XI FOR BETTER YIELD

DR YIELD is proud to announce the availability of **YieldWatchDog^{XI}** - the e**X**panded **I**ntelligence addition to its acclaimed data analytics solution:

- ✓ Deep-learning AI solution
- ✓ Smart pattern recognition
- ✓ Intelligent tool analytics
- ✓ Multidimensional view
- ✓ Deep root cause analytics

Contact us at **www.dryield.com** today.

D|R|YIELD

Making Data Smart

ISSN 1752-2935 (online)

semiconductorTODAY

COMPOUNDS & ADVANCED SILICON

Vol. 16 • Issue 6 • July/August 2021

www.semiconductor-today.com

Silicon carbide expanding for power electronics

Nexperia buying Newport Wafer Fab • 5G handsets drive growth
First Solar factory for India • Luminar acquiring OptoGration

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

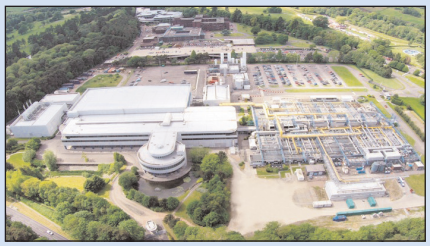
EUROPE: +44 2920 839 400
AMERICAS: +1 508 824 6696
APAC: +886 3 579 8181
ALL INQUIRIES: sales@iqep.com

www.iqep.com

contents

semiconductorTODAY
COMPOUNDS & ADVANCED SILICON

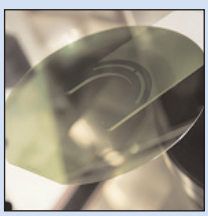
Vol. 16 • Issue 6 • July/August 2021



p14 Nexperia has agreed to acquire 100% of Newport Wafer Fab (NWF) in South Wales, the UK's 200mm compound semiconductor wafer foundry.

p28 Transphorm has completed the transaction for its AFSW wafer fab in Japan to be acquired by GaNovation, the joint venture formed with its new Palo Alto-based financial partner JCP Capital. The fab was previously a JV with Fujitsu Semiconductor Ltd.

p68 First Solar has broken ground on a new $680m, 3.3GW PV module manufacturing facility in Ohio.



Cover: STMicroelectronics has manufactured the first 200mm (8-inch) silicon carbide bulk wafers for prototyping next-generation power devices from its facility in Norrköping, Sweden, marking a milestone in the capacity build-up for ST's customer programs in automotive and industrial sectors. **p17**

editorial

Changes in the ecosystem

Just in time for a brief mention in last issue's editorial was the news on 5 July that Netherlands-based Nexperia (a subsidiary of China-based Wingtech Technology since 2019) was to acquire Newport Wafer Fab (NWF) in South Wales, the UK's biggest semiconductor foundry for not only silicon but also compound semiconductor on silicon 200mm wafer processing (see page 14).

Subsequently, prime minister Boris Johnson directed the UK National Security Adviser to review the acquisition. Nevertheless, statements filed by Wingtech with the UK's Companies House on 12 August and on the Shanghai stock exchange confirmed that the transfer of shares and ownership of NWF to Nexperia had been completed.

Previously (on 6 August), Nexperia general counsel Charles Smit said: "We have also agreed to the spin out of various ongoing compound semiconductor activities to a separate new organization, and Drew Nelson [former owner of Newport Wafer Fab] is providing his commitment, as we are, that we will work closely together to ensure this is done in a way which gets the best result for South Wales and preserves all the key initiatives of the Compound Semiconductor Cluster [CSconnected]."

Supported by the Welsh Government and Cardiff Capital Region (CCR), the CSconnected (formed in South Wales in 2017) involves the Institute for Compound Semiconductors (ICS), the Compound Semiconductor Centre (CSC), CS Hub, the Compound Semiconductor Applications Catapult, and the Swansea University-based Centre for Integrative Semiconductor Materials (CISM). Business partners include equipment maker SPTS, epiwafer foundry IQE, device makers Rockley Photonics and MicroLink, and Newport Wafer Fab.

It remains to be seen first if the UK government is able or willing to retrospectively intervene in the acquisition of NWF, and secondly to what extent Nexperia/Wingtech, via initial support for the NWF-10 Ltd spin-off registered by Nelson as sole director on 5 July, will interface with the CSconnected cluster and its ecosystem.

One UK government investment (of £4.8m, announced in March) forming a key part of CISM and involving CSconnected partners is the creation of 6-8"-wafer silicon carbide (SiC) pilot line, with equipment at both Swansea University and NWF, for manufacturing power electronics devices targeted at sectors such as automotive, aerospace, medical and energy.

The SiC power device market is burgeoning (to $4bn by 2026, reckons Yole — see page 88), partly due to the rapid adoption of electric vehicles (EVs). This is driving both existing SiC firms and established silicon chip makers to invest massively in SiC substrate and device manufacturing capacity. Dominant SiC firm Cree is expanding its operations leadership team as it prepares for the Summer 2022 start-up of its new SiC wafer fab under construction in Marcy, NY (see page 16). Also, Cree has expanded its long-term agreement to supply Europe-based STMicroelectronics with 150mm SiC bare and epitaxial wafers, extending the deal to now over $800m (and Cree's total supply agreements with device makers to over $1.3bn).

Meanwhile, ST has made its first 200mm SiC bulk wafers at its plant in Norrköping, Sweden (formerly Norstel, acquired in 2019) — a "key milestone in the capacity build-up for its customer programs in automotive and industrial sectors [page 17]". As well as scaling up from 150mm to 200mm wafers compatible with silicon-focused high-volume processing equipment, ST aims to source 40% of its SiC substrates internally by 2024, marking a diversification of sourcing and further development of the SiC ecosystem.

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

VIGO SYSTEM

Epitaxial nanotechnology

GaAs- and InP- related epi-wafers for VCSELs, F-Ps, QCLs, photodetectors, diodes, transistors, and other devices.

- Custom products for niche markets
- Insightful characterization
- Longstanding epitaxy experience
- Individual approach and full commitment
- Extensive R&D knowledge

Contact us at
info@vigo.com.pl

Read more
www.vigo.com.pl

news

Micro-LED display development unhindered by COVID-19

East Asia to dominate, despite number of start-ups in Europe and USA

The importance of displays has become more significant during the COVID-19 pandemic, as the need to have a display for remote communication has increased. An emerging display type is the micro-LED display, which has the potential to become the next-generation mainstream due to its ability to be fabricated in array sizes ranging from tiny to huge. The challenges and opportunities of this are discussed in IDTechEx's report 'Micro-LED Displays 2021–2031: Technology, Commercialization, Opportunity, Market and Players'.

COVID-19 has not stopped the development of micro-LED displays. With the Consumer Electronics Show (CES) and Display Week, as well as a number of events being put online, it can be seen that the progress and new launches of micro-LED display prototypes and products are not greatly affected, says IDTechEx.

The increasing activity of display suppliers can be seen from the cumulative investment and increasing number of patent filings, as well as the prototypes/products introduced by micro-LED vendors, such as AUO, PlayNitride, RiTdisplay, Samsung, LG, Sony, TCL, Tianma, Konka, Glo, Plessey, JBD, X-Display, VueReal, CSOT, Sharp, Kyocera etc.

However, prototypes for proving the readiness of technology through lab/fab-scale production are very different from mass-manufactured commercial products. The latter require zero defects for consumer products. Although the science has been proved, there are further engineering and manufacturing issues.

