semiconductorTODAY

COMPOUNDS & ADVANCED SILICON

www.semiconductor-today.com

Join our LinkedIn group: Semiconductor Today

Follow us on Twitter: Semiconductor_T

Choose *Semiconductor Today* for . . .

MAGAZINE

Accurate and timely coverage of the compound semiconductor and advanced silicon industries

Targeted 82,000+ international circulation

Published 10 times a year and delivered by e-mail and RSS feeds

WEB SITE

Average of over 26,000 unique visitors to the site each month

Daily news updates and regular feature articles

Google-listed news source

E-BRIEF

Weekly round-up of key business and technical news

E-mail delivery to entire circulation

Banner and text marketing opportunities available

ISSN 1752-2935 (online)

semiconductorTODAY
COMPOUNDS & ADVANCED SILICON
Vol. 17 • Issue 5 • June/July 2022
www.semiconductor-today.com

Fraunhofer IAF inaugurates new MOCVD and lab buildings

II-VI now Coherent • Scintil raises €13.5m • Transphorm gains $16m • Fraunhofer ISE raises solar cell efficiency record to 47.6%

IQE

THE GLOBAL LEADER IN EPIWAFER SUPPLY

Enabling the Best RF, Photonics & Power Semiconductors

- 'One-stop-shop' for III-V & Silicon epiwafer products
- 2" to 6" epitaxy ready substrates & polycrystalline materials
- Multiple manufacturing sites; Europe, Asia & America
- Leveraging 30+ years of compound semiconductor IP
- Custom engineered structures; R&D to production volumes

RF

GaN HEMT
5G Infrastructure
Radar, EW/ECM, & SATCOM

GaAs HBT / pHEMT / BiHEMT
5G Smartphones & Infrastructure
WiFi6 Hotspots, GPS & IoT

SiGe HBT
5G Smartphones
WiFi6, Bluetooth, GPS & IoT

PHOTONICS

InP Laser & Detector
Optical Comms & Data Centres
SW IR Imaging

GaSb Laser & Detector
MW-LW IR imaging
Biometrics

GaAs VCSEL
3D Sensing & LiDAR
Datacoms

POWER

GaN on Si HEMT
GaN on GaN
Electric Vehicle Systems
Power Conversion & Storage

GaAs Multi-Junction Solar
High Efficiency Terrestrial CPV & Space PV

GaN LED & Laser
MicroLED Display & AR/VR
UV Sterilisation

EUROPE: +44 2920 839 400
AMERICAS: +1 508 824 6696
APAC: +886 3 579 8181
ALL INQUIRIES: sales@iqep.com

www.iqep.com

contents

Editorial 4

Markets News 6
Micro-LED AR smart glass display chip market to jump from $5m in 2025 to $41m in 2026 • RF GaN device market growth slowed to 10% in 2021 as Huawei ends buffering of trade sanctions

Microelectronics News 10
University of Southern California's MOSIS Service announces MoU with WIN for III-V MMIC manufacturing • WIN releases second-generation 0.1µm GaAs pHEMT technology

Wide-bandgap electronics News 13
Finwave targets 5G with 3DGaN FinFETs • WIN releases 0.12µm-gate RF GaN-on-SiC • HG collaborates with China Titans Energy • Integra ships first production 100V RF GaN products • Transphorm raises extra $16m; joins Russell 2000 and 3000 Indexes • Vitesco extends cooperation with Infineon from Si to SiC

Materials and processing equipment News 32
Fraunhofer IAF inaugurates MOCVD and lab research buildings • Umicore develops ultra-low-resistivity 8" n-type germanium wafers • Advantest acquires test equipment supplier CREA • CompoundTek and STAr Technologies co-develop silicon photonics wafer testers

LED News 40
Perovskite–GaN tandem LED with improved tunable luminance and color • Cubic-phase III-nitride LEDs overcome efficiency droop

Optoelectronics News 44
II-VI completes acquisition of Coherent • IQE announces multi-year, high-volume strategic epiwafer supply agreement with Lumentum • BluGlass ships first prototype laser diode products • III-V Epi completes SHARK-VECSEL project for University of Strathclyde

Optical communications News 47
Scintil raises €13.5m • OpenLight unveils open silicon photonics platform with integrated lasers • II-VI and ADVA unveil first 100ZR pluggable coherent transceiver for optical network edge

Photovoltaics News 53
Fraunhofer ISE raises four-junction solar cell efficiency record to 47.6%

Technology focus: Optoelectronics 56
InGaAs/AlGaAs nanowires on silicon substrates

Technology focus: Nitride materials 58
AlN doping for future deep UV/power tech

Technology focus: Nitride materials 60
Magnesium doping of hot-wall MOCVD GaN

Market focus: Power electronics 62
Power GaN device market growing at 59% CAGR to $2bn in 2027

Technology focus: Power electronics 64
Gallium oxide beats silicon power limit

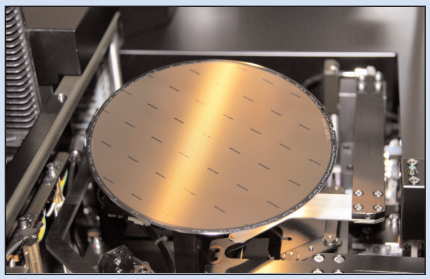
Market focus: Smartphones 66
Smartphone production volume falls 12.8% to 310 million in Q1/2022 due to amplified off-season effect

Suppliers' Directory 68

Event Calendar and Advertisers' Index 74

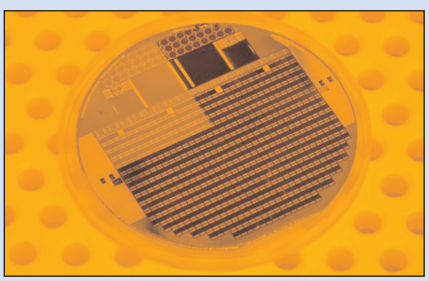
semiconductorTODAY
COMPOUNDS & ADVANCED SILICON

Vol. 17 • Issue 5 • June/July 2022



p12 WIN Semiconductors has released its PP10-20 second-generation 0.1µm GaAs pHEMT technology.

p14 Vitesco has extends its cooperation with Infineon from silicon to silicon carbide, targeting electric vehicle battery voltages of 800V.



p53 Fraunhofer ISE has raised the four-junction solar cell efficiency record from 46.1% to 47.6%.

Cover: Fraunhofer Institute for Applied Solid State Physics IAF has officially inaugurated a new MOCVD hall and a new laboratory research building, expanding its activities in optoelectronic metrology, quantum sensor technology and materials science. **p32**

editorial

Remaking the supply chain

While the Conservative Party was ousting UK Prime Minister Boris Johnson as their leader (resulting in an interim Government for a few months while it selects a new Prime Minister), the Business, Energy and Industrial Strategy (BEIS) Committee of the UK Parliament's House of Commons held the latest hearing in its inquiry into 'The semiconductor industry in the UK', which has assumed heightened importance post-Brexit, and due to the disruption from both the coronavirus pandemic and geo-political conflicts.

A prior hearing in June (involving the Compound Semiconductor Application Catapult) examined the security of the supply chain, noting the presence of dominant compound semiconductor epiwafer foundry IQE (in South Wales) and 20–25 niche chip manufacturing facilities — such as the Scotland-based start-up Clas-SiC (which is making silicon carbide devices for power electronics applications such as electric vehicles) — but the absence of large-scale substrate manufacturing and multi-billion-dollar high-volume, leading-edge silicon fabs (dominated by Taiwan's TSMC and South Korea's Samsung) and advanced chip assembly, packaging and test.

The latest hearing concerned the acquisition of South Wales' Newport Wafer Fab (the UK's largest fab) by Netherlands-based Nexperia, which is owned by China-based Wingtech Technology and is hence being investigated under the UK's National Security and Investment Act. Nexperia UK general manager Toni Versluijs noted that, as part of a £160m investment in the UK over the past 15 months, the firm had saved Newport Wafer Fab from bankruptcy, and that the option it had provided to the previous owner (to use an unused building to pursue the plans to establish an open-access compound semiconductor fab) has been outstanding for almost a year.

The USA in particular is concerned about China's access to semiconductor technology, and the USA's dependence on an increasingly vulnerable Taiwan (especially since TSMC provides foundry manufacturing for US-based gallium nitride device firms GaN Systems and Navitas). Steps have already been taken towards on-shoring chip manufacturing, both to persuade TSMC to establish fabs in the USA, and through the USA's $52bn 'CHIPS for America Act' and the EU's €43bn 'European Chips Act' to boost domestic manufacturers' capacity and technology capabilities.

Supply chains have been further disrupted by not just the pandemic but also the Russia–Ukraine war, which has halted supplies of some chip manufacturing materials (such as neon), putting greater reliance on sourcing from China and elsewhere as well as increasing pricing. Also, as well as barring the export of end-products to Russia, the US Department of Commerce is preparing to bar the export of US-made tech products (including chips), and those made with US equipment, software and IP (similar to the ban on exports to China-based Huawei in 2019). The EU, Japan, Australia, UK, Canada and New Zealand are expected to follow suit.

This will likely increase Russia's sourcing of chips from China, which is lagging in silicon manufacturing technology — and its foundry SMIC is subject to US sanctions — but can still fulfill Russia's needs.

Whereas globalization proliferated for decades, the return of geo-political divisions is forcing a realignment of supply chains and a revival of on-shore manufacturing. While high-volume, leading-edge silicon chip making may only be fundable in the USA and EU, in the UK and other countries that no longer have that critical mass of infrastructure, manufacturing of more niche devices based on compound semiconductors SiC and GaN — which can use existing legacy silicon manufacturing equipment — can perhaps gain the most from rapidly growing applications such as power electronics for EVs.

Mark Telford, Editor

semiconductorTODAY
COMPOUNDS & ADVANCED SILICON

Editor
Mark Telford
Tel: +44 (0)1869 811 577
Cell: +44 (0)7944 455 602
Fax:+44 (0)1242 291 482
E-mail: mark@semiconductor-today.com

Commercial Director/Assistant Editor
Darren Cummings
Tel: +44 (0)121 288 0779
Cell:+44 (0)7990 623 395
Fax:+44 (0)1242 291 482
E-mail: darren@semiconductor-today.com

Advertisement Sales
Darren Cummings
Tel: +44 (0)121 288 0779
Cell:+44 (0)7990 623 395
Fax:+44 (0)1242 291 482
E-mail: darren@semiconductor-today.com

Original design Paul Johnson
www.higgs-boson.com

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

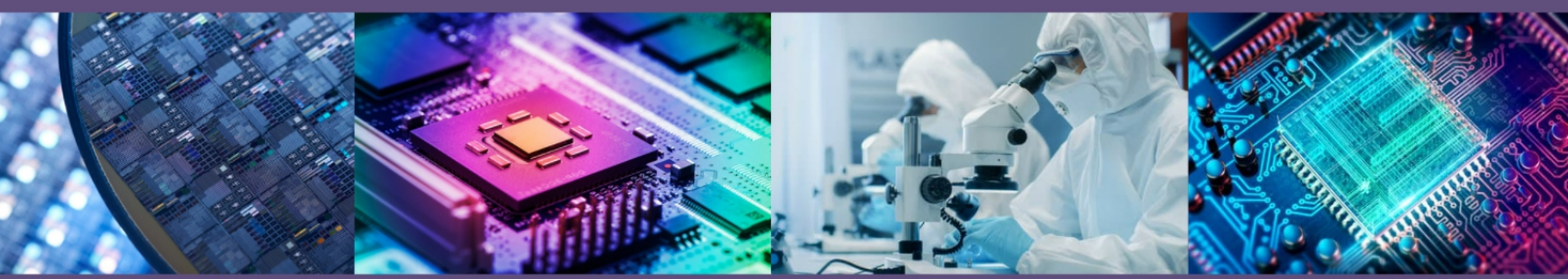
Regular issues contain:

- news (funding, personnel, facilities, technology, applications and markets);
- feature articles (technology, markets, regional profiles);
- conference reports;
- event calendar and event previews;
- suppliers' directory.

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

csconnected

THE WORLD'S FIRST COMPOUND SEMICONDUCTOR CLUSTER



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

Driving tomorrow's technologies

csconnected.com | info@csconnected.com

LED package market grew 15.4% to $17.65bn in 2021, with Nichia ranking first

Market growing more slowly in 2022

The global LED market beat market expectations in 2021, growing 15.4% year-on-year to $17.65bn as a slowing pandemic drove the recovery of various global economic activities, according to TrendForce's latest LED report.

From the revenue ranking of LED makers, most constituents benefited from the rebound in market demand and showed significant revenue growth, with the top three manufacturers accounting for 29.5% of the market.

Nichia's backlight LED business revenue declined due to increasing organic light-emitting diode (OLED) penetration. However, driven by the rapid growth of revenue in the flash LED, automotive LED and general lighting markets, overall revenue continued to grow steadily, ranking Nichia first in the world.

Exemplified by stable product quality, excellent light efficiency, and cost-effectiveness, ams OSRAM is regarded as a first-choice supplier for high-end automobiles and new energy vehicles (NEV) worldwide. In addition, benefiting from orders for horticultural lighting and infrared sensing, its revenue ranks second in the world.

Samsung LED also benefited from improved sales in automotive lighting, horticultural lighting, general lighting and mini-LED backlights, ranking third. Among these products, Samsung Lighting LEDs are positioned in the high-end market. In high-end markets such as Europe and the USA, Samsung LED's market share is gradually expanding due to its advantages in quality and patents. Notably, Samsung LED's horticultural lighting orders also showed rapid growth, driving its whole lighting LED business revenue to rank first in the world.

2020 Rank	2021 Rank	Company
1	1	Nichia
2	2	ams OSRAM
3	3	Samsung LED
4	4	Seoul Semiconductor
5	5	Lumileds
6	6	MLS
8	7	Everlight
7	8	LITEON
9	9	Nationstar
10	10	Hongli

Global top-ten LED package revenue ranking, 2020–2021. (LED package business includes visible light, invisible light, and photocouplers.

The remaining top-ten LED makers are rounded out by Seoul Semiconductor, Lumileds, MLS, Everlight, LITEON, Nationstar, and Hongli. Seoul Semiconductor took advantage of revenue growth from large-size backlights, automotive LEDs and lighting LEDs. Lumileds also performed well in automotive LEDs and lighting LEDs, and continued to launch a variety of LEDs for commercial lighting, horticultural lighting and architectural lighting to seize market share. MLS, Nationstar and Hongli have significantly increased their revenue in the display LED and lighting LED markets. Everlight and LITEON continue to develop photocoupler, infrared sensing and consumer electronic indicator LED products.

Due to the impact of the pandemic in China, the industrial chain in some cities has experienced interruptions

Looking at performance in first-half 2022, TrendForce indicates that, despite the gradual recovery of demand in Europe and the USA, the Russian–Ukrainian war continued to drive raw material pricing upward and exacerbate inflation, in turn suppressing demand in the consumer market. In addition, due to the impact of the pandemic in China, the industrial chain in some cities has experienced interruptions and disruption, with the scope to influence enveloping industries such as electronics and automobiles, inflicting a certain degree of collateral damage on supply and demand in the LED market.

Looking forward to second-half 2022, it is worth observing the imminent launch of corresponding economic stimulus policies by the Chinese government, says TrendForce. The global LED market is forecast to maintain a growth trajectory in 2022, but at a slower rate than the growth performance in 2021.

www.trendforce.com

Micro-LED AR smart glass display chip market to jump from $5m in 2025 to $41m in 2026

Maturity of red chip, laser transfer, wafer bonding and full-colorization technologies to boost yield and reduce production costs

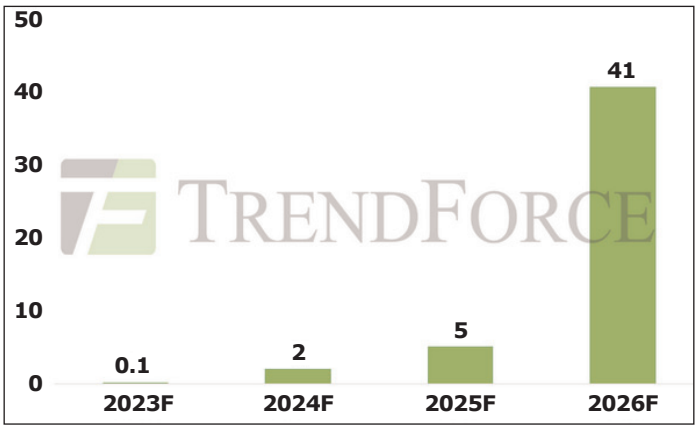
Among many micro-LED display applications, micro-LED micro-displays will be the next new high-end product following on from large-scale display development, according to TrendForce's latest micro-LED research report.

Specifically, the market for micro-LED augmented reality (AR) smart glasses display chips is forecast to grow from just US$5m in 2025 to US$41m in 2026. The reason for such significant growth in just one year from 2025 to 2026 is primarily due to the gradual maturity of technologies such as red chips, laser transfer, wafer bonding and full-colorization, which can improve yield and reduce production costs.

TrendForce indicates that the current status of micro-LED AR smart glasses is dominated by monochrome displays due to a full-color technology bottleneck, and they can only display basic informational functions such as information prompts, navigation, translation, and teleprompter applications. In the future, after full-color technology matures, it will first be applied in special fields such as medical surgery/testing instruments, factory environment monitoring/maintenance tools, and military applications. Only after the technology is sufficiently advanced and cost has been reduced for commercialization will micro-LEDs have the opportunity to be applied to full-color consumer display products.

TrendForce says that the ideal display for transmissive smart glasses must meet the following three conditions:

- In terms of controlling weight and dimensions, in order to reduce the burden of wearing such glasses as much as possible, the size of the corresponding display light engine should be about 1-inch or smaller.
- In terms of content recognition requirements, the brightness specification of the display must be at least 4000 nits to ensure that it is not affected by external environment factors such as weather or venue.
- Resolution must be at least more than 3000 PPI (pixels per inch), so that projected images can be read clearly.



However, few technologies can simultaneously meet the stringent aforementioned requirements for micro-displays. The most popular technologies are micro-LEDs and micro-OLEDs (organic light-emitting diodes), both of which are self-illuminating. However, micro-LEDs are currently at an early stage of AR application technology development and challenges remain to be overcome. Due to a significant increase in demand for resolution, increased pixel density will inevitably lead to a simultaneous shrinking of chips. In a situation where the size of the micro-LED needs to be reduced to at least 5μm or less, wavelength uniformity issues in the epitaxial process will affect yield.

Secondly, a smaller chip also raises a problem with the external quantum efficiency (EQE) of the red chip exterior, which in turn affects the luminous efficiency of full color and will face the challenge of only being able to display a single color.

Third, although the problem of full color can be overcome by combining blue light chips with quantum dot technology, many technical bottlenecks still remain to be overcome in the application of quantum dot technology in the micro-LED process at the current stage.

Fourth, when the micro-LED chip and the CMOS backplane are connected by wafer, if the RGB chip is transferred to the backplane using laser transfer, micro-LED chip transfer yield will be impacted when the energy control of the laser transfer area is not uniform.

Finally, quickly detecting the electrical and optical properties of the micro-LED micro-display light engine on the backplane and repairing defective pixels after inspection are also key factors affecting process and cost.

TrendForce concludes that, although there are still many obstacles to overcome in the application of micro-LEDs in AR smart glasses (and the development of full-color technology and a mass-production schedule lags relative to micro-OLEDs), micro-LED performance outclasses micro-OLED performance in specifications such as contrast, responsiveness, lifespan, power conservation, etc. Considering that it is difficult for the light efficiency of transmissive AR smart glasses to break through the 1% limit due to the limitations of optical waveguide element technology, micro-LEDs still represent an excellent light engine technology option for micro-displays in the medium and long term.

www.ledinside.com

RF GaN device market growth slowed to 10% in 2021 as Huawei ends buffering of trade sanctions

Rebound in base-station applications, plus growth in defense, to push revenue past $2.1bn in 2026

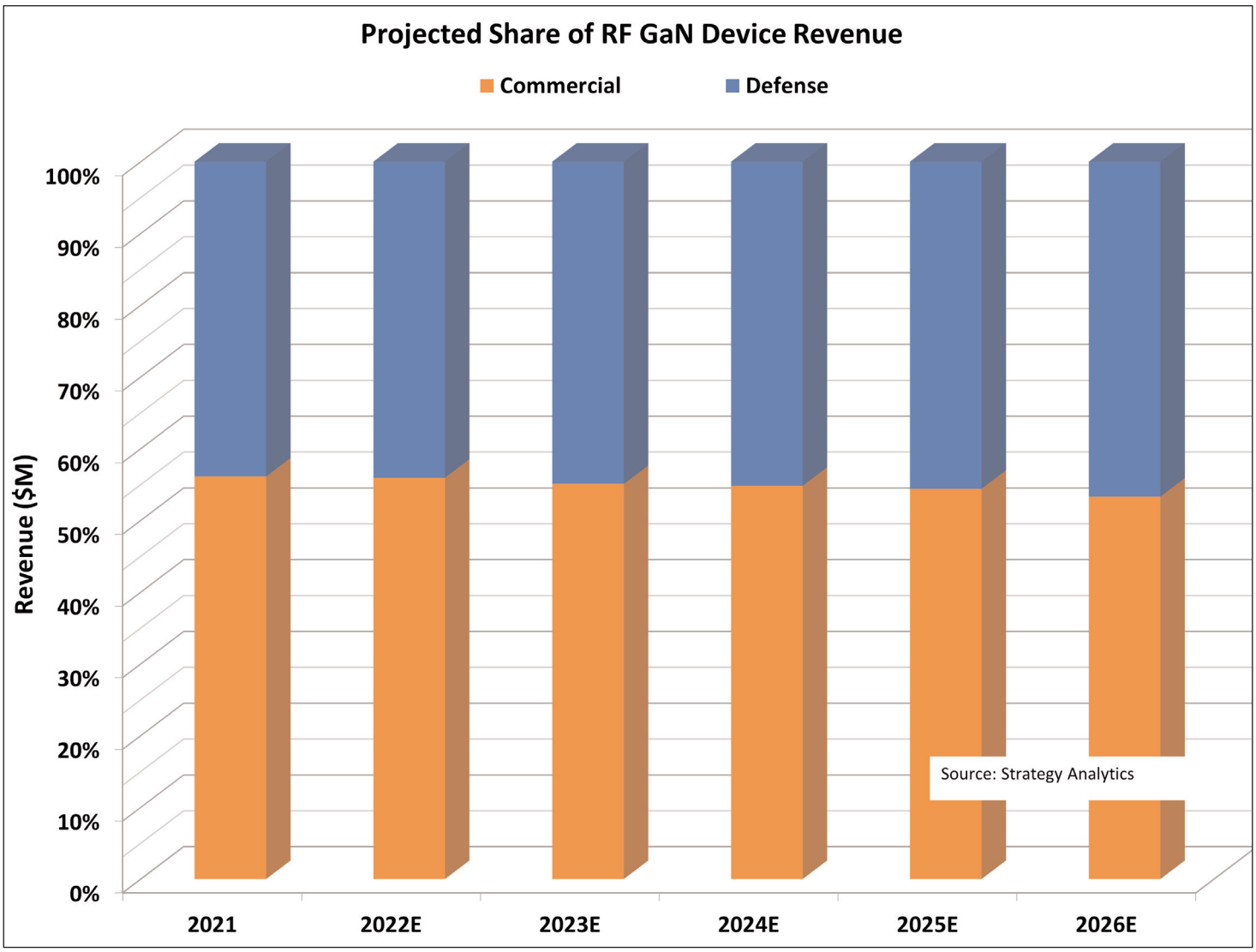
Revenue growth from RF GaN-enabled devices slowed down in 2021, but still managed to increase by 10%, according to the Strategy Analytics Advanced Semiconductor Applications (ASA) and Advanced Defense Systems (ADS) report 'RF GaN Device Market Forecast: 2021–2026'.

Base-station applications continue to be the largest source of RF GaN device revenue but this segment declined in 2021, while defense applications drove overall revenue growth in 2021, the report concludes. However, it forecasts that a return to growth from base stations, coupled with defense applications, will push total RF GaN device revenue past $2.1bn in 2026.

"The past few years have seen extraordinary growth in RF GaN device revenue in base-station applications as a result of Huawei trying to buffer the consequences of trade sanctions, but this effort has ended," notes Eric Higham, director of the Advanced Semiconductor Applications (ASA) and Advanced Defense Systems (ADS) services. "Despite a slight drop in base-station revenue in 2021, I expect this segment will return to growth and will be a growth engine, along with expanding defense applications to power RF GaN device revenue past $2.1bn in 2026."

The past few years have seen extraordinary growth in RF GaN device revenue in base-station applications as a result of Huawei trying to buffer the consequences of trade sanctions

www.strategyanalytics.com



Projected RF GaN device revenue share (source: Strategy Analytics Advanced Semiconductor Applications service).

Fuji Electric
Innovating Energy Technology

Fuji Electric G-Twin UL Plug-In Series

New High Quality Product with improved safety features, easy installation and compact

TÜV Rheinland IEC JIS EN c UL us LISTED CE

Global Standard

The New Generation of Molded Case Circuit Breakers and Earth Leakage Circuit Breakers.

- ★ Built-In Compact Ground Fault for Space Saving Designs
- ★ Same Footprint! MCCBs and ELCBs interchangeable without Panel Modifications
- ★ All frame sizes (50AF-250AF) can be mounted with the same mounting pitch of 70mm
- ★ Lock Out Tag Out (LOTO) safety devices (fixed and removable types) are available as an option
- ★ Improves safety measures and easy & quick installation
- ★ UL489 and CSA C22.2 No.5 approved and certified

Fuji Electric Corp. of America **Distribution & Control Department**

For sales, product & distributor information, please visit americas.fujielectric.com/UL-Plug-In

or contact us: x-fea-fuji-dc@fujielectric.com

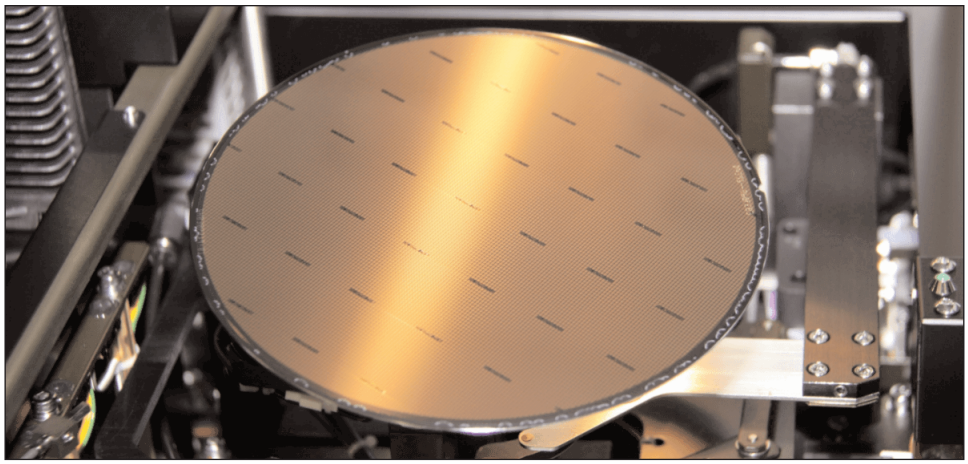
University of Southern California's MOSIS Service announces MoU with WIN for III-V MMIC manufacturing

Project flows to be released for using MOSIS Service to fabricate microwave integrated circuits at Taiwan foundry WIN

The MOSIS Service of the Information Sciences Institute, University of Southern California (USC) in Los Angeles has announced a memorandum of understanding (MoU) to accelerate the development of gallium arsenide (GaAs) and gallium nitride (GaN) monolithic microwave integrated circuits (MMICs) using the process technologies of WIN Semiconductors Corp of Taoyuan City, Taiwan — the largest pure-play compound semiconductor wafer foundry. Project flows for customers to utilize the MOSIS Service to fabricate MMICs at WIN Semiconductors will be released.

The collaboration combines the MOSIS semiconductor design support and manufacturing expertise, including multi-project wafer (MPW) runs, and WIN's manufacturing technologies for high-speed devices utilizing III–V compound semiconductors including GaAs and GaN, and prototype packaging technologies. With this collaboration, universities, research organizations and industry organizations will have access to an extensive portfolio of heterojunction bipolar transistor (HBT), pseudomorphic high-electron-mobility transistor (pHEMT) and RF GaN HEMT technology platforms to develop new high-performance MMIC designs. The collaboration lays the foundation for reliable and efficient design and prototyping flows through the MPW projects with The MOSIS Service and WIN Semiconductors.

"This is a new and important capability for The MOSIS Service to provide access and support to non-silicon wafer fabrication processes with the microelectronics community," says Craig Knoblock, executive director of Information Sciences Institute. "For the first time, the US Government, R&D laboratories, companies and academia will have access to WIN Semiconductors' portfolio of III–V compound semiconductor processes with MOSIS' legacy design and manufacturing service capabilities… This collaboration will significantly advance microelectronics R&D and accelerate the development of advanced GaAs and GaN MMICs," he believes.



"WIN Semiconductors is the world leader in the pure-play compound semiconductor foundry space and offers a comprehensive portfolio of III–V technologies," comments Lifu Chang, director of The MOSIS Service. "These III–V foundry technologies require a higher level of design-technology interplay compared to silicon technologies. Our MOSIS experience provides a platform for tightly coupled and efficient design and manufacturing flows, to support universities and design companies interested in high-performance front-end applications," he adds.

"There are serious concerns with the access to wide varieties of semiconductor processes and design support for universities and corporations in the US, in the context of worldwide competition and wafer supply constraints," notes Knoblock. "The MOSIS Service is positioned to contribute to the resolution. The addition of GaAs and GaN technologies is necessary, and we will push hard in this direction."

"The collaboration between WIN Semiconductors and The MOSIS Service creates a new platform for many new users to access WIN's market-leading compound semiconductor technologies," says WIN's senior VP of technology & strategic business development David Danzilio. "We are building a robust project framework with MOSIS' team. I expect to attract and enable many customers that have been interested but need the level of technical support that MOSIS can provide."

The WIN–MOSIS collaboration is focused on the development of new MMICs, and the technologies included in the program support amplifier designs and integrated front-ends operating from 100MHz to 175GHz. These technology platforms incorporate various integration options including multiple metal layers, logic interfaces, compact ESD protection, copper-pilar bumps and through-chip RF transitions. WIN's proven GaAs and GaN technologies support large-scale chip manufacturing, delivering billions of MMICs annually to WIN's customers. The collaboration will also provide access to prototype QFN packaging technologies from WIN.

www.winfoundry.com
https://viterbischool.usc.edu

Sivers completes integration of MixComm

MixComm CEO to become Sivers' US president

Sivers Semiconductors AB of Kista, Sweden (which supplies chips and integrated modules) has completed the integration of fabless semiconductor company MixComm Inc of Chatham, NJ, USA (which also has design centers in Oregon and California), creating a global provider in 5G, SATCOM and radar. Along with broadening Sivers' portfolio and increasing its presence in the USA, the integration entails synergies of about SEK10m per year. Sivers writes down intangible assets of about SEK22m due to overlapping product development areas. The firm is also introducing a new role in the USA, making former MixComm CEO Mike Noonen its US president.

Sivers has found large synergies in development tools and some personnel, yielding a total saving of about SEK10m per year (compared with if MixComm and Sivers had been two autonomous units). At the end of first-quarter 2022, Sivers had 137 staff, which includes personnel synergies.

Sivers Wireless has minimal product overlap with MixComm. However, there is a one product, a beam-forming IC (BFIC), that Sivers and MixComm had both independently developed, where Sivers has determined that MixComm's BIFC is the most sophisticated solution. Sivers has therefore chosen to write down intangible assets of about SEK22m for the product that Sivers Wireless developed.

"MixComm's key area has been BFICs, where MixComm founder Harish Krishnaswamy and his team had invested many years in optimizing technology at Columbia University with significant DARPA support," notes Sivers Semiconductors' CEO Anders Storm. "This technology is 'state-of-the-art', and the one we will continue to develop within BFIC and later also RFICs," he adds.

As US president in the new organization, Noonen will focus on business development and sales for both Sivers Wireless and Photonics. During a transition period, he will also be managing director (MD) of Sivers Wireless. Pelle Wijk will take on a new role as chief operating officer (COO) of Sivers Wireless. Patric Erlandsson, former VP sales of Sivers Wireless, becomes senior VP marketing for the parent company Sivers Semiconductors.

Sivers Wireless will be divided into two different development units, one in the USA which will be run by MixComm's co-founder & former chief technology officer Dr Harish Krishnaswamy, and one in the EU which will be run by Magnus Sneitz, previously head of the Project Management Office (PMO) at Sivers Wireless.

"With MixComm now fully integrated, we now have a much stronger presence in the US, and I am very happy that Mike Noonen is taking on this new role," says Storm. "He has a network in the USA that is top tier and is very well known in the semiconductor industry," he adds.

