Wafer processing materials

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

Praxair Electronics
(see section 5 for full contact details)

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

8 Wafer processing equipment

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

EV Group
DI Erich Thallner Strasse 1,
St. Florian/Inn, 4782,
Austria
Tel: +43 7712 5311 0
Fax: +43 7712 5311 4600
www.EVGroup.com
EV Group is a technology and market leader for wafer processing equipment. Worldwide industry standards for aligned wafer bonding, resist processing forthe MEMS, nano and semiconductor industry.

Logitech Ltd
Erskine Ferry Road,
Old Kilpatrick, near Glasgow G60 5EU,
Scotland, UK
Tel: +44 (0) 1389 875 444
Fax: +44 (0) 1389 879 042
www.logitech.uk.com

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

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

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

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

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

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

Veeco Instruments Inc
(see section 6 for full contact details)

9 Materials & metals

Goodfellow Cambridge Ltd
Ermine Business Park, Huntingdon,
Cambridgeshire PE29 6WR, UK
Tel: +44 (0) 1480 424800
Fax: +44 (0) 1480 424900
www.goodfellow.com

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

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

10 Gas and liquid handling equipment

Cambridge Fluid Systems
12 Trafalgar Way, Bar Hill,
Cambridge CB3 8SQ,
UK
Tel: +44 (0)1954 786800
Fax: +44 (0)1954 786818
www.cambridge-fluid.com

CS CLEAN SOLUTIONS GmbH
Fraunhoferstrasse 4,
Ismaning, 85737,
Germany
Tel: +49 89 96 24000
Fax: +49 89 96 2400122
www.csclean.com

Entegris Inc
129 Concord Road,
Billerica, MA 01821, USA
Tel: +1 978 436 6500
Fax: +1 978 436 6735
www.entegris.com

IEM Technologies Ltd
Fothergill House, Colley Lane,
Bridgwater, Somerset TA6 5JJ, UK
Tel: +44 (0)1278 420555
Fax: +44 (0)1278 420666
www.iemtec.com

Vacuum Barrier Corporation
4 Barton Lane,
Woburn, MA 01801,
USA
Tel: +1 781 933 3570
Fax: +1 781 933 9428
www.vacuumbarrier.com

VACUUM BARRIER VBC CORPORATION

Vacuum Barrier's vacuum-jacketed dynamic and sealed SEMIFLEX LN2 pipe delivers LN2 at bulk tank pressure in two-phase condition for on-demand supply. Our liquid/vapor phase separators deliver low-pressure LN2 to each use point for on-demand supply. Combine with SEMIFLEX Triax LN2 pipe eliminates two-phase flow to all use points.

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

11 Process monitoring and control

Conax Technologies
2300 Walden Avenue,
Buffalo, NY 14225,
USA
Tel: +1 800 223 2389
Tel: +1 716 684 4500
www.conaxtechnologies.com

k-Space Associates Inc
2182 Bishop Circle
East, Dexter, MI 48130,
USA
Tel: +1 734 426 7977
Fax: +1 734 426 7955
www.k-space.com

KLA-Tencor
One Technology Dr,
1-2221I, Milpitas,
CA 95035, USA
Tel: +1 408 875 3000
Fax: +1 408 875 4144
www.kla-tencor.com

LayTec AG
Seesener Str. 10–13,
10709 Berlin,
Germany
Tel: +49 30 89 00 55 0
Fax: +49 30 89 00 180
www.laytec.de

LAYTEC Knowledge is key

LayTec develops and manufactures optical in-situ and in-line metrology systems for thin-film processes with particular focus on compound semiconductor and photovoltaic applications. Its know-how is based on optical techniques: reflectometry, emissivity corrected pyrometry, curvature measurements and reflectance anisotropy spectroscopy.

Vacuum Barrier Corporation
4 Barton Lane, Woburn, MA 01801, USA
Tel: +1 781 933 3570
Fax: +1 781 933 9428
www.vacuumbarrier.com

VACUUM BARRIER VBC CORPORATION

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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

CST Global Ltd
4 Stanley Boulevard, Hamilton International Technology Park,
Blantyre, Glasgow, G72 0BN,
UK
Tel: +44 (0) 1698 722072
www.cstglobal.uk

United Monolithic Semiconductors
Route departementale 128,
BP46, Orsay, 91401,
France
Tel: +33 1 69 33 04 72
Fax: +33 169 33 02 92
www.ums-gaas.com

19 Facility equipment

RENA Technologies NA
3838 Western Way NE,
Albany, OR 97321, USA
Tel: +1 541 917 3626
www.rena-na.com

Vacuum Barrier Corporation
4 Barton Lane, Woburn, MA 01801,
USA
Tel: +1 781 933 3570
Fax: +1 781 933 9428
www.vacuumbarrier.com

VACUUM BARRIER VBC CORPORATION

Vacuum Barrier's vacuum-jacketed dynamic and sealed SEMIFLEX LN2 pipe delivers LN_2 at bulk tank pressure in two-phase condition for on-demand supply. Our liquid/vapor phase separators deliver low-pressure LN_2 to each use point for on-demand supply. Combine with SEMIFLEX Triax LN_2 pipe eliminates two-phase flow to all use points.