For example, conventional LEDs can reach external quantum efficiencies (EQEs) of ~70%, while micro-LEDs of less than 10μm may struggle to reach 20%. Red LEDs are especially challenging due to their low EQEs and brittle features. Tiny micro-LEDs have a large surface area, which may lead to more defects during the fabrication process. Therefore, solving engineering/manufacturing challenges is important, including die size miniaturization while maintaining high efficiency, chip design, and chip manufacturing technique improvement. Other issues include mass-transfer yield and accuracy, defect repair, testing, uniformity, light management, color conversion, etc.

To fabricate a micro-LED display, many technologies and processes are involved, such as epitaxy, photolithography, chip fabrication, substrate removal, inspection, mass transfer, bonding and interconnection, testing, repair, backplane and drive IC, etc. After years of development, some technology difficulties have been solved, while new challenges sit in front of us, says IDTechEx. For example, several years ago most effort was concentrated on die miniaturization, chip design, and mass transfer, etc. Recently, more players have realized that it is key to have a complete understanding of all the processes. Therefore, more people are putting increasing emphasis on technologies such as inspection, repair, driving, image improvement, light management, and high-volume production equipment.

Another interesting phenomenon is the increasing number of partnerships, mergers, acquisitions, joint ventures, and further investment. This aligns with the display cycle trend. There was hype in the micro-LED display one or two years ago, but now major players are gradually establishing their roadmaps. Mini-LED displays and large signage & TVs are introduced by many vendors, and in the meantime players are still working on micro-LED displays. Compared with previous years, consolidation is becoming more evident.

Following on from the LCD industry, China has likewise invested greatly in micro-LED displays. Before 2019, BOE was not active in the micro-LED display arena. However, after 2019, BOE jumped to be the top company in terms of the number of patents filed. Sizeable investment also indicates huge interest. Although there are quite a few start-ups in Europe and America, it seems that East Asia will dominate micro-LED display development, reckons the report.

www.IDTechEx.com/MicroLED

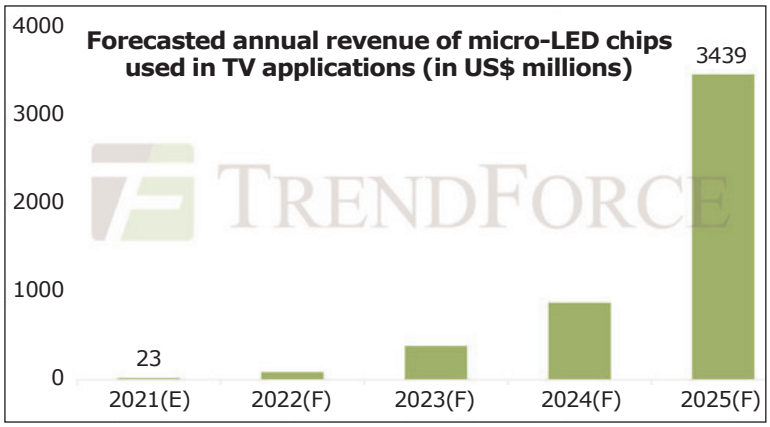
Micro-LED chip revenue for TVs to grow at 250% CAGR to $3.4bn in 2025 despite cost and technology challenges

According to TrendForce's report '2021 Mini/Micro LED Self-Emissive Display Trends and Analysis on Suppliers' Strategies', annual revenue of micro-LED chips for TV will rise at a compound annual growth rate (CAGR) of 250% to $3.4bn in 2025, due mostly to the early planning by display manufacturers to adopt micro-LED technology for large-sized displays.

Although the prohibitive cost of this technology is unlikely to be overcome in the short run, TrendForce still forecasts this revenue growth in light of several factors: first, micro-LED technology enables the production of gapless, large-sized modular displays; second, displays featuring micro-LED technology are able to meet the standards of cinema-grade displays or high-end TVs; finally, Korean TV brands have been aggressively investing in micro-LED TV development.

After TV market leader Samsung released its 146" TV 'The Wall' in 2018, the firm has continued to announce large-sized modular video walls and micro-LED TVs (which come in sizes 75", 110", 219" and 292") at each subsequent Consumer Electronics Show (CES). TrendForce indicates that, prior to widespread commercialization of micro-LED TVs, TV makers will continue to face challenges in terms of both technological barriers and costs. In particular, breakthroughs in three areas remain the most noteworthy: micro-LED chips, backplanes/drivers and mass transfer.

With regards to cost, micro-LED chips comprise the highest share of micro-LED TV manufacturing costs, and their persistently high prices can be attributed to three factors. The first is the enormous number of chips used in TV manufacturing. For example, a 4K resolution TV requires 24.88 million micro-LED chips. Second, due to the diminutive size of micro-LED chips, their manufacturing process involves extremely stringent requirements regarding wavelength uniformity and cleanroom particle count. Finally, as micro-LED chips are smaller than 75μm, existing photoluminescence (PL) technologies are unable to fully detect defects in micro-LED chips, in turn increasing the difficulties in the mass transfer process of chips to backplanes.



With regards to backplane and driver technology, PCB backplanes paired with passive matrix (PM) are a relatively mature solution that has become the predominant choice for P>0.625mm pixel-pitch displays. But, for micro-LED TVs, which are smaller in size but maintain the same resolution, once their pixel pitch shrinks below 0.625mm challenges begin to arise with PCB backplane development, such as line width and line space, both of which can pose limits on mass production and increase manufacturing costs. Conversely, TFT glass backplanes paired with LTPS arrays can accurately control and drive the electrical circuits in micro-LED displays. So, this type of active matrix (AM)-equipped backplane is expected to become the mainstream technology of micro-LED TVs going forward.

Another technological challenge in backplane development is glass metallization. As displays approach increasingly high resolutions, they require correspondingly smaller gaps between modules. Now that traditional COF (chip on film) designs are no longer viable, manufacturers are instead routing the wirings on the surface of the TFT glass either from the side or through TGV (through glass via) processes. To achieve this routing, manufacturers need to use glass metallization technology. But, as many technological bottlenecks still remain with regards to glass metallization (such as low yield rate and high cost), manufacturers must work to overcome these barriers as the industry moves forward.

In terms of manufacturing process, the main hurdles in micro-LED development are twofold: mass transfer and testing/repairing. The 24.88 million micro-LED chips used in each micro-LED TV pose an enormous demand in terms of mass transfer yield rate, manufacturing time, and testing/repairing processes. At the moment, the industry's predominant mass transfer technologies consist of pick and place, laser transfer, fluidic assembly, magnetic mass transfer, roll-based transfer, and wafer bonding. The adoption of each respective mass transfer technology depends on the resolution of the display products as well as the size of micro-LED chips to be transferred, and each of these technologies comes with its own impact on production capacity, yield rate, and manufacturing equipment costs. That is why micro-LED production lines involve such a high degree of complexity. TrendForce believes that the mass transfer process in micro-LED TV manufacturing needs to reach a rate of at least 20 million UPH (units per hour) and a 99.999% yield for micro-LED TVs to be viable for wide commercial release.

www.ledinside.com

5G smartphone market share to rise from 19% to 43% this year

Sub-6GHz to comprise 81% of 5G phones; mmWave to reach 32% in 2022

The share of 5G smartphones in the global smartphone market is expected to increase to 43% this year, more than doubling from 19% last year as the number of mid- to low-end 5G smartphones rapidly increases, according to new data released by market research firm Omdia.