MixComm was founded in 2017 based on more than 10 years of development at Columbia University led by Krishnaswamy through externally funded research projects totalling $94m. The firm is an active US participant in 5G BFIC (repeaters/base stations), SATCOM and radar verticals. Most employees hold a PhD and the company is the only mmWave company selected to join the 5G Open Innovation Lab founded by T-Mobile and Intel. The flagship beam-forming IC SUMMIT 2629 was the recipient of numerous 'Best Products' citations in 2020, including 'The Broadband Innovation of the Year' from the Mobile Breakthrough Awards. MixComm has established partnerships with minority investor GlobalFoundries for RF-SOI fabrication, packaging and test services, and with Richardson RFPD for distribution and logistics globally. Both the GlobalFoundries and Richardson RFPD collaborations will continue under the Sivers Wireless brand and be expanded to all products by the company.

www.mixcomm.com
www.sivers-semiconductors.com

Altum RF showcases new GaN power amplifiers and GaAs pHEMT low-noise amplifiers and linear amplifiers

At the IEEE International Microwave Symposium (IMS 2022) at the Colorado Convention Center in Denver (21–23 June), Altum RF of Eindhoven, The Netherlands (which designs high-performance RF to millimeter-wave solutions for commercial and industrial applications) showcased its technical expertise as well as new gallium nitride (GaN)-based power amplifiers (PAs) and gallium arsenide (GaAs)-based pseudomorphic high-electron-mobility transistor (pHEMT) low-noise amplifiers (LNAs) and linear amplifiers. These include:

- ARF1009Q5: 9–11GHz GaN PA, 10W, >30dB power gain;
- ARF1020Q5: 9–11GHz GaN PA, 10W, >20dB power gain;
- ARF1208: 37–59GHz GaAs pHEMT LNA, 2.5dB noise figure, 26.5dB linear gain;
- ARF1207: 57–71GHz GaAs pHEMT linear amplifier, >20dB gain, 22dBm saturated output power (P_{sat});
- ARF1206: 71–86GHz GaAs pHEMT LNA, 22dB gain, 3.8dB noise figure.

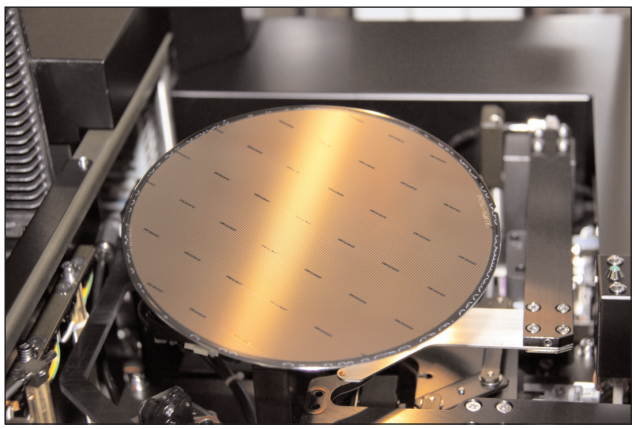
www.ims-ieee.org
www.altumrf.com

WIN Semiconductors releases second-generation 0.1µm GaAs pHEMT technology

PP10-20 boosts gain and improves f_T/f_{max} to 160GHz/240GHz, for W-band to D-band frequencies

WIN Semiconductors Corp of Taoyuan City, Taiwan — the world's largest pure-play compound semiconductor wafer foundry — has released its latest-generation 0.1µm gallium arsenide (GaAs) pseudomorphic high-electron-mobility transistor (pHEMT) technology, PP10-20. Building on the mature and production-proven PP10 platform, this second-generation technology provides a substantial increase in transistor gain and improves f_T/f_{max} to 160GHz and 240GHz respectively. These improvements have been achieved while maintaining reliable 4V operation necessary for backhaul power amplifiers and high-linearity receivers operating from W-band though D-band.

Targeting applications above 100GHz, this multi-function GaAs pHEMT technology can be used for low-noise amplifiers (LNAs) and power amplifiers (PAs) as well as wide-bandwidth modulator drivers for high-data-rate fiber-optics. PP10-20 has two interconnect metal layers with air-bridge crossovers and includes monolithic PN junction diodes for compact on-chip ESD protection circuits. The technology is manufactured on 150mm-diameter GaAs substrates with a final wafer thickness of 50µm. A backside ground plane with through-wafer-vias (TWV) is standard for PP10-20, and TWVs can be configured as through-chip RF transitions to eliminate the adverse impact of bond wires at millimeter-wave frequencies.



PP10-20 provides additional gain and higher bandwidth for power, low-noise and linear amplifiers through D-band.

"PP10-20 builds upon the mature PP10-10 platform used in many of today's E-band power amplifiers deployed in wireless backhaul," says senior VP David Danzilio. "WIN's deep understanding of III-V junction engineering yielded a substantial improvement in transistor performance without the need to reduce gate length," he adds. "This approach reduces overall technology risk and achieves increased transistor performance while maintaining the high production yields our customers expect."

www.winfoundry.com

Tagore launches GaAs pHEMT ultra-low-noise amplifiers and linear power amplifier driver

Fabless semiconductor company Tagore Technology Inc — which was founded in January 2021 and has design centers in Arlington Heights, IL, USA and Kolkata, India developing gallium nitride-on-silicon (GaN-on-Si) technology for RF and power management applications — has launched ultra-low-noise amplifiers (LNA) and a companion linear power amplifier (PA) driver. Tunable from 100MHz to 5GHz and operating from a 2.7–5V supply, the family of devices is suitable for a broad range of applications including 5G infrastructure and high-performance Satellite Digital Audio Radio Service (SDARS).

The TL0374J and TL0375J are ultra-low noise figure LNAs utilizing pseudomorphic high-electron-mobility transistor (pHEMT) gallium arsenide (GaAs) process technology. The TL0374J is optimized for below 3GHz frequency bands and the TL0375J is optimized for above 3GHz frequency bands. Ultra-low noise figure LNAs offer a noise figure of 0.35dB and gain of 18dB with adjustable bias current through an external resistor. The TP0310K is a linear PA driver with gain of 17dB, OP1dB of 27dBm and OIP3 of 39dBm at 2GHz.

"The new ultra-low-noise amplifier and linear PA driver device deliver a very low NF, high linearity and good gain required for high-performance receivers such as 5G infrastructure and SDARS," says chief sales & marketing officer Klaus Buehring. "Our applications team has developed custom tuning for a broad range of applications at 5V/60mA and 3V/30mA bias for common cellular band frequencies which can be adopted by our customers."

The ultra-low-noise amplifiers are available in a 2x2 DFN package and the linear PA driver is available in a compact 3mm x 3mm QFN package. Samples and evaluation boards are available now for all devices.

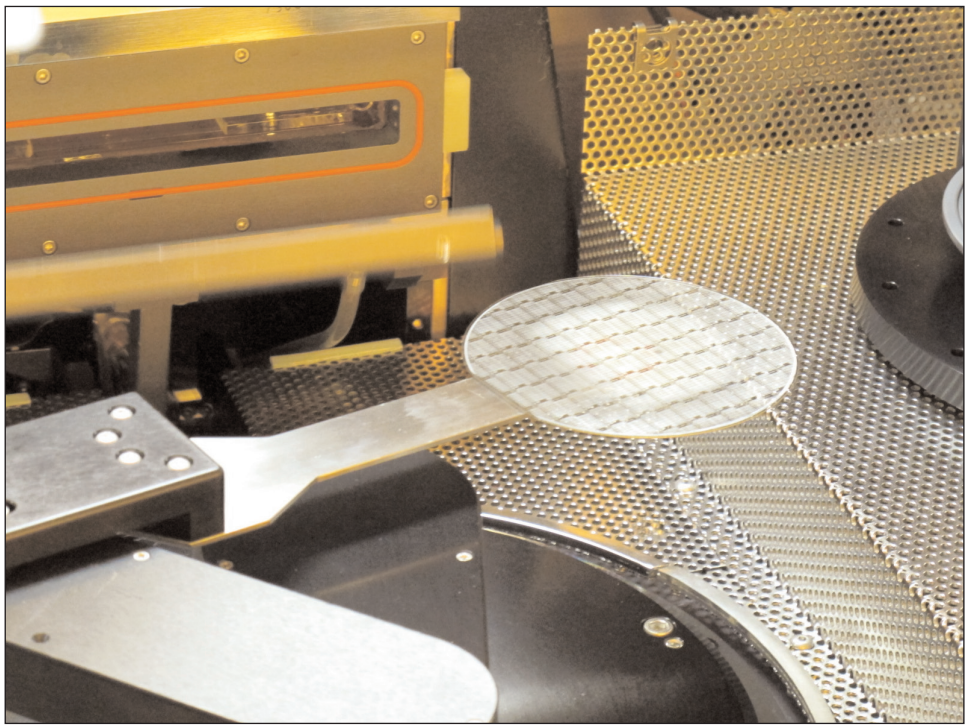
www.tagoretech.com

WIN releases 0.12µm-gate RF GaN-on-SiC technology

NP12-01 platform provides increased gain and efficiency for high-transmit-power applications through Ka-band

WIN Semiconductors Corp of Taoyuan City, Taiwan — the world's largest pure-play compound semiconductor wafer foundry — has expanded its portfolio of RF GaN technologies with the release of a new gallium nitride (GaN) on silicon carbide (SiC) 0.12µm-gate process. The NP12-01 millimeter-wave (mmWave) technology provides increased gain and improved transistor stability factor. The NP12-01 technology is suitable for the high-power amplifiers used in 5G mmWave radio access networks, satellite communications, and radar systems.

Supporting full monolithic microwave integrated circuits (MMICs), the NP12-01 platform allows customers to develop compact linear or saturated power amplifiers up to 50GHz. This process is qualified for 28V operation and, in the 29GHz band, generates saturated output power over 4W/mm with 13.5dB linear gain and nearly 50% efficiency. When optimized for power-added efficiency (PAE), NP12-01 provides over 3.5W/mm output power and greater than 50% PAE at 29GHz.



WIN says that higher gain and PAE provided by the NP15-01 platform affords designers a larger trade-space to optimize amplifier performance and chip size to meet increasingly difficult specifications of current-generation communication platforms and radar systems. Depending on the function, these high-performance applications require precise optimization of output power, linearity, gain and efficiency, and a broad trade-space is crucial to balance amplifier performance and product cost.

WIN showcased its RF and mm-Wave solutions at June's 2022 IEEE International Microwave Symposium (IMS) in Denver, CO, USA.

www.winfoundry.com

Qorvo adds 2W S-band and 4W C-band MMIC power amplifiers for radar systems

Footprint compatibility with predecessors enables drop-in improvement in power and efficiency

Qorvo Inc of Greensboro, NC, USA (which provides core technologies and RF solutions for mobile, infrastructure and defense applications) has introduced two power amplifiers (PAs) offering superior power-added efficiency (PAE) for radar systems.

The QPA2935 is a 2W S-band (2.7–3.5GHz) MMIC PA with PAE of 52%. The QPA0506 is a 4W C-band (5.0–6.0GHz) MMIC PA with PAE of 53%. Both have large-signal gain of 18dB. With package dimensions of 4mm x 4mm, both are footprint compatible with the predecessor devices TGA2597-SM and TGA2599-SM, enabling a simple drop-in replacement option to instantly improve system performance in power and efficiency. The devices offer flexible bias points, giving users the ability to increase RF power as well.

"These new PAs expand the wide range of applications served by Qorvo's defense and aerospace portfolio," says Doug Cole, general manager of Qorvo's Defense and Aerospace business. "The QPA2935 and QPA0506 each provide best-in-market power-added efficiency for 2–4W and 4–5W amplifiers, providing a simple means to a 20-percentage-point efficiency upgrade with drop-in pin-compatibility."

The QPA2935 and QPA0506 are available now in production quantities.

www.qorvo.com/applications/defense-aerospace

Vitesco extends cooperation with Infineon from Si to SiC

Silicon carbide targeted for EV battery voltage of 800V

Vitesco Technologies of Regensburg, Germany, which supplies drive technologies and electrification solutions for electro-mobility, has signed a cooperation agreement with Infineon Technologies AG of Munich, Germany, which it says is the world's leading manufacturer of semiconductors for automotive electronics and a global supplier of power semiconductors made from silicon carbide (SiC). Vitesco is already using SiC components in its existing generation of electronics, where they enable small sizes with high efficiency, for example in very compact high-voltage inverters that control electric drive motors.

"Partnering up with leading semiconductor manufacturers is important for us to master dynamic growth," believes Vitesco's CEO Andreas Wolf. "We have been collaborating with Infineon on silicon for a long time. We are now expanding this with SiC power

semiconductors. Jointly refining chips specifically for our applications, in the area of electro-mobility, will lead to highly attractive solutions," he adds.

"Our second silicon carbide generation enables us to develop even more compact and efficient systems," notes Dr Stephan Zizala, head of Infineon's Automotive High Power business unit. "With our decades of experience and continuous expansion of manufacturing capacities, we are well positioned for the accelerated growth of the SiC market," he says.

SiC power semiconductors provide voltage layers for electrified drives up to 800V system voltage. Compared with silicon, SiC offers an efficiency advantage, especially at a battery voltage of 800V, extending the range of an electric vehicle (EV). "Range is a key performance characteristic in battery electric driving; higher-efficiency power semiconductors such as SiC will therefore be increasingly used in the future," says Thomas Stierle, member of the executive board and head of the Electrification Technology business unit at Vitesco.

For Vitesco, this is the second partnership in SiC devices. "We have had excellent experience with the partnership already underway and have industrialized initial applications," says Stierle. "In view of the strong order intake for electric drives, for example for very compact axle drives, the broad supply base is a strategically important course setting."

www.vitesco-technologies.com

MACOM extends PURE CARBIDE GaN-on-SiC power amplifier range to 7kW

High-voltage circuit topologies combined with advanced packaging materials for improved thermal management

At the IEEE International Microwave Symposium (IMS 2022) in Denver, CO, USA (21–23 June), MACOM Technology Solutions Inc of Lowell, MA, USA announced that it has expanded its power amplifier product portfolio with the MAPC-A1605 7.0 kilowatt power amplifier, suitable for high-power and high-voltage aerospace and defense applications, including radar and electronic warfare (EW) systems.

The MAPC-A1605 can operate at 960–1215MHz and currently represents MACOM's highest-power-level RF amplifier component product. This extremely high power level was achieved by combining novel high-voltage circuit topologies with advanced packaging materials for improved thermal management. The MAPC-A1605 utilizes MACOM PURE CARBIDE gallium nitride-on-silicon carbide (GaN-on-SiC) technology and operates at 150V bias levels.

MACOM also introduced the MAPC-A1603 and MAPC-A1604, which operate at similar frequencies but lower voltages and lower output powers of 3.3kW and 5.0kW, respectively. Previously, MACOM's highest-power amplifier was the MAPC-A1500, operating at 2.6kW.

"Our customers want to transmit higher power levels and these new amplifiers will help enable that," notes president & CEO Stephen G. Daly.

www.macom.com

MACOM demonstrates RF and microwave amplifiers, switches and filters at IMS 2022

Ten live demonstrations span telecom, satcom, aerospace & defense, test & measurement, and industrial applications

At IMS, MACOM demonstrated a range of new products optimized for telecom, satcom, aerospace & defense, test & measurement, and industrial applications.

MACOM's Design, Applications and Sales Engineering teams hosted ten live demonstrations involving the following product categories:

RF and microwave amplifiers

- Aerospace — MACOM's new, customizable RF pallet designs using MACOM PURE CARBIDE GaN amplifiers and integrated power management solutions.
- Radar — High-voltage power amplifier with greater than 4.5kW output power performance.
- Satcom — Ka-band GaN MMICs for pulsed and continuous wave (CW) power applications, and advanced E-band MMIC solutions with a power amplifier combiner using waveguide WR-12 packaging.
- 5G telecom — 8W and 10W power amplifier modules (PAMs) for mMIMO applications.

BAW filters

MACOM showcased its first bulk acoustic wave (BAW) filter products for industrial and defense applications. The high-performance chip-scale filters will be integrated into a switched filter bank and customized signal chain to demonstrate their selectivity and power-handling capability.

Switches

The switch product demonstrations showcased MACOM's high-frequency silicon-on-insulator (SOI) and aluminium gallium arsenide (AlGaAs) switch performance.

www.ims-ieee.org/ims2022
www.macom.com

Wolfspeed's Rick Madormo succeeds Thomas Wessel as senior VP of sales & marketing

Owen DeLeon replaces Madormo as new VP of sales for Americas

Wolfspeed Inc of Durham, NC, USA — which makes silicon carbide materials as well as silicon carbide (SiC) and gallium nitride (GaN) power-switching & RF semiconductor devices — has promoted Rick Madormo to senior VP of sales & marketing, succeeding Thomas Wessel, who is retiring at the end of June. In anticipation of Madormo's promotion, Wolfspeed has hired Owen DeLeon as its new VP of sales for the Americas.

"For the past four years, Rick has led our Americas sales team and, with his deep experience and strong track record of leadership and execution, he is the right choice to lead Wolfspeed through its next phase of continued growth and value creation," says president & CEO Gregg Lowe. "Thomas demonstrated tremendous leadership and vision during his tenure at Wolfspeed and leaves us having achieved a great deal, not the least of which was developing a depth and breadth of talent that is the best in the industry," he comments.

Madormo has led Wolfspeed's Americas sales organization since 2018, focused on the business development strategy, pipeline growth, and organizational structure, supporting the company's most recent quarterly revenue growth of 37%. An industry veteran, Madormo has more than 25 years of semiconductor experience with sales leadership roles at Intel, Altera and others.

DeLeon adds 15 years of semiconductor industry experience to Wolfspeed, most recently with Intel Corp, where he served as senior director of sales, Americas and general manager of its Programmable Solutions Group business in the Americas.

www.wolfspeed.com

Ampleon showcases new products at IMS 2022

New GaN amplifiers for broadband L- and S-band applications plus rugged GaN amplifiers pre-matched for 915MHz and 2.4GHz industrial applications

At June's IEEE International Microwave Symposium (IMS 2022) in Denver, CO, USA, Ampleon Netherlands B.V. of Nijmegen, The Netherlands introduced several new gallium nitride (GaN) and LDMOS solutions intended for use in wireless infrastructure, aerospace & defense, non-cellular communications (NCC), industrial, scientific & medical (ISM), cooking and defrosting applications.

Visitors to the booth could see selected key products from the wireless infrastructure portfolio including GaN and LDMOS RF power solutions for 4G and 5G base-station applications. Also on show is Ampleon's highly efficient small-cell power amplifier portfolio that enables high output powers in footprint-compatible packages.

Visitors could also see a variety of integrated massive MIMO RF solutions, suitable for use in all 5G frequency bands for 64T and 32T systems. The best-in-class RF power amplifiers for high-power macro base stations with LDMOS Doherty drivers and GaN final-stage devices for a wide range of output powers. The integrated LDMOS Doherty drivers (including the B11G2327N70D and B11G3338N80D) have the carrier, peaking device, input splitter, output combiner and pre-match all in a compact PQFN package. The C4H10P600A is a 600W GaN packaged asymmetric Doherty power transistor for base-station applications at frequencies from 700MHz to 1GHz.

Ampleon's booth also showcased the latest RF power amplifiers from the industrial, medical, aerospace and broadband domains including new next-generation GaN amplifiers for broadband L- and S-band applications and an exclusive preview of rugged GaN amplifiers that have been pre-matched for industrial applications at 915MHz and 2.4GHz.

Also on show were what are claimed to be the industry's most rugged 50V and 65V LDMOS amplifiers suitable for RF power generators that are required to operate in the harshest possible environments. In addition, suited to tough conditions is a range of all-in-one RF generators based on the ART150PEG. These RF power generators are tailored for defrosting applications at 40.68MHz or for use in wireless charging at 6.78MHz.

Also at the International Microwave Symposium, senior team members from Ampleon presented technical papers. Namely:

- Ammar Issaoun gave a talk about a 'GaN characterization method towards linearizability prediction', and
- Fred van Rijs gave the presentation 'A 39W Fully Digital Wideband Inverted Doherty Transmitter'.

www.ims-ieee.org
www.ampleon.com

ST-ONE power supply controller boosts energy efficiency in consumer electronics

New chip combines with ST's MasterGaN power output modules in laptop/smartphone charger design with energy recovery

STMicroelectronics of Geneva, Switzerland says that its new ST-ONE chip can increase energy efficiency in a wide variety of AC–DC adapters, fully compliant with USB-PD 3.1, including laptop and smartphone chargers. New adapters built with ST-ONE can reduce both CO_2 emissions and the quantity of plastics consumed, the firm adds.

The new ST-ONE chip pairs with ST's MasterGaN power output modules based on gallium nitride (GaN). The GaN chips enable significant energy savings and smaller equipment dimensions.

Although laptops provide optional power-saving settings, every machine can save even more energy if equipped with a more efficient power adapter. This improves the environmental profile and CO_2 footprint. The ST-ONE chip is optimized for controlling power supplies that recover energy normally dissipated as heat from conventional circuits. It also simplifies circuit design with a significant reduction in the number of components, enabling this type of power supply to become more robust, affordable and more widely adopted throughout the market.

"If every power adapter achieved at least 1% higher efficiency, which is possible using the ST-ONE energy-recovery circuit design, the world could save about 93 terawatt-hours of energy, equivalent to the output of 15 nuclear plants," comments Domenico Arrigo, Industrial and Power Conversion Division general manager, STMicroelectronics. "In addition, if 1 billion chargers worldwide were to use our technology, 0.2 million tons of plastics and raw materials could be saved."

The reduction in consumption of materials such as plastics is achieved with the increase in power density that enables smaller components to manage a larger power delivery. A high power density also cuts down recycling and environmental costs.

On display at the Embedded World exhibition in Nuremberg, Germany, ST's reference design EVLONE65W enables a 65W USB-C adapter of the same size and weight (less than 70g in a 37cm^3) of a standard 20W smartphone charger to handle the demands of charging a laptop. This unit achieves what is claimed to be the world's highest power density, packing more than 1.8W of power per cubic centimeter.

ST-ONE is optimized for designs based on a non-complementary active-clamp flyback topology, which allows high power (above 65W) with higher efficiency than other topologies such as the quasi-resonant flyback.

The chip is reckoned to be the world's first digital controller to integrate a programmable offline power-supply controller based on an Arm Cortex-M0+ core, a high-voltage start-up circuit, a synchronous-rectification controller, and USB Power Delivery (USB-PD) circuitry in one package.

The ST-ONE contains all the peripherals required to control the conversion. USB-PD communication is implemented on the secondary side and reinforced galvanic isolation is provided to let the primary and the secondary side circuits communicate while respecting safety requirements.

Also, using the MasterGaN integrated power stage with advanced wide-bandgap transistors and optimized drivers, adapters operate at elevated switching frequencies and thus permit smaller-size magnetic components to maximize power density.

The ST-ONE comes with 64kByte of embedded flash for designers to customize both the USB-PD protocol and the power-conversion stage.

The ST-ONE controller comes with USB-PD 3.1 PPS-certified firmware pre-loaded into the flash memory, presenting users with a turnkey solution for designing standard applications.

ST-ONE is in production and available now, in a SSOP36 package, from $3.70 for orders of 1000 pieces.

www.st.com/st-one

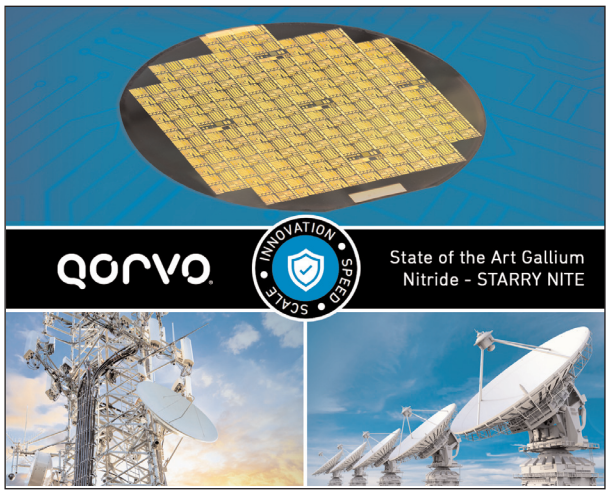
Qorvo awarded US Department of Defense advanced RF GaN program

STARRY NITE developing and maturing domestic, open 90nm RF GaN foundry in alignment with the DoD advanced packaging ecosystem

Qorvo Inc of Greensboro, NC, USA (which provides core technologies and RF solutions for mobile, infrastructure and defense applications) has been selected by the US Department of Defense (DoD) to proceed with the program 'Advanced Integration Interconnection and Fabrication Growth for Domestic State of the Art (SOTA) Radio Frequency Gallium Nitride (GaN)', also known as STARRY NITE, as part of the Office of Undersecretary of Defense Research & Engineering's (OUSD R&E) microelectronics roadmap.

The STARRY NITE program seeks to develop and mature domestic, open SOTA RF GaN foundries in alignment with the DoD advanced packaging ecosystem. The Qorvo team will leverage over 30 years of technology development and a long record of establishing high-performance, reliable GaN manufacturing technology to achieve these primary goals:

To offer secure, domestic high-volume manufacturing of 90nm GaN foundry processes, along with advanced interconnect features that enable high-performing, innovative and compact solutions for next-generation military and commercial wireless communications systems.



Qorvo reckons it is well positioned to realize STARRY NITE's vision and ensure accessibility of 90nm RF GaN and 90nm GaN with advanced interconnects across the Defense Industrial Base (DIB), delivering manufacturing maturity with performance and advanced integration features such as copper bumps.

"Qorvo looks forward to providing best-in-class advanced GaN technology that will enable high-performing, reliable and compact RF solutions for future needs through the STARRY NITE prototype project," says Philip Chesley, president of Qorvo's Infrastructure and Defense Products.

Qorvo provides 5G and other commercial products that require an understanding of existing market requirements, as well as the advanced GaN nodes and interconnects needed to support/achieve those requirements. As a commercial provider for dual-use applications, the firm reckons that it is uniquely positioned to leverage wafer volumes to drive manufacturing process control, accelerate process and reliability maturation, and drive down costs for the entire DIB.

Qorvo supplies high-performance RF products and compound semiconductor foundry services to defense primes and other global defense and aerospace customers. Using the MRL concept developed by the US DoD, Qorvo has achieved Manufacturing Readiness Level 10 for its GaN technology.

www.qorvo.com/foundry

Qorvo introduces 20W GaN-on-SiC MMIC power amplifier for satellite communications

QPA1724 operates at 17.3–21.2GHz

Qorvo has introduced a 20W GaN-on-SiC (gallium nitride on silicon nitride) power amplifier (PA) for defense and commercial satellite applications, including low Earth orbit (LEO) constellations.

The QPA1724 amplifier operates at 17.3–21.2GHz (Ku–K band) and offers twice the power of competing PAs, it is claimed, along with excellent wideband linear power, gain (small-signal gain of 25dB) and power-added efficiency (PAE = 27% with P_{IN} = 29dBm) in a compact 7.5mm x6mm x 1.6mm surface-mount package. The QPA1724 is optimized for wideband multi-carrier high-data-throughput satellite applications.

"Qorvo is a pioneer in developing high-performance millimeter-wave solutions for satellite communication systems," says Dean White, senior director of defense & aerospace market strategy at Qorvo. "The QPA1724 is a breakthrough device for both commercial and defense markets. At 20W saturated power, the QPA1724 offers twice the power of alternative PAs," he claims. P_{SAT} is 43dBm (P_{IN} = 27dBm).

The QPA1724 is available now and is lead-free, RoHS-compliant and 100% DC and RF tested to ensure compliance with electrical specifications.

Qorvo introduces GaN PA biasing reference design

Built-in configurability allows biasing of GaN PAs across many markets

Qorvo Inc of Greensboro, NC, USA (which provides core technologies and RF solutions for mobile, infrastructure and defense applications) has announced the availability of the ACT41000-104-REF1, a gallium nitride (GaN) power amplifier (PA) biasing reference design that enhances the design and testing of the firm's GaN PAs.

Since GaN devices are depletion-mode FETs that require a negative gate voltage during operation, in systems using GaN PAs a specific bias sequencing is required: a negative gate voltage must be applied before increasing the drain bias voltage to protect the device from damage.

The ACT41000-104-REF1 provides built-in configurability that enables it to bias a variety of GaN PAs and auto-calibrate the system. It integrates the power MOSFETs and current digital-to-analog converter to allow the device to precisely detect the PA quiescent drain current. The design uses power management to simplify the GaN biasing procedure.

The ACT41000 can operate from an input voltage of 4.5–40V, which enables it to generate a regulated adjustable output voltage up to 24V at 4A, in small steps of 12.5mV. It comes with an evaluation platform and GUI, allowing users to adjust the output drain voltage, quiescent and maximum drain current, PA device current and voltage protection, switching frequency and other features to optimize GaN PA performance.

This procedure takes place every time a user powers up the system, providing auto-tuning under conditions such as aging or temperature fluctuations, hence making testing easier and more automated. The ACT41000's built-in configurability allows it to bias a variety of Qorvo GaN PAs across many markets, including satellite communications, 5G, and radar.

"Qorvo is dedicated to simplifying the design and testing of real-world solutions for our customers and suppliers," says David Briggs, senior director of Qorvo's Programmable Power Management Products. "This newest integration of Qorvo's power products into our GaN portfolio is just the tip of the iceberg of our planned portfolio expansion," he adds.

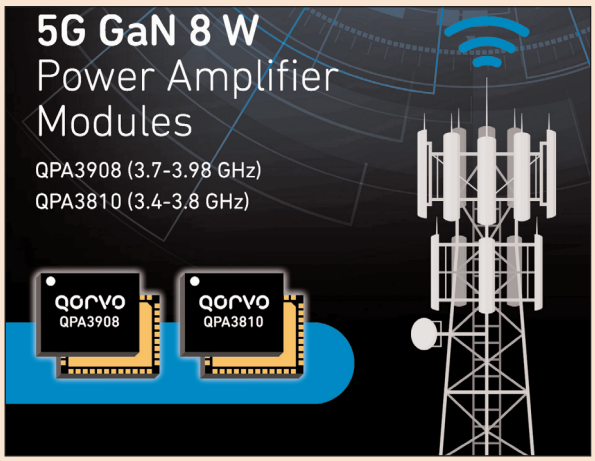
www.qorvo.com/products/p/ACT41000#reference-designs

Qorvo launches 8W GaN PA modules for 5G designs

First 8W GaN power amplifier modules optimized for USA & EU

Qorvo has launched the QPA3908 and QPA3810, two gallium nitride (GaN) 8W power amplifier modules (PAMs) that offer a combination of high performance and a significantly smaller footprint than traditional discrete component solutions, reducing the board-level footprint required by network infrastructure equipment manufacturers. The products target applications such as massive MIMO (multiple-input, multiple-output) base stations and open radio access networks (O-RAN) for active antenna systems.

The QPA3908 and QPA3810 are integrated two-stage PAMs designed for massive MIMO applications with 8W RMS at the device output. The QPA3908 has an operating frequency range of 3.7–3.98GHz, supporting US C-band applications. The QPA3810 has an operating frequency range of 3.4–3.8GHz, supporting applications in European markets. Both modules are input/output matched at 50Ω and require minimal external components.



Japan's NEC Corp has partnered with Qorvo to implement the QPA3908 and QPA3810 PAMs to deliver an advanced 5G end-to-end O-RAN network.

"Qorvo's GaN solutions for 5G are a means to minimize cost and increase capacity," says Diwakar Vishakhadatta, general manager of Qorvo's Infrastructure business. "These two GaN-powered modules support the growth of 5G rollouts in the US and Europe with greater integration at the board level, and reduced complexity," he adds. "Our focus is on efficiency and linearity for our customer partners."

The QPA3908 and QPA3810 each incorporate a driver PA and Doherty final stage delivering high power-added efficiency (PAE) for the entire module at 8W average power. The modules are input and output matched components providing superior performance and are completely assembled with no additional tuning necessary. These single-tuned modules simplify 5G network architecture and reduce design time, offering a more elegant solution than multiple discrete PAs, says Qorvo.

The QPA3908 and QPA3810 PAMs are available now and are ramping up to support key customer 5G deployments for North America.

www.ims-ieee.org
www.qorvo.com/

Navitas appoints Ron Shelton as new CFO

Interim CFO to continue as senior VP of finance

GaN power integrated circuit firm Navitas Semiconductor of El Segundo, CA, USA and Dublin, Ireland has appointed Ron Shelton as senior VP, chief financial officer & treasurer. In parallel, interim CFO Todd Glickman will continue in his integral role as senior VP of finance.

"He brings rich experience as a public-company CFO in semiconductors, in M&A and other strategic transactions, which will be invaluable in our mission to become the leading next-generation power-semiconductor company," comments CEO & co-founder Gene Sheridan.

"I would like to thank Todd for his support and leadership through Navitas' journey from a start-up through our debut as a public company last October, as our interim CFO," he adds. "I am grateful to have his continued support as we enter a new phase of growth for our company."