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
422 North Broad Street,
Mooresville,
NC 28115,
USA
Tel: +1 704 664 9251
Email: sales@brumleysouth.com
www.brumleysouth.com

BSI

As an ISO 9001 registered global leader in the remanufacturing of wafer inspection systems, Brumley South Inc specializes in designing, installing and supporting upgrades for ADE, Nanometrics, Dryden and KLA-Tencor Surfscan tools, polysterene latex sphere calibration standards, particle deposition systems, and semiconductor parts and service.

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5302 Snapfinger Woods Drive,
Decatur, GA 30035,
USA
Tel: +1 770 808 8708
Fax: +1 770 808 8308
www.ClassOneEquipment.com

23 Services

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

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

24 Resources

Al Shultz Advertising Marketing for Advanced Technology Companies
1346 The Alameda,
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

10-13 November 2023
2nd IEEE International Power Electronics and Application Symposium (PEAS 2023), incorporating:
2023 China Power Electronics and Energy Conversion Congress (CPEEC)
26th China Power Supply Society (CPSS) Conference and Exhibition (CPSSC 2023)
Guangzhou Yuexiu International Congress Center, China
E-mail: peas@cpss.org.cn
http://peas.cpss.org.cn

12–17 November 2023
14th International Conference on Nitride Semiconductors (ICNS-14)
Hilton Fukuoka Sea Hawk, Fukuoka, Japan
E-mail: secretary@icns14.jp
www.icns14.jp

14 November 2023
ALD TechDay at SEMICON Europa 2023, Powered by Beneq
ICM (Internationales Congress Center München), Munich, Germany
E-mail: semieurope@semi.org
www.semiconeuropa.org/program/ALD_TechDay

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

22–23 November 2023
Power Semiconductor User Forum 2023
Novotel Messe Munich, München, Germany
https://events.weka-fachmedien.de/anwenderforum-leistungshalbleiter/home

9–13 December 2023
69th annual IEEE International Electron Devices Meeting (IEDM 2023) – 'Devices for a Smart World Built Upon 60 Years of CMOS'
Hilton San Francisco Union Square Hotel, CA, USA
E-mail: iedm-info@ieee.org
www.ieee-iedm.org

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

13–17 December 2023
XXII International Workshop on the Physics of Semiconductor Devices (IWPSD 2023)
Indian Institute of Technology Madras, Tamil Nadu, India
E-mail: admin.iwpsd2023@ee.iitm.ac.in
https://mems.iitm.ac.in/iwpsd2023

23–24 December 2023
Asia Power Technology Development Forum
Crowne Plaza Shenzhen Nanshan, Shenzhen, China
E-mail: meeting@21dianyuan.com
https://meeting.21dianyuan.com/szthousand2023/index

advertisers' index

27 January – 1 February 2024
SPIE Photonics West 2024
The Moscone Center, San Francisco, CA, USA
E-mail: customerservice@spie.org
www.spie.org/conferences-and-exhibitions/photonics-west

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

25-29 February 2024
IEEE Applied Power Electronics Conference (APEC 2024)
Long Beach Convention & Entertainment Center,
Long Beach, CA, USA
E-mail: apec@apec-conf.org
https://apec-conf.org

24–28 March 2024
Optical Fiber Communication Conference and Exposition (OFC 2024)
San Diego Convention Center,
San Diego, CA, USA
E-mail: ofc@mcievents.com
www.ofcconference.org

7–11 April 2024
SPIE Photonics Europe 2024, co-located with SPIE Optical Systems Design 2024
Palais de la Musique et des Congrès,
Strasbourg, France
E-mail: customerservice@spie.org
www.spie.org/conferences-and-exhibitions/photonics-europe

30 April – 2 May 2024
27th annual Components for Military & Space Electronics conference & exhibition (CMSE 2024)
Four Points by Sheraton (LAX), Los Angeles, CA, USA
E-mail: info@tjgreenllc.com
www.tjgreenllc.com/cmse

20–23 May 2024
2024 CS MANTECH: International Conference on Compound Semiconductor Manufacturing Technology
JW Marriott Starr Pass Resort,
Tucson, AZ, USA
E-mail: registration@csmantech.org
www.vlsisymposium.org

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

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

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

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

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
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22–26 September 2024
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