In the first release of its newly launched 'Smartphone Feature Forecast Database' covering first-half 2021, Omdia reports that 81% of 5G smartphones this year will support only Sub-6, the sub-6GHz mid- and low-frequency 5G that supports lower data transmission speeds. Meanwhile, 19% of 5G smartphones this year will support both millimeter-wave (mmWave) and Sub-6, the higher-frequency radio bands that offer higher transmission speeds.

However, as China commercializes mmWave service next year, and as major Asian countries start deploying mmWave service, the proportion of 5G smartphones that support mmWave is expected to increase to 32% of the total 5G smartphone shipments next year and continue to grow.

Elsewhere, the Omdia data show that low-end smartphones with set prices of $91–150 hold the largest share of the smartphone market, but the price of smartphone sets is continuing to rise due to increased demand for 5G smartphones and improved hardware features.

As demand for premium smartphones has also steadily increased recently, shipments of premium smartphones with a set price exceeding $751 are expected to exceed 200 million units for the first time this year, says Omdia.

https://technology.informa.com

Despite pandemic, GaAs device market bounces back

5G becomes revenue growth engine

After 2019 saw the first decline in over a decade, market revenue for RF gallium arsenide (GaAs) devices returned to growth in 2020 and will approach $9.5bn by 2025, according to the Strategy Analytics Advanced Semiconductor Applications (ASA) report 'RF GaAs Device Technology and Market Forecast: 2020 – 2025', which identifies 5G devices and networks as the primary driver. Wider deployment of millimeter-wave-capable 5G handsets and networks will be the main contributors to future RF GaAs device revenue growth.

"In the early part of 2020, things looked pretty serious for the GaAs device market," notes Eric Higham director of Strategy Analytics' Advanced Semiconductor Applications (ASA) and Advanced Defense System (ADS) service. "The market was starting to digest the impacts of the COVID pandemic and the US–China trade sanctions were weighing heavily on the entire electronics supply chain," he adds. "As 2020 progressed, it became clear that 5G device and network deployments would propel revenue growth in GaAs devices. As millimeter-wave 5G devices and networks become more widely deployed, the increased RF content will become the growth engine for the entire RF GaAs device market," Higham concludes.

www.strategyanalytics.com/

Skyworks and Qualcomm gain RF front-end market share despite challenges in 2020

China suppliers to gain share as OEMs increase use of domestic sources

Skyworks and Qualcomm gained market share in the RF front-end sector despite challenges in 2020, according to the report 'Power Amp & RF Front-end Share and Outlook: Skyworks & Qualcomm Make Gains' from Strategy Analytics.

"Demand for 5G mobile devices and semiconductor shortages helped push up prices and revenue for the RF front ends in cellular devices in 2020," says report author Christopher Taylor. "Downlink MIMO, carrier aggregation, higher frequencies, and wider channel bandwidths for 5G helped boost sales of the most advanced integrated RF FE solutions, leading to gains in market share for both Skyworks and Qualcomm," he adds.

"Suppliers Qorvo, Broadcom and Murata won significant slots in 5G mobile devices as well," notes Stephen Entwistle, VP of Strategic Technologies. "These firms have made significant advances in RF FE integration and filters in particular, a key aspect of the RF front-end. At the same time, suppliers in mainland China made technical and market advances, and it appears will take more RF FE share this year and in 2022 as Chinese OEMs attempt to increase their use of domestic suppliers," he concludes.

www.strategyanalytics.com

Smartphone shipments grow 17.4% from 555.4 million in first-half 2020 to 651.8 million units in first-half 2021

Xiaomi takes second place, behind Samsung

Global smartphone shipments grew 6.9% year-on-year (YoY) from 279.7 million units in second-quarter 2020 to 299.1 million in second-quarter 2021, according to Omdia.

First-half shipments grew 17.4% from 555.4 million in first-half 2020 to 651.8 million in first-half 2021.

In further signs of change in the global smartphone market, Xiaomi took the number 2 position for shipments in a quarter and the first half of the year for the first time. The firm shipped 49.9 million units in Q2/2021, second only to Samsung's 57.3 million. In first-half 2021, Xiaomi shipped 99.4 million units, behind only Samsung's 133.3 million. The era of Huawei as a key smartphone influencer has come to an end, believes Omdia.

Samsung took the top spot, shipping 57.3 million units, up 5.6% year-on-year on 54.3 million in Q1/2020. The mild growth was largely attributed to a supply constraint of key components and reduced operations at production facilities due to the spread of the Covid-19 Delta variant in India and Vietnam, where Samsung's main production bases are located.

Xiaomi reached second place in Q2/2021, shipping 49.9 million units — up 72.9% on Q2/2020. Xiaomi did not see shipments decline quarter to quarter, instead growing by just under 1% from Q1/2021 to Q2/2021. Xiaomi also saw a decrease in production due to the spread of the Covid-19 Delta variant in India in Q2/2021, but the decrease in shipments was relatively small compared with Samsung. On the other hand, a significant increase in sales outside the Asia-Pacific region, where the spread of the coronavirus is severe, is the main reason for the increase in shipments.

Apple, in third position, saw shipments increase 7.5% year-on-year, due to a recovery in demand in developed markets and an increase in demand for premium smartphones in emerging markets.

	OEM	1H21		1H20		YoY
		Shipment	M/S	Shipment	M/S	
1	Samsung	133.3	20%	113.2	20%	17.8%
2	Xiaomi	99.4	15%	56.6	10%	75.6%
3	Apple	98.0	15%	78.4	14%	24.9%
4	Oppo	70.3	11%	42.9	8%	64.0%
5	vivo	69.8	11%	43.2	8%	61.7%
6	Huawei	24.5	4%	74.0	13%	-66.9%
7	Motorola	23.2	4%	12.9	2%	79.2%
8	Realme	22.8	3%	10.3	2%	122.4%
9	Tecno	15.3	2%	8.8	2%	74.8%
10	iTel	11.5	2%	6.5	1%	78.2%
	Others	83.7	13%	108.8	20%	-23.1%
	Total	651.8	100%	555.4	100%	17.4%

OPPO and vivo reversed rankings again in Q2/2021. OPPO shipped 32.5 million units — slightly more than vivo's 31.6 million. Year-on-year, OPPO grew shipments by 44.7% and vivo by 33.5%.

Realme grew shipments by 174.5% from 4.2 million in Q2/2020 to 11.4 million units in Q2/2021, retaining 6th position globally again. Quarter-on-quarter, shipments were flat. Realme is one of the few OEMs that saw QoQ growth in Q2, along with Xiaomi and Honor.

Huawei shipped 9.8 million units in Q2/2021, down 33.3% on Q1/2021 and 74.6% on Q2/2020.

Motorola's shipments grew by 42.8% year-on-year, from 7.4 million units in Q2/2020 to 10.6 million in Q2/2021. But, quarter-on-quarter, Motorola's shipments fell by 15.9%.

Transsion holdings brand Tecno grew shipments by 35.7% year-on-year, from 5.3 million units in Q2/2020 to 7.1 million in Q2/2021.

Honor rounds out the top 10, shipping 6.7 million units, up 86.1% on Q1/2021.

The Q2 rankings also reflect those for first-half 2021 to a large extent.

Samsung leads with 133.3 million units shipped, compared to 113.2 million in first-half 2020.