Shelton was previously CFO at Adesto Technologies, a provider of application-specific semiconductors and embedded systems for Internet of Things (IoT) devices, from 2011 to 2020. Prior to that, he was CFO at GigOptix, Cirrus Logic and other semiconductor companies. Shelton is currently a member of the board of directors and an officer of Parabellum Acquisition Corp, a blank-check company formed for the purpose of effecting a business combination. Parabellum has announced its intention to focus its search for a business combination target on companies that are actively engaged in IoT technology in various segments.

Shelton has significant transactional experience and has been involved in various transactions with an aggregate value of over $2bn, including mergers & acquisitions, IPOs, debt and equity financings, joint ventures, strategic investments, and technology licensing. Shelton has a bachelor's degree in economics from Stanford University.

www.navitassemi.com

Navitas GaN ICs enable TurboPower 68W charging with new motorola edge+

GaNFast power ICs charge new flagship smartphone over 50% in 15 minutes

GaN power integrated circuit firm Navitas Semiconductor of El Segundo, CA, USA and Dublin, Ireland says that its GaNFast technology has been selected to charge Motorola's flagship motorola edge+ (2022) smartphone. The TurboPower 68W (MC-681) charger has arrived in the USA as a standalone accessory to provide fast charging on top of the battery life of the new edge+.

When used with the TurboPower 68W fast charger (sold separately), the powerful 4800mAh battery of the new motorola edge+ can be charged by over 50% in just 15 minutes.

The TurboPower 68W is an all-in-one travel-charger option for USB-C phones, tablets and laptops. Due to efficiencies from the GaNFast power IC, it is notably smaller than most adapters in its power range, it is reckoned. At only 58mm x 41mm x 28mm (66cc), the TurboPower 68W achieves a power density of 1W/cc at a weight of just 95g for ultra-portability. Built-in protection from power surges, extreme heat and other dangers ensures that the smartphone or tablet remains safe while charging. The design and manufacturing enable a 2-year limited manufacturer's warranty for the new charger.

The TurboPower 68W (MC-681) was jointly designed and built for Motorola by Salom, which is now selling them in the USA. "The TurboPower 68W is our most powerful addition to the Motorola Charging line-up to date as Navitas' GaN technology advances keep driving TurboPower speeds higher while maintaining compact form factors," says Joseph Reisinger, president of Salom America Company.

Navitas' proprietary GaN power ICs integrate GaN power (FET) and GaN drive plus control, sensing and protection circuits in a single SMT package. Since GaN can run 20x faster than traditional silicon, the result is easy-to-use, high-speed, high-performance 'digital-in, power-out' building blocks that deliver up to 3x faster charging in half the size and weight, and with up to 40% energy savings versus earlier silicon solutions.

"Motorola customers have high standards, and GaN delivers the high speed and small size to exceed those expectations," says Navitas' CEO & co-founder Gene Sheridan. "GaN provides next-generation performance while ensuring a focus on efficiency and sustainability — another Motorola-Navitas shared goal. Every GaNFast power IC shipped reduces CO_2 emissions by 4kg," he reckons.

www.salom.com

www.motorola.com/us/motorola-turbopower-68w-wall-charger-with-6-5-amp-usb-c-cable/p

Navitas highlights long-term partnership and record GaN shipments at TSMC Technology Symposium

GaN power IC firm highlights 50 million units shipped, 20-year warranty, and CarbonNeutral-company status

On 16 June in Santa Clara, CA, USA., Navitas Semiconductor participated in the 2022 North America Technology Symposium of Taiwan Semiconductor Manufacturing Co (TSMC)

Since GaN runs 20 times faster than traditional silicon, gallium nitride chargers can achieve 3x the power or 3x faster charging with up to 40% energy savings in just half the size and weight compared with traditional silicon chargers. GaNFast power ICs with GaNSense technology integrate GaN power with drive, control, protection and sensing circuitry to enable faster charging, higher power density and greater energy savings for mobile, consumer, enterprise, eMobility and new-energy markets.

"GaN semiconductors are becoming increasingly important for fast charging and power conversion that drive energy efficiency to the next level," notes Lucas Tsai, director of market development and emerging business management, TSMC North America. "We're very pleased with the results of our long-term partnership with Navitas in delivery of high-quality, reliable GaN semiconductors using our industry-leading GaN manufacturing technology and platform, and we look forward to our continuous collaboration with Navitas to unleash more green and sustainable innovations."

At the TSMC 2022 NA Technology Symposium, Navitas demonstrated its GaN fast and ultra-fast mobile charging, and displayed higher-power system hardware including data-center and electric vehicle (EV) applications at its booth in the Innovation Zone, which spotlighted the achievements of TSMC's emerging startup customers.

"Navitas' partnership with TSMC goes back over a decade, and for me personally, long before that," says Navitas' chief operating officer (COO)/chief technology officer (CTO) & co-founder Dan Kinzer. "Excellent teamwork, learning and collaboration has created a proven, high-yielding platform on which Navitas can build next-generation GaNFast power ICs via GaN-on-Si fabricated by TSMC."

www.navitassemi.com

Navitas highlights power IC technology at GaN Marathon Workshop

Integrated GaN at forefront of market penetration versus silicon

Gallium nitride (GaN) power IC firm Navitas Semiconductor Corp of El Segundo, CA, USA and Dublin, Ireland participated in the third 'GaN Marathon' Workshop in Venice, Italy on 20–22 June.

Founded at the 800-year-old University of Padova, the 'GaN Marathon' is a forum covering the latest developments in the GaN community, with over 60 speakers, informal talks and networking opportunities. On 21 June in session reference RPG1_3, Navitas' Matteo Uccelli presented a technical paper 'Evolution in GaN Power IC Integration: Loss-less Sensing and Autonomous Protection' introducing the latest developments in GaNFast ICs with GaNSense technology, and leading-edge applications.

"The GaN Marathon has become an important event for the GaN community and we are happy to participate in the sold-out 2022 workshop," commented Navitas' chief operating officer/chief technology officer & co-founder Dan Kinzer.

www.ganmarathon.com

GaN Systems showcases power electronics advances at TSMC Technology Symposium

Collaboration with primary foundry partner bringing new products to high-volume production

On 16 June in Santa Clara, CA, USA at the 2022 North America Technology Symposium and Innovation Zone of Taiwan Semiconductor Manufacturing Co (TSMC), GaN Systems Inc of Ottawa, Ontario, Canada (a fabless developer of gallium nitride-based power switching semiconductors for power conversion and control applications) showcased its latest GaN power electronics innovations across consumer, data-center, industrial and automotive markets.

Additionally, a GaN Systems charging station invited attendees to charge their phones, tablets and laptops and gain real-world experience with fast-charge GaN AC/DC chargers.

CEO Jim Witham provided his perspective on the power market with a presentation 'Transforming the World with Smaller, More Efficient, More Reliable, Cost-Effective Power Electronics' highlighting the long-standing GaN Systems and TSMC partnership.

"GaN power semiconductors are becoming the transistor technology of choice in many major markets," says Stephen Coates, general manager of GaN Systems Asia. "Our ongoing collaboration with TSMC is reinforced by our joint commitment to innovate and push GaN technology to higher performance continuously. In partnership with TSMC, we have brought the promise of gallium nitride from concept to high-volume production."

GaN Systems says its long-standing partnership with its primary and long-time foundry partner TSMC has given confidence to global industry leaders to adopt GaN in the most conservative, high-reliability markets, including data centers, motor drives, automotive, and HiRel (space and avionics).

The GaN Systems Taiwan campus is within walking distance from TSMC in the Hsinchu Science Park and has enabled constant collaboration between the two companies.

"For over a decade, our partnership with TSMC has supported our strategy to deliver the most extensive and highest-performance power semiconductors," says Witham. "Together, TSMC and GaN Systems will continue to fuel new products of importance in our increasingly electrified world."

www.tsmc.com

GaN Systems launches 650V, 18A, 78mΩ transistor for consumer, industrial and data-center applications

GaN Systems has expanded its portfolio of high-performance, low-cost gallium nitride (GaN) power transistors by launching the GS-065-018-2-L, which features lower on-resistance, increased robustness and thermal performance, and an 850V $V_{DS(transient)}$ rating.

The GS-065-018-2-L is a 650V, 18A, 78mΩ bottom-side-cooled transistor suitable for smaller and lighter consumer adapters for laptops and gaming consoles and higher power density and efficiency in televisions and server SMPS (switched-mode power supplies). Lower on-resistance ($R_{DS(on)}$) means lower power loss and higher power rating, resulting in higher efficiency and power density. The 78mΩ transistor joins the 150mΩ GS-065-011-2-L and 50mΩ GS-065-030-2-L. The new product targets 100–800W adapters, consumer and industrial power supplies, LED drivers, bridgeless totem-pole PFC (power factor correction) circuits and motor drives.

The firm says that the new addition empowers designers to further improve efficiency, thermal management, and power density performance while increasing design flexibility and cost-effectiveness to meet new demands from consumer, industrial and data-center customers. The transistor's industry-standard 8mm x 8mm PDFN form factor eases customer adoption, scalability and commercialization.

"Our continuous design advancements are making GaN power semiconductors the transistor of choice in power electronics," says CEO Jim Witham.

www.gansystems.com

GaN Systems makes available GaN transistor ADS models for ISM RF power applications spanning 2–250kW

GaN Systems Inc of Ottawa, Ontario, Canada (a fabless developer of gallium nitride-based power switching semiconductors for power conversion and control applications) has made available its GaN transistor ADS (Advanced Design System) models to facilitate customer ease-of-use in RF power markets traditionally dominated by expensive silicon LDMOS and other RF power technologies. By replacing these existing with GaN Systems' power semiconductors at frequencies of typically 13–81MHz, customers can benefit from high power output and efficiency while reducing the size and at about a third of the cost of their existing solutions, the firm says.

The availability of the ADS models is a key ingredient for high-frequency design. GaN Systems' power transistors, such as its GS66502B and GS66508B, have been implemented in several applications. Capable of operating up to 100MHz and at power levels from 2kW to 250kW, applications include RF heating and drying systems, high-frequency radar systems, CO_2 lasers, RF defrosters, communication jammers, and plasma generators.

GaN Systems reckons that its expertise in both power and RF uniquely positions it to provide solutions for the ISM RF power market. Customers already rely on the firm's high-frequency expertise for solutions in the wireless power segment for applications in the 6–27MHz area. With RF power, as frequencies increase, the tools required increase with the need for ADS models to ensure high reliability of simulation results prior to final design.

"GaN Systems is making its mark in the RF power world," reckons CEO Jim Witham. "We have a winning combination of world-class GaN power transistors, high reliability, and application expertise to capture and revolutionize these market segments with lower-cost, high-efficiency GaN devices," he adds.

www.gansystems.com

HG collaborating with China Titans Energy

Hong Kong-based HG Semiconductor Ltd has entered into a framework agreement with China Titans Energy Technology Group Co Ltd to begin a three-year strategic cooperation on fast-charging pile (station) technology promotion and product sales in mainland China and Hong Kong.

HG designs, develops and makes LED beads as well as gallium nitride (GaN) chips, GaN components and fast-charging products, focusing on China. Leveraging its expertise in LED making, HG is accelerating its R&D and expansion into GaN-related products. In 2021, it obtained six fast-charging battery system patents for charging stations, charging conversion systems, charging modules and fast-charging equipment for electric vehicle (EV) charging stations.

China Titans Energy develops power electronics and automation control to address the needs of power transformation, supervision, control, optimization, energy saving and new energy utilization.

China Titans Energy will provide support for HG to build fast-charging pile products, run fast-charging pile services in Hong Kong and jointly launch fast-charging system solutions.

The cooperation provides HG with the opportunity to commercialize its fast-charging battery products under its own brand in mainland China and Hong Kong, and accelerate its ramp-up of production capacity. With the growing popularity of EVs in mainland China and Hong Kong, the development and commercialization of next-generation charging piles in both places is reckoned to be a promising business prospect. HG aims to explore establishing a business presence in Hong Kong for fast-charging battery solutions.

Both HG and China Titans Energy intend to leverage the advantage of HG being in cooperation with a statutory body in Hong Kong, to jointly promote the development of the Hong Kong smart city and provide upgrades to EVs and charging facilities in Hong Kong, in order to achieve the international standard of 400kW direct current charging, data on the cloud, safety monitoring etc for smart management. The new energy fast-charging solution is expected to help to create a new local business model and investment opportunities in Hong Kong, such as constructing a vehicle-to-grid (V2G) energy network, distributed energy storage and grid-level direct current electrical substation.

Under China's Fourteenth Five-Year Plan, the 'New-Energy Vehicle Industry Development Plan for 2021–2035' has deployed five strategic tasks, including
(1) improving technological innovation capability,
(2) constructing a new industrial ecology,
(3) promoting industrial integration development,
(4) improving the infrastructure system, and
(5) deepening open cooperation.
The development plan also explicitly pointed out the necessity of establishing a technological innovation system with enterprises as the main body, strengthening infrastructure such as charging and replacing, while the battery management system and batteries are also recognized as key technologies.

Meanwhile, the Hong Kong government has announced a roadmap for the popularization of EVs, aiming to achieve zero emissions for all vehicles by 2050.

www.hg-semiconductor.com

Transphorm receives $16m from existing investors' exercise of green shoe

Total proceeds from equity financings since October rise to $61m

Transphorm Inc of Goleta, near Santa Barbara, CA, USA — which designs and manufactures JEDEC- and AEC-Q101-qualified gallium nitride (GaN) field-effect transistors (FETs) for high-voltage power conversion — has received gross proceeds of $16m as a result of the exercise of the 'green shoe' (over-allotment option) associated with the firm's private placement completed in November 2021.

The exercise brings the total proceeds from equity financings since October 2021 to about $61m, before deducting offering expenses. As a result of the exercise, the firm has cash and cash equivalents of more than $45m as of 3 June.

Under the terms of the green shoe exercise, Transphorm issued 3,199,999 shares of its common stock as well as warrants to purchase an aggregate of 666,668 shares of its common stock at an exercise price of $6 per share.

"Over the past three quarters we have completed multiple equity financings from a combination of strategic and institutional investors, resulting in a significant increase in both the company's cash position and stockholders' equity," says chief financial officer Cameron McAulay. "This additional capital provides expanded operational flexibility in support of our current and anticipated future growth."

www.transphormusa.com

Transphorm's GaN FET used in Nayuta's LEMURIA Li-ion battery power supply

Transphorm's GaN technology is powering the LEMURIA ME3000 of power supply manufacturer Nayuta Power Energy Co Ltd of Hamamatsu, Japan. Nayuta uses the GaN FETs in the LEMURIA's AC inverter to achieve 99% efficiency in a fanless system. Notably, the LEMURIA ME3000 is Japan's first lithium-ion (Li-ion) battery power storage device for medical equipment to earn S-JQA certification for electrical products (indicating a product's safety and performance quality).

Transphorm's JEDEC-qualified TP65H035WS is a high-performance 650V, 35m_ GaN device in a thermally robust TO-247 package. It is claimed to offer the industry's highest reliability with a ±20V gate safety margin and a 4V noise immunity threshold. It can also yield greater than 99% power efficiency while reducing power system size, weight and overall cost. The TP65H035WS GaN FET can be used in AC-to-DC and DC-to-DC converters as well as DC-to-AC inverters. Target markets include computing, crypto-mining, datacenter, medical and telecommunications applications.

The LEMURIA ME3000 is a small, lightweight product that is easily portable in medical facilities as well as in the field. It has a continuous 1.5kW output and a 3.3kWh storage capacity with up to 33 hours of usability before needing to be recharged. Whereas an incumbent silicon product was fan cooled, the GaN FET's performance enabled Nayuta to build the LEMURIA ME3000 as a fanless power system that increased power efficiency from 96.24% to 99.01% (a 73% reduction in power loss operating at the same frequency). As a result, the power supply is a hermetically sealed unit without ventilation holes, which prevents liquids and dust from contaminating or damaging the system.

The LEMURIA ME3000 is JIS T060-1 certified, a Japan Quality Assurance Organization (JQA) standard based on the international IEC 60601 standard. These quality controls ensure that electrical equipment used in medical environments meet higher safety and performance requirements, particularly with respect to electromagnetic interference and current leakage.

"Medical environments call for solutions that offer extremely high reliability all while meeting rigid safety and sanitation protocols. A power supply running a respirator cannot fail. Nor can it expose patients to potential germs harbored in areas that cannot be easily cleaned — which is where a sealed, GaN-based unit offers incredible value," comments Morgan Yoshiyuki Habuta, executive director, Nayuta Power Energy. "The high switching capability and reliability offered by Transphorm's GaN FETs enabled us to achieve our goals with respect to the LEMURIA ME3000. Incorporating the FETs into our advanced power system design delivered a Li-ion battery supply capable of supporting a wide range of high-power medical applications at any location."

Due to its portability, the LEMURIA ME3000 can be used in numerous environments including large hospitals (operating, diagnostic, and patient rooms); long-term care facilities; individuals' homes; and disaster sites.

www.nayuta-co.jp/products/lemuria
www.transphormusa.com/en/

Transphorm joins Russell 2000 and 3000 Indexes

Inclusion to provide greater visibility among institutional investors

Transphorm Inc of Goleta, near Santa Barbara, CA, USA — which designs and manufactures JEDEC- and AEC-Q101-qualified gallium nitride (GaN) field-effect transistors (FETs) for high-voltage power conversion — is joining the FTSE Russell 2000 and Russell 3000 Indexes at the conclusion of the Russell US Indexes annual reconstitution, which takes effect after the day's close of the US market.

Russell indexes are part of global index provider FTSE Russell, and are widely used by investment managers and institutional investors for index funds and as benchmarks for active investment strategies. About $16 trillion in assets are benchmarked against Russell's US indexes.

"Being added to the Russell 2000 and 3000 Indexes provides greater visibility and stature among institutional investors and signifies the value we are creating for our shareholders," says president & co-founder Primit Parikh.

Membership in the US all-cap Russell 3000 Index, which remains in place for one year, means automatic inclusion in the small-cap Russell 2000 Index or the large-cap Russell 1000 Index, as well as the appropriate growth and value style indexes. FTSE Russell determines membership for its indexes primarily by objective, market-capitalization rankings and style attributes.

Transphorm's reference design portfolio kick-starts USB-C PD GaN power adapter development

Seven design tools capture advantages of 650V GaN FETs for 45–140W adapters

Transphorm has announced the availability of seven reference designs intended to speed development of GaN-based USB-C PD power adapters. The portfolio includes a wide range of open frame design options with various topologies, outputs, and wattages (45–140W) to choose from.

SuperGaN technology difference

The power adapter reference designs use SuperGaN Gen IV 650V FETs to deliver ease-of-design and high reliability with high performance. In recent analysis, compared with a 175mΩ e-mode GaN device, Transphorm's 240mΩ SuperGaN FET showed lower on-resistance rise with temperatures above 75°C and higher performance at 50% and 100% (full) power.

Power adapter reference designs

Transphorm's portfolio includes five open frame USB-C PD reference designs ranging in frequency from 140kHz to 300kHz. As an example, Transphorm partnered with Silanna Semiconductor on a 65W active clamp flyback (ACF) RD running at 140kHz with a peak efficiency of 94.5%:

- (1x) 45W adapter RD offers 24W/in^3 power density in a quasi-resonant flyback (QRF) topology;
- (3x) 65W adapter RDs offer 30W/in^3 power density in ACF or QRF topologies;
- (1x) 100W adapter RD offers 18W/in^3 power density in a power factor correction (PFC)+QRF topology.

Transphorm's portfolio also includes two open frame USB-C PD/PPS reference designs ranging in frequency from 110kHz to 140kHz. Transphorm partnered with Diodes Inc on both solutions, leveraging the company's ACF controller to achieve greater than 93.5% peak efficiency:

- (1x) 65W adapter RD offers 29W/in^3 power density in an ACF topology;
- (1x) 140W adapter RD offers 20W/in^3 power density in a PFC+ACF topology.

Our power adapter reference designs spotlight our low-power capabilities. We offer controller-agnostic PQFN and TO-220 devices that can dramatically simplify design. These features, along with others, help our customers go to market quickly and easily with a GaN solution capable of achieving ground-breaking power efficiency levels

"Transphorm is unique in that it offers the only portfolio of GaN FETs covering the widest range of power levels for the broadest range of applications," says Tushar Dhayagude, VP, field applications & technical sales. "Our power adapter reference designs spotlight our low-power capabilities. We offer controller-agnostic PQFN and TO-220 devices that can dramatically simplify design," he adds. "These features, along with others, help our customers go to market quickly and easily with a GaN solution capable of achieving ground-breaking power efficiency levels."

www.transphormusa.com/en/design-resources/#reference-designs

Elevation launches high-voltage power conversion ICs

GaN and synchronous rectifier controller ICs target fast charging

Elevation Semiconductor of Irvine, CA, USA, a high-voltage power conversion solutions developer founded in 2021, has launched two high-efficiency power ICs with smaller footprints for fast-charging solutions.

Part of the integrated GaN switch family of devices with ultra-efficient GaN high-performance controller ICs for switched-mode power supplies (SMPS), the HL9550/52/54 support QR, DCM, CCM and multiple frequency hybrid-mode operations. The various 300kHz/225kHz/129kHz/82kHz frequency options provide a possibility of flexible design for optimizing the transformers' size and EMI performance, offering efficient and compact 20-65W charger solutions. The charger solution can cover a wide range of VDD operations without an additional clamp circuit for USB PD applications, as it helps to save bill-of-materials (BOM) cost and PCB space. For protection, they include the LPS function to limit input power and to avoid unexpected overpowering that would damage the system when the PD controller has failed.

The HL9701 synchronous rectifier (SR) is a high-performance controller IC for switched-mode power supplies dedicated to the secondary side of flyback converters. It drives the SR MOSFET and is compatible with high/low-side applications for QR, DCM and CCM operations. The HL9701 intelligently rectifies for secondary current, providing proprietary transient judgment to complete fast turn on/off control for maximum efficiency and high reliability at any load compared with the conventional ultra-fast diode or Schottky diode.

The primary applications for these high-performance controllers are USB PD quick chargers for smartphones and tablet PCs, power adaptors for portable devices, and flyback power supplies with fixed or variable output voltage applications. The power solutions meet DoE VI and CoC 2 efficiency rules (average efficiency above 93% for $115V_{ac}/230V_{ac}$), and the technology enables the systems to consume only 20mW of no-load power consumption.

"With industry veterans from leading analog companies experienced in high-voltage power solutions, AC–DC controllers and HV drivers, and wide-bandgap (WBG) semiconductor devices such as GaN, Elevation is well-positioned to enable the next generation of advanced power systems and accelerate the world's transition to electrification and sustainability," says CEO David Nam.

www.elevation-semi.com

Wise-integration launches compact 120mΩ GaN half-bridge power IC

650V E-mode GaN-on-silicon IC targets applications in consumer, mobile, industrial power supplies

Wise-integration of Meylan, France, which was founded in 2020 and specializes in the digital control of gallium nitride (GaN) power supplies and GaN integrated circuits, has launched its first commercial product: the 120mΩ WI62120 half-bridge power circuit, which is claimed to provide power electronics designers with new levels of power density, performance and cost-effectiveness.

The JEDEC-certified WI62120, a 650V enhancement-mode GaN-on-silicon IC, is part of Wise-integration's WiseGan family of power devices. It leverages the intrinsic properties of GaN to provide improved current capabilities, voltage breakdown and switching frequencies for applications in high-efficiency and high-density power conversion, including AC/DC, DC/DC and DC/AC, from 30W to 3kW.

Target market sectors include consumer (such as ultra-fast chargers for mobile and desktop devices), E-mobility and industrial AC/DC power supplies and designs utilizing bridgeless totem pole power factor conversion (PFC) active clamp flyback (ACF), two-inductor one-capacitor (LLC) resonant converters, and synchronous buck or boost half-bridge topologies.

"The 120mΩ WI62120 is the most compact half-bridge in the market, with a 6x8 PQFN package that maximizes customer benefits in terms of high power density, performance, and bill-of-materials cost reduction," claims Wise-integration's CEO Thierry Bouchet. "We're confident that our customers will find it very useful in all ACF topologies and PFC-LCC architectures, and that it will help them leverage the benefits provided by smaller, more efficient and more cost-effective power electronics."

Wise-integration says that, with its WiseWare embedded digital control software; subsequent generations of WiseGan devices will integrate functions such as gate control, protection, security and other designer-friendly capabilities into AC/DC GaN applications.

www.wise-integration.com

LIQUID NITROGEN PIPING

Single phase, low pressure LN_2 to your use point for on-demand supply

- Clean, frost-free cooling to cryogenic temperatures
- Automatic LN_2 circulation for MBE cryopanels
- Variety of internal diameter piping to accommodate a range of flow rates
- Modular and re-configurable with vacuum jacketed feed-through connections

Since 1958

VACUUM BARRIER VBC CORPORATION

4 Barten Lane, Woburn, MA 01801
T 781 933 3570 | F 781 932 9428
sales@vacuumbarrier.com

vacuumbarrier.com

Integra Technologies begins production shipments of first 100V RF GaN products

Teledyne offering high-reliability options for defense market

Integra Technologies Inc (ITI) of El Segundo, CA, USA, which provides RF and microwave high-power semiconductor and pallet solutions for mission-critical applications (including radar, electronic warfare and advanced communications systems), has begun production shipments to US and European customers of its 100V RF gallium nitride (GaN) technology.

"In collaboration with our customers, our system engineers have helped design new radar architectures that take full advantage of the benefits of our third-generation 100V RF GaN technology," says Integra's VP of sales & marketing Tom Kole. "It's exciting to see Integra's 100V RF GaN products move into production with customers as it signifies another industry first."

Integra also announced expansion of its 100V RF GaN product portfolio with the introduction of seven new products for avionics, directed energy, electronic warfare (EW), radar and scientific market segments with power levels up to 5kW in a single transistor. These products incorporate Integra's 100V RF GaN technology optimized to deliver the highest power and efficiency in a single transistor while maintaining reliable operating junction temperatures. Combined with Integra's thermally enhanced patents and transistor design expertise, the products offer reliable operation with a mean-time-to-failure (MTTF) of 10^7 hours. "Integra has spent a decade innovating, maturing and commercializing our ground-breaking 100V RF GaN technology," notes president & CEO Suja Ramnath. "Building upon our 25 year heritage of semiconductor innovation, this third-generation 100V RF GaN continues to extend our technical and market leadership."

Additionally, Integra's partner Teledyne e2v HiRel Electronics of Milpitas, CA, USA (part of the Teledyne Defense Electronics Group that provides solutions, subsystems and components to the space, transportation, defense and industrial markets) is offering high-reliability options for all of Integra's 100V RF GaN power devices and pallets targeted at the defense market. "Our space customers can benefit from Integra's 100V RF GaN products combined with Teledyne's expertise and long heritage providing space RF components," says Brad Little, VP & general manager of Teledyne e2v HiRel. "These innovative products offer space payload engineers state-of-the-art power devices for insertion into their applications," he adds.

www.integratech.com
www.tdehirel.com

Teledyne e2v HiRel releases rad-hard 30GHz SPDT RF switch for space applications

First 30GHz switch qualified as TID radiation tolerant to 100krad (Si)

Teledyne e2v HiRel Electronics of Milpitas, CA, USA (part of the Teledyne Defense Electronics Group that provides solutions, subsystems and components to the space, transportation, defense and industrial markets) has announced the availability of the model TDSW030A2T radiation-tolerant 30GHz, single-pole double-throw (SPDT) reflective RF switch, which is suitable for demanding high-reliability, space and defense applications and is now available with qualified material off-the-shelf. Developed on 0.15μm indium gallium arsenide (InGaAs) pseudomorphic high-electron-mobility transistor (pHEMT) technology, the new RF switch will be available as die and is qualified per MIL-PRF-38534 Class K equivalency for space applications.

The TDSW030A2T leverages monolithic microwave integrated circuit (MMIC) design techniques that deliver superior performance in the Ku and Ka microwave and millimeter-wave bands. The switch delivers low insertion loss, high isolation, fast switching times, and high linearity across a wide frequency band from DC to 30GHz and attains an input power 1dB compression of 25dBm (typical). Class K equivalent element evaluation is performed per wafer.

"While switching is one of the core microwave building blocks, there has been a lack of choice for designers working on high-reliability applications," says Mont Taylor, VP & business development manager at Teledyne e2v HiRel. "Joining our successful release of a 20GHz switch last fall, this new product is the first 30GHz switch qualified as TID radiation tolerant to 100krad (Si) on the market," he adds.

Devices are available for ordering and shipment now, from Teledyne e2v HiRel or an authorized distributor, in commercial versions and with the option of Class H equivalent screening. They are shipped from the firm's DoD Trusted Facility in Milpitas.

www.tdehirel.com
www.teledynedefelec.com

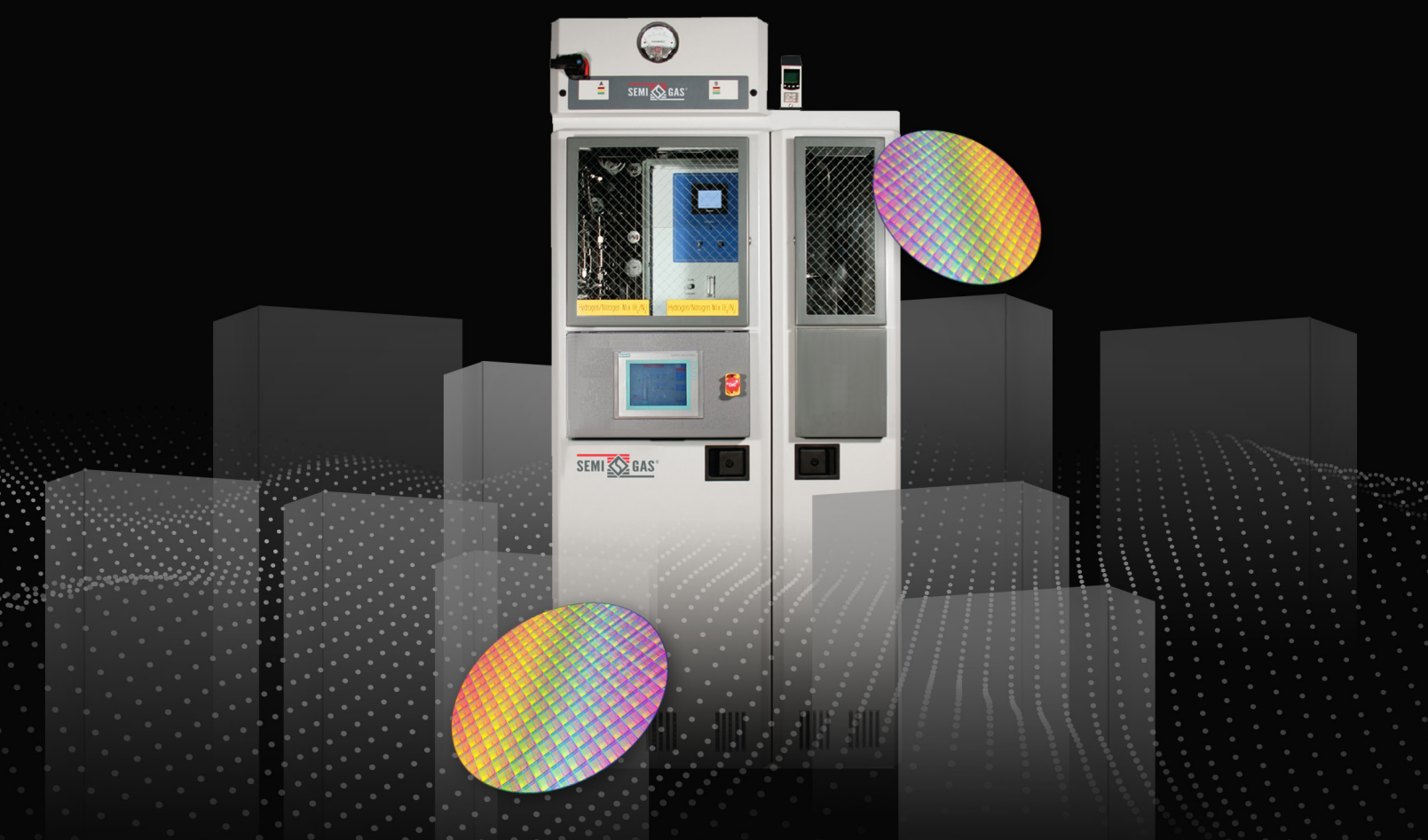
SEMI GAS®

Power **Semiconductor Innovation**

ULTRA HIGH PURITY GAS DELIVERY SYSTEMS FOR FABS

AES' SEMI-GAS® line serves industries with demanding ultra high purity requirements for mission-critical applications.

Our premier, production-ready gas delivery & distribution solutions are **renowned for quality and meet the most rigorous needs for precision & purity.** SEMI-GAS® has been the semiconductor industry's go-to source for SEMI S2 compliant gas delivery & equipment for 40 years. Today, Tier 1 leaders & innovators consider SEMI-GAS® their **partner of choice.**



BROUGHT TO YOU BY

APPLIED ENERGY SYSTEMS

High innovation has high stakes. Improve yield, ensure high-performance output & enable innovation with SEMI-GAS®.
Visit appliedenergysystems.com/stakes.