With steady performance in the first two quarters, Xiaomi secures second place, at 99.4 million units.

Apple is in third place with 98 million units, up 24.9% on first-half 2020.

For first-half 2021, Huawei retains sixth place (24.5 million), but that is a drop of 66.9% year-on-year.

Motorola and Realme are close in seventh and eighth, with 23.2 million and 22.8 million units, respectively.

Instead of LG, iTel made 10th place. Transsion's sub-brands Tecno and iTel made it into the top 10. Including Infinix, Transsion is the 6th largest OEM worldwide.

"Despite the spread of the Corona Delta variant and the component shortages, smartphone shipments grew year-on-year in the second quarter," notes Jusy Hong, senior research manager, consumer devices. "However, Q3 shipments are expected to turn to negative growth compared to the previous year due to continued supply shortage and reduced demand," he cautions.

https://omdia.tech.informa.com

Qorvo's quarterly revenue grows as infrastructure recovers despite supply constraints

Full-year growth forecast raised as capacity expands to meet demand

For fiscal first-quarter 2022 (ended 3 July), Qorvo Inc of Greensboro, NC, USA has reported revenue of $1110.4m, up 3.5% on $1072.7m last quarter and up 41% on $787.5m a year ago (and over $30m above the midpoint of the $1065–1095m guidance).

Demand was broad-based and included new product categories such as 5G diversity receive modules, MEMS-based touch sensors and Wi-Fi 6E front-end modules (FEMs).

Infrastructure & Defense Products (IDP) revenue was $274m, down 14% on $319m a year ago (when there was very strong infrastructure demand) but recovering slightly by 3.4% on $265m last quarter as Wi-Fi and programmable power management growth continued and infrastructure growth resumed.

Mobile Product revenue was $836m, up 3.5% on $808m last quarter and 79% on $468m a year ago due to growth in higher-content 5G smartphones.

Mobile Products

In 5G handsets, customer demand for highly integrated modules is expanding, notes president & CEO Bob Bruggeworth. Highlights during the quarter included:

- launching a next-generation complete main-path solution, which includes low-band, mid-high-band and ultra-high-band modules, offering higher output power and enhanced MIMO support for upcoming 5G phones; and
- for the diversity path, sampling the firm's first 5G DRX, a sub-6GHz ultra-high-band (UHB) placement (offering what is claimed to be best-in-class receive sensitivity).

"We've entered the diversity market," notes Mobile Products Group president Eric Creviston. "A lot of the activity in next-generation 5G phones is around antenna management. So that part of our business, which has been strong for some time, continues to see a lot of design interest and customers asking us to even step up and take maybe a larger role in terms of determining the antenna control, the interfaces, the tuning and the antenna flexing and so forth in and out of the antenna."

"These main-path and diversity-path solutions integrate filtering and amplifiers that were formally discrete, helping our customers to save board space, improve device performance and accelerate product development efforts," says Bruggeworth.

Qorvo also announced interoperability of its family of ultra-wideband (UWB) products with Apple's U1 chip and the recently introduced Nearby Interaction protocol. "With more in-house software capability from our recent 7Hugs acquisition [last November], we now offer a complete solution, and we're working with customers on products combining our ultra-wideband hardware with our latest software release, shortening their time to market," says Bruggeworth. "We see a growing set of applications for our ultra-wideband solutions and customer design activity is accelerating."

In Wi-Fi for mobile handsets, Qorvo secured new reference design engagements with its Wi-Fi 6E chip-on-board front-end modules (which reduce insertion loss and enhance handset design flexibility – compared with system-in-a-package solutions – by enabling placement closer to the antenna).

Infrastructure & Defense Products

In infrastructure, Qorvo has increased shipments to major OEMs in support of 5G sub-6GHz massive MIMO (mMIMO) and macro deployments in the USA, Japan, Korea and Canada. The firm has also achieved initial design wins supporting mMIMO deployment in India, and secured BAW filter design wins with a major China-based OEM for 3.5GHz and 4.9GHz 5G small-cell applications. New product launches included gallium nitride (GaN) integrated power amplifier (PA) modules for mMIMO systems and a family of high-efficiency power amplifiers for 5G small cells serving densely populated areas.

In automotive, Qorvo achieved record revenue and shipped a broad range of solutions for leading automotive OEMs (driven mainly by the increased demand and expanding connectivity requirements for Wi-Fi, VDX, LTE and 5G), including MEMS-based touch sensor solutions enabling configurable smart interiors.

For the smart home, Qorvo has partnered with a leading supplier of home mesh networks to introduce the first Wi-Fi 6 router with integrated Bluetooth low energy (BLE), Thread and Zigbee multi-protocol operation, leveraging Qorvo's ConcurrentConnect technology.

Qorvo secured a bulk acoustic wave (BAW) filter design win with a leading supplier of high-end audio speakers to support pairing of Wi-Fi 6 and Bluetooth low energy. As a member of the Connectivity Standards Alliance and early participant in the upcoming matter connectivity standard, Qorvo expects to benefit as multi-protocol, seamless interoperability drives IoT adoption and growth.

In power management, Qorvo released 40V motor control solution supporting the ongoing transition to higher-voltage battery power tools. "Demand for our motor control and power management products has been very strong, driving growth in applications from appliances and battery power tools to enterprise compute, laptops and gaming. We are seeing demand for brushless DC motors expand into lower-cost power tools and smaller appliances, given the advantages in efficiency, size and reliability," notes Bruggeworth. "We are also leveraging the configurability of our power management solutions to address new applications in defense and other markets."

Operational performance

Fiscal Q1/2022 gross margin was 52.5%, down from last quarter's 52.6% but up from 48.6% a year ago (exceeding the 50% guidance), due to a more favorable product mix and pricing, improved manufacturing yields, good utilization and lower-than-expected inventory charges.

Operating expenses have risen from $178.7m a year ago and $207.5m last quarter to $215.6m (exceeding the expected $214m), driven by technology and product development expenses associated with key organic growth programs and recent acquisitions. But, as a proportion of revenue, OpEx has been cut from 22.7% a year ago to 19.4%.

Operating income has risen further, from $203.7m a year ago and $357.2m last quarter to $367m (operating margin of 33.1% — the third consecutive quarter over 33%).

Likewise, net income has risen, from $175.1m ($1.50 per diluted share) a year ago and $315.4m ($2.74 per diluted share) last quarter to $322.6m ($2.83 per diluted share, $0.38 above the $2.45 guidance).

Cash flow from operations was $341.6m. Capital expenditure (CapEx) remained high, at $65.3m (consistent with the level of spending to support the firm's outlook). Free cash flow was hence $276.3m.

During the quarter, Qorvo actually deployed $467m in cash. Specifically, Qorvo repurchased $300m of shares — the largest dollar amount since an accelerated share repurchase (ASR) program in the March 2016 quarter. Since its formation (from TriQuint and RF Micro Devices), Qorvo's has now repurchased a total of $3.7bn of shares at an average price of about $71 each.

Also, in early May Qorvo completed the acquisition of NextInput Inc of Mountain View, CA, USA, a pioneer in force-sensing human-machine interface (HMI) solutions utilizing MEMS-based sensors.

Overall, cash and cash equivalents hence fell during fiscal Q2/2022 from $1398m to $1200m.