Finwave targeting 5G with 3DGaN FinFET technology

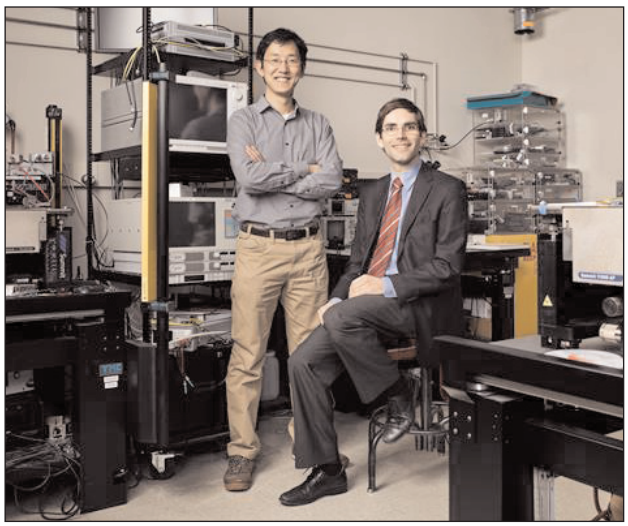
MIT spin-off aims to boost linearity, power and efficiency at millimeter-wave frequencies

Founded in 2012 by researchers at Massachusetts Institute of Technology (MIT), Cambridge Electronics has rebranded as Finwave Semiconductor Inc of Waltham, MA, USA (with offices in San Diego, CA and the Bay Area), as it aims to revolutionize 5G communications with its three-dimensional gallium nitride (3DGaN) technology, which features a 3D fin transistor (GaN FinFET) structure.

The benefits of 5G networks will never be fully realized without high-power, high-linearity millimeter-wave (mmWave) power amplifier technology, says Finwave. Current approaches are throttling 5G due to their inability to deliver the higher linearity and efficiency needed to solve uplink issues facing mmWave frequencies (which do not propagate nearly as far as microwave signals).

"Today's 5G millimeter-wave networks are severely constrained by the inefficient performance of power amplifiers," comments Joe Madden, chief analyst at Mobile Experts. "RF-SOI and CMOS technologies are used today instead of GaN because of the need to integrate logic circuits with the RF front end, but this brings significant tradeoffs in power consumption and heat dissipation. High-performance GaN-on-silicon brings a new option to the table that could make 5G millimeter-wave more practical."

With 10 times higher breakdown electric field than silicon, high electron mobility and the ability to operate at higher junction temperature, GaN is poised to play a significant role for the next decade's technology revolutions, says Finwave. At mmWave frequencies, GaN-on-Si amplifiers excel versus alternative solutions such as silicon CMOS, gallium arsenide (GaAs) pseudomorphic high-electron-mobility transistors (pHEMTs) or silicon germanium (SiGe) devices, the firm adds.



Finwave's co-founders professors Tomas Palacios and Dr Bin Lu first teamed at MIT to invent several technologies, including a novel type of GaN transistor based on a FinFET architecture. Their focus is to apply those foundational technologies to revolutionize 5G communications.

Finwave's co-founders professor Tomas Palacios and Dr Bin Lu first teamed at MIT to invent several of the firm's foundational technologies, including a novel type of GaN transistor based on a FinFET architecture. After being spun out of MIT, the company spent several years developing the technology further for manufacturing in standard silicon CMOS fabs. By 2020, Finwave demonstrated the first GaN insulating-gate FinFETs fabricated with 8" silicon CMOS tools.

The benefits of 5G networks will never be fully realized without high-power, high-linearity mmWave power amplifier technology. Current approaches are throttling 5G due to their inability to deliver the higher linearity and efficiency needed to solve uplink issues

"As GaN continues to gain market share from silicon, first in 4G high-power macro base-stations, then in fast chargers for mobile phones and laptops, we are convinced that the next biggest opportunity for GaN-on-Si will be 5G infrastructure and handset applications," says Lu.

Finwave's 3DGaN technology is said to significantly improve linearity, output power and efficiency in 5G mmWave systems – while greatly reducing costs for carriers. By leveraging high-volume 8" Si CMOS, Finwave's devices benefit from both the cost model and scalability of silicon technology. "The combination of the outstanding electrostatic control and linearity of the GaN FinFET structure, with the cost model of silicon, and the scaling ability of state-of-the-art 8" — and, in the future, 12" fabs — makes 3DGaN a true game changer," reckons Palacios.

"5G will be a huge engine for economic growth, making this a very exciting time to be working for a company that is bringing a disruptive, enabling technology to the market," says executive chairman & chief strategy officer Jim Cable Ph.D. "I look forward to continuing to build our IP portfolio, and our product and customer base."

Beyond 5G, Finwave aims to also bring its technology to artificial intelligence (AI), cloud computing, and electric vehicles (EVs) and autonomous vehicles (AVs).

Finwave was present at the IEEE International Microwave Symposium (IMS 2022) in Denver (21–23 June), meeting with partners, industry experts and other interested parties.

www.finwavesemi.com

Chalmers demos GaN power devices with >1600V breakdown and 22nA/mm leakage current on SweGaN's QuanFINE epi

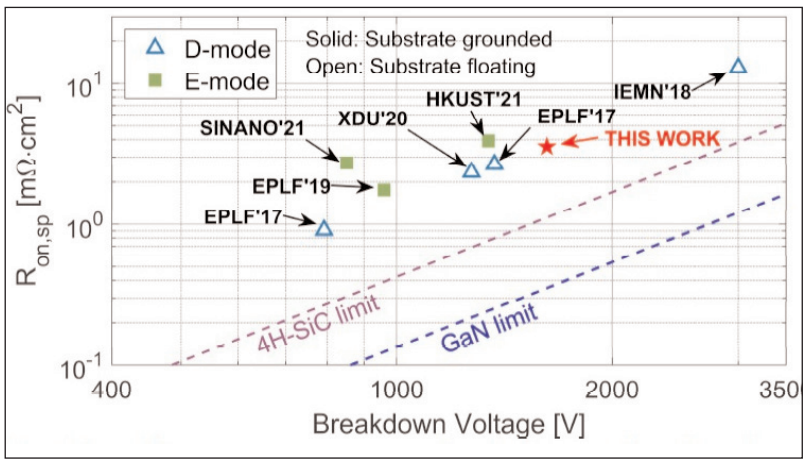
QuanFINE buffer-free GaN-on-SiC material addresses high-voltage power applications

New state-of-the-art results have been reported for high-voltage GaN power devices enabled by the MIS-HEMT technology of Chalmers University of Technology in Gothenburg, Sweden and the QuanFINE buffer-free gallium nitride on silicon carbide (GaN-on-SiC) materials of Linköping-based epitaxial wafer foundry SweGaN AB (Björn Hult et al, 'High Voltage and Low Leakage GaN-on-SiC MISHEMTs on a "Buffer-Free" Heterostructure', IEEE Electron Device Letters, volume 43, issue 5 (May 2022), p781).

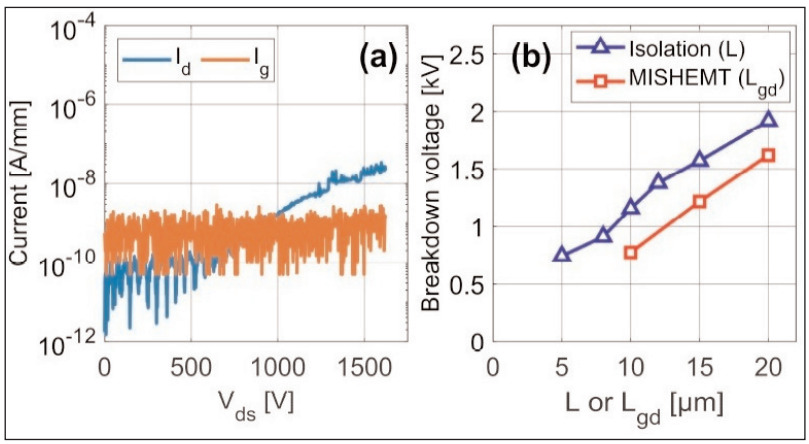
Among key findings, the research identifies QuanFINE epiwafers as a highly competitive candidate for high-voltage power devices in 1200V applications, in addition to its strong traction in the RF market at present.

Existing GaN power devices available on the market have been limited to a rating of 650V, due to their GaN material quality and low-breakdown silicon substrates. However, by fabricating GaN power devices on buffer-free GaN-on-SiC materials with total epilayer thickness roughly 20 times thinner than that of commercial GaN-on-Si epiwafers (see Figure 1), high-voltage operation with exceptionally low gate and drain leakage currents has now been demonstrated. Specific on-resistance of 3.61mΩcm^2 and an off-state breakdown voltage of 1622V at a drain current of 22nA/mm have been achieved, as well as a vertical breakdown voltage of more than 3000V (see Figure 2).

The results are reckoned to demonstrate the significant potential of SweGaN's QuanFINE epitaxial solutions for high-voltage GaN power devices in applications where the performance and reliability of the devices are both strictly required, e.g. in on-board chargers and power inverters in electric vehicles (EVs).



Specific on-resistance versus breakdown voltage benchmark using the 1μA/mm current criterion.



(a) Off-state breakdown characteristics at V_{gs} = −20V of MISHEMT with L_{gd} = 20μm. (b) Breakdown voltage of MISHEMTs and two-terminal isolation structures with varying L_{gd} and L.

"With excellent results establishing the robust capability of our material, we anticipate there will be growing opportunities for SweGaN in this era of electric vehicles, where the power devices are critical for the vehicle's performance," says SweGaN's chief technology officer Dr Jr-Tai Chen. "We are currently in discussions with early-adopter GaN power device companies to launch high-voltage power solutions that harvest the true advantages of GaN," he adds.

"SweGaN has developed highly robust and innovative GaN-on-SiC materials," comments Chalmers professor Niklas Rorsman. "We are happy to collaborate with SweGaN on a continuous basis to perform joint research and development," he adds.

"The collaboration of Chalmers and SweGaN have been successful on numerous research projects," notes SweGaN's CEO Jonas Nilsson. "Harnessing the combined expertise from the material level to the device level is the key behind this achievement, which will also further enhance SweGaN's long-term market strategy and product innovation — and provide significant benefits to our global customer base."

www.swegan.se

Fraunhofer IAF inaugurates new MOCVD and laboratory research buildings

New buildings expand activities in optoelectronic metrology, quantum sensor technology and materials science

On 30 June, Fraunhofer Institute for Applied Solid State Physics IAF in Freiburg, Germany officially inaugurated two new buildings with a ceremonial ribbon-cutting by executive director professor Rüdiger Quay, Freiburg's mayor for construction professor Martin Haag, and managing director of Freiburg Wirtschaft Touristik Messe GmbH & Co KG (FWTM) Hanna Böhme.

In addition to representatives of various Fraunhofer institutions, invited guests included Gabriele Rolland from the state parliament of Baden-Württemberg, professors Stefan Glunz and Frank Balle from the Institute for Sustainable Technical Systems (INATECH) and professors Jürgen Wöllenstein, Matthias Kuhl and Stefan Rupitsch from the Institute for Microsystems Technology (IMTEK) at the University of Freiburg, as well as the buildings' architects Ann-Kathrin Goerke and Matthias Solbach.

Financial support from the German federal government, the state of Baden-Württemberg and the German Federal Ministry of Defense (BMVg) has funded construction of a new laboratory building as well as a new hall for metal-organic chemical vapor deposition (MOCVD), enabling Fraunhofer IAF to intensify its activities in optoelectronic metrology and quantum sensing as well as materials science.

"The application laboratories for quantum sensing and laser spectroscopy significantly expand the opportunities for cooperation with partners from industry and research," notes Dr Martin Walther, head of research infrastructure.

"The new MOCVD hall has also enabled us to enlarge our epitaxy equipment park, further increase the level of material quality and reproducibility, and at the same time ensure significantly more efficient operation," says executive director professor Rüdiger Quay. "The buildings exceed the requirements of the German Energieeinsparverordnung EnEV (Energy Saving Ordinance) and feature CO_2-neutral construction elements. This is an important signal for our plan to achieve climate neutrality by 2030 together with the Fraunhofer-Gesellschaft."

Fraunhofer IAF has expanded its research infrastructure for semiconductor technologies with a new MOCVD hall (front) and a new laboratory building (back).

Optimal research conditions and sustainable construction

The new laboratory building has a total of 22 labs on 900m^2 of floor space, designed in terms of building dynamics for the use of highly vibration-sensitive equipment. They comply with the vibration limit lines B and C of the so-called Vibration Criteria (VC) and are thus suitable, for example, for the operation of microscopes with magnifications of up to 1000 times or lithography and inspection equipment with structure widths of up to 3µm and 1µm, respectively. In the long term, this ensures the use of demanding measurement technology for ever smaller structures and allows intensive R&D of quantum sensors such as scanning probe, wide-field and laser threshold magnetometers as well as laser-based sensor technology and innovative semiconductor lasers.

The newly constructed MOCVD hall provides space for five systems, which will enable Fraunhofer IAF to expand its epitaxial activities in high-bandgap semiconductors in particular. The four existing systems (moved from the cleanroom of the main building) have been joined by a new system specifically for the deposition of aluminium gallium nitride (AlGaN) with high aluminium content. The new system reaches temperatures of up to 1400°C, which has a positive effect on crystal quality and homogeneity. Advantages also result from the hall's equipment, which has autonomous regenerative processing systems, enabling more energy-efficient and sustainable manufacturing processes.

At 388kWh/(m^{2}a) for the laboratory building and 245kWh/(m^{2}a) for the MOCVD hall, the primary energy requirements of both new buildings are below the EnEV requirements for comparable buildings. In addition, the flooring installed in both buildings is particularly environmentally friendly and will be recycled at the end of its functional life. The German-manufactured floor coverings are made from natural raw materials, and their entire production cycle has a neutral CO_2 footprint. In the MOCVD hall alone, 47t of CO_2 have been offset by the flooring.

www.iaf.fraunhofer.de

Advantest acquires test equipment supplier CREA

Tokyo-based automated test & measurement equipment maker Advantest Corp has agreed to acquire power semiconductor test equipment supplier CREA — Collaudi Elettronici Automatizzati S.r.l. (CREA) of Ciriè, near Turin, Italy, which will become a subsidiary of Advantest Europe GmbH (subject to regulatory approvals).

CREA's products are used to test all kinds of power devices, and are utilized by global semiconductor companies worldwide.

CREA has many years of experience in the development and production of test equipment for power semiconductors, including SiC and GaN. The acquisition will enable Advantest to provide broader test & measurement solutions to a wider range of customers in high-growth sectors.

"Acquisition of CREA will expand our test and measurement solutions within the evolving semiconductor value chain to meet a wider range of customer needs," says Advantest's president & CEO Yoshiaki Yoshida.

"By integrating CREA's product lineup, development capabilities, excellent customer base, and world-class R&D team into the Advantest Group, we can enrich our portfolio of power semiconductor test solutions," he adds. "I am also confident that, as the power device market is expected to grow in the future, this acquisition will contribute directly to our and our customers' efforts to help achieve net zero."

www.crea-test.com
www.advantest.com

Riber wins order for MBE 6000 production systems

Riber S.A. of Bezons, France — which makes molecular beam epitaxy (MBE) systems as well as evaporation sources and effusion cells — has received an order from industrial client for two MBE 6000 production systems (for delivery this year) worth a total of several million euros, as well as options for four additional MBE 6000 systems.

With about 40 systems in operation worldwide, the MBE 6000 is claimed to be the benchmark MBE system for the mass production of electronic and optoelectronic device material used in telecommunications and fiber-optic networks.

www.riber.com

IQE commits to net zero carbon neutrality by 2050

Epiwafer and substrate maker to formulate science-based targets to reduce greenhouse gas emissions

Epiwafer and substrate maker IQE plc of Cardiff, UK has announced a formal commitment to net zero carbon neutrality across its operations by 2050, in accordance with the Science Based Targets initiative (SBTi).

As part of this commitment, IQE will formulate science-based targets to reduce greenhouse gas emissions in line with the SBTi Net Zero Standard, which seeks to limit global warming to 1.5°C. The SBTi defines and promotes best practice in emissions reductions and net zero targets in line with climate science.

IQE and its board remain committed to the implementation of Environmental, Social and Governance (ESG) best practice across the group. The announcement marks a step for IQE's ESG Committee following its establishment in January, as it continues to build on IQE's strategy to deliver sustainable growth. The board-level group oversees ESG activities and performance against commitments for the long-term benefit of all stakeholders.

"This commitment is an important milestone for IQE in our journey towards improving our own operations, delivering sustainable growth and being a truly responsible business for the benefit of all," says IQE's CEO Americo Lemos. "The world's net zero targets will not be met without the widespread uptake of compound semiconductors, which are vital in enabling next-generation efficient technologies, such as those needed for the mass adoption of electric vehicles, in the power electronics industry and smart power grids."

www.science-based targets.org
www.iqep.com

Taiwan Semiconductor Research Institute selects Veeco's Propel MOCVD system

R&D and technology collaboration for GaN-based power & RF devices

Epitaxial deposition and process equipment maker Veeco Instruments Inc of Plainview, NY, USA says that its Propel R&D metal-organic chemical vapor deposition (MOCVD) system has been selected by the Taiwan Semiconductor Research Institute, National Applied Research Laboratories (TSRI, Narlabs) for development and collaboration related to gallium nitride (GaN)-based power and RF devices.

The single-wafer Propel platform is suitable for high-volume manufacturing and 300mm capabilities, as well as R&D applications. The Propel R&D system has been installed in TSRI's Hsinchu laboratory and enables a joint collaborative effort to drive technology innovation, as well as develop and demonstrate technical capabilities in emerging GaN markets. The joint effort and collaboration aims to accelerate wide-bandgap compound semiconductor technology to high-volume and low-cost applications on 200mm and 300mm substrates.

Veeco's Propel R&D MOCVD system

"Veeco's Propel R&D system is uniquely qualified to deliver the performance and flexibility required to conduct advanced developments of power and RF devices," comments Dr Chang-Hong Shen, deputy director-general, Research Fellow at TSRI. "We are excited to have this R&D system operating in our facility and look forward to support from the Veeco team in the years to come," he adds.

Veeco's Propel GaN MOCVD system is designed specifically for power and RF applications. Featuring a single-wafer reactor platform, the system deposits GaN films for the production of highly efficient power and RF devices. The single-wafer reactor is based on Veeco's TurboDisc technology including the IsoFlange and SymmHeat technologies, which provide homogeneous laminar flow and uniform temperature profile across the entire wafer.

"We now have multiple technologies installed at TSRI's facility and we look forward to helping them maximize the value of our platforms and the opportunity for technology collaboration," says Adrian Devasahayam Ph.D., senior VP, product line management.

www.tsri.org.tw/en
www.veeco.com

5N Plus renews $124m syndicated credit facility

Option to increase to $154m through $30m accordion feature

Specialty semiconductor and performance materials producer 5N Plus Inc of Montreal, Québec, Canada has announced the renewal of its US$124m senior secured multi-currency revolving syndicated credit facility. Subject to lenders' approval, 5N Plus can opt to increase its credit facility to $154m through a $30m accordion feature.

5N Plus provides purified metals such as bismuth, gallium, germanium, indium, selenium and tellurium, and also produces related II-VI semiconducting compounds such as cadmium telluride (CdTe), cadmium sulphide (CdS) and indium antimonide (InSb) as precursors for the growth of crystals for solar, LED and eco-friendly materials applications. Sectors addressed include renewable energy, security, space, pharmaceutical, medical imaging, and industrial and additive manufacturing.

"In late 2021, supported by our senior lending partners, we completed the acquisition of Germany-based AZUR SPACE GmbH [which develops and manufactures multi-junction solar cells based on III-V compound semiconductor materials], significantly strengthening our specialty semiconductor value chain and competitive capabilities in a critical sector, thereby also expanding our addressable market," says chief financial officer Richard Perron. "5N Plus has a growing and resilient business with a greater proportion of revenues driven by value-added products and promising end markets," Perron adds. "We are pleased to have the continued support of leading financial institutions to fund our operations and growth initiatives as we pursue our growth trajectory."

The new credit facility has a four-year term, bearing interest and a margin based on the firm's senior consolidated debt-to-EBITDA ratio.

HSBC Bank Canada acted as sole lead arranger, sole bookrunner and administrative agent for the syndicate of five lenders participating in the credit facility.

www.azurspace.com
www.5nplus.com

Optimizing AlInP/AlGaInP laser epilayer uniformity by combining in-situ and ex-situ metrology

FBH uses LayTec's EpiX mapping station plus EpiCurve TT AR VCSEL+ to optimize MOCVD gas flow profile and susceptor configuration

The combination of ex-situ wafer mapping and optical in-situ measurements during metal-organic vapor phase epitaxy (MOVPE) for laser devices constitutes a powerful method for obtaining maximum layer and die uniformity across the wafer for the production of devices such as vertical-cavity surface-emitting laser (VCSEL) or edge-emitting laser (EEL) structures, notes in-situ metrology system maker LayTec AG of Berlin, Germany.

This uniformity directly increases the yield in subsequent device processing, with a strong cost impact. Ex-situ mapping measurements by means of white light reflectance (WLR) and photoluminescence (PL) are well-established methods for ensuring sufficient uniformity prior to further processing in expensive dicing and packaging processes. Unfortunately, they do not directly disclose the root-cause of inhomogeneity that might be observed in these measurements.

In contrast, in-situ measurements by means of emissivity-corrected pyrometry (ECP), reflectance and curvature directly reveal the effect of certain process parameter changes like heater or gas flow settings on the wafer temperature or layer composition. However, they never cover the entire wafer area and do not probe the layers under device operating conditions.

Therefore, only a smart combination of both methods constitutes an efficient way for identifying the parameter most affecting the uniformity and tuning the process towards the most uniform layer properties across the wafer for cost-effective production, says LayTec.

Dr André Maaßdorf et al at the Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenztechnik (FBH) of Berlin, Germany established this approach by combining LayTec's EpiX mapping station (Figure 1(a), (b)) and LayTec's in-situ measurement tool EpiCurve TT AR VCSEL+ (Figure 1(e)) for optimizing the gas flow profile and the susceptor configuration at their Aixtron AIX 2800 G4 IC2 (12x4") epitaxial deposition system for AlInP/AlGaInP edge-emitting lasers. The EpiCurve TT AR VCSEL+ combines the curvature, three-wavelength reflectance and emissivity-corrected pyrometry (ECP) of an EpiCurve TT with additional spectral reflectance capability. The EpiX-Mapper equipped with WLR and PL was deployed for wafer mapping to deduce properties like layer thickness and emission wavelength. At the beginning of the optimization process a significant deviation in layer thickness (relative deviations ≤8%) was observed (Figure 1c). Moreover, in-situ ECP data obtained during deposition (Figure 1d) revealed that the wafer temperature profile also exhibited a similar non-uniformity at the edges and further in the wafer center.

Based on the results of the comparison of in-situ and ex-situ results, gradual modification of the gas foil rotation (GFR) and absolute gas flow, its distribution over the gas inlet as well as modification of recess of the wafer satellite led to an almost perfectly flat thickness profile (pink trace, Figure 1(c), (d)).

LayTec says that the results clearly demonstrate the advantage of combining ex-situ wafer mapping to detect and eliminate wafer non-uniformities. The upcoming application note will provide more details about this optimization process and will be available soon on the firm's website.

www.fbh-berlin.com
www.laytec.de

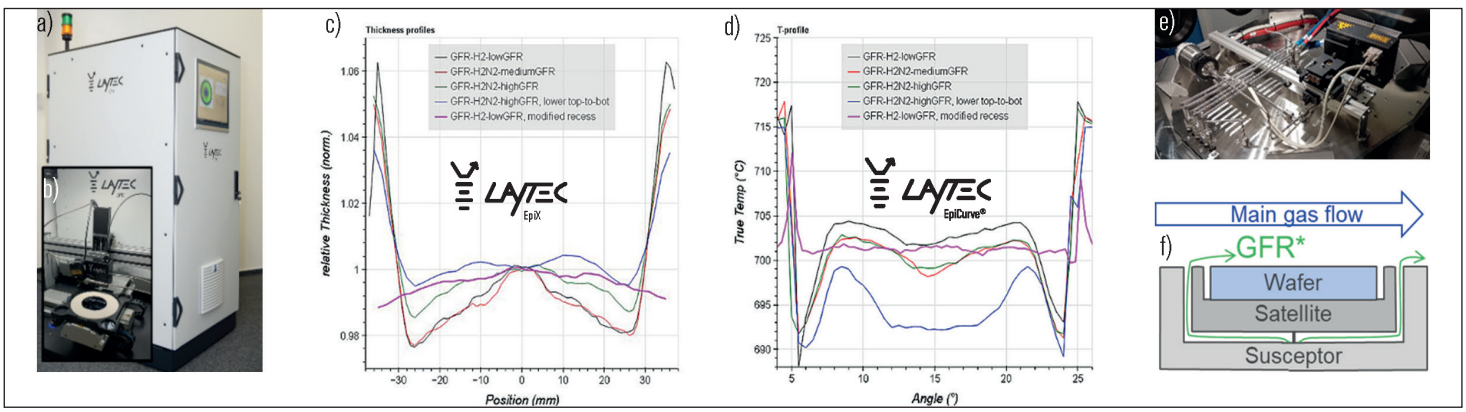
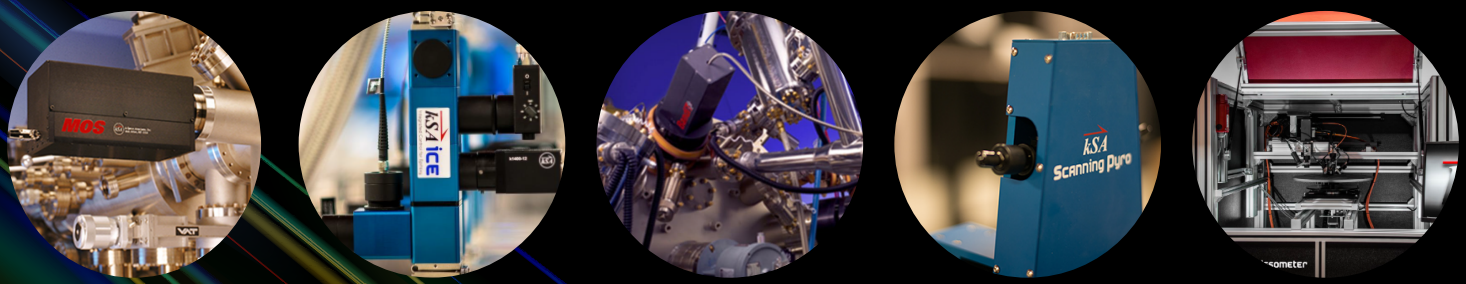


Figure 1 (a) EpiX mapping station for areal wafer inspection; (b) xy-mapping stage of EpiX mapping station inside the cabinet shown in; (c) layer thickness wafer uniformity for various experimental configurations, as measured with LayTec EpiX; (d) Emissivity-corrected temperature wafer uniformity for the same configurations, as measured in-situ by LayTec EpiCurveTT; (e) EpiCurveTT mounted on the MOCVD reactor at FBH; (f) schematic sketch of the wafer susceptor configuration (GFR: Gas Foil Rotation).

When Accurate Real-Time Measurement Matters



In Situ Thin-Film Metrology Solutions for Research, Development, and Production

- Film thickness and deposition rate
- Wafer and film temperature
- Thin-film stress and strain
- Wafer curvature, bow, and tilt
- Surface roughness and quality
- Wafer carrier characterization
- Analytical RHEED

Visit www.k-space.com today to discover the measurement solution that's right for you.

k-Space Associates, Inc.
Putting Light to Work
www.k-space.com

CompoundTek and STAr Technologies co-develop silicon photonics wafer testers

Enhanced test coverage and cost efficiencies for reliable, high-volume testing

Singapore-based silicon photonic (SiPh) foundry services provider CompoundTek Pte Ltd and reliability test system and probe-card supplier STAr Technologies Inc of Hsinchu, Taiwan have developed a silicon photonics (SiPh) wafer test solution with automatic fiber array block edge coupling.

This should help to address the demand from SiPh product companies and manufacturers to be able to test the wafer according to how the light is coupled into the SiPh product in the end application, thus expanding the test coverage capability of the wafer test. This is possibly the only SiPh tester with the capability for edge coupling fiber arrays automatically to SiPh ICs with trench widths smaller than 100µm, with high repeatability and efficiency.

"Testing the die using vertical grating coupler will compromise the test coverage of the wafer testing, as the test condition is not the same as per what it is going to be used in the field," notes CompoundTek's CEO Raj Kumar. "Furthermore, designers will have to allocate space in the prime die for this vertical grating coupler and their test structure, increasing the die size as a result, while lowering gross die per wafer," he adds.

"Skipping the wafer test totally will drive up the overall cost of products, as companies cannot identify SiPh known good dies (KGD) before assembling with other dies, resulting in overall high costs and material wastage if a defective SiPh is assembled," Kumar continues.

SiPh is now a technology that is not only used to displace traditional electrical interconnects but also used in a broad range of applications, including light detection & ranging (LiDAR), quantum computing, and biosensing. However, the integration of optical components on a chip creates a host of new engineering and high-volume manufacturing challenges in wafer-level testing of SiPh devices as most of the products use an edge coupler to couple the light in and out of the chip. To get around the challenges of the edge coupler, most product companies either use a vertical grating coupler during wafer test or they choose to skip wafer test and only test after the SiPh test is assembled and packaged. CompoundTek and STAr enable this technology with very precise positioning of a fiber array block with accuracy and repeatability down to 0.1µm, in a narrow trench typically less than 100µm wide. The test fibers can deflect the light at about 90 degrees into the edge coupler with low optical power insertion loss and extremely low light reflection. This is enabled through patent-pending fiber alignment test kits and pattern recognition software that applies to all SiPh devices for both optical–optical and electro–optical tests.

"The jointly developed tester managed to address the technical challenges required for wafer-level efficient edge coupling testing with up to 50% reduction in setup and alignment test time while keeping test system cost as low as 40% lower than that of others available in the market," says STAr's CEO & founder Dr Choon Leong. "This partnership marks a new milestone for SiPh testing that successfully meets the market's present and future needs for a reliable and cost-efficient test system for both vertical and edge coupling, especially for high-volume testing. We believe that our test solution has hit the sweet spot in terms of meeting performance and cost requirements."

The technology shift in the form of SiPh demonstrates the potential for measurable gains in speed, power efficiency and density, says CompoundTek. The first wave of the SiPh revolution is poised to roll over data centers around the world with optical interconnects that break the barriers set by copper wire. In parallel, the development of SiPh transceivers has resulted in increased demand for cost-effective wafer test solutions, enabling the industry to improve its quality control coverage at the wafer level, potentially driving down product costs due to failures after packaging. CompoundTek has a line-up of over 20 global commercial customers alongside collaborations with more than 20 research institutes and universities in various applications such as telecommunications, automotive radar, data communications, biosensing, artificial intelligence (AI), quantum computing and smart sensors.

www.star-quest.com
https://compoundtek.com

Palomar places vacuum reflow furnace at UK's EPIC

Electronics and Photonics Innovation Centre to use SST 5100 for optoelectronic packaging

Photonics and microelectronic device assembly & packaging equipment maker Palomar Technologies Inc of Carlsbad, CA, USA has announced the consignment of an SST 5100 vacuum reflow furnace at the Electronics and Photonics Innovation Centre (EPIC) in Paignton, Torbay, UK. The focus will be on delivering higher-quality optoelectronics packaging for several different applications.

EPIC is a center of excellence supporting technological innovation and promoting collaborative activity between businesses and research institutions. It focuses on supporting start-up and spin-off companies and encourages foreign direct investment to Torbay and its microelectronics and photonics sector. Previously, Palomar has placed a 3880 die bonder and 8000 wire bonder at the EPIC Prototyping Suite, which were subsequently purchased and are now available for use by EPIC members and other photonics companies to use on photonics/optoelectronics projects.

Palomar's SST 5100 vacuum reflow furnace.

For the manufacture of optical transceiver engines, using the void-free solutions delivered by the SST 5100 can deliver higher thermal conductivity, thinner bond lines and a cleaner finish. This requires changing from epoxy bonding of a thermoelectric cooler (TEC)-to-gold-box bond — as well as for the chip-on-chip (CoC)-to-TEC bond — to a eutectic sandwich bond process achieved with a vacuum reflow furnace.

For higher-bit-rate transceivers (over 400G to 1.6T), supplementing ball bumping from the Palomar 8000/8100 ball bonder and flip-chip thermos-compression bond on the Palomar 3880/3880-II die bonder with the over-pressure advantage provided by the SST 5100 is expected to provide the superior RF performance needed for market success.

https://epic-centre.co.uk
www.palomartechnologies.com

Umicore develops ultra-low-resistivity 8" n-type germanium wafers

6" and 8" Ge wafers with resistivity <1mΩ.cm to improve electrical performance of VCSELs

Germanium product and materials solutions supplier Umicore Electro-Optic Materials (EOM) has announced the development of ultra-low resistivity (<1mΩ.cm) 6" and 8" germanium wafers for vertical-cavity surface-emitting lasers (VCSELs).