Chief financial officer Mark Murphy notes that, in the last 12 months, Qorvo generated $1.2bn of free cash, and deployed about 80% of that (of which three-quarters was on share repurchases). Over the last eight quarters, Qorvo has generated $2bn of free cash, and deployed $2.1bn in cash (60% on repurchases and 40% on acquisitions). Including the acquisition in May 2019 of power management IC designer Active-Semi International, over the last nine quarters Qorvo has deployed 50% of its cash ($1.2bn) on acquisitions, increasing its total addressable market (TAM) by $4bn (which is expected to grow to over $10bn over the next several years), even excluding markets for the new BAW-based Omnia point-of-care diagnostic test platform of Qorvo Biotechnologies LLC.

Financial outlook

"End-market demand is robust, and our outlook is strong," Bruggeworth says. "Qorvo is investing in new product areas and differentiated technologies to broaden our reach and extend our leadership in integrated RF modules and other products."

For fiscal Q2/2022 (to end-September 2021), Qorvo expects revenue to grow to $1.235–1.265bn (up 13% sequentially and 18% year-on-year (or 27% after adjusting for last year's 14-week quarter). Mobile Products revenue should be $985m (up 18% sequentially and 31% year-on-year). IDP revenue is expected to fall slightly to $265m due to defense program timing and continued supply constraints.

Gross margin should be steady at 52–52.5%, up 55 basis points year-on-year, reflecting "ongoing portfolio management and sustained strong operating performance," says Murphy. Due to added labor and other development expenses associated with recent acquisitions and key growth programs, OpEx is projected to rise further to $233m. Despite this, operating margin should remain over 33% for a fourth consecutive quarter. Diluted earnings per share is forecasted to surge to $3.24.

As Qorvo works to meet demand and support long-term supply agreements with multiple customers, CapEx should increase to $75m (although this would still be only about 6% of revenue, compared with almost 20% in the past).

The outlook reflects "sustained and broad-based customer demand, driven by multi-year technology upgrade cycles," says Murphy. "We are off to a strong start in fiscal 2022, and we are well positioned to continue delivering premium technology to an expanding set of customers in 5G, Wi-Fi, IoT, defense, power management and other growth markets," he believes.

For fiscal third-quarter 2022 (to end-December 2021), revenue is expected to be "flattish" sequentially, with Mobile Products down slightly, counteracting IDP returning to sequential and year-on-year growth (albeit still less than $300m), due to the continued supply-constrained environment.

"We are bringing on internal capacity that really does start to help us as we go into the end of the calendar year," notes IDP president James Klein. "And the same note on our supply constraints from outside; those start to get significantly better as we go into our fourth quarter, with some improvement in the December quarter as well. So, I think that really allows us to move back into starting to grow in Q3 and Q4 for IDP," he adds.

For the fiscal fourth-quarter, Mobile Products will be down a bit seasonally, but IDP should continue to grow, surpassing $300m.

Gross margin is expected to level out at about 52% in fiscal second-half 2022, resulting in full-year gross margin a little above 52%. "We've stabilized around 52%, and the business is structurally better than it was," says Murphy.

The expectation for full-year fiscal 2022 revenue growth has now increased from "about 15%" to "well north of 15%, but probably less than 20%," says Murphy. "We also forecast another year of free cash flow growth while investing in capacity to support our outlook."

www.qorvo.com

Skyworks reports record fiscal Q3 revenue of $1.116bn, up 52% year-on-year

Design wins in Mobile & Broad Markets driven by 5G performance gains

Despite being its slowest seasonal quarter of the year, Skyworks Solutions Inc of Woburn, MA, USA (which manufactures analog and mixed-signal semiconductors) has reported record revenue for fiscal third-quarter 2021 (ended 2 July) of $1116.4m, down 4.7% on last quarter's record $1171.8m but up 52% on $736.8m a year ago and exceeding the midpoint of the $1075–1125m guidance, demonstrating "exceptional" performance across both Mobile and Broad Markets segments, says senior VP & chief financial officer Kris Sennesael.

Mobile revenue was up 52% year-on-year. "We capitalized on technology-rich content, powering an impactful set of 5G customers," says Sennesael.

Broad Markets revenue was up 50% year-over-year, benefiting from strong demand for IoT solutions, including Wi-Fi 6 and 6E, and smart audio, as well as emerging use cases in industrial and automotive markets.

In Mobile, Skyworks expanded the reach of its Sky5 portfolio, powering upcoming smartphone launches at tier-1 manufacturers including Google, Oppo, Vivo and Xiaomi.

In Internet of Things (IoT), Skyworks secured wins across a diverse set of customers. Specifically, it delivered Wi-Fi front-end modules to Facebook for their new portal launch, captured design wins at Peloton supporting home fitness applications, partnered with Linksys to debut the market's first Wi-Fi 6E mesh network system, and ramped additional Wi-Fi 6 and 6E platforms at Altice, Charter Communications and Aruba Networks. Skyworks also launched connected home and security solutions at Honeywell and shipped cognitive audio platforms to Samsung and Vizio for their home theater systems.

In wireless infrastructure, Skyworks continues to leverage its small-cell and advanced MIMO expertise in support of multiple tier-1 OEMs in Europe and Asia. Finally, in automotive, Skyworks strengthened its position across the global ecosystem, with its integrated solutions enabling advanced telematics systems for leading auto manufacturers.

On a non-GAAP basis, gross margin was 50.6%, down slightly from 50.8% last quarter but up on 50.1% a year ago.

Operating expenses have risen further, from $155m (13.2% of revenue) last quarter to $161m (14.5% of revenue), albeit still down on 18.9% of revenue a year ago, "demonstrating spending discipline while continuing our strategic investments to drive growth," says Sennesael.

Net income has fallen from last quarter's $395.2m ($2.37 per dilute share) to $358.6m ($2.15 per diluted share, although this is a record for fiscal Q3 and exceeded the $2.13 guidance). Also, this is up on $210.8m ($1.25 per diluted share) a year ago.

"Skyworks delivered record third quarter results, with strong year-over-year growth in both revenue and earnings per share," says chairman, CEO & president Liam K. Griffin.

Operating cash flow was $272.9m. Capital expenditure (CapEx) was $115m. During the quarter, Skyworks paid $83m in dividends. Net cash was hence about $1.5bn, comprising $2.98bn in cash & investments and $1.49bn in debt.

"An expanding array of usage cases — from mobile to automotive, cloud computing and intelligent energy management — is accelerating the adoption of 5G across numerous end-markets. Our decades-long experience and deep customer relationships, combined with the strength and scale of our internal fabrication capabilities, position Skyworks to enable a broad set of applications and opportunities," he adds.

"Looking ahead, we expect continued momentum as we execute on strong design wins with our Mobile and Broad Markets customers, levered by the performance gains of 5G," says Griffin. "We are seeing a tipping point with 5G acting as the catalyst transforming entire industries, from telemedicine and autonomous driving to factory automation and intelligent energy management," he adds. "By increasing efficiency, these 5G-enabled applications are also lowering carbon footprints and driving renewable energy. Skyworks is at the center of this unique technological shift and its reliance on wireless connectivity, with innovative solutions developed over 20 years and across multiple technology transitions. The combination of our innovative solutions, broad customer reach and unrivaled manufacturing scale drove another quarter of strong design-win execution."

"The recent addition [on 26 July] of the Infrastructure & Automotive business of Silicon Labs immediately adds unique technologies as we expand our addressable markets and lead across a wide range of diversified and differentiated solutions," says Griffin.

"Based on continued robust demand for connectivity solutions in Mobile and Broad Markets and the inclusion of a partial quarter of revenue from the recently completed acquisition of the Infrastructure & Automotive business from Silicon Labs, we expect further strong year-over-year growth in the September quarter," says Sennesael.

For fiscal fourth-quarter 2021, Skyworks expects revenue of $1.27–1.33bn, up 36% or (excluding the two months of revenue from

the I&A acquisition, which has a $100m per quarter run-rate) double-digit sequential growth in both Mobile and Broad Market segments.

Gross margin should be 51–51.5%, up 65 basis points sequentially and 85 basis points year-over-year (aided by the I&A business, which is running at about 60% gross margin). Operating expenses are expected to be $80–183m. diluted earnings per share of $2.53, up 37% year-on-year.

"Skyworks is clearly on track to deliver record financial results for fiscal 2021," believes Griffin. "The addition of the I&A business further propels our expansion into strategic growth segments. And, with a widening array of usage cases, the proliferation of 5G is driving significant momentum," he adds. "Our powerful cash generation capabilities, technology-centric operational scale, and global reach are fueling a robust design-win pipeline. And finally, the strength of our balance sheet allows us the flexibility to invest to win, while delivering consistent shareholder returns."

"Given our conviction in Skyworks' strategic outlook and predictable strong cash generation, we are announcing another substantial increase to our quarterly dividend," says Sennesael. Skyworks' board of directors has declared a cash dividend of $0.56 per share of common stock, representing a 12% increase from the prior quarterly dividend of $0.50 per share. The dividend is payable on 7 September to stockholders of record at the close of business on 17 August.

www.skyworksinc.com

Skyworks completes acquisition of Silicon Labs' Infrastructure & Automotive business

$2.75bn acquisition to aid growth in EV, industrial & motor control, power supply, 5G wireless infrastructure, optical datacoms and data-center segments

Skyworks Solutions says that it has completed its acquisition of the Infrastructure & Automotive business of Silicon Laboratories Inc of Austin, TX, USA (a provider of silicon, software and solutions) in an all-cash asset transaction valued at $2.75bn.

Over the past two decades, the Infrastructure & Automotive business has provided solutions to a highly diversified customer base. The acquisition encompasses the technology portfolios and related assets of Silicon Labs' power/isolation, timing and broadcast product lines, which are highly complementary to Skyworks' connectivity portfolio.

Mark Thompson, senior VP of Silicon Labs and general manager of the Infrastructure & Automotive business, joins Skyworks, reporting directly to Skyworks' chairman, CEO & president Liam K. Griffin. In addition, about 350 staff, including the senior management team of the business, join Skyworks.

"In addition to a strong legacy of innovation and execution, the Infrastructure & Automotive business brings a highly diversified customer base that will enable our continued expansion into strategic end-markets," comments Skyworks' chairman, CEO & president Liam K. Griffin. "Together, we will accelerate profitable growth in key industry segments, including electric and hybrid vehicles, industrial and motor control, power supply, 5G wireless infrastructure, optical data communications and data center."

www.skyworksinc.com

Nexperia acquires Newport Wafer Fab

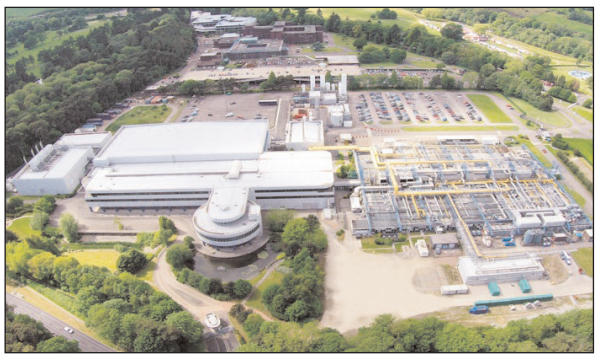
Nexperia Newport to focus on MOSFETs, IGBT, analog and compound semiconductor automotive-grade products

Nexperia BV of Nijmegen, Netherlands — which makes diodes, bipolar transistors, ESD protection devices, MOSFETs, gallium nitride (GaN) field-effect transistors (FETs) and analog & logic ICs — has acquired 100% of Newport Wafer Fab (NWF) in South Wales, the UK's 200mm silicon and compound semiconductor on silicon wafer foundry.

Nexperia was the Standard Products business unit of NXP Semiconductors (formerly Philips Semiconductors) until 2016 and has been a subsidiary of China-based Wingtech Technology since 2019. Certified to IATF 16949, ISO 9001, 14001 and OHSAS 18001 and with over 12,000 staff, Nexperia ships 90 billion products annually.

The Newport site was founded in 1982 as INMOS. Monthly capacity is over 35,000 200mm wafer starts, spanning silicon technologies ranging from MOSFETs and Trench IGBTs (insulated-gate bipolar transistors) using wafer-thinning methods to CMOS and analog, as well as compound semiconductors.

In 2017, NWF became the foundry and development center for the new south Wales-based CSconnected compound semiconductor cluster. Supported by the Welsh Government and Cardiff Capital Region (CCR) City Deal, CSconnected involves (as core partners) the Institute for Compound Semiconductors (ICS), Compound Semiconductor Centre (CSC, a joint venture between Cardiff University and IQE), the Future Compound Semiconductor Manufacturing Hub (CS Hub), the Compound Semiconductor Applications Catapult, and the Swansea University-based Centre for Integrative Semiconductor Materials (CISM). Business partners include equipment maker SPTS, epiwafer foundry and substrate maker IQE, device makers Rockley Photonics and MicroLink Devices. NWF was acting as a manufacturing site for about 20 multi-year R&D projects.



On 7 July, UK prime minister Boris Johnson directed the UK National Security Adviser to review if the acquisition presented national security implications. Nevertheless, statements filed by Wingtech with the UK's Companies House on 12 August and on the Shanghai stock exchange confirmed that the transfer of shares and ownership of NWF to Nexperia had been completed.

As a customer of the foundry services offered by NWF, Nexperia became its second largest shareholder in 2019. The Newport site complements Nexperia's other European plants in Manchester, UK and Hamburg, Germany, which have also seen significant recent investments.

The firm says Nexperia Newport will continue to have a strong position in the Welsh ecosystem and technology development and will secure the current jobs at the Newport site and others across the region.

Newport will support Nexperia's strategic $10bn growth target and enrich Nexperia's product lines in IGBT, analog and compound semiconductors in parallel to the current 8" investments at the Manchester and Hamburg wafer fabs. Nexperia reckons that the Newport acquisition significantly enhances its automotive-qualified product supply capability and market share.

"Nexperia has ambitious growth plans, and adding Newport supports the growing global demand for semiconductors," says chief operations officer Achim Kempe.

"The Newport facility has a very skilled operational team and has a crucial role to play to ensure continuity of operations," he adds.

"Nexperia is providing much-needed investment and stability for the future," comments Paul James, operations director at the Newport site. "We are keen to keep the current workforce. Additional local resources may be required too… We will be able continue to contribute to the local ecosystem," he adds.

"The change in ownership of the Newport site marks an important step for the future of the facility as well as for the region," believes Drew Nelson, departing chairman of Newport, and outgoing president & CEO of epiwafer foundry and substrate maker IQE plc of Cardiff, Wales. "We are able to maintain the expertise in developing high-end silicon devices in the 200mm wafer fab while at the same time opening up opportunities for us to add new semiconductor technologies."