As a key component in telecom and 3D sensor systems, the applications of VCSELs range from data centers to smartphone security and light detection & ranging (LiDAR) sensors for autonomous vehicles (AVs).

Umicore says that, due to its latest breakthrough, VCSELs on the firm's 6" or 8" wafers will have superior electrical performance on top of the already proven better optical performance compared with gallium arsenide (GaAs) wafers traditionally used for this application.

"We are seeing growing interest in our germanium wafers for photonic applications," notes Bendix De Meulemeester, director marketing & business development. "Thanks to the Umicore material expertise and know-how, our team has been able to develop an innovative germanium crystal technology that achieves below 1mΩ.cm resistivity in n-type germanium wafers without affecting the excellent crystal quality such as zero dislocations and high doping uniformity," he adds. "With the development of the first 6" VCSEL Ge wafer in 2020 and the first 8" VCSEL Ge wafer in 2021, this is the third innovation of our germanium R&D team in relatively short time, a testament of our commitment to the photonic industry."

Our team has been able to develop an innovative germanium crystal technology that achieves below 1mΩ.cm resistivity in n-type Ge wafers without affecting the excellent crystal quality

https://eom.umicore.com

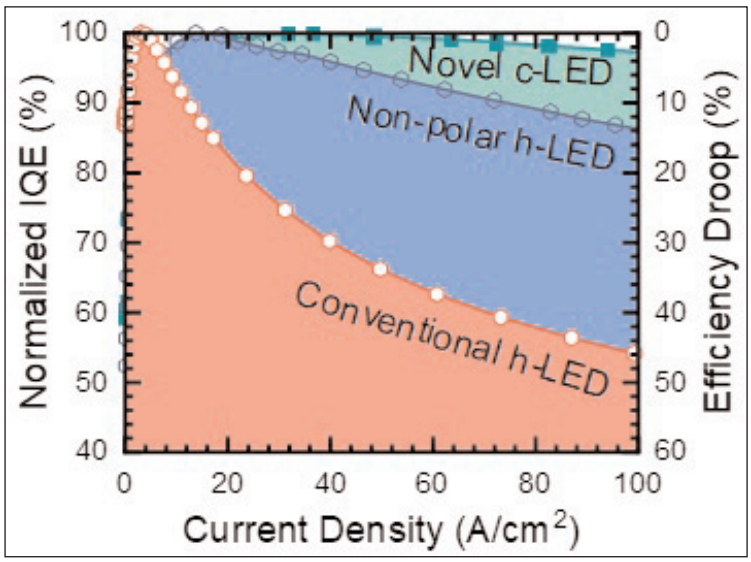
Cubic-phase III-nitride LEDs overcome efficiency droop

Polarization in hexagonal-phase LEDs enhances Auger recombination or carrier leakage

Annually, lighting accounts for 15% of global electricity consumption and 5% of worldwide greenhouse-gas emissions. In the USA alone, the transition to solid-state lighting has already reduced lighting-related energy needs and greenhouse-gas emissions by about 25% with respect to non-solid-state lighting (SSL). However, the average household energy consumption for lighting is set to triple over the next 50 years due to population growth and an increase in housing size. Accelerating the transition to energy-efficient lighting is one of the most significant initiatives to improve the global economy and climate conditions.

If the US Department of Energy's Solid-State Lighting Program goals are met by 2035, SSL will further reduce lighting-related energy needs and greenhouse-gas emissions by about 55%, reducing the US energy bill by ~$50bn (equal to about a 5% reduction in the total primary energy budget of the USA).

However, the performance of LED-based SSL is far below its theoretical limit because conventional, hexagonal (h)-phase indium gallium aluminium nitride (InGaAlN) multi-quantum well (MQW) LEDs suffer from efficiency rollover under high current density, i.e. efficiency droop. This issue imposes a trade-off between light output power, efficiency, and cost.



Normalized internal quantum efficiency (IQE) (left y-axis) and efficiency droop (right y-axis) as a function of current density.

Numerous mechanisms, such as Auger recombination, carrier leakage, internal polarization, and, last but not least, phase-space filling have been proposed to explain the efficiency droop in conventional h-LEDs, yet none of them explains the efficiency droop alone.

Now, Yi-Chia Tsai, Can Bayram, and Jean-Pierre Leburton at the University of Illinois at Urbana-Champaign (UIUC) have provided a detailed computational analysis of the various factors influencing the internal quantum efficiency (IQE) of InGaAlN MQW-based LEDs as a function of design and crystallographic structure ('Interplay between Auger recombination, Carrier Leakage, and Polarization in InGaAlN Multiple-Quantum-Well Light-Emitting Diodes', J. Appl. Phys. 131, 193102 (2022)). Their analysis shows that the primary factor for IQE degradation and the so-called 'efficiency droop' is the internal polarization arising in strained h-LEDs, which enhances either Auger recombination or carrier leakage from the QWs.

As both effects cannot be averted by modifying the device design alone, their work indicates that switching to novel, cubic (c)-phase LEDs would strongly enhance the IQE peak over 80%, while quenching the efficiency droop to just a few percent.

Perovskite–GaN tandem LED with improved tunable luminance and color

Blue GaN LED vertically integrated with green PeLED overcomes low brightness and stability of blue PeLEDs

In conventional display panels, the red, green and blue sub-pixels are assembled in a side-by-side structure, which intrinsically leads to a large pixel area, making it difficult to fulfill the requirements of applications requiring ultra-high display resolution, e.g. advanced high-dynamic-range (HDR) and virtual-reality (VR) displays, notes the South China University of Technology. An efficient approach to reducing the pixel area is to combine two (or even three) colors (red, green or blue) within one sub-pixel. However, this requires excellent color tunability for the lighting device. To meet this demand, multi-color electroluminescence (EL) devices with a tandem structure are becoming a straightforward solution to improve space utilization.

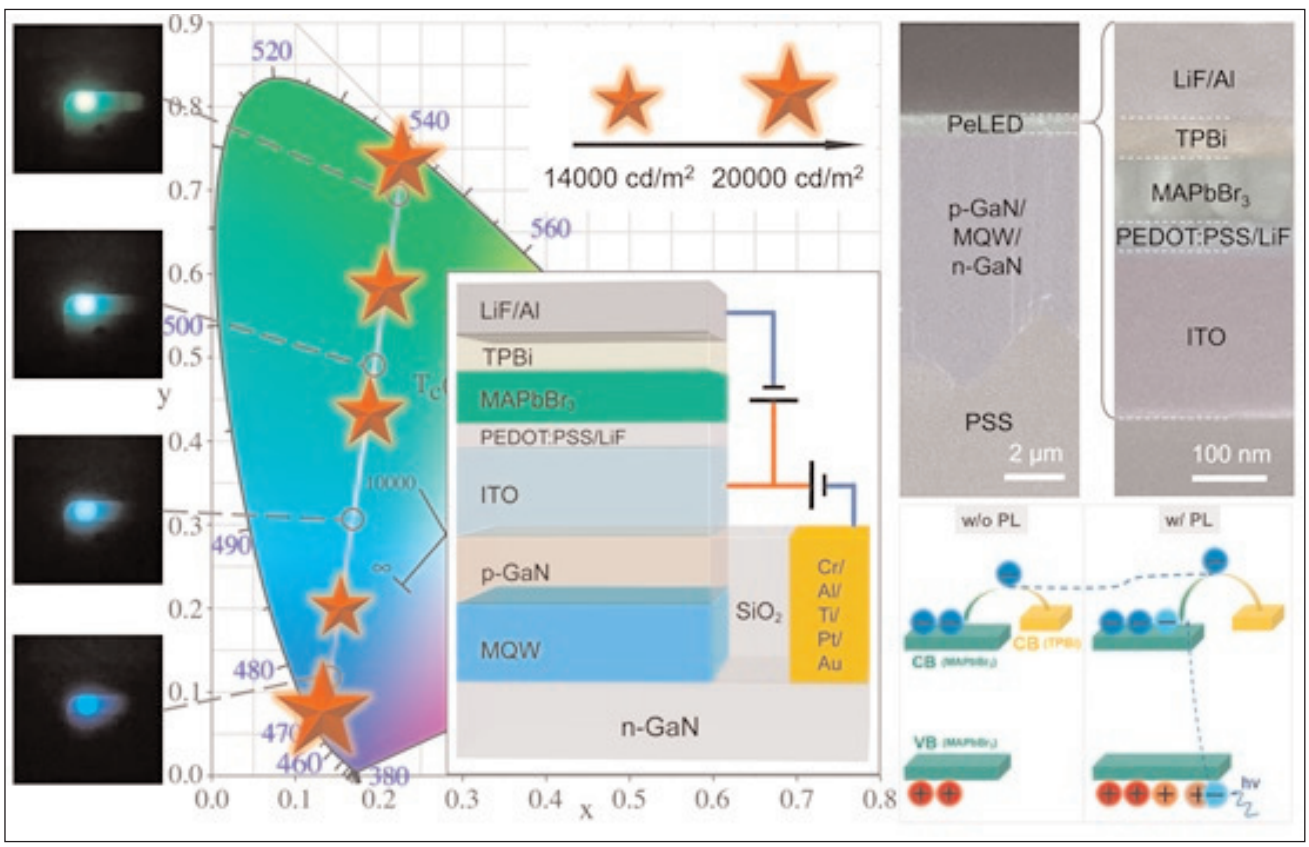
In particular, tandem structures with different subpixels are promising for perovskite-based multi-color EL devices in ultra-high-resolution full-color displays. However, considering the low brightness and stability of blue perovskite light-emitting diodes (PeLEDs), realizing excellent luminance- and color-independent tunability remains a challenge.

To overcome this, Li Zongtao and Li Jiasheng at South China University of Technology have fabricated a tandem structure in which a bright and stable blue gallium nitride (GaN) LED has been vertically integrated with a green $MAPbBr_3$ (methylammonium lead bromide) PeLED, achieving a Pe–GaN tandem LED with independently tunable luminance and color.

The electronic and photonic co-excitation (EPCE) effect is found to suppress the radiative recombination and current injection of PeLEDs, leading to degraded luminance and current efficiency under direct-current modulation. Accordingly, pulse-width modulation (PWM) is introduced to the tandem device with a negligible EPCE effect, and the average hybrid current efficiency is significantly improved by 139.5%, finally achieving record tunable luminance (average tuning range of 16631cd/m^2 at an arbitrary color from blue to green) for perovskite-based multi-color LEDs (Li Zongtao et al, 'Perovskite-Gallium Nitride Tandem Light-Emitting Diodes with Improved Luminance and Color Tunability', Advanced Science (2022), 2201844).

The reported independent tunability can be the starting point for perovskite-based multi-color EL devices, enabling the combination with matured semiconductor technologies to facilitate their commercialization in advanced display applications with ultra-high resolution, believe the researchers.

https://doi.org/10.1002/advs.202201844
www.scut.edu.cn/en



Tandem LED structure, LED performance and EPCE effect.

Cree LED launches XLamp Element G LEDs for multi-color directional lighting

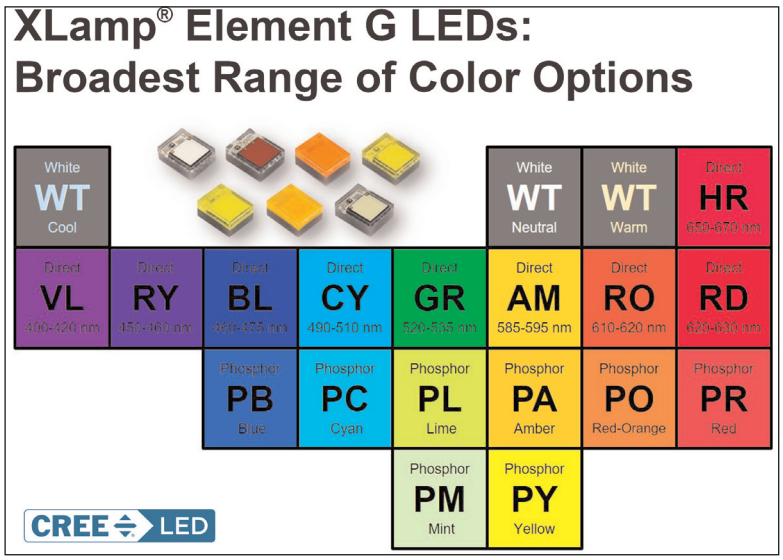
Nearly 3x output of XQ-E and 9x lumen density of XP-E2

Cree LED Inc of Durham, NC, USA (a company of SMART Global Holdings of Milpitas, CA) has launched XLamp Element G LEDs, delivering a new product class with what is claimed to be unmatched light output and efficiency for LEDs of this size. Product samples are available now and production quantities are available with standard lead times.

The XLamp Element G LEDs are the latest in Cree LED's portfolio of lighting solutions enabling maximum light output and optical performance with new levels of precision and control.

Expanding on Cree LED's technology breakthroughs, the XLamp Element G LEDs provide next-level performance in color mixing applications:

- new performance class delivering nearly 3x the output of the XQ-E and 9x the lumen density of XP-E2;
- the broadest range of color options available in the industry, it is claimed;
- no-compromise package design with minimal LED chip-to-edge spacing featuring a large, electrically isolated thermal pad and ESD protection.



The XLamp Element G LEDs are optimized for multi-color directional lighting products for indoor and outdoor directional, architectural and entertainment applications.

"Customers have been asking for the next flagship color platform and we've delivered — providing more color options and better control than ever before," says president Claude Demby. "XE G LEDs deliver an innovative building block approach to lighting system design, providing an entirely new performance standard for this category."

www.cree-led.com/products/xlamp-leds-discrete/xlamp-xe-g

Cree LED unveils latest LED innovations at LightFair

XLamp Element G LED a 'LightFair Top 10 MUST SEE' product

At LightFair 2022 in Las Vegas (21–23 June), Cree LED debuted its XLamp Element G (XE-G) LEDs (launched in early June).

The XE-G LED family of products was recognized by EdisonReport as a 'LightFair Top 10 MUST SEE' product. The new products were part of two demonstrations at the event highlighting the performance advantages for color mixing applications: one optimized for outdoor architectural lighting and the other optimized to deliver very high color-rendering index (CRI) across a wide range of 1800–7500K correlated color temperature (CCT) for indoor lighting.

Additional LED innovations on display included:

- Color-tunable projector: featuring the new XLamp XM-L Color Gen 2 High Intensity LED, demonstrating extremely tight LED die spacing that delivers optimum color mixing for directional color-changing lighting.
- Photophyll Select: the first LED color fully optimized for horticulture, designed to replace the white LEDs common in two-channel white + red horticulture luminaires. Cree LED's full-spectrum luminaire design featuring this new color delivers efficiency up to 3.25PPF/W.
- Precision dimming: a simplified approach to address unacceptable variations in LED light output and hue when using low-current dimming.
- Circadian Stimulus (CS): J Series 2835 Color LEDs featured in different scenarios demonstrate CS, considered to be the best new metric for measuring the effects of light on the melatonin content in a person's body, which affects alertness.
- XLamp XD16 Premium White LEDs and XLamp CHA family LEDs: recent product launches.
- XLamp XP-G3 S Line LEDs: Leading efficacy for outdoor lighting and J Series 5050 K Class LEDs for industrial lighting.

"These innovations demonstrate our continued efforts to push the boundaries of LED technology along with our commitment to lead the industry with best-in-class technology, quality and performance."

www.cree-led.com/lightfair-2022

ams OSRAM launches OSLON Optimal LEDs for horticulture lighting

Flexible mix of color and white options meeting requirements of growing applications

ams OSRAM GmbH of Premstätten, Austria and Munich, Germany has launched the OSLON Optimal family of LEDs, based on the firm's latest 1mm^2 chip for horticulture lighting, which offer a combination of high efficiency, reliable performance and value.

The OSLON Optimal LEDs are available at launch in Hyper Red (660nm) and Far Red (730nm) colors. Deep Blue and Horti White versions are expected to be available in third-quarter 2022. The mix of colors and white provides fixture manufacturers with the flexibility to address the spectral requirements of any horticulture application.

Their 3.0mm x 3.0mm footprint makes the OSLON Optimal LEDs particularly well suited to the horticulture lighting fixtures used in vertical farms and high-density greenhouses, where tight clustering of LEDs is often necessary. In these applications, the chief requirement is to balance efficiency (photosynthetic photon flux per Watt, or PPF/W) with low cost of light (PPF/$).

The OSLON Optimal LEDs balance performance and cost with robustness, high reliability and lifetime, says the firm. The new products are based on the same indium gallium aluminium phosphide (InGaAlP) thin-film chip technology as used in the OSLON Square family of 2mm^2 die high-performance horticulture LEDs. This technology enables the OSLON Optimal LEDs to handle high drive currents and high operating temperatures, while maintaining what are claimed to be excellent operating lifetimes with minimal drop in photon flux over time. The 3030 High Power ceramic package is highly resistant to corrosion even when operating in harsh horticultural environments.

In addition, the OSLON Optimal LEDs feature a new, larger spherical lens that produces a wide 120° viewing angle, providing an even distribution of light over crops without 'hot spots' of concentrated light.

"The new OSLON Optimal products family of products based on our latest ams OSRAM's chip technology, achieve market-leading performance/price ratio in LEDs that are based on a 1mm^2 die," claims Renil P. Singh, portfolio management director Horticulture at ams OSRAM. "They offer higher PPF/$ and PPF/W than the OSLON SSL horticulture LEDs, and are solder pad-compatible with the OSLON SSL and the OSLON Square LEDs," he adds. "Fixture manufacturers and growers can be assured that the new LEDs benefit from the same robustness, reliability and long life that they are used to in ams OSRAM LEDs."

Efficient spectral coverage

For horticulture lighting applications, the OSLON Optimal Hyper Red, Deep Blue (450nm) and Far Red LEDs have a tight tolerance of peak wavelength. The Horti White LED offers reduced output in the red spectrum compared with standard white LEDs for illumination applications. This allows growers to use more direct red emitters such as the Hyper Red OSLON Optimal LEDs to provide the red wavelengths needed for biomass growth, and to reduce the reliance on less efficient phosphor-converted white emitters to cover the red part of the spectrum. This enables growers to achieve higher overall efficiency in PPF/W.

www.osram.com

AquiSense launches European subsidiary

Expansion to support continued growth in region

AquiSense Technologies LLC of Erlanger, KY, USA (which designs and makes water, air and surface disinfection systems based on UV-C LEDs) has unveiled its latest subsidiary AquiSense Technologies Europe GmbH, providing support to local business development strategies and existing efforts to maintain customer relationships. The development comes at a strategic time, as sales are growing and large partners are coming online for the firm's UV-C LED disinfection products.

Located near Frankfurt, Germany, AquiSense Technologies Europe is led by Thomas Arnold, who has a background of 15 years in the conventional mercury lamp industry. He joined AquiSense as European sales director five years ago when we saw the full potential of UV-C LEDs. "This new company will support our efforts in this region, including maintaining and building our distributor network and continuing to build relationships with our customers in the region," he comments. "This development comes with additional staff and resources to grow our sales efforts in the region for all AquiSense products," he adds.

"AquiSense has operated on a global basis from inception in 2015, however steps such as this are important as we scale revenue and operations," says CEO & president Oliver Lawal. "This company formation is just one of many globalization strategies we have put into action recently."

www.aquisense.com

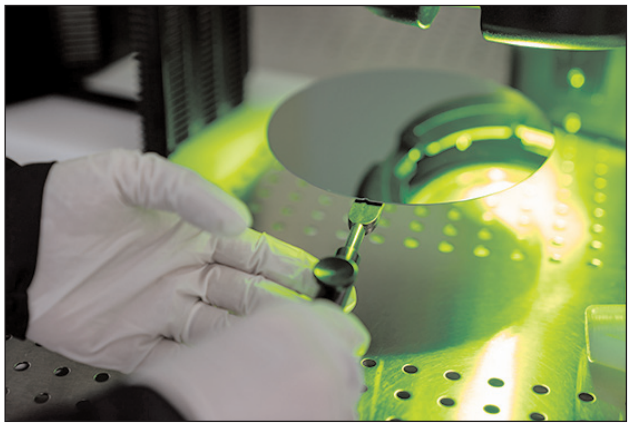
IQE announces multi-year, high-volume strategic epiwafer supply agreement with Lumentum

Lasers to be used in 3D sensing, automotive LiDAR and optical networking applications

Epiwafer and substrate maker IQE plc of Cardiff, UK has signed a multi-year agreement with Lumentum Holdings Inc of San Jose, CA, USA (which designs and makes photonics products for optical networks and lasers for industrial and consumer markets) for the supply of epiwafers supporting 3D sensing, light detection & ranging (LiDAR) for automotive and optical networking applications.

Lumentum has been a long-term partner of IQE. Effective immediately, the multi-year agreement is focused on high-volume production of epiwafers which will be used across Lumentum's portfolio of laser products, in particular to enable LiDAR for autonomous vehicles (AVs), where IQE will be the epitaxy partner of choice for this technology.

The partnership between IQE and Lumentum will also span a wider range of technologies such as biometric security, data communications, and extended reality. There is also further provision for multi-year joint R&D initiatives.



"Our partnership with Lumentum is in alignment with our strategy to strengthen our customer relationships and to enter into long-term agreements securing wafer supply," says IQE's CEO Americo Lemos. "Lumentum and IQE are industry leaders in the 3D sensing space, and this partnership is underpinned by IQE's unrivalled technology portfolio. We look forward to our continued collaboration and expansion of our business relationship into new market segments," he adds.

"I am pleased to extend our fruitful partnership with IQE into the future. They supported our ramp to high volumes in the consumer space, where we have shipped more than 1 billion large-scale VCSEL [vertical-cavity surface-emitting laser] arrays," says Lumentum's CEO Alan Lowe. "As we start to ramp high volumes of differentiated solutions into even more demanding applications in the coming years in the automotive, extended reality and industrial spaces, I'm sure our partnership will continue to flourish."

www.lumentum.com
www.iqep.com

BluGlass ships first prototype laser diode products

Fully packaged 405nm and 420nm multi-mode products to be evaluated within new customer designs and applications

BluGlass Ltd of Silverwater, Australia — which has developed proprietary low-temperature, low-hydrogen remote-plasma chemical vapor deposition (RPCVD) technology for manufacturing devices such as laser diodes, next-generation LEDs and micro-LEDs — has shipped its first fully packaged laser diode prototypes to its initial customer.

BluGlass' 405nm and 420nm alpha products (for collecting customer feedback in real-world applications) will be integrated and tested by the customer within their new product design and development cycles.

These alpha products have undergone internal preliminary performance and life-time reliability testing and are at a stage where customers can assess the products in their own development-stage applications. BluGlass' 405nm and 420nm single-mode and multi-mode products are progressing towards achieving commercial performance and reliability.

"This is a key commercialization milestone for BluGlass, representing the first delivery of our laser diodes to an external customer," notes BluGlass' president Jim Haden. "While still in the alpha (development) stage, our laser products are demonstrating significantly improved performance, and now are suitable for customers to evaluate during their product and application development process," he adds. "We are working with several customers wanting to trial alpha laser diodes for innovative new applications, including medical devices, sensing, quantum computing, and automotive products. The fact that we have customers anxious to receive our alpha products, ahead of our full product launch, is indicative of the significant unmet demand within the 405nm and 420nm wavelengths, and a testament of our improved performance."

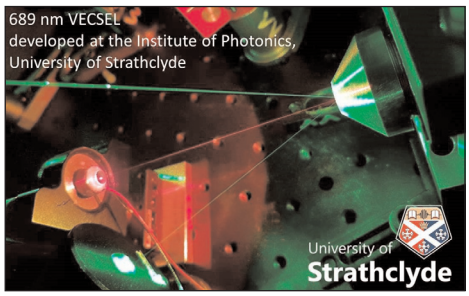
www.bluglass.com.au

III-V Epi completes SHARK-VECSEL project for University of Strathclyde

MOCVD-grown AlGaInP VECSELs achieve 130mW single-mode operation at 689nm

III-V Epi Ltd of Glasgow, Scotland, UK has completed the project SHARK-VECSELs (Supply cHAin for stRontium clocK Vertical External Cavity Surface Emitting Lasers) with the University of Strathclyde. Funded by UK Government agency Innovate UK (which provides funding and support for business innovation as part of UK Research and Innovation), the £50,000 project has developed high-power, narrow-linewidth visible lasers for next-generation strontium-atom-based quantum atomic clocks.

"The SHARK-VECSELs project represents a significant developmental step in the commercialization of atomic-clock-based precision



positioning and timing devices," says Dr Jennifer Hastie, director of the Institute of Photonics at Strathclyde University. "III-V Epi used its MOCVD [metal-organic chemical vapor deposition] facility to produce an aluminium gallium indium phosphide (AlGaInP)-based VECSEL structure, which the University of Strathclyde used to realise lasers with greater than 130mW single-mode operation, at 689nm. This is the wavelength used to cool neutral strontium atoms in quantum atomic clocks."

Quantum technologies play a mission-critical role in defence, security and other sensitive markets, but require low-volume production quantities. III-V Epi was set up specifically to address the needs of this low-volume, fast-turnaround market. The SHARK-VECSELs project has helped to consolidate III-V Epi's critical position in the worldwide commercial quantum supply chain, the firm reckons.

www.iii-vepi.com
http://uknqt.epsrc.ac.uk

Vector's business support manager joins 'Opening up Photonics' Steering Board

Photonic-crystal surface-emitting laser (PCSEL) firm Vector Photonics Ltd of Glasgow, Scotland, UK says that its business support manager Sharon Doonin has joined the Steering Board of the 'Opening up Photonics' (OUP) initiative. The initiative was set up to discuss and address the barriers faced by minority groups in Scotland's photonics sector, aiming to increase accessibility and champion diversity.

The newly appointed Steering Board members have diverse experience of the Scottish photonics sector with industrial, academic, human resources (HR) and business development expertise. They will provide strategic guidance for increased inclusivity — broadening the talent pool, driving innovation, and encouraging growth.

"Vector Photonics has backed the OUP initiative since its formation and strongly supports its inclusivity, accessibility, and diversity agenda," says Vector Photonics' CEO Neil Martin. "Sharon Doonin brings current HR, corporate governance, project and quality management experience to the Steering Board. The managerial roles she has held within large energy, construction and insurance companies brings an even wider perspective," he adds.

"We are also pleased that Adam McKenzie, working as a research associate at the University of Glasgow on a PhD project with Vector Photonics, is also joining the Steering Board," Martin notes.

Opening up Photonics is a partnership between Photonics Scotland, the University of Glasgow, the Institute of Physics, and Innovate UK's Knowledge Transfer Network (KTN). The complete list of Steering Board members includes:

- Sharon Doonin, business support manager, Vector Photonics;
- Adam McKenzie, KTP associate, University of Glasgow and Vector Photonics;
- Ben Hanley, director, Enigma People Solutions Ltd;
- Dr Marie Hutin, research grant manager, Edinburgh Instruments;
- Lesley Laird, director of Equate Scotland
- Dr Rair Macêdo, lecturer, University of Glasgow;
- Jennifer MacDonald, equality, diversity & inclusion project manager – NMIS;
- Elissa McKay, PhD student, University of Glasgow;
- Una Marvet, head of Design Centre, Alter Technology;
- Christopher Payne-Dwyer, business development manager, QuantIC;
- Tracey Skivington, electro-optics consultant, Thales;
- Professor Graham Turnbull, University of St. Andrews;
- Kirsty Annand, University of Glasgow.

www.vectorphotonics.co.uk

II-VI completes acquisition of Coherent

Combined materials, networking and lasers firm Coherent to trade as COHR on Nasdaq stock market

After obtaining anti-trust clearance from the State Administration for Market Regulation of the People's Republic of China (SAMR), engineered materials and optoelectronic component maker II-VI Inc of Saxonburg, PA, USA has completed its acquisition (announced in late March) of Coherent Inc of Santa Clara, CA (which provides lasers and laser-based technology for scientific, commercial and industrial applications).

Under the terms of the merger agreement, each share of Coherent common stock was converted into the right to receive $220 in cash and 0.91 of a share of II-VI common stock.

II-VI will continue to be led by a leadership team that leverages the strengths of the combined company and a board of directors consisting of executives and thought leaders from highly diverse industries. Former Coherent directors Stephen A. Skaggs and Sandeep S. Vij join the board.

"Coherent is an innovator with a rich portfolio of some of the most advanced technologies in the world, which have been transformative in a broad range of markets," comments II-VI's chair & CEO Dr Vincent D. Mattera Jr. "I would like to thank Andy Mattes for his leadership of Coherent and enabling a very successful integration planning process," he adds.

The combined business will be more distributed across the value chain from materials to components, subsystems, systems and service. II-VI reckons that its scale — at the levels of the value chain where expertise in materials matters — is complementary to Coherent's scale where laser systems play. The aim is to leverage that complementary scale in ways that matter to customers in strategic markets.

With a global workforce of over 28,000 associates in 130 locations, the combined firm will serve the four markets of industrial, communications, electronics, and instrumentation, which together represent a fast-growing total addressable market of $65bn.

The combined company will be organized into three business segments:

- Dr Giovanni Barbarossa will continue to serve as chief strategy officer and lead the Materials Segment (previously the Compound Semiconductors Segment).
- Sunny Sun will continue to lead the Networking Segment (previously the Photonic Solutions Segment).
- Former Coherent chief operating officer & executive VP Dr Mark Sobey will be president of the new Lasers Segment.

"We plan for the combined company to be named Coherent [trading under the ticker symbol 'COHR' on the Nasdaq stock market]. We will soon announce the date of the launch of our new brand identity," says Mattera. "While the name Coherent has a strong association with lasers, the broader meaning of the word is 'bringing things together.' It represents our diversity in thinking distilled into our clarity of purpose, our unity in action, and our broader sense of engagement by connection to our mission, vision, and values," adds Mattera.

"With our foundation in materials and our unstoppable imagination, we will enable the next evolution of the cloud, 3D sensing, electric vehicles, additive manufacturing, the commercialization of space, and the personalization of healthcare, just to name a few," Mattera continues. "We are together on a journey towards a future that will be increasingly mobile, intelligent and electric, accelerating the pace of innovation."

www.Coherent.com
www.ii-vi.com

II-VI Inc reduces global carbon footprint with renewable energy contracts in Asia

Firm now purchasing 38% of electricity from renewable sources

Engineered materials and optoelectronic component maker II-VI Inc of Saxonburg, PA, USA has signed renewable energy contracts for powering multiple sites throughout Asia with 100% renewable electricity. These new agreements represent 35GWh of renewable electricity per year, avoiding an additional 18,000 metric tons of CO_2 emissions annually. The agreement covers II-VI sites in India, the Philippines, Vietnam, China and Japan.

II-VI has set reducing its carbon footprint across its global operations as a top priority. Including this latest announcement, II-VI has entered into renewable electricity contracts for over 40 sites around the world, including over 35 sites that now cover 100% of their annual electricity usage with renewable sources.

"II-VI now purchases approximately 38% of our electricity from renewable sources," says Tim Challingsworth, chief sustainability officer. "This announcement is an important next step in fulfilling our commitment to steadily reduce our carbon footprint position around the globe."

II-VI announced on Earth Day 2022 (22 April) that nine of its US sites will now cover 100% of their annual electricity usage with renewable sources. The firm announced in October 2021 that it was powering all of its facilities in Europe with 100% renewable electricity sources, and this January that its largest plant in China would be powered with 100% renewable electricity sources within four years.

www.ii-vi.com

II-VI and ADVA unveil first 100ZR pluggable coherent transceiver for optical network edge

II-VI and open optical networking solutions provider ADVA of Munich, Germany have launched what is claimed to be the first 100ZR pluggable coherent transceiver. Jointly defined and purpose-built for the optical network edge, the coherent 100ZR transceiver is rated for both commercial- and industrial-temperature (C-temp and I-temp) operating ranges. The new 100ZR digital coherent optics (DCO) transceiver features the Steelerton coherent digital signal processor (DSP). Co-funded by both companies, this all-new DSP is said to be completely unique to the marketplace.

The rapid growth of data traffic in 5G wireless and broadband access networks is driving demand for next-generation transmission technology that enables service providers to expand the capacity of their bandwidth aggregation infrastructure at the edge of the network. The new coherent 100ZR transceiver now empowers service providers to deploy 100Gbps coherent transceiver technology in the access network easily and affordably. These benefits are achieved due to the transceiver's unique features, including a coherent DSP optimized for 100ZR, cost-efficient silicon photonics technology, a standard QSFP28 interface, and Flextune technology.

"With this new application-specific transceiver technology, service providers can now benefit from the simplicity and robustness of coherent technology in the access network and seamlessly upgrade millions of 10Gbps Ethernet links to 100Gbps," says Henning Hinderthür, VP of product line management at ADVA. "While this product design is perfectly tailored to this application, it will also achieve economies of scale by leveraging II-VI's track record of manufacturing transceivers in high volume," he adds.

"We've had great feedback from both carriers and OEMs on this product, and are pleased to partner with ADVA on this key milestone for the industry," states Matthias Berger, VP, coherent technology, at II-VI Inc. "The transceiver includes the Steelert on DSP, a first-of-its-kind and game-changing coherent processor, due to its small size and low power consumption, which are both key to achieving the standard QSFP28 power dissipation requirement of less than 5W," he adds. "What makes this transceiver even more compelling for carriers is the embedded auto-tunable Flextune technology, which lowers operational expenses by simplifying network deployments. It's the ideal combination of cost-effective coherent technology with plug-and-play ease of use."

The new coherent 100ZR transceiver plugs directly into existing head-ends, switches and routers, enabling existing network elements to transmit 100Gbps signals over links stretching up to several hundred kilometers. The 100ZR transceivers are offered in both C-temp and I-temp variations to meet a broad range of deployment options, including central offices and local exchanges, as well as in more challenging ambient environments, such as in street cabinets.

www.adva.com

OpenLight unveils open silicon photonics platform with integrated lasers

Technology passes qualification and reliability tests on Tower's PH18DA production process

Addressing the growing silicon photonics market requirements for improved performance, power efficiency and reliability, newly launched company OpenLight of Santa Barbara, CA, USA has introduced what it claims is the first open silicon photonics platform with integrated lasers.

The platform provides increased laser integration and scalability to accelerate the development of high-performance photonic integrated circuits (PICs) in applications such as datacom, telecom, light detection & ranging (LiDAR), healthcare, high-performance computing (HPC), artificial intelligence (AI), and optical computing. The technology has passed qualification and reliability tests on the PH18DA production process of foundry Tower Semiconductor. OpenLight expects the first open multi-project wafer (MPW) shuttle run on the PH18DA process as well as 400G and 800G reference designs with integrated lasers to be available in the summer.

"OpenLight's technology will transform the silicon photonics industry," believes Dr Marco Racanelli, senior VP & general manager of Tower Semiconductor's Analog business unit. "Providing an open silicon photonics platform with integrated lasers that has been qualified on Tower's process will help mutual customers innovate and fuel the next generation of silicon photonics designs at scale."

As the optics industry advances, a major challenge for silicon photonics has been laser integration and the high cost of adding discrete lasers, including the manufacturing, assembly and alignment of those lasers. This becomes more important as the number of laser channels and the overall bandwidth increases. By processing the indium phosphide (InP) materials directly on the silicon photonics wafer, the PH18DA platform reduces the cost and time of adding lasers, enabling volume scalability and improved power efficiency. In addition, monolithically integrated lasers improve overall reliability and simplify packaging.

"OpenLight is paving the way for the new generation of silicon photonics by enabling the scalable integration of lasers in pluggable and co-packaged optics," comments Aveek Sarkar, VP of engineering at Synopsys Inc of Mountain View, CA, USA. "The combination of Synopsys' unified electronic and photonic design solution and OpenLight's innovative silicon photonics platform will significantly accelerate the development of photonics ICs," he believes.

The open platform includes integrated lasers, optical amplifiers, modulators, photodetectors, and other key photonic components to form a complete solution for low-power, high-performance photonics ICs. In addition, OpenLight offers select PIC designs and design services to accelerate time-to-market.

OpenLight's executive team is led by chief operating officer Dr Thomas Mader, VP of business development & strategy Dr Daniel Sparacin, and VP of engineering Dr Volkan Kaman.

"The rapidly growing silicon photonics market is being driven by the relentless demand for higher bandwidth needed to analyze, store and move complex data," notes Mader. "OpenLight's open silicon photonics platform with integrated lasers enables scaling from one laser to hundreds, or even thousands of lasers per PIC, all monolithically integrated at the wafer level," he adds. "With our platform, companies can enter emerging markets faster, accelerate new applications and completely change the way their teams build photonic systems of tomorrow."

www.openlightphotonics.com
www.synopsys.com/

Tower showcases key process and PDK features of silicon photonics process

Webinar to demo end-to-end design flow for PIC design on Tower's PH18 process

On 28 June the technology and design enablement experts of specialty analog foundry Tower Semiconductor Ltd of Migdal Haemek, Israel hosted a webinar 'Develop and Verify Designs Using a Silicon Photonics Platform with Integrated Lasers' introducing key process and process design kit (PDK) features of its PH18 process.

Attendees saw a demonstration of an end-to-end design flow using Synopsys products for photonic integrated circuit (PIC) design together with Tower's silicon photonics platform which includes OpenLight's technology with indium phosphide (InP)-based integrated lasers, amplifiers, modulators and photodetectors.

The platform targets datacom, telecom, light detection & ranging (LiDAR), healthcare, high-performance computing (HPC), artificial intelligence (AI), and optical computing applications.

As the optical transceiver market moves from 400Gb/s to 800Gb/s, many complex analog components are required to assemble energy-efficient and cost-effective optical modules. The webinar will examine an 800G-DR8 PIC design case study to show how to accurately develop PIC designs with a focus on co-simulating and synthesizing an integrated laser.

The webinar showcases key process and PDK features of Tower's PH18 process along with OpenLight's silicon photonics platform with integrated lasers and what is reckoned to be the industry's only unified electronic and photonic design solution consisting of Synopsys' OptoCompiler, OptSim, PrimeSim and IC Validator products. These solutions and techniques help to improve performance and scalability, while reducing the cost of design for some of the world's fastest-growing markets. The 800G-DR8 PIC example can be extrapolated to develop PICs for other applications that can benefit from silicon photonics.

www.towersemi.com
www.synopsys.com/photonic-solutions.html
www.openlightphotonics.com

Source Photonics ships 2 millionth 28G EML laser chip

Zero field returns since first shipments in 2019

Source Photonics Inc of West Hills, CA, USA (which provides optical connectivity products for data centers, metro and access networks) says that it has now shipped more than 2 million 28G high-speed EML laser chips for data centers and optical transmission applications. Source Photonics began production shipments of 28G EMLs (externally modulated lasers) with its 10km QSFP28 100G LR4 products in first-quarter 2020, after successful introduction and qualification by many of the firm's leading customers and partners throughout 2019.

Source Photonics is a first-to-market and first-to-scale provider of high-performance 100G QSFP28 LR4 transceivers using 28G EML laser chips, enabling data centers to increase their bit rate and lower their overall power consumption. The 28G EML chip is now widely used in many more NRZ and PAM4-based platforms, such as 400G LR8/ER8, 100G ER4/ZR4, 200G LR4/ER4 and 50G LR/ER etc.

Source Photonics says that the operational simplicity and reliability combined with the economic value proposition continues to drive the adoption of EML solutions in the market place. With over 2 million EMLs shipped to the field with zero field returns to date, the firm is investing in leading-edge technology for the transition to 800G/1.6T direct detection.

The expected strong growth of data traffic in hyperscale data centers and 5G wireless networks is driving increasing requirements for volume, reliability, cost and speed in EML laser chips. "Today's announcement underlines our commitment and leadership in large-scale production capacity of high-speed EML chip and transceiver products," says CEO John Wang. "Vertical integration remains Source Photonics' core competitiveness. More than 90% transceiver products transition to use our own optics chips now, including the newest 800G products under pre-production," he adds.

"Strong demand for 100/400G optics in mega data centers has been making headlines over the last three years, attracting many new suppliers and technologies," comments Vladimir Kozlov, CEO & founder of LightCounting Market Research. "Source Photonics remains uniquely positioned to deliver its portfolio of 100G QSFP28 LR4 and higher-performance transceiver products by vertical integration, which allows for faster deployment of next-generation 100/400GbE optical solutions in enterprise, data-center and service provider networks."

www.sourcephotonics.com

POET Technologies appoints silicon photonics expert Michal Lipson as board advisor

Lipson to also be nominated as director at AGM

POET Technologies Inc of Toronto, Ontario, Canada — a designer and developer of the POET Optical Interposer and photonic integrated circuits (PICs) for the data-center and telecom markets — has appointed Michal Lipson, a pioneer in silicon photonics as well as a highly published researcher in physics, as an advisor to its board of directors. The firm also plans to nominate Lipson as a director at its upcoming Annual General Meeting scheduled for 6 October.

"Michal is a pioneer of silicon photonics, president-elect of the Optical Society of America (OSA), MacArthur Fellow, member of the National Academy of Science, founder of three startups, and inventor of 45+ US patents on transformative photonic technologies," notes chairman & CEO Dr Suresh Venkatesan. "Her impressive track record and highly regarded opinion in the field of optics and photonics will be invaluable to POET and our board, and we look forward to leveraging her perspective, guidance and expertise," he adds. "We will be proposing to shareholders at the upcoming AGM an increase in the size of the board and appointment of both Michal and Theresa Lan Ende."

Lipson is currently a Eugene Higgins Professor of Electrical Engineering and Professor of Applied Physics at Columbia University. Her research focus is on Nanophotonics and includes the investigation of novel phenomena, as well as the development of novel devices and applications. Lipson pioneered critical building blocks in silicon photonics, which today is recognized as one of the most promising directions for solving the major bottlenecks in microelectronics. She is the inventor of over 45 issued patents and has co-authored more than 250 scientific publications. In recognition of her work in silicon photonics, she was elected as a member of the National Academy of Sciences and the American Academy of Arts and Sciences. She was also awarded the NAS Comstock Prize in Physics, the MacArthur Fellowship, the Blavatnik Award, the Optical Society's R. W. Wood Prize, the IEEE Photonics Award, and has received an honorary degree from Trinity College, University of Dublin. In 2020, she was elected the 2021 Vice President of The Optical Society and will serve as OSA President in 2023. Every year since 2014 she has been named by Thomson Reuters as a top 1% highly cited researcher in the field of Physics.

Michal is a pioneer of silicon photonics, president-elect of the OSA, MacArthur Fellow, member of the National Academy of Science, founder of three startups, and inventor of 45+ US patents

Lipson's work has been cited in high-impact journals such as Nature, Nature Photonics, Nature Physics, IEEE Photonics Technology Letters, Nanoletters, Lab on Chip, Physical Review Letters and IEEE Journal of Lightwave Technologies. Today more than 1000 papers published yearly involve devices and circuits based on Lipson's original modulators or based on other silicon photonics devices demonstrated by her group, including slot waveguides.

Arista's chief procurement director made board advisor

Theresa Lan Ende also to be nominated as director

POET has appointed Theresa Lan Ende, currently chief procurement director of Arista Networks, as an advisor to its board of directors. The firm also intends to nominate her as a director at its Annual General Meeting scheduled for 6 October.

"As part of that upcoming meeting, we will be proposing to shareholders an increase in the size of the board and appointment of Theresa," says chairman & CEO Dr Suresh Venkatesan. "She brings to our board a wealth of knowledge and experience in global supply chain management, operations and planning gained from several leading companies in our industry, including Arista Networks, JDS Uniphase, Force10 Networks, Cisco Systems and ROLM Telecommunications," she adds. "She has a unique and valuable perspective on present-day supply chain matters and is expected to be an insightful voice on the board as the company grows in size and stature."

Before her appointment as chief procurement director of Arista Networks in 2019, Theresa Lan Ende served for 10 years as its senior director of global supply chain management. Prior to Arista, she held senior positions at JDSU Optical Division and Force10 Networks. At Cisco Systems and ROLM Telecommunications, Ende held various program management and planning management positions over a 20-year period. In 2019, she was honored as one of the 'Top 100 Women of Influence' by Silicon Valley Business Journal.

www.poet-technologies.com

POET makes available 400G FR4 and 800G (2x400G FR4) receive optical engines for QSFP-DD and OSFP transceivers in cloud data centers

Samples shipped to lead customers; production at Super Photonics joint venture to commence by the end of Q3/2022

POET Technologies Inc of Toronto, Ontario, Canada has announced the availability of its 400G FR4 and 800G (2x400G FR4) receive (RX) optical engines based on the POET Optical Interposer, a unique hybrid integration photonics packaging platform.

The firm has shipped samples to multiple lead customers and expects the 400G FR4 receive optical engine to be in production by the end of third-quarter 2022 at Super Photonics (its China-based joint venture formed in October 2020 with Sanan Integrated Circuit Co Ltd of Xiamen City, Fujian province).

The 400G FR4 receive optical engine integrates four 56Gigabaud photodetectors each operating at 100Gb/s speed with a low-loss AWG (arrayed waveguide grating)-based demultiplexer that is monolithically integrated on the Optical Interposer. A single-mode optical fiber with LC connector is attached to the optical engine for seamless integration in a 400GBASE-FR4 transceiver module.

"We are excited to announce the completion of design, verification testing and availability of pre-production parts for customers to take advantage of our highly integrated optical engines to build 400G FR4 and 800G (2x400G FR4) transceivers," says president Vivek Rajgarhia. "Our small form factor and easy-to-integrate optical engine enables cost-effective and scalable solutions for cloud data centers. Customers can integrate a single receive engine or dual engines in a QSFP-DD or OSFP pluggable transceiver form factor to achieve a 400GBASE-FR4 or 800G (2x400GBASE-FR4) solution," he adds. "The shipping of 400G receive samples marks a significant milestone for the company, as we continue to commercialize multiple products and align them with the needs of customers."

Key features of the 400G FR4 receive optical engine include:

- Four 56Gigabaud photodetectors each operating at 100Gb/s speed, flip-chipped onto the Optical Interposer and coupled passively to vertical mirrors embedded in the Optical Interposer;
- A low-loss AWG-based quad-wavelength demultiplexer that is polarization independent, temperature independent and is monolithically integrated into the optical waveguide layer of the Optical Interposer;
- A small size (3.8mm x 10mm) form factor, which enables an 800G optical engine in a 2x400G configuration in both QSFP-DD800 and OSFP optical transceiver modules; and
- LC connectorized single-mode fiber attached to the optical engine.

www.poet-technologies.com

Scintil raises €13.5m in second-round financing led by Robert Bosch Venture Capital

New funds to speed up commercialization of products for data centers, HPC and 5G networks

Scintil Photonics of Grenoble, France and Toronto, Canada, a fabless developer of silicon photonic integrated circuits (integrated laser arrays, 800Gb/s transmitters and receivers, tunable transmitters and receivers, as well as optical I/O for near chip and chip–chip communication), has secured €13.5m ($14.4m) in a second round of funding, led by Robert Bosch Venture Capital (RBVC) and joined by reinvestment from historic shareholders Supernova Invest, Innovacom and Bpifrance (through its Digital Venture fund). Total funding to date is now €17.5m ($18.8m) following the €4m ($4.4m) first round in September 2019.

Scintil's optical communications aim to significantly enhance traditional high-speed system and chip interconnections. The company's Augmented Silicon Photonic Integrated Circuit (IC) product is a single-chip solution consisting of active and passive components, all made entirely from standard silicon photonics processes available at CMOS commercial foundries, and where III-V optical amplifiers and lasers are integrated on the backside of silicon photonic circuits. This unique all-in-one integration of amplifiers and lasers enables ultra-high-speed communications, due to extensive parallelization and higher bit rates, e.g. from 800Gb/s to 3,200Gb/s with very compact chips.

Scintil will use the new funds to take its industrialization program to the next level and speed up the global commercialization of products that boost communications in data centers, high-performance computing (HPC) and 5G networks. Scintil's products are said to be unique in providing optical communication applications with higher bit rates and scalable, cost-effective and mass-producible photonic integrated circuit (PIC) solutions. This can enable the multi-billion-dollar electronics industry to overcome the end of Moore's Law with the integration of very high-speed optical communications, the firm adds.

"Scintil Photonics is delighted to welcome Robert Bosch Venture Capital, a leading global investor; this is a great opportunity for us to boost our global footprint," comments Scintil's president & CEO Sylvie Menezo. "We are also grateful for the support of our first customers, to whom we have shipped or are currently shipping product prototypes, as well as our trusted suppliers and employees. Together, including the significant contributions in this round from our existing investors, this demonstrates the major progress we have made over the past three years in taking our disruptive photonic circuit technology to the fast-growing market segments of optical interconnects in 5G, cloud HPC and datacom," she adds.

The company's Augmented Silicon Photonic Integrated Circuit product is a single-chip solution consisting of active and passive components, all made entirely from standard silicon photonics processes available at CMOS commercial foundries, and where III-V optical amplifiers and lasers are integrated on the backside of silicon photonic circuits

"Scintil Photonics' monolithic integration of III-V lasers into silicon photonic chips is a key enabler for next-generation telecom, datacom and sensing," comments RBVC's managing director Ingo Ramesohl. "The CMOS-compatible process allows for higher design freedom, lower losses and a smaller footprint at low cost. We are excited to partner with Scintil Photonics as it uniquely unlocks further miniaturization and integration of photonic integrated circuits," he adds.

"We have supported Scintil since its inception and believe that the company's capability to integrate lasers in advanced silicon photonics is second to none currently on offer for the industry," says Marion Aubry, investment director of the Bpifrance Digital Venture team.

"We are delighted to strengthen our continuous support to Scintil Photonics as the company reaches a new dimension," says Vincent Deltrieu, partner and member of the board at Innovacom. "As a multi-stage deep-tech specialist, we are impressed by its technological success and the team's ability to transform that into a commercial success. Scintil Photonics products are tackling the energy-efficiency issue in heavy loaded data-center applications and 5G infrastructures," he adds.

"Our continuous engagement with Scintil Photonics is another example of how Supernova Invest partners with game-changing deep-tech start-ups to deliver to industry highly innovative and fast-to-market solutions, while reducing the cost of mass-produced fully integrated photonic circuits," says Pierre-Emmanuel Struyven, president & managing partner at Supernova Invest.

www.scintil-photonics.com

Fraunhofer ISE raises solar cell efficiency record from 46.1% to 47.6%

Improved contact layer and four-layer anti-reflection coating boost GaInP/AlGaAs-GaInAsP/GaInAs tandem cell

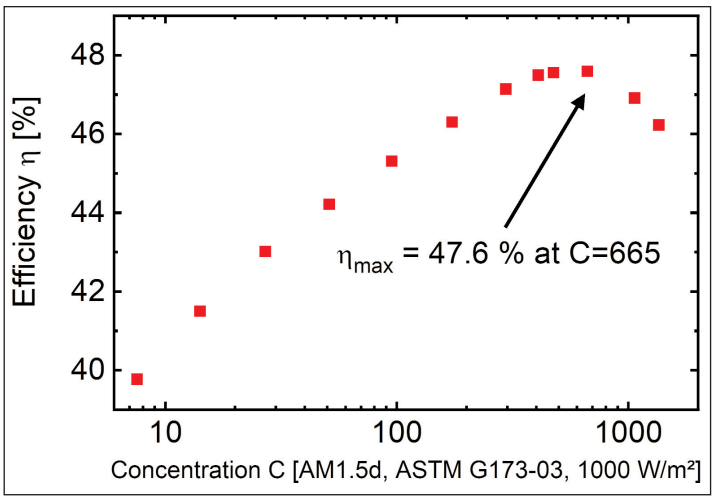
At the 2nd International tandemPV Workshop in Freiburg, Germany (30 May-1 June), Freiburg-based Fraunhofer Institute for Solar Energy Systems ISE has reported that, by using a new anti-reflection coating, it has increased the solar energy conversion efficiency of the best four-junction solar cell to date from 46.1% to 47.6% at a light concentration of 665 suns.

For the last two years, Fraunhofer ISE has been working on the project '50 Percent', which — funded by the German Federal Ministry for Economic Affairs and Climate Action BMWK — aims to develop the first solar cell with efficiency of 50%. To achieve this, each individual layer of the complex multi-junction solar cell has undergone further optimization. Improvements in the process technology have been incorporated for metal contacts and anti-reflection layers.

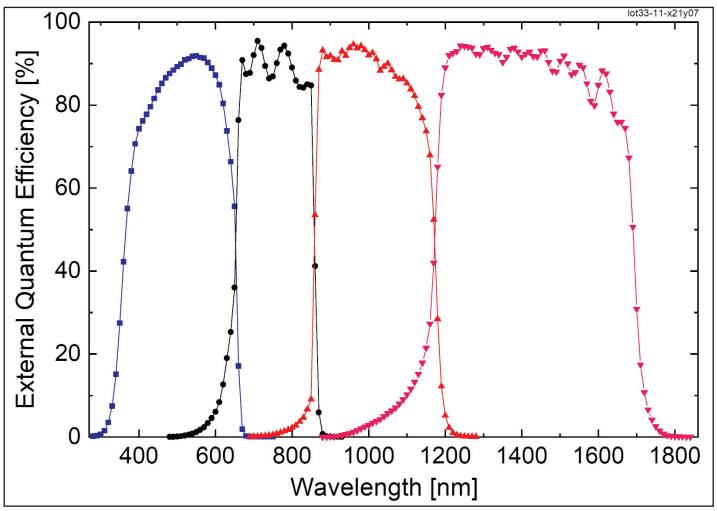
The result was achieved only one year after the opening of Fraunhofer ISE's new Center for High Efficiency Solar Cells, says Dr Frank Dimroth, department head of III-V Photovoltaics and Concentrator Technology at Fraunhofer ISE. "In our research, we aim to make concentrating photovoltaics even more efficient and competitive, as we believe that this is the most sustainable form of renewable electricity generation," he adds.

Multi-junction solar cells made of III-V compound semiconductors have always been among the most efficient solar cells, and they reach their highest potential when the incoming sunlight is concentrated by lenses onto solar cell devices of just a few square millimeters in size.

The layer structure of the new solar cell was developed in 2016 together with the French company Soitec Inc, which designs and manufactures semiconductor materials. The upper tandem solar cell is made of gallium indium phosphide (GaInP) and aluminum gallium arsenide (AlGaAs), which was bonded by Soitec onto a lower tandem solar cell made of gallium indium arsenide phosphide (GaInAsP) and gallium indium arsenide (GaInAs).



Efficiency of the new four-junction solar cell increases with concentration up to 665 suns, reaching a record 47.6% conversion efficiency.



Quantum efficiency of the new four-junction solar cell. The top sub-cell made of GaInP absorbs short-wave sunlight in the visible spectral range. Infrared light is converted in the sub-cells beneath, which are made of AlGaAs, GaInAsP and GaInAs respectively.

Now, in Fraunhofer ISE's Center for High Efficiency Solar Cells, an improved contact layer and a four-layer anti-reflection coating have been applied to the tandem cell structure. These measures reduce the resistance losses and the reflection on the front side of the cell, which is spectrally sensitive within a broad wavelength range of 300–1780nm. Conventional solar cells made of silicon absorb sunlight only up to 1200nm and thus do not require such a broadband anti-reflection coating.

"Possible applications of such highly efficient tandem solar cells include concentrator photovoltaic systems, which contribute to efficient power generation in sun-rich countries," says professor Stefan Glunz, division director of Photovoltaics Research at Fraunhofer ISE. "With tandem photovoltaics, it is possible to leave the limitations of single-junction solar cells behind and ultimately achieve a reduction in solar power costs," he adds.

https://50-percent.de
https://tandempv.conexio-pse.de
www.ise.fraunhofer.de

First Solar's Ohio complex rated Platinum in RBA's Validated Assessment Program audit

Platinum status in standard for onsite compliance verification and effective, shareable social and environmental audits

Cadmium telluride (CdTe) thin-film photovoltaic (PV) module maker First Solar Inc of Tempe, AZ, USA says that its 2.7GW$_{DC}$ vertically integrated manufacturing complex in Ohio has achieved Platinum status in a Responsible Business Alliance (RBA) Validated Assessment Program (VAP) audit. Platinum is the highest rating awarded on completion of a full VAP audit, which is considered a leading standard for onsite compliance verification and effective, shareable social and environmental audits across industries.

The audit was conducted at First Solar's manufacturing facilities in Perrysburg and Lake Township, Ohio, by independent third-party auditors specially trained in social and environmental auditing and the VAP audit protocol. It covered the full scope of the VAP, including fair labor practices and human rights, health & safety measures, environmental performance, business integrity, ethics, and supporting management systems. The rating is valid until 5 May 2024.

"The fact that we achieved Platinum status on our first try is a tribute to the passion and purpose of our people who exemplify First Solar's commitment to responsible solar," says CEO Mark Widmar. "We have demonstrated that competitiveness and scale do not need to come at the cost of people or the environment, and that our country's transition to a sustainable energy future can be powered by responsibly produced solar technology."

First Solar joined the RBA (the world's largest industry coalition dedicated to supporting the rights and well-being of workers and communities in the global supply chain) in 2021. The audit of its Ohio facilities was the first in a series of VAP audits that are expected to also include its other manufacturing facilities in Malaysia and Vietnam.

"Completion of this audit demonstrates that responsible solar is central to the way we operate. It impacts everything we do, from how we treat our people to the care with which we manage our supply chains," says chief manufacturing operations officer Mike Koralewski. "It also demonstrates to the solar industry that credible onsite social auditing and supply chain due diligence frameworks exist and that we do not need to invent tailor-made solutions."

First Solar's Northwest Ohio footprint is the Western Hemisphere's largest solar manufacturing complex. The firm is investing $680m in building a third factory that will expand the complex by an annual capacity of 3.3GW. The new facility is expected to be commissioned in first-half 2023 and, when fully operational, will scale the company's Ohio footprint to a total annual capacity of 6GW (making it the largest fully vertically integrated solar manufacturing complex outside China). First Solar has already invested over $2bn in its US manufacturing footprint and, when its third factory is fully operational, will directly employ over 2500 people in Ohio while supporting an estimated 15,000 indirect jobs through its American supply chain.

In addition to its Ohio manufacturing facilities, First Solar also operates factories in Vietnam and Malaysia, and is building a new 3.3GW factory in India that is expected to be commissioned in second-half 2023. With First Solar's expansion in the USA and India and optimization of its existing fleet, the firm expects that its nameplate manufacturing capacity will double to 16GW in 2024. First Solar is the only US-headquartered company among the world's ten largest solar manufacturers.

www.firstsolar.com
www.responsiblebusiness.org/vap/

National Grid orders 2GW of First Solar modules

Deliveries scheduled for 2024 and 2025

First Solar Inc of Tempe, AZ, USA has signed a framework agreement to supply $2GW_{DC}$ of its cadmium telluride (CdTe) thin-film photovoltaic (PV) solar modules to Minneapolis-headquartered National Grid Renewables, for delivery in 2024 and 2025 throughout the USA. The deal was booked prior to the release of First Solar's first-quarter 2022 earnings in April.

Over the past decade, National Grid Renewables and First Solar have partnered on multiple projects, including the recently operational 200MW Prairie Wolf Solar Project in Illinois and the currently under construction Noble Solar (275MW) and Storage (125MWh) Project in Texas. As a farmer-friendly and community-focused company, National Grid Renewables develops projects for corporations and utilities that seek to repower America's electricity grid by reigniting local economies and reinvesting in a sustainable future. As part of the Ventures division of National Grid, National Grid Renewables develops, owns and operates large-scale renewable energy assets across the USA, including solar, wind and energy storage projects.

"National Grid Renewables and First Solar share more than just deep roots in the US Midwest and a longstanding strategic partnership. We share a common view on the need to create a sustainable energy future," says Nathan Franzen, VP development for National Grid Renewables.

First Solar notes that it is the only one of the world's ten largest solar manufacturers to be a member of the Responsible Business Alliance (RBA), the world's largest industry coalition dedicated to supporting the rights and well-being of workers and communities in the global supply chain, and has zero tolerance for forced labor in its manufacturing or its supply chains. Its modules have a carbon footprint that is 2.5 times lower and a water footprint that is three times lower than the average crystalline silicon solar panel made with cells produced in China, the firm claims.

"Experienced project developers and owner-operators like National Grid Renewables understand the criticality of both insulating themselves from pricing and supply volatility and staying true to their values and principles," says First Solar's chief commercial officer Georges Antoun. "Both factors are invaluable in helping them successfully navigate some of the industry's headwinds."

First Solar is investing $680m in expanding America's domestic PV solar manufacturing capacity by 3.3GW annually, by building its third US manufacturing facility, in Lake Township, Ohio. The new facility is expected to be commissioned in first-half 2023 and, when fully operational, will scale the firm's Northwest Ohio footprint to a total annual capacity of 6GW (making it the largest fully vertically integrated solar manufacturing complex outside China). First Solar has invested over $2bn in its US manufacturing footprint and, when its third factory is fully operational, will directly employ over 2500 people in Ohio while supporting an estimated 15,000 indirect jobs through its American supply chain.

In addition to its Ohio manufacturing facilities, First Solar also operates factories in Vietnam and Malaysia, and is building a new 3.3GW factory in India that is expected to be commissioned in second-half 2023. With First Solar's expansion in the USA and India and optimization of its existing fleet, the firm expects that its nameplate manufacturing capacity will double to 16GW in 2024. First Solar is the only US-headquartered company among the world's ten largest solar manufacturers.

https://nationalgridrenewables.com

Midsummer finalizes installation of UNO thin-film solar cell R&D tool at University of New South Wales

Midsummer AB of Järfälla, near Stockholm, Sweden — a provider of turnkey production lines as well as flexible, lightweight copper indium gallium diselenide (CIGS) thin-film solar panels for building-integrated photovoltaics (BIPV) — has finalized installation of its unique UNO machine for thin-film solar cell research at the University of New South Wales (UNSW) in Sydney, Australia (home to the School of Photovoltaic and Renewable Energy Engineering), where it will be used to develop a new type of tandem solar cell.

Sold to UNSW a little over a year ago, the UNO research tool has now passed the site acceptance test (SAT) in Sydney, confirming that it is officially installed and delivered to the customer. With the SAT, Midsummer has invoiced the customer for the final payment of the machine.

Delivery and installation were hit by some delays due to closed borders related to Covid restrictions but, once those were lifted, Midsummer delivered according to plan.

Midsummer's UNO is a generic R&D tool for the production of thin-film solar cells, and is used for solar cell research at universities, among other things. Results from it are said to be simple to implement for commercial production with Midsummer's DUO machinery.

www.midsummer.se

InGaAs/AlGaAs nanowires on silicon substrates

Inclusion of InGaAs in AlGaAs QWs extends the emission wavelength to 1.3μm.

Researchers based in Russia report on molecular beam epitaxy (MBE) of indium gallium arsenide (InGaAs) quantum dots/wires (QDs/QWs) in aluminium gallium arsenide (AlGaAs) nanowires (NWs) on silicon (Si) "for the first time" [Rodion R. Reznik et al, Phys. Status Solidi RRL, p2200056, 2022].

The research team at St. Petersburg State University, Alferov University, Institute for Analytical Instrumentation RAS, Ioffe Physical Technical Institute RAS, and National Research University Higher School of Economics, have previously studied MBE synthesis of GaAs QDs inside AlGaAs nanowires on silicon.

The researchers comment that these hybrid nanostructures were effective sources of single photons in a wavelength range of 750–800nm. Thus, they constitute "promising candidates for use in quantum cryptography and alkali metal (e.g. rubidium or cesium)-based atomic clock adjustments."

The replacement of GaAs by InGaAs allows access to longer wavelength, including those in the important

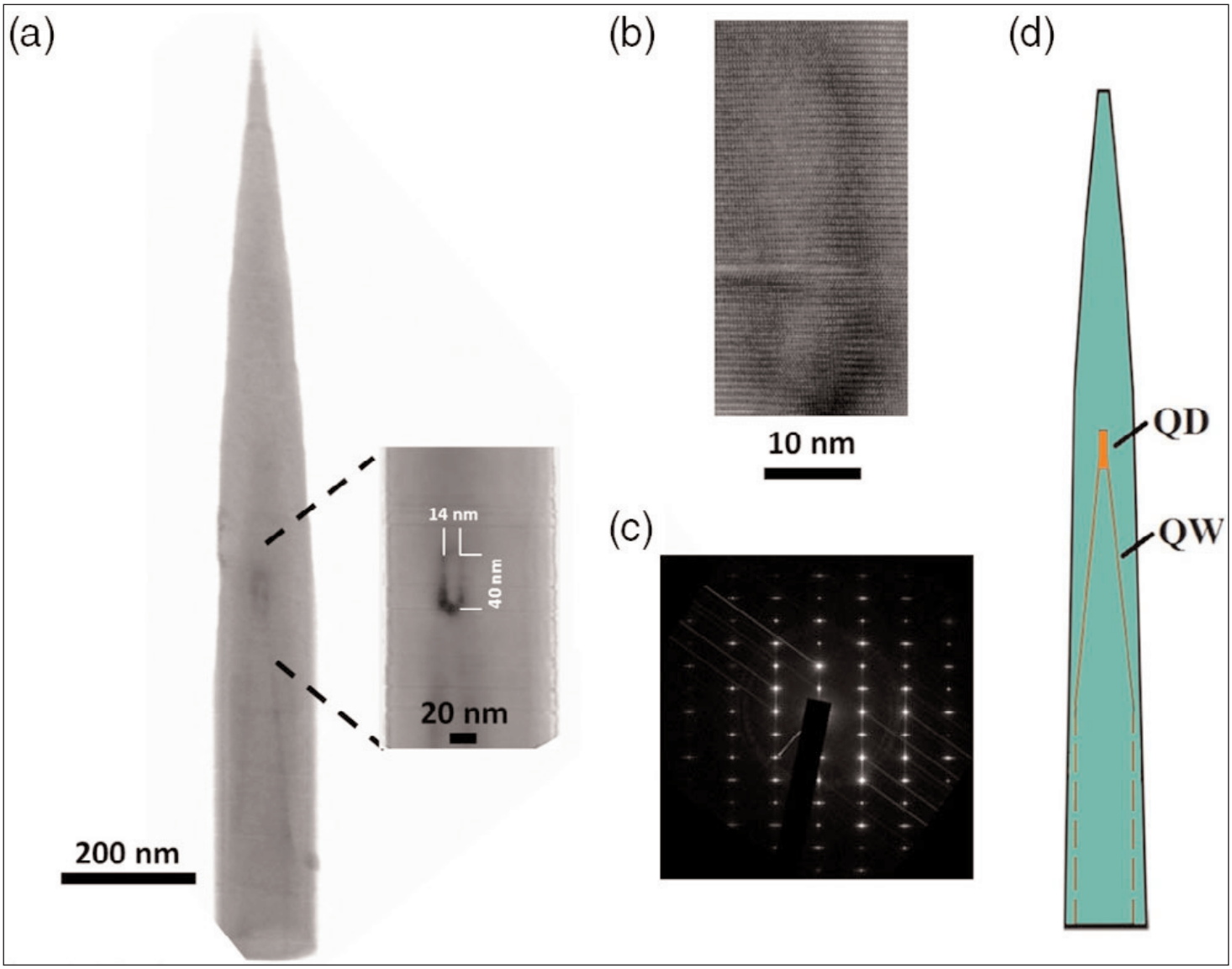


Figure 1. (a) Typical transmission electron microscope (TEM) image of single AlGaAs nanowire with InGaAs QD grown at 510°C. (b) Typical high-resolution TEM image. (c) Typical diffraction pattern obtained at QD location. (d) Schematic representation of structure.