On 5 July, the new firm Newport Wafer Fab 10 Ltd (named after the Fab 10 INMOS building) was registered with Companies House, with Nelson as sole director.

On 6 August, in an open letter in the South Wales Argus, Nexperia board member & general counsel Charles Smit said: "We have also agreed to the spin out of various ongoing Compound Semiconductor activities to a separate new organization, and Drew Nelson [former owner of Newport Wafer Fab] is providing his commitment, as we are, that we will work closely together to ensure this is done in a way which gets the best result for South Wales and preserves all the key initiatives of the Compound Semiconductor Cluster."

www.newportwaferfab.co.uk
www.nexperia.com

Fuji Electric
Innovating Energy Technology

Fuji Electric Lambda Series
Safety, Compact, Powerful

JIS EN

GB

Global Standard

The New Generation of Low Voltage Earth Leakage Circuit Breakers

- Compact! Ground Fault Protection Built in One Unit for Space Saving Designs
- Same Footprint! MCCBs & ELCBs Interchangeable without Panel Modifications
- 18mm Per Pole Width(2P & 3P), IEC 35mm DIN Rail Mounting
- Higher Capacity SCCR ⇒ 18kA@ 240VAC UL489
- Lock Out Tag Out (LOTO) safety devices (fixed and removal types) are available as option.

Fuji Electric Corp. of America Distribution & Control Department

For sales, product & distributor information, please visit https://americas.fujielectric.com/products/distribution-control/

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

Cree|Wolfspeed and ST expand 150mm SiC wafer supply agreement to over $800m

Cree Inc of Durham, NC, USA, and STMicroelectronics of Geneva, Switzerland have expanded their existing multi-year, long-term silicon carbide wafer supply agreement. The amended agreement, which calls for Cree to supply ST with 150mm SiC bare and epitaxial wafers over the next several years, is now worth more than $800m.

"This latest expansion to our long-term wafer supply agreement with Cree will continue to contribute to the flexibility of our global silicon carbide substrate supply," says STMicroelectronics' president & CEO Jean-Marc Chery. "It will continue to contribute importantly to our global silicon carbide supply, complementing the other external capacity we have secured and the internal capacity we are ramping," he adds. "The agreement will help meet the high volumes required by our product manufacturing operations in the next years, with a large number of automotive and industrial customer programs in high volumes or ramping up."

The adoption of SiC-based power solutions is rapidly growing across the automotive market as the industry moves from internal combustion engines to electric vehicles, enabling greater system efficiencies that result in electric cars with longer range and faster charging, while reducing cost, lowering weight and conserving space, notes Cree. In the industrial market, SiC solutions enable smaller, lighter and more cost-effective designs, converting energy more efficiently to unlock new clean energy applications. To better support these growing markets, device manufacturers are interested in securing access to high-quality silicon carbide substrates to support their customers.

"STMicroelectronics will continue to leverage Wolfspeed silicon carbide materials as part of their supply strategy for the next several years," says Cree's CEO Gregg Lowe. "Our long-term wafer supply agreements with device manufacturers now total more than $1.3bn and help support our efforts to drive the industry transition from silicon to silicon carbide," he adds. "Our partnerships and significant investments in increased production capacity ensure we are well positioned to capitalize on what we believe to be is a multi-decade growth opportunity for SiC-based applications."

www.st.com
www.cree.com

Cree expands operations leadership team

Director of Marcy silicon carbide fab construction to oversee fab operations, planning and quality

Cree has expanded its operations leadership team as part of its accelerated growth and capacity expansion plans and planned retirement of Rick McFarland, senior VP of global operations, in Summer 2022.

Rex Felton, currently directing the construction of the new silicon carbide facility in Marcy, NY, will now oversee the firm's fab operations, planning functions and quality efforts, reporting to CEO Gregg Lowe. McFarland will continue to lead the company's materials and back-end operations along with facilities and procurement activities through first-half 2022 and assist Felton with the transition.

"As we continue to drive the industry's transition from silicon to silicon carbide, it is critically important that we continue to scale our operations to meet the growing needs of our customers. Rick has done an incredible job of helping us position the company for long-term growth and improve performance across our operations footprint. We appreciate his willingness to support an orderly transition prior to his retirement and we believe Rex is the perfect leader for the organization going forward," said Lowe.

Felton joined Cree in 2019 and currently serves as senior VP of fab operations. Prior to joining Cree, he was VP of powertrain electronics operations at Delphi Technologies, responsible for powertrain electronics, electrification manufacturing facilities, and associated support functions. Prior to Delphi, Felton was senior wafer fab manager for Texas Instruments' three Dallas fabs and the Operations Fab/Assembly Test Site in Chengdu, China. Felton was also general manager for DMOS 5, TI's largest fab in terms of size and volume, and home to the company's most advanced ICs for analog, logic and embedded memory.

Cree has also appointed Missy Stigall as the new VP of fab operations based in North Carolina, reporting directly to Felton. She joins Cree with more than 20 years of engineering and people leadership experience at Texas Instruments. As a former factory and site manager for a high-volume wafer fab, she has extensive expertise in overseeing large-scale manufacturing operations. In this role, she pioneered and managed high-visibility global projects in collaboration with executive leadership and cross-functional teams while also orchestrating a high-performing workforce, says Cree.

STMicroelectronics manufactures its first 200mm silicon carbide wafers

Transition from 150mm marks milestone in capacity build-up to support automotive and industrial markets

Semiconductor device maker STMicroelectronics of Geneva, Switzerland has manufactured the first 200mm (8-inch) silicon carbide (SiC) bulk wafers for prototyping next-generation power devices from its facility in Norrköping, Sweden.

The transition to 200mm SiC wafers marks a key milestone in the capacity build-up for ST's customer programs in automotive and industrial sectors. Silicon carbide allows for more efficient power conversion, lighter and more compact designs, and lower overall system-design costs — all key parameters and factors for automotive and industrial systems, the firm notes.

ST says that its initial 200mm SiC wafers have minimal yield-impacting and crystal-dislocation defects. The low defectivity has been achieved by building on the expertise in SiC ingot growth technology developed by Norrkoping-based STMicroelectronics Silicon Carbide A.B. (formerly Norstel A.B., which ST acquired in 2019).

In addition to meeting the quality challenge, the transition to 200mm SiC substrates requires a step forward in manufacturing equipment and the overall support ecosystem performance. In collaboration with technology partners covering the entire supply chain, ST is hence developing its own 200mm SiC manufacturing equipment and processes.

ST currently manufactures its high-volume STPOWER SiC products on two 150mm wafer lines in its fabs in Catania (Italy) and Ang Mo Kio (Singapore) and performs assembly & test at its back-end sites in Shenzhen (China) and Bouskoura (Morocco). The latest milestone comes as part of the firm's planned move to more advanced, cost-efficient 200mm SiC volume production. This transition is within the firm's ongoing plan to build a new SiC substrate plant and source over 40% of its SiC substrates internally by 2024.