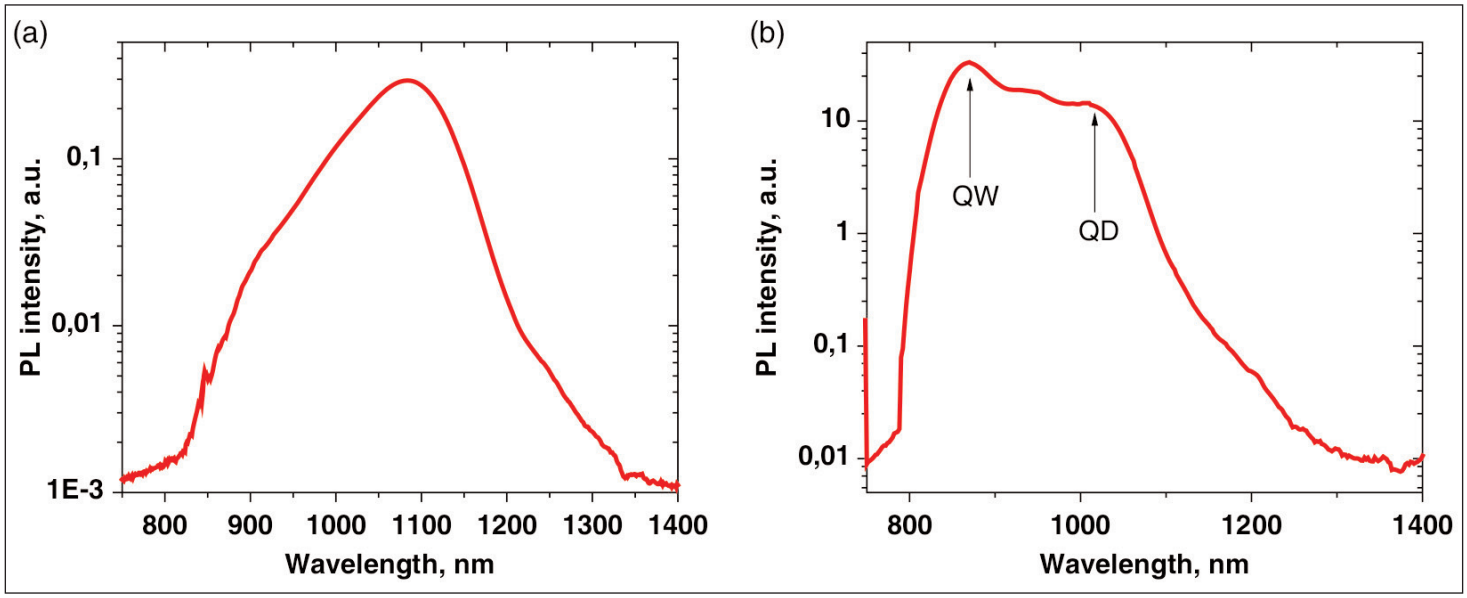


Figure 2. Typical photoluminescence spectra of InGaAs QDs in AlGaAs nanowires grown on silicon measured: (a) at room temperature; (b) at 77K.

telecommunication optical fiber range of 1.3μm. Such wavelengths can also be transmitted through waveguides formed in the silicon substrate itself.

The team writes: "Our work, therefore, opens up new prospects for the integration of direct-bandgap semiconductors with the silicon platform for various applications in the fields of silicon photonics and quantum communication technology."

There have been previous reports of InGaAs/GaAs nanowires, but grown on GaAs rather than silicon substrates, and photoluminescence emissions only presented at low temperature.

Similar QD/QW formations have been studied in the indium arsenide phosphide (InP/InAsP) system. However, phosphorus tends to be tricky to handle in a safe, controlled manner during MBE growth.

The researchers comment: "The results of both optical and structural properties studies of grown structures showed that, similar to the case of the InP/InAsP system, radial InGaAs QWs in addition to InGaAs QDs are formed inside the nanowires as a result of lateral and axial InGaAs growth competition."

The nanowires were grown by MBE on (111) oriented Si. The sources were delivered from effusion cells of Ga, Al, In and As_4. Gold was used as a catalyst for the seeding of vertical nanowire arrays. The transfer from the gold droplet deposition to the MBE chamber was achieved without breaking vacuum.

The main nanowire material was AlGaAs with ~30% Al content. The InGaAs inclusion was achieved by replacing the Al flow with In after about 20 minutes for about 20 seconds. This resulted in InGaAs QW around the previously grown nanowire and an InGaAs QD tip (Figure 1). Photoluminescence (PL) spectra at low temperature show two prominences associated with the QW and the QD (Figure 2). The QW bump was at shorter wavelength (867nm), indicating higher energy and greater confinement than the QD transitions (1028nm). The room-temperature peak intensity was around 1090nm.

The InGaAs material of the QD/QW regions was found to have around 22% In content, according to energy-dispersive x-ray (EDX) analysis. The QD dimensions were 14nm diameter and 40nm height. The QW layer was 2nm thick. The nanowires were typically 1.6μm high with a base diameter of 140nm tapering to 30nm at the tip. The density of nanowires on the silicon substrate was $8x10^8/cm^2$.

In-situ reflection high-energy electron diffraction (RHEED) indicated that the main crystal phase of the nanowires was wurtzite, except during the first minute of growth. The fraction of cubic phase was not more than 0.1, according to the diffraction patterns.

The optimal growth temperature was found to be 510°C. Higher temperatures resulted in nanowires that did not produce detectable radiation in the target 800–1300nm wavelength range. The team comments: "In this case, the InGaAs QDs growth process was apparently suppressed due to intensive desorption of In adatoms, leading to the formation of pure GaAs insertion and significant shift of PL band maximum toward ≈800nm."

On the other hand, reducing the growth temperature to 430°C decreased the integrated luminescence intensity by a factor of 15. The researchers suggest that this could be either due to increased In content in the QDs with greater lattice mismatch or due to a decrease in the overall quality of the nanowires. Lower growth temperature also resulted in shorter, more tapered nanowires. ■

https://doi.org/10.1002/pssr.202200056

Author: Mike Cooke

AlN doping for future deep UV/power tech

Researchers achieve state-of-the-art n-type doping and PN homojunctions in AlN.

Georgia Institute of Technology in the USA has reported "state-of-the-art" n-type doping of aluminium nitride (AlN) and PN AlN homojunction diodes [Habib Ahmad et al, J. Appl. Phys., v131, p175701, 2022].

The researchers comment: "This study demonstrates near-future exciting promise for AlN-based DUV [deep-ultraviolet] optical emitters and detectors, high-power/voltage/temperature, and high-frequency switching devices capable of operation in extreme radiation and heat environments."

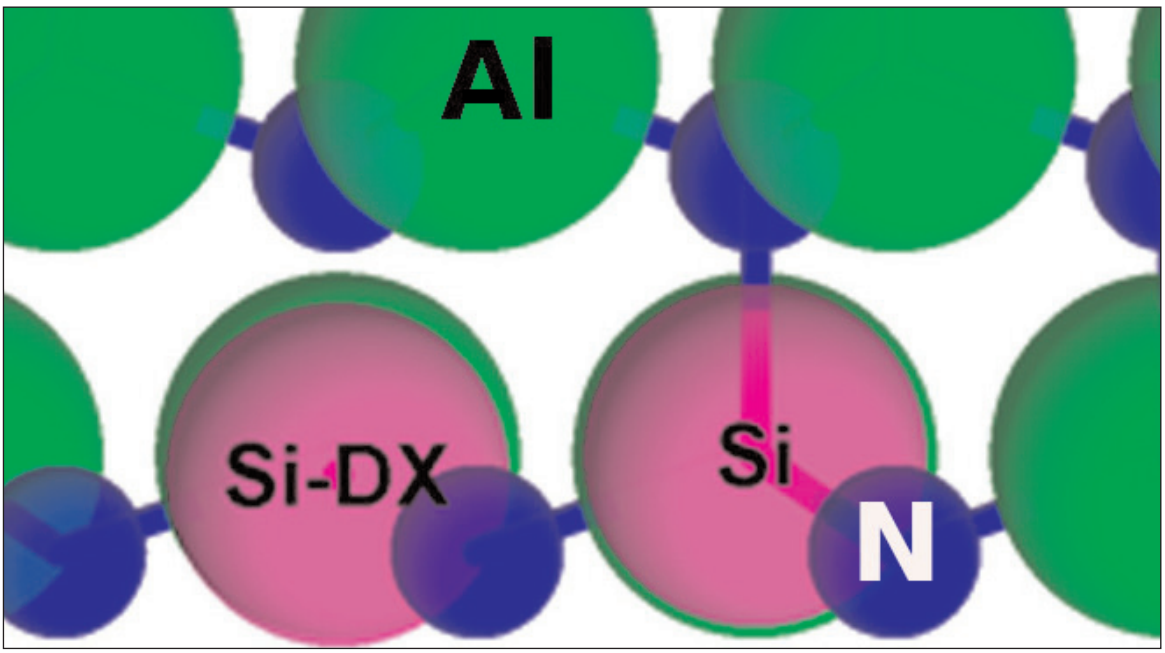


Figure 1. DX center formation of silicon by transitioning to deep state compensating n-type AlN with broken N-bond in c-direction (vertical).

Up to now AlN's extreme 6.1eV bandgap has led to its being used mainly in electrically insulating regions. A particularly attractive quality is a high thermal conductivity of 319W/mK, relative to materials such as gallium oxide (27W/mK). Also, AlN has a significantly higher critical breakdown electric field of 15MV/cm, compared with 9MV/cm for gallium oxide, 4.9MV/cm for gallium nitride, and 3.1MV/cm for silicon carbide.

The Georgia work has improved the electrical conductivity of AlN by doping with beryllium (Be) for p-AlN, based on the group's prior work, and silicon (Si) for n-AlN.

The challenge of AlN:Si doping includes problems such as electrons being trapped at Al vacancies, threading dislocations, and 'DX centers'. The last problem involves creating a deep state via electron capture. In the case of silicon, a secondary electron is captured, causing a geometric rearrangement with the c-axis N-bond breaking and the three other basal N-bonds shortening by 2% (Figure 1).

The researchers add: "Complicating issues, the Al-vacancy forms a complex with Si resulting in self-compensation of the doping at high Si doping levels."

The team used metal modulated epitaxy (MME), a cyclic molecular beam epitaxy (MBE) variant, to reduce threading dislocation and Al vacancy formation. "MME compensates for the lower growth temperature with extremely metal-rich surface chemistry that virtually eliminates the harmful Al vacancies and allows easier surface bond breakage and, thus, long surface adatom diffusion lengths," they write. A denser crystal also makes geometric rearrangements for creating DX centers less likely.

The researchers conclude: "The evidence of six orders of magnitude rectification with the proper turn-on voltage of ~6V for a 6.1eV AlN semiconductor offers ultimate confidence that the pioneering doping results shown are in fact real."

The MME (Table 1) was performed on 4μm-thick hydride vapor phase epitaxy (HVPE) AlN on sapphire templates (MSE Supplies) using plasma-assisted molecular beam epitaxy (PAMBE) equipment (Riber 32). The templates were backed with tantalum to promote uniform heating during growth. The metalized wafers were diced into 1cmx1cm squares. Much care was taken to remove contaminants before the growth.

The Al, Be and Si were sourced from standard effusion cells. The nitrogen came from an RF plasma

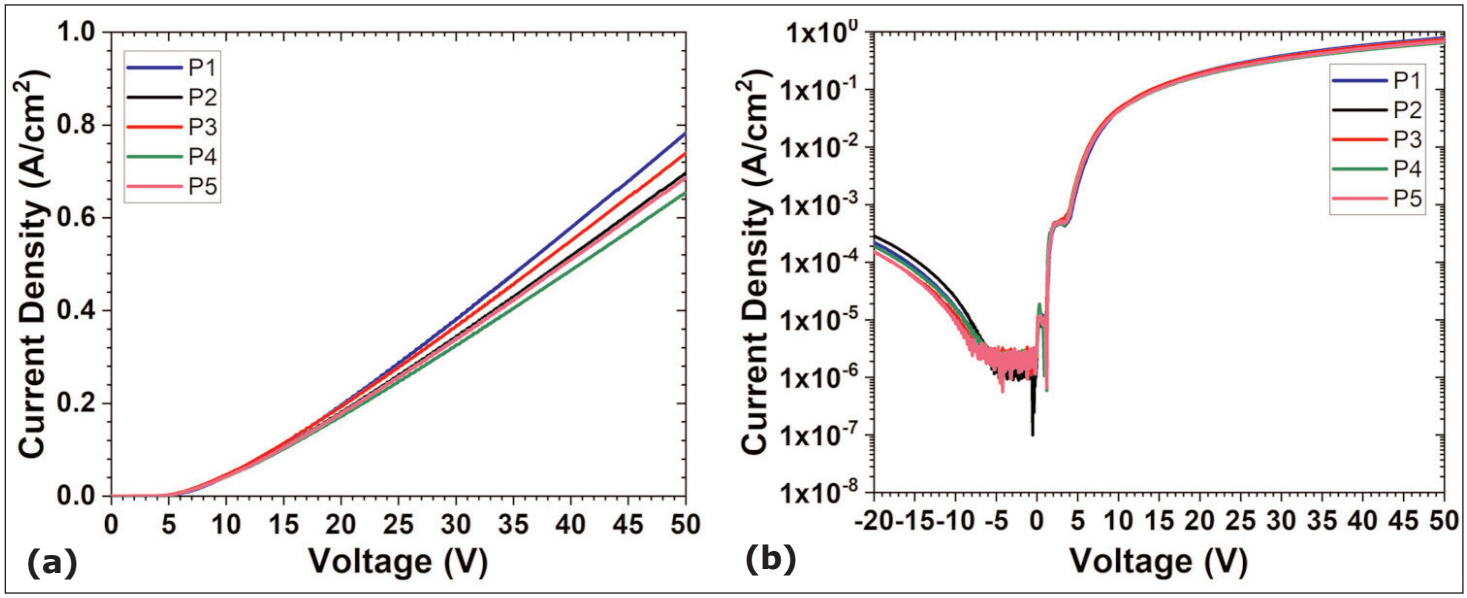


Figure 2. (a) Current density–voltage (JV) and (b) semilog JV characteristics of five equal dimension AlN homojunction PN diodes.

Table 1. Description of MME p-type AlN:Be and n-type AlN:Si films.

Doping	Shutter cycle open/close	Growth time/cycle	Temperature	Growth rate
AlN:Be	5s/10s	6.5s	700°C	700nm/h
AlN:Si	21s/11s	27.3s	800°C	1.4μm/h

source (Veeco UNI-bulb). The growth chamber had a high-vaccum base pressure of around $5x10^{-11}$Torr. The nitrogen beam equivalent pressure was around $1.2x10^{-5}$Torr.

The PN homojunction consisted of AlN:Be and AlN:Si, respectively. The corresponding growth rates were 700nm/h and 1.4μm/h. The researchers point out that MME has demonstrated growth rates up to 10μm/h. The III/V ratio was 1.3 in both cases.

The diode material consisted of 1μm n-AlN:Si with $8x10^{18}$/cm^3 Si concentration, 200nm intrinsic AlN with 5x1017/cm^3 Si concentration, and 200nm p-AlN:Be with $7x10^{18}$/cm^3 Be concentration. This material was fabricated into 100μm-diameter quasi-vertical devices with annealed platinum/palladium/gold contacts.

In preliminary experiments on AlN:Si doping, the team grew material with Hall electron concentrations measured at up to $6x10^{18}$/cm^3 with $7x10^{19}$/cm^3 Si concentration. The team comments that this is around "6000 times higher than the previously reported state-of-the-art".

A preliminary mobility of 17cm^2/V-s is given for the $6x10^{18}$/cm^3 electron concentration material, subject to "additional verification", needed due to the contact resistance not meeting standard assumptions. Higher preliminary mobility is reported for lower electron concentrations: 370cm^2/V-s at $5x10^{17}$/cm^3 electron concentration ($8x10^{18}$/cm^3 Si).

The current through the PN diode was lower than what would be expected from contact experiments on separate AlN:Si and AlN:Be films (Figure 2). The team suggests that this is related to problems with inductively-coupled plasma etch of the mesa during device fabrication.

In particular, the team noted that the material took on a "dark tint". The researchers comment: "This color change (presumed to be contamination) could not be removed and could introduce a combined increase in the contact resistance of the homojunction AlN diode by 3–4 orders of magnitude for two contacts."

Both the n- and p-type layers were impacted. The current was 2–3 orders down in the n-AlN and 1 order in the p-AlN. The researchers suggest the reduced current flow in the p-AlN was due to the sub-optimal contact anneal temperature, which was focused on reducing the resistance of the n-contact. Separate annealing of the two contacts is planned to reduce the contact resistances in future work.

The forward diode performance was considered "nearly ideal except for the high series resistance owing to the aforementioned contact issues with the fabricated device."

The turn-on voltage was around 6V, in line with expectations arising from the 6.1eV AlN bandgap. The researchers comment: "While a clear six orders of magnitude of rectification is shown, a low breakdown voltage and very high series resistance are also evident by the high current density tail on the semilog plot and the soft turn on in the linear plot." ■

https://doi.org/10.1063/5.0086314

Author: Mike Cooke

Magnesium doping of hot-wall MOCVD GaN

Gallium supersaturation enables hole conductivity even without annealing.

Researchers based in Sweden and Iceland report on the growth of p-type magnesium-doped gallium nitride (p-GaN:Mg) using hot-wall metal-organic chemical vapor deposition (MOCVD) [A. Papamichail et al, J. Appl. Phys., v131, p185704, 2022]. The growth technique has been shown to provide "superior III–nitride material quality and high-performance devices," according to the team from Linköping University, University of Iceland, Chalmers University of Technology, Hitachi Energy Sweden, SweGaN AB, and Lund University. The researchers point out that, up to now, there have been no reported studies of the capability of hot-wall MOCVD to deliver high-quality GaN:Mg layers with p-type conductivity.

The optimizing of p-type doped material is a key step toward GaN-based power diodes, vertical transistors, and normally-off high-electron-mobility transistors (HEMTs). The hot-wall MOCVD technique was found to enable p-type GaN even without the usual annealing process used to drive out hydrogen incorporated during the growth process, which passivates the ability of Mg to act as an acceptor.

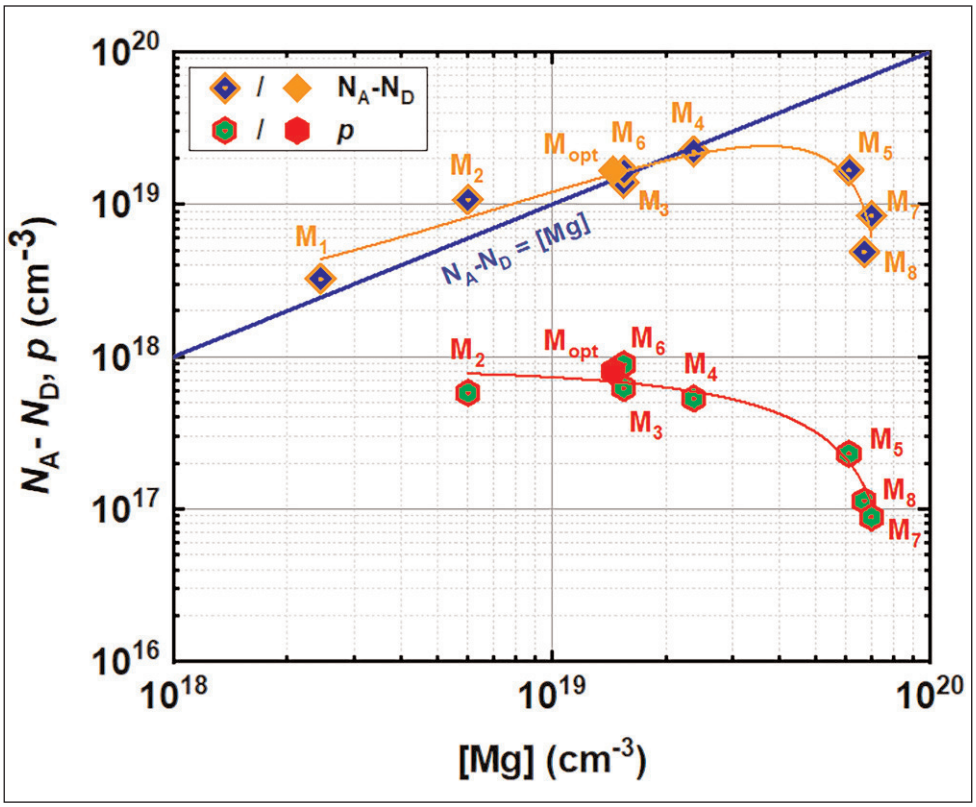


Figure 1. Net acceptor concentration N_A–N_D (from capacitance–voltage measurements) and free-hole concentrations (from Hall analysis) in annealed p-GaN as function of [Mg]. Red and orange curves offer guides to the eye. Blue solid line corresponds to N_A–N_D = [M_g].

The samples consisted of 500nm p-GaN grown on (0001) on-axis silicon carbide (SiC) wafers in a horizontal hot-wall MOCVD reactor. The nucleation layer was 50nm aluminium nitride (AlN) grown at 1250°C with a V/III ratio of 1258. The nitrogen component was sourced from ammonia (NH_3, 2l/minute) in nitrogen/hydrogen carrier gas at 100mbar pressure. The group III metals were from trimethyl (TMGa/Al) metal-organic compounds. The magnesium-doping precursor was bis(cyclopentadienyl)magnesium (Cp_2Mg).

Most of the GaN:Mg samples were grown at 1120°C. Variations were made in V/III ratio, growth rate, Cp_2Mg/TMGa ratio, and carrier gas flows. Apart from an unintentionally doped (UID) Ga sample, the Mg concentration ranged from $2.45x10^{18}cm^3$ to $1.10x10^{20}cm^3$. Activation was accomplished using rapid thermal annealing (RTA) at 900°C in nitrogen.

The team found that Ga supersaturation had a strong effect on Mg incorporated for samples with a given Cp_2Mg/TMGa ratio. The researchers comment: "Our results indicate that Ga supersaturation can be conveniently used as a universal parameter for the optimization of Mg incorporation and C reduction in MOCVD of GaN instead of multiple growth parameters independently used for the same purpose." Carbon (C) tends to form a shallow donor state that reduces the effectiveness of Mg as an acceptor, lowering the free-hole concentration.

After exploring these factors the researchers grew an optimized 550nm GaN:Mg layer on 1µm GaN UID buffer (M_{opt}). The optimized parameters were 1120°C temperature, 100mbar pressure, 906 V/III ratio, 0.6µm/h growth rate, 0.167% Cp2Mg/TMGa, 19l/min H_2, and 9l/min N_2.

The researchers comment: "The free-hole concentration of $8.4x10^{17}/cm^3$ and the resistivity of 0.77Ω-cm in the annealed sample are among the best results reported in the literature." The hole mobility was $10cm^2/V-s$. The hole density represented a Mg activation rate of 5.25%.

Even without annealing to activate the sample, the free-hole density reached $1.67x10^{16}/cm^3$. "Hence, hot-wall MOCVD addresses a practical challenge related to the realization of as-grown p-GaN without the need for ex-situ post-growth annealing for Mg activation," the team writes, adding, "These results provide an intriguing opportunity to exploit the technique for delivering lightly p-type doped material required in device heterostructures, e.g. vertical MOSFETs, and simplifying the device fabrication process."

The growth on a buffer layer also enabled a reduction of screw- and edge-type dislocation densities to $1.6x10^7/cm^2$ and $4.3x10^8/cm^2$, respectively.

Mg concentrations ([Mg]) beyond $2.4x10^{19}/cm^3$ were found to suffer from the generation of pyramidal inversion domains (PIDs) (Figure 2). These structures tend to segregate out Mg atoms, rendering them electrically inactive. ■

https://doi.org/10.1063/5.0089406

Author: Mike Cooke

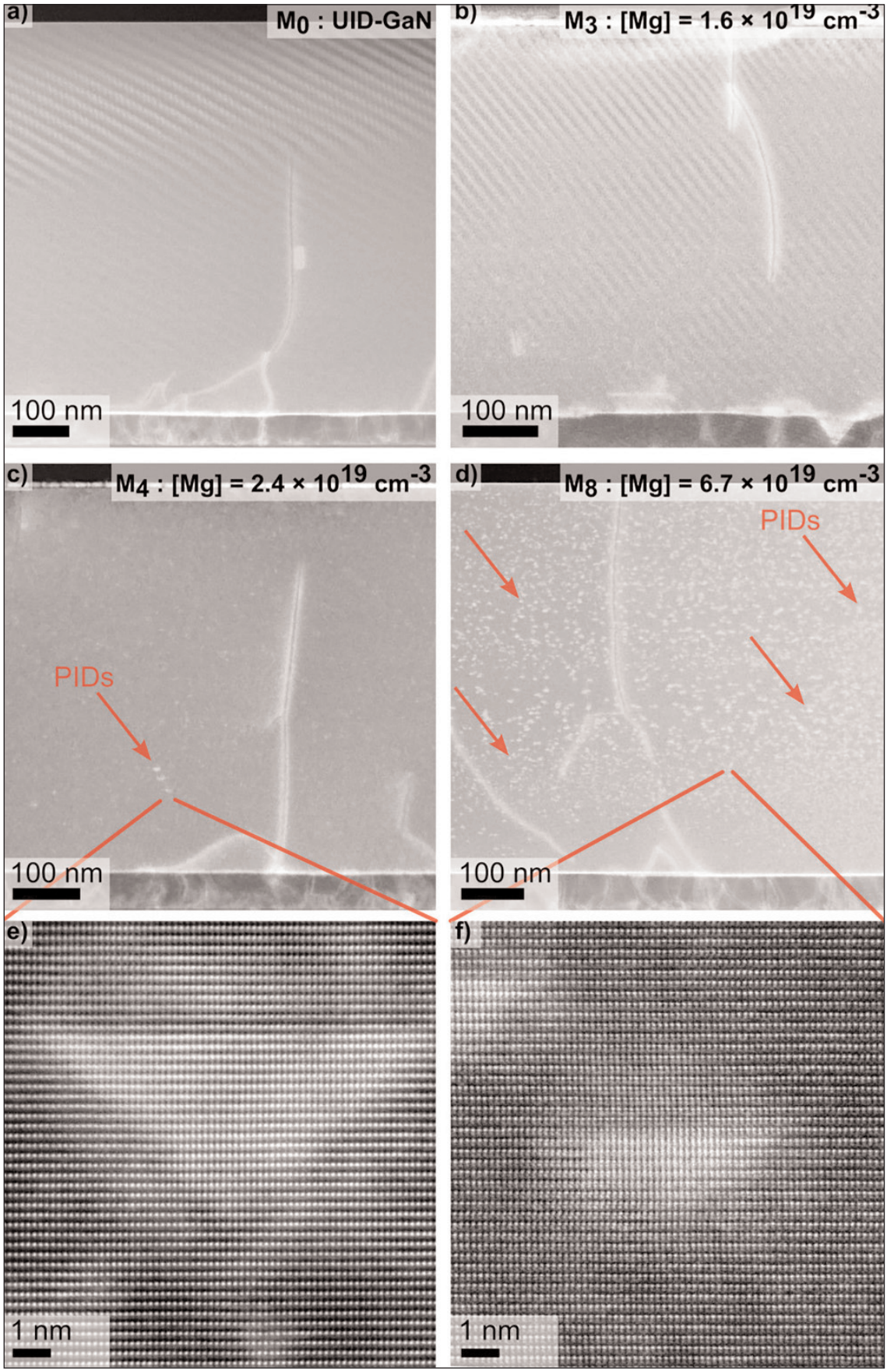


Figure 2. Scanning transmission electron microscope (STEM) images of as-grown GaN:Mg layers with different [Mg]: (a) UID, (b) $1.6x10^{19}/cm^3$, (c) $2.4x10^{19}/cm^3$, and (d) $6.7x10^{19}/cm^3$. Arrows in (c) and (d) highlight some PIDs. Higher-magnification images of PIDs for (c) and (d) shown in (e) and (f), respectively, both in [$1\bar{1}00$] projection.

Power GaN device market growing at 59% CAGR to $2bn in 2027

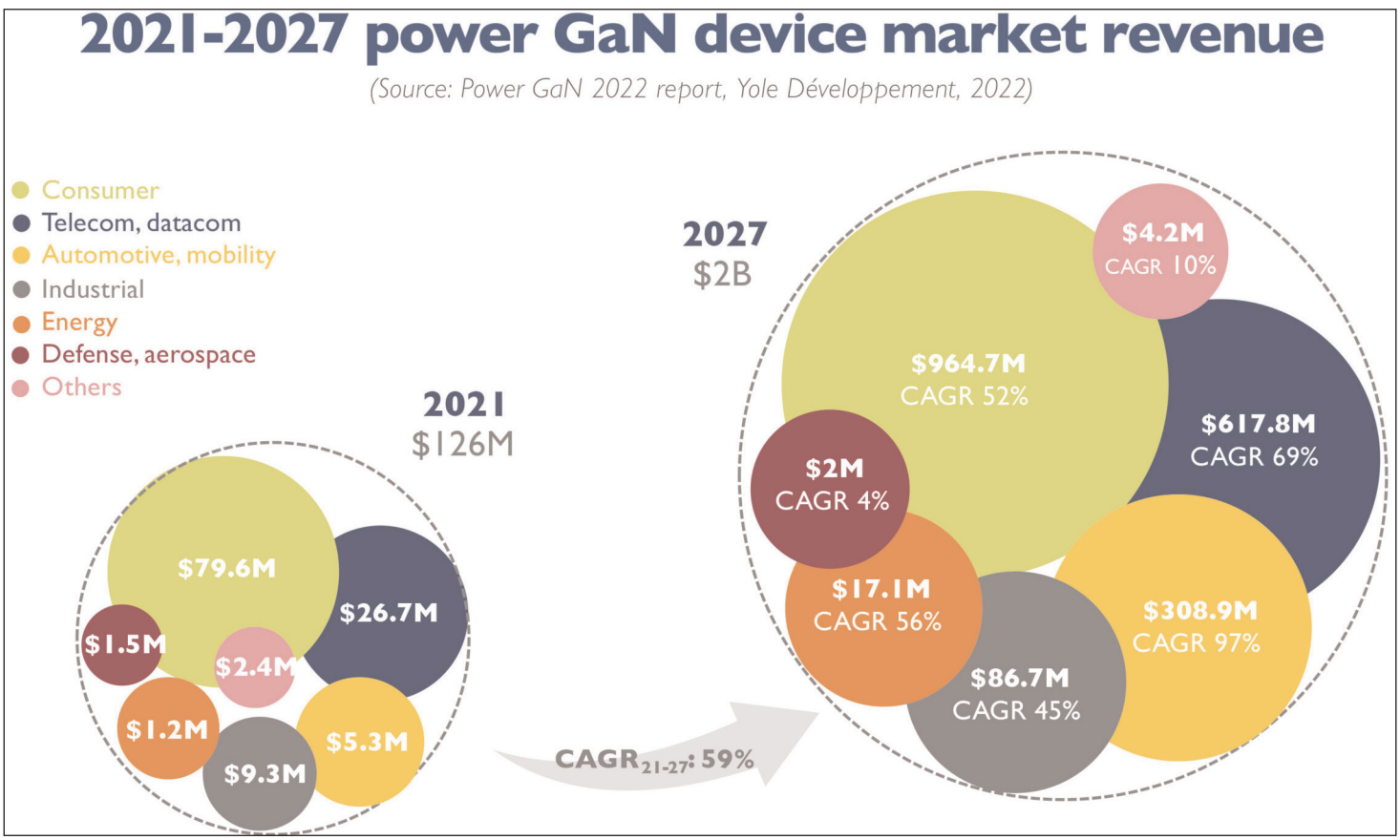
Consumer to comprise 48% of market, but datacom/telecom and automotive/mobility growing at 69% and 97% CAGRs respectively, says Yole.

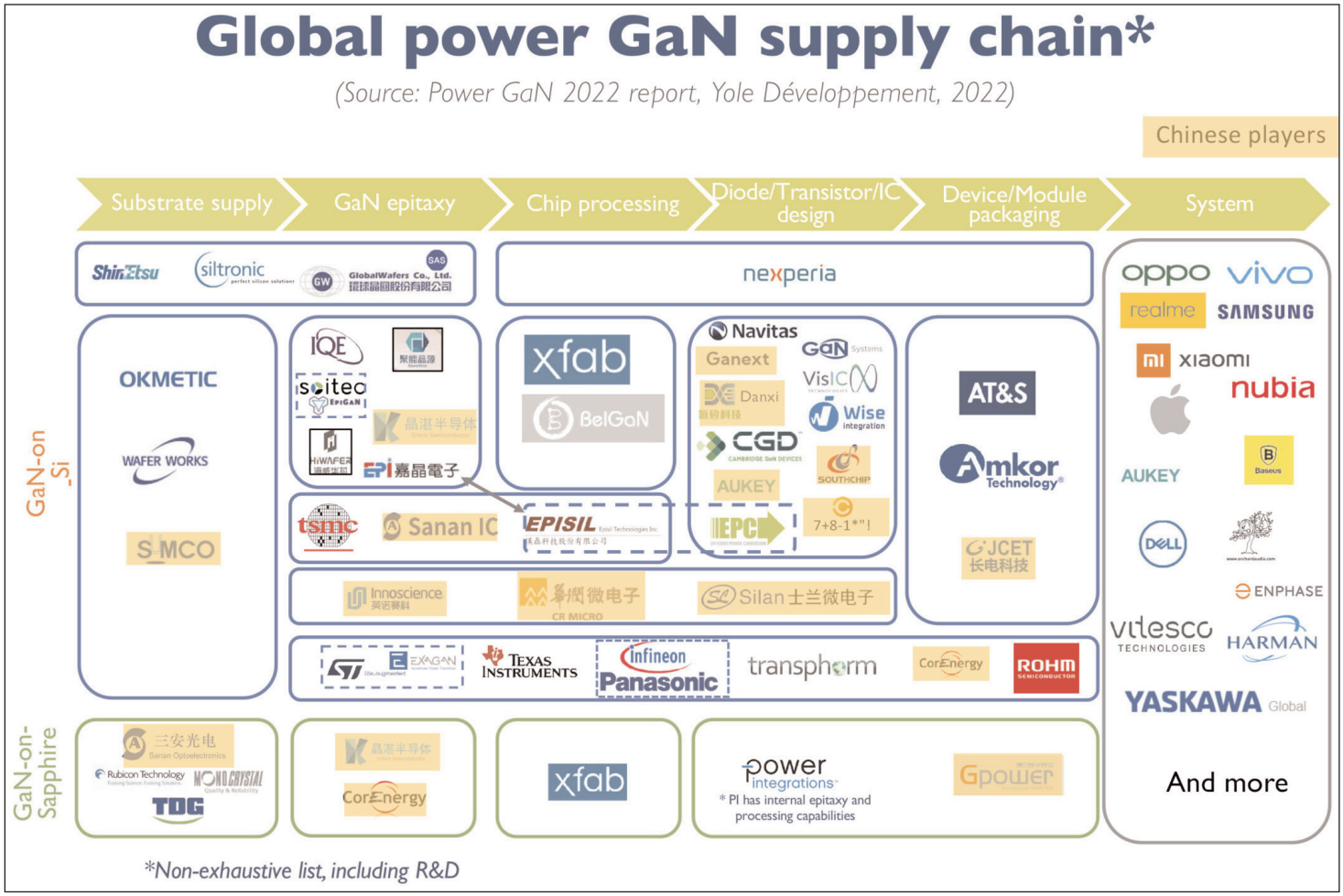
The power gallium nitride (GaN) device market is growing at a compound annual growth rate (CAGR) of 59% from just $126m in 2021 to $2bn in 2027, estimates market research and strategy consulting company Yole Développement in the latest edition of its annual report 'Power GaN 2022'.

In particular, the consumer sector (including power supplies and Class D audio amplifiers) is growing at a 52% CAGR from $79.6m in 2021 to $964.7m in 2027 (comprising 48% of the total market). "GaN fast chargers are growing rapidly in the handset market," notes Taha Ayari Ph.D., technology & market analyst, compound semiconductors, at Yole. "Since 2020, Yole has seen an increasing number of fast chargers featuring GaN devices from several players, like Power Integrations, Navitas and GaN Systems. Now, Innoscience is also contributing to this market with high volumes."

The consumer sector (including power supplies and Class D audio amplifiers) is growing at a 52% CAGR from $79.6m in 2021 to $964.7m in 2027 (comprising 48% of the total market)

For datacoms/telecoms, Yole expects an increase in GaN penetration in the mid-term as regulations become stricter. The interest in adopting 48V point-of-load systems in data centers to reduce power consumption and cabling volume will favor GaN for low-voltage applications. An increasing number of power supply firms are adopting GaN in their systems. Transphorm, EPC, Texas Instruments, Infineon and GaN Systems have all announced several design wins. Therefore, the GaN device market for the datacom/telecom sector is





estimated to be growing at a 69% CAGR from $26.7m in 2021 to $617.8m in 2027.

At a lower penetration level, automotive DC–DC converters and on-board chargers (OBCs) will be part of the next wave of growth during the forecast period, reckons Yole. There are ever more collaborations between GaN device players, who are accelerating the automotive qualification of their products, and the tier-1 and original equipment manufacturer (OEMs), who are evaluating automotive GaN solutions. The GaN automotive/mobility sector is estimated to be growing at a 97% CAGR from $5.3m in 2021 to $308.9m in 2027.

In terms of technology, 6" GaN-on-silicon is still the mainstream platform. However, the transition to the 8-inch platform plus consolidation of the supply chain with more players at each level are driving lower manufacturing costs, especially at the epitaxy step, which constitutes the most significant part of a GaN device's cost structure, notes Yole. In fact, one of the big questions is around the use of in-house epitaxy versus outsourced epitaxy for future high volumes

The Power GaN 2022 report also highlights the dynamic supply chain, with new entrants and significant investments. Indeed, since the release of the 2021 report, Yole has seen the entry of new players into the supply chain. Notably, ROHM is offering a 150V GaN product for telecom/datacom applications as part of its new EcoGaN portfolio. New GaN foundry BelGaN has recently acquired onsemi's fab in Belgium. On the fundraising front, Navitas went public through a special purpose acquisition company (SPAC) business combination after an agreement valued at $1.04bn with Live Oak Acquisition Corp.

Focusing on the Chinese ecosystem, the government has supported more investments from GaN players. Notably, privately owned company Innoscience is investing more than $400m to expand its 8-inch wafer capacity from 10,000 to 70,000 wafers per month by 2025. A domestic supply chain for GaN power is well developed, especially for the consumer market.

In terms of technology, 6-inch GaN-on-silicon is still the mainstream platform. However, the transition to the 8-inch platform plus consolidation of the supply chain with more players at each level are driving lower manufacturing costs, especially at the epitaxy step, which constitutes the most significant part of a GaN device's cost structure, notes Yole. In fact, one of the big questions is around the use of in-house epitaxy versus outsourced epitaxy for future high volumes, the report says. ■

www.yolegroup.com

Gallium oxide beats silicon power limit

Researchers report simultaneous high breakdown/low resistance in β-Ga_2O_3.

Researchers based in the USA claim the first more than 4kV-capable β-Ga_2O_3 lateral metal–semiconductor field-effect transistors (MESFETs) surpassing the theoretical unipolar figures of merit (FOMs) for silicon-based devices [Arkka Bhattacharyya et al, Appl. Phys. Express, v15, p061001, 2022].

The team from University of Utah, University at Buffalo, Agnitron Technology Inc and University of California Santa Barbara (UCSB) also say that, to date, the devices show the highest maximum drain current (I_{DMAX}) and lowest on-resistance (R_{ON}) simultaneously for any β-Ga_2O_3 with breakdown voltage (V_{BR}) more than 4kV.

The 4.6–4.9eV ultra-wide bandgap of β-Ga_2O_3 implies high breakdown capabilities with potential for power-efficient next-generation high-voltage power devices. Breakdown voltages up to 8kV have been achieved, but practical devices also need low resistance for power efficiency.

A 230nm layer of β-Ga_2O_3 was grown on an iron-doped bulk substrate oriented as (010). The researchers used Agnitron's Agilis 700 metal-organic vapor phase epitaxy (MOVPE) equipment with triethyl-gallium and oxygen precursors. Silane (SiH_4) was the source for n-type silicon doping.

The mesa and recessed contact regions were fabricated using sulfur hexafluoride (SF_6)/argon inductively coupled plasma reactive ion etch (ICP-RIE) — see Figure 1.

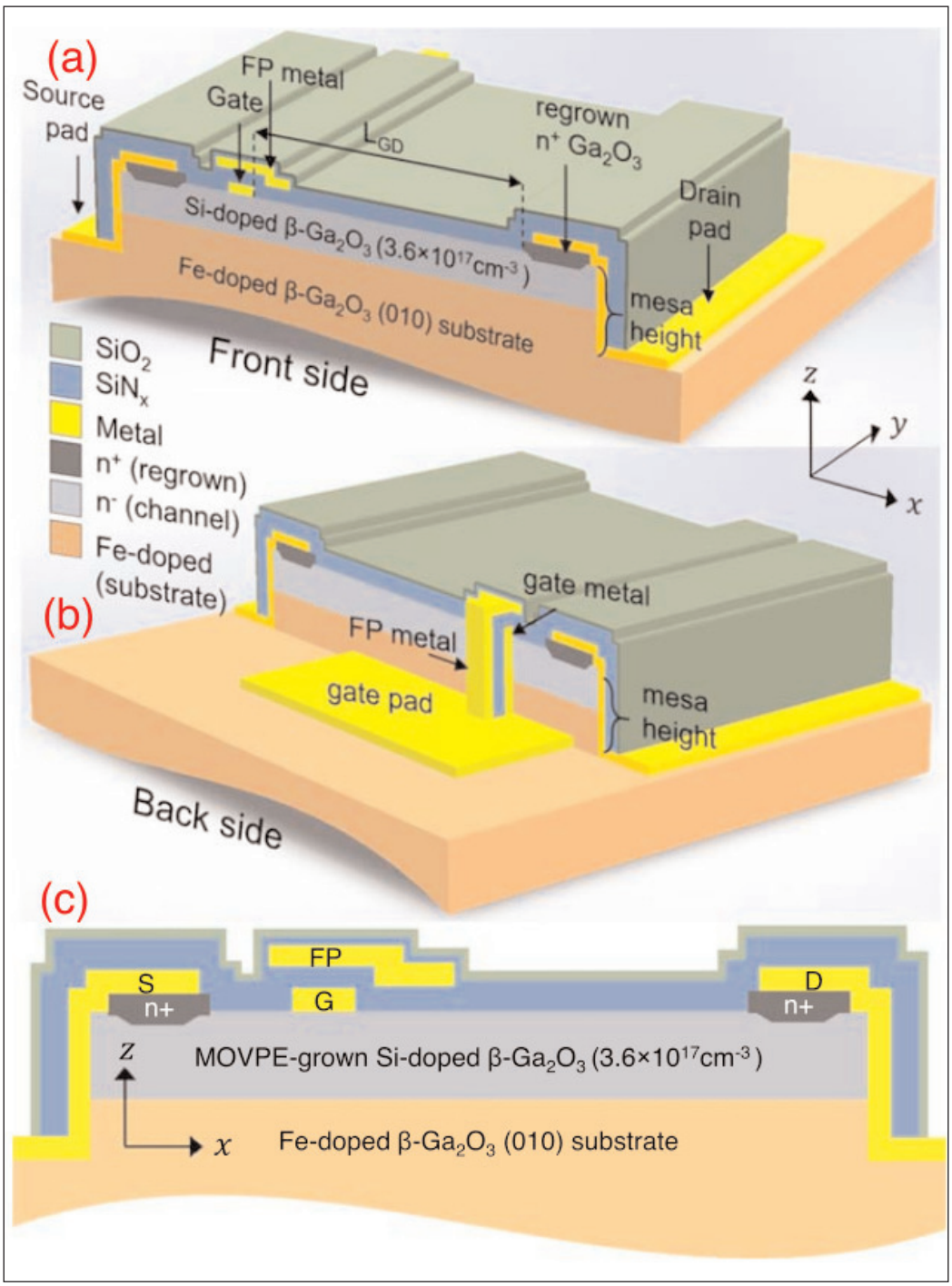


Figure 1. (a) 3D cross-section schematic of β-Ga_2O_3 MESFET showing FP design. (b) Gate FP metal electrically connected to gate pad outside mesa (inset: coordinate planes/axes) and (c) 2D cross-section schematic along x–z plane.

The mesa height was 500nm, meaning that the etch continued into the substrate. The ohmic contact region

consisted of heavily doped n^+-β-Ga_2O_3 regrown in the recessed region.

The MESFET consisted of annealed titanium/gold/nickel ohmic source/drain contacts and a nickel/gold/nickel Schottky gate.

The titanium/gold/nickel gate field plate (FP) was insulated from the gate metal with 170nm of plasma-enhanced chemical vapor deposition (PECVD) silicon nitride (SiN_x). The electrical connection between the gate and FP was made away from the device mesa. The FP fabrication was designed to avoid plasma-related damage in the active region.

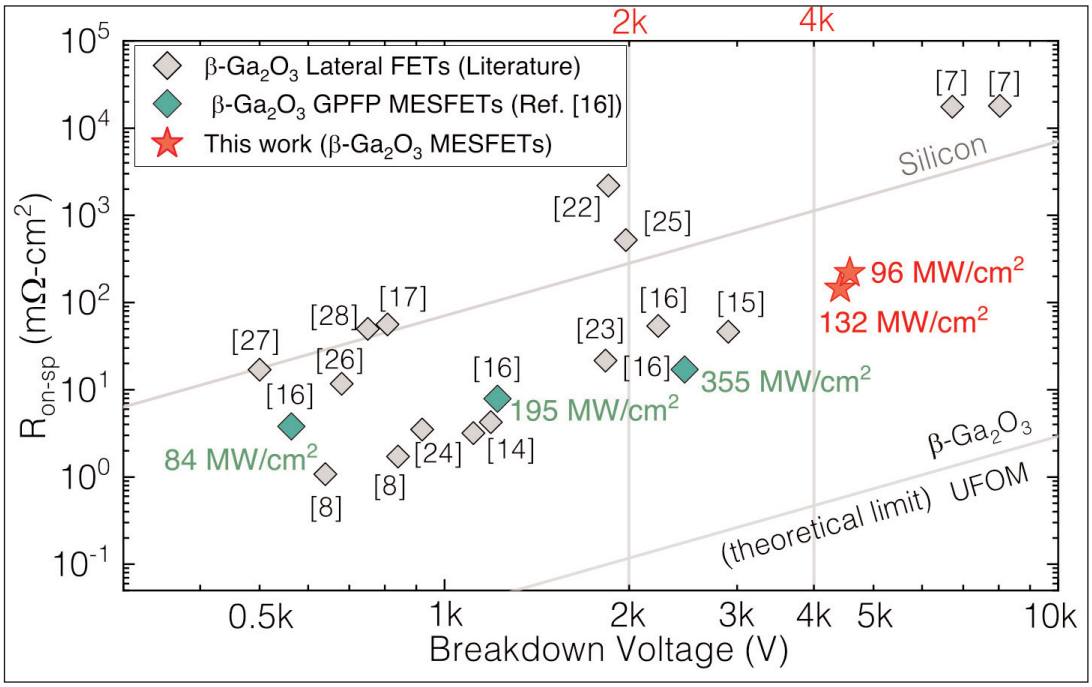


Figure 2. Differential $R_{on,sp}$–V_{BR} benchmark plot of latest β-Ga_2O_3 MESFET with literature reports. Green data represent previous work of the team.

The device mesa was finally passivated with a combination of 50nm silicon nitride and 50nm silicon dioxide. The gate length of the devices was 2.4μm, and the gate–source spacing 1μm.

Hall measurements gave a channel charge carrier density and mobility of $5.7x10^{12}m^2$ and $95cm^2$/V-s, respectively. The corresponding sheet resistance was 11.7kΩ/square.

The maximum on-current in devices with 34.5μm gate–drain distance (L_{GD}) and 3.2μm FP was 56mA/mm at 2V gate potential. The on-resistance was 385Ω-mm. The device pinched-off sharply with the gate at −13V. The on/off current ratio was more than 108. The maximum transconductance was 6.2mS/mm, and the sub-threshold swing 186mV/decade.

The breakdown characteristics were explored with the devices submerged in FC-40 Fluorinert dielectric liquid. The breakdown voltage, with the device off at −20V gate potential, occurred with a drain-gate potential difference of 4415V. This naturally increased with 44.5μm L_{GD} (3.5μm FP) to 4567V. Before the catastrophic breakdown the leakage varied in the range 10–100nA/mm.

The researchers attribute the improved breakdown performance on steps taken to minimize reverse leakage. The team comments: "The long HF substrate cleaning before the epilayer growth helped in suppressing the parasitic channel at the epilayer/substrate interface that is believed to come from residual silicon impurities from the substrate polishing or ambient exposure." They also believe that the mesa etching deep into the substrate eliminates fringing leakage paths around the device mesa.

Devices with L_{GD} less than 10μm demonstrated average breakdown fields (V_{BR}/L_{GD}) around 2.5MV/cm. Above 10μm L_{GD} the V_{BR} tended to saturate around 4.5kV.

On the basis of simulations, the researchers suggest that below 10μm L_{GD} the field profile was of a punchthrough form with non-zero field at the drain contact at breakdown. Longer L_{GD} resulted in a non-punchthrough field up to breakdown.

The simulations also raised concerns of the peak field occurring at the FP edge in the silicon nitride layer: "Dielectric leakage/breakdown could also be limiting the V_{BR} and causing the saturation in V_{BR}." The team suggests that the dielectric performance would be improved by using materials with a high product of relative DC dielectric permittivity (ε) and critical electric field for breakdown.

The $V_{BR}^2/R_{on,sp}$ power figure of merit (PFOM) reached $132MW/cm^2$ for 34.5μm L_{GD}. The specific on-resistance was normalized according to L_{GD} and the transfer lengths of the source/drain contacts (0.6μm each). The longer 44.5μm L_{GD} resulted in a lower $96MW/cm^2$ PFOM.

Commenting on benchmarking against other reports (Figure 2), the researchers write: "It can be seen that the devices reported here are the first >4kV-class β-Ga_2O_3 FET devices to surpass the theoretical unipolar FOM of silicon. Furthermore, our reported $R_{on,sp}$ are the lowest for any β-Ga_2O_3 FET exceeding a breakdown voltage of 4kV." ■

https://doi.org/10.35848/1882-0786/ac6729

https://agnitron.com/

Author: Mike Cooke

Smartphone production volume falls 12.8% to 310 million in Q1/2022 due to amplified off-season effect

Rising inflation, intensified by the Russia–Ukraine war and China's lockdowns, is constraining smartphone production in Q2 to 309 million units, says TrendForce.

The multiplicative effect of the traditional off-season further weakened smartphone production performance in first-quarter 2022, with global output only reaching 310 million units, down 12.8% quarter-on-quarter, according to market research firm TrendForce. Compared with the same period last year, the strategic planning adopted by smartphone brands in response to Huawei's market share collapse is quite different, with annual decline in production as high as 10.1%.

Looking to Q2/2022, in the face of rising inflation intensified by the Russian–Ukrainian war and the direct impact of China's lockdowns, the momentum of consumption continues to weaken. According to TrendForce's current observations, global smartphone production volume in Q2/2022 is forecast at about 309 million units, which is roughly on par with Q1, but the lingering possibility of a subsequent downgrade this quarter cannot be ruled out.

Global top-five brands accounts for 78% of market in Q1; Samsung regains top spot

Benefiting from an easing of 4G low-end processor chip supply and the launch of its new Galaxy S22, Samsung's production volume in Q1/2022 increased to 73.8 million units, ranking first in the world. Looking at developments in Q2, since Samsung's central production sites are located in Vietnam and India and its market share in China is merely 1%, it is unruffled by the turmoil in the supply chain and domestic demand stemming from China's dynamic zero-COVID policy. However, the impact of the Russian–Ukrainian war festers in Q2. Samsung was originally the leading smartphone brand in Russia but in March it joined sanctions against the country and completely suspended product shipments. Coupled with rising inflation, Samsun's production performance in Q2 will be dampened and is expected to decline compared with Q1.

Apple's iPhone 13 series continued to sell well, and the new SE3 helped Apple's production volume reach 60 million units in Q1, achieving excellence performance compared with the same period last year, with an annual growth of rate 11.1%. This was due mainly to cannibalizing Huawei's former high-end model orders while making up for losses incurred from the suspension of mobile phone sales in Russia in response to the Russia–Ukraine war. The Chinese lockdowns adversely affected the operation performance of foundries and the supply chain. Fortunately, during Q2 Apple was in a transition period between new and old models and, since Q2 normally posts the lowest production performance in the year, any collateral impact was relatively limited.

The iPhone 14 series to be launched by Apple in second-half 2022 will feature four new models. Most notably and unlike prior offerings, only the latest processors are employed in the Pro series. In addition to taking into account terminal pricing strategy, this can also highlight differences in market positioning. As rising inflation changes consumer behavior, this type of product positioning is expected to attract more buyers.

The Chinese smartphone market had begun showing obvious signs of weakness since second-half 2021, leading to more cautious quarterly production planning from Xiaomi (including Redmi, POCO, Black Shark), OPPO (including Realme, OnePlus), and Vivo (including iQoo), with Q1/2022 production volume coming in at 44.5 million, 40.5 million and 23.5 million units, respectively. Due to the high overlap between positioning and product planning of these three brands in the sales market, factors such as delayed delivery of 4G low-end processor chips at the beginning of the quarter and sluggish sales in the Chinese market will directly affect production performance. OPPO and Vivo exhibited a more significant quarterly decline due to their large market share in China. At the same time, the rapid rise of Honor, coupled with its strategy of focusing on the

Chinese market as its primary sales foundation, will also threaten Xiaomi, OPPO and Vivo, which likewise focus on the domestic demand market in China. TrendForce says that it has also observed the rapid rise of Honor's market share and forecasts its market share in China will surpass that of Xiaomi and close in on OPPO and Vivo in 2022.

Company	1Q22		2Q22E	
	Ranking	Market Share	Ranking	Market Share
Samsung	1	23.8%	1	22.8%
Apple	2	19.3%	3	14.5%
Xiaomi	3	14.3%	2	14.7%
Oppo	4	13.1%	4	13.4%
Vivo	5	7.6%	5	8.9%

Top five global smartphone brands by market share, for Q1/2022 and Q2/2022.

5G mobile phones grow steadily, with market share reaching 50% in 2022

According to TrendForce, looking at performance in 2022 as a whole, first-half 2022 was mainly influenced by China's lockdowns and the Russian–Ukrainian war, and second-half 2022 will be influenced by the inflation crisis, with annual production volume coming in at about 1.333 billion units. However, if China continues its dynamic zero-COVID policy into Q3/2022, combined with the one-two punch of inflation and energy shortages, the global smartphone market may face further downward revision.

Despite the continuous adjustment of production targets, 5G mobile phones continue growing steadily. Since being released in 2019, 5G mobile phones have benefited from the Chinese government's diligent promotion of commercial transformation. In 2021, 5G's global market share reached 38%. The subsequent growth momentum of 5G mobile phones will be driven by markets outside of China. With the steady increase in global 5G base-station coverage, the global market share of 5G mobile phones is forecast to reach 50% in 2022, or about 661 million units, of which Apple possesses the lion's share, says TrendForce. ■

www.trendforce.com

suppliers' directory

Index

1 Bulk crystal source materials p68
2 Bulk crystal growth equipment p68
3 Substrates p68
4 Epiwafer foundry p69
5 Deposition materials p69
6 Deposition equipment p70
7 Wafer processing materials p70
8 Wafer processing equipment p70
9 Materials and metals p71
10 Gas & liquid handling equipment p71
11 Process monitoring and control p71
12 Inspection equipment p72
13 Characterization equipment p72
14 Chip test equipment p72
15 Assembly/packaging materials p72
16 Assembly/packaging equipment p72
17 Assembly/packaging foundry p73
18 Chip foundry p73
19 Facility equipment p73
20 Facility consumables p73
21 Computer hardware & software p73
22 Used equipment p73
23 Services p73
24 Resources p73

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

1 Bulk crystal source materials

Vital Materials Co Ltd (head office)
Floor 49, International Metropolitan Plaza,
68 Huacheng Avenue,
Tianhe District,
Guangzhou, Guangdong,
China 510623
Tel: +86 020-83511906
Fax: +86 020-83511907
E-mail: Sales@vitalchem.com
www.vitalchem.com
Vital Materials is the world's leading producer of rare metals as well as the first Chinese manufacturer to deliver G11 rotary ITO target. Vital is also one of the world's three major supplier of infrared materials, a key supplier of compound semiconductor substrates, and a strategic partner of the world's largest thin film solar manufacturer.

United Mineral & Chemical Corp
1100 Valley Brook Avenue,
Lyndhurst, NJ 07071, USA
Tel: +1 201 507 3300
Fax: +1 201 507 1506
www.umccorp.com

2 Bulk crystal growth equipment

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

3 Substrates

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

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

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

VIGO SYSTEM S.A.
ul. Poznanska 129 /133, 05-850
Ozarów Mazowiecki, Poland
Tel: +48 22 733 54 10
E-mail: ent@vigo.com.pl
ent-epitaxy.com

www.vigo.com.pl www.ent-epitaxy.com

VIGO System's Epitaxy Division produces high-grade III–V compound semiconductor epitaxial structures for photonic and microelectronic devices. With more than 35 years' experience, the division offers a broad range of epi-wafers, both in large volumes and small customised batches. It focuses on innovative products for wireless, TC, sensing or printing applications.

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, 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 AG
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 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'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.

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.

Class One Equipment Inc
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

10–14 July 2022
20th International Conference on Metal Organic Vapor Phase Epitaxy (ICMOVPE XX)
Schwabenlandhalle Fellbach, Stuttgart, Germany
E-mail: info@icmovpexx.eu
www.icmovpexx.eu

13–15 July 2022
LASER World of PHOTONICS CHINA
Shanghai, China
E-mail: info@world-of-photonics-china.com
www.world-of-photonics-china.com/en

21–25 July 2022
3rd International Congress on Advanced Materials Sciences and Engineering (AMSE-2022)
Hotel Ambasador, Opatija, Croatia
E-mail: eve4@amse-materials2021.com
www.istci.org/amse2022

21–25 August 2022
SPIE Optics + Photonics 2022
San Diego Convention Center, San Diego, CA, USA
E-mail: customerservice@spie.org
www.spie.org/opstm

24–26 August 2022
2022 IEEE International Workshop on Integrated Power Packaging (IWIPP)
World Trade Centre of Grenoble, Grenoble, France
www.iwipp.org

31 August – 2 September 2022
PCIM (Power Conversion, Intelligent Motion) Asia 2022
Shanghai New International Expo Centre, China
E-mail: pcimasia@china.messefrankfurt.com
www.pcimasia-expo.com

7–9 September 2022
CIOE 2022 (24th China International Optoelectronic Exposition)
Shenzhen World Exhibition & Convention Center, China
E-mail: cioe@cioe.cn
www.cioe.cn/en

11–16 September 2022
19th International Conference on Silicon Carbide and Related Materials (ICSCRM 2022)
Davos, Switzerland
E-mail: info@icscrm2022.org
www.icscrm2022.org

14–16 September 2022
SEMICON Taiwan 2022
TaiNEX 1, Taipei, Taiwan
E-mail: semicontaiwan@semi.org
www.semicontaiwan.org/en

19–21 September 2022
48th European Conference on Optical Communication (ECOC 2022)
Basel, Switzerland
E-mail: info@ecoc2020.org
www.ecoco2020.org

advertisers' index

Advertiser	Page no.	Advertiser	Page no.
AFC Industries	14	IQE	2
Applied Energy Systems	29	k-Space	37
CS Clean Solutions	35	Vacuum Barrier Corp	27
CSconnected	5	Vistec	33
Fuji Electric	9		

19–22 September 2022
IEEE 48th European Solid-State Circuits Conference (ESSCIRC 2022)
IEEE 52nd European Solid-State Device Research Conference (ESSDERC 2022)
Università degli Studi di MILANO – BICOCCA, Milan, Italy
www.esscirc-essderc2022.org

25–30 September 2022
25th European Microwave Week (EuMW 2022) including:
52nd European Microwave Conference (EuMC 2022)
17th European Microwave Integrated Circuits Conference (EuMIC 2022)
19th European Radar Conference (EuRAD 2022)
Milano Convention Centre (MICO), Milan, Italy
E-mail: eumwreg@itnint.com
www.eumweek.com

2–6 October 2022
Light + Building Autumn Edition 2022
Frankfurt, Germany
E-mail: tickets@messefrankfurt.com
https://light-building.messefrankfurt.com/frankfurt/en.html

9–14 October 2022
International Workshop on Nitride Semiconductors (IWN 2022)
Berlin, Germany
E-mail: carolin.geppert@conventus.de
www.iwn2022.org

16–19 October 2022
28th International Semiconductor Laser Conference (ISLC 2022)
Kunibiki Messe, Matsue, Japan
E-mail: islc2022@or.knt.co.jp
www.islc2022.org

16–19 October 2022
2022 IEEE BiCMOS and Compound Semiconductor Integrated Circuits and Technology Symposium (BCICTS)
Sheraton Phoenix Downtown, Phoenix, AZ, USA
E-mail: cs@cshawevent.com
www.bcicts.org

16–21 October 2022
International Workshop on Bulk Nitride Semiconductors — XI (IWBNS-XI)
Lehigh Valley, PA, USA
E-mail: iwbns-xi@gmail.com
www.iwbns-xi.org

23–27 October 2022
4th IEEE Workshop on Gallium Oxide and Related Materials (IWGO 2022)
Saihokukan Hotel, Nagano, Japan
E-mail: secretary@iwgo2022.org
www.iwgo2022.org

7–9 November 2022
9th IEEE Workshop on Wide Bandgap Power Devices & Applications (WiPDA 2022)
Sonesta Redondo Beach and Marina, Redondo Beach, CA, USA
https://wipda.org

15–18 November 2022
SEMICON Europa 2022 (co-located with electronica)
Messe München, Munich, Germany
E-mail: semiconeuropa@semi.org
www.semiconeuropa.org

3–7 December 2022
68th annual IEEE International Electron Devices Meeting (IEDM 2022)
Hilton San Francisco Union Square hotel, San Francisco, CA, USA
E-mail: iedm-info@ieee.org
www.ieee-iedm.org

7–9 December 2022
LASER World of PHOTONICS INDIA
Bombay Exhibition Centre, Mumbai, India
E-mail: info@world-of-photonics-india.com
www.world-of-photonics-india.com/en

14–16 December 2022
SEMICON Japan 2022
Tokyo Big Sight, Tokyo, Japan
E-mail: jcustomer@semi.org
www.semiconjapan.org/en

8–9 February 2023
17th International Conference on Compound Semiconductor Devices: Structures and Processing (ICCSDSP 2023)
Lisbon, Portugal
https://waset.org/compound-semiconductor-devices-structures-and-processing-conference-in-february-2023-in-lisbon

19–23 February 2023
2023 IEEE International Solid- State Circuits Conference (ISSCC 2023)
San Francisco, CA USA
E-mail: Isscinfo@yesevents.com
www.isscc.org

semiconductorTODAY

COMPOUNDS & ADVANCED SILICON

www.semiconductor-today.com

Join our LinkedIn group: Semiconductor Today

Follow us on Twitter: Semiconductor_T

Choose *Semiconductor Today* for . . .

MAGAZINE

Accurate and timely coverage of the compound semiconductor and advanced silicon industries

Targeted 82,000+ international circulation

Published 10 times a year and delivered by e-mail and RSS feeds

WEB SITE

Average of over 26,000 unique visitors to the site each month

Daily news updates and regular feature articles

Google-listed news source

E-BRIEF

Weekly round-up of key business and technical news

E-mail delivery to entire circulation

Banner and text marketing opportunities available