"The transition to 200mm SiC wafers will bring substantial advantages to our automotive and industrial customers as they accelerate the transition towards electrification of their systems and products," says Marco Monti, president of STMicroelectronics' Automotive and Discrete Group. "It is important in driving economies of scale as product volumes ramp," he adds. "Building robust know-how in our internal SiC ecosystem across the full manufacturing chain, from high-quality SiC substrates to large-scale front- and back-end production, boosts our flexibility and allows us to better control the improvement of yield and quality of the wafers."

www.st.com

ROHM launches hybrid IGBTs with built-in 650V SiC diode

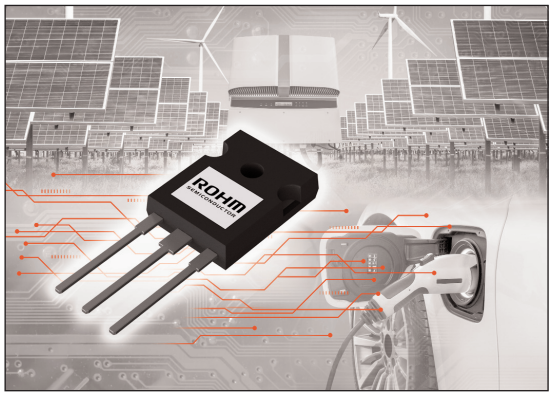
Lower loss and power consumption while improving cost performance

Power semiconductor maker ROHM has developed the RGWxx65C series of hybrid insulated-gate bipolar transistors (IGBTs) with an integrated 650V silicon carbide (SiC) Schottky barrier diode (SBD). After making samples available in March, mass production is scheduled for December.

Qualified under the AEC-Q101 automotive reliability standard, the RGW60TS65CHR, RGW80TS65CHR and RGW00TS65CHR are suitable for automotive and industrial applications that handle large power, such as photovoltaic power conditioners, onboard chargers, and DC/DC converters used in electric and electrified vehicles (xEV).

The RGWxx65C series utilizes ROHM's low-loss SiC Schottky barrier diodes in the IGBT's feedback block as a freewheeling diode that has almost no recovery energy and thus minimal diode switching loss. Additionally, since the recovery current does not have to be handled by the IGBT in turn-on mode, the IGBT turn-on loss is reduced significantly. Both effects together result in up to 67% lower loss over conventional IGBTs and 24% lower loss compared with super-junction MOSFETs (SJ MOSFETs) when used in vehicle chargers, it is reckoned. This effect provides good cost performance while contributing to lower power consumption in industrial and automotive applications, the firm adds.

In recent years, global efforts to reduce environmental burden and achieve a carbon-neutral and decarbonized society have spurred the proliferation of electric vehicles (xEV), notes ROHM. At the same time, the diversification of power semiconductors used in various vehicle inverter and converter circuits necessary to configure more efficient systems is currently underway,

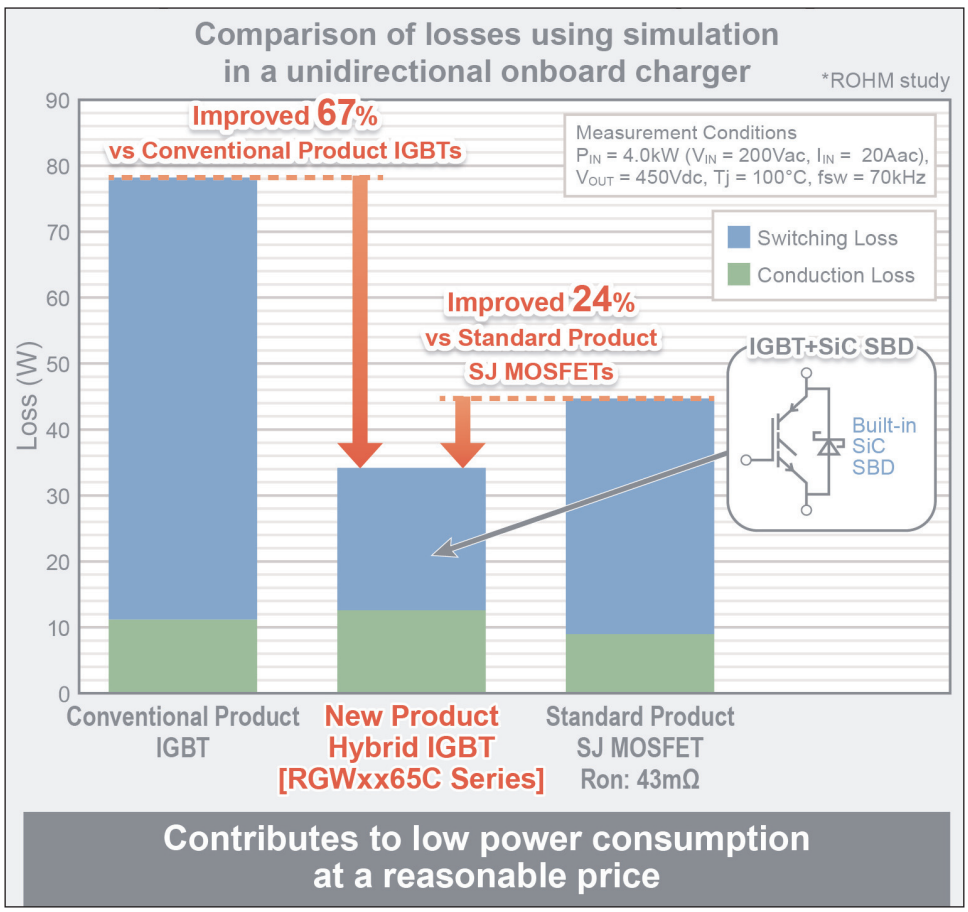


along with the technological innovation of both ultra-low-loss SiC power devices (SiC MOSFETs, SiC SBDs) and conventional silicon power devices (e.g. IGBTs, super-junction MOSFETs).

ROHM says that, to provide effective power solutions for a wide range of applications, it is focusing not only on product and technology development for SiC power devices but for silicon products and driver ICs as well.

In addition to the new hybrid IGBTs, ROHM also offers products utilizing silicon fast recovery diodes (FRDs) as the freewheeling diode as well as products without a freewheeling diode.

www.rohm.com/products/igbt/field-stop-trench-igbt/



Part No.	Withstand Voltage V_{CES} (V)	Collector Current I_C@100°C (A)	Conduction Loss $V_{CE(sat)}$ Typ (V)	Freewheeling Diode	AEC-Q101 Qualified	Package
New RGW60TS65CHR	650	30	1.5	SiC SBD	YES	TO-247N
New RGW80TS65CHR		40				
New RGW00TS65CHR		50				
☆ RGW40NL65CHRB		20				TO-263L (LPDL)
☆ RGW50NL65CHRB		25				
☆ RGW60NL65CHRB		30				

☆: Under Development

Package indicates JEDEC code. ( ) denotes ROHM package type.

Littelfuse extends SiC Schottkys range to 1700V

Fast and low-loss switching for data centers, building automation and high-power electronics

Littelfuse Inc of Chicago, IL, USA, which provides circuit protection technologies (including fuses, semiconductors, polymers, ceramics, relays and sensors), has expanded its portfolio of silicon carbide (SiC) Schottky barrier diodes to include the 1700V-class.

The LSIC2SD170Bxx Series SiC Schottky diodes are available in the TO-247-2L package with a choice of current ratings (10A, 25A or 50A). Offering power electronics system designers a variety of performance advantages, including close-to-zero reverse recovery current, high surge capability and a maximum operating junction temperature of 175°C, they are suitable for applications that require enhanced efficiency, reliability and simplified thermal management.

SiC Schottky barrier diodes suit a wide range of AC/DC and DC/DC power converters for industry, energy generation and distribution/storage, including: industrial switch-mode power supplies (SMPS); uninterruptable power supplies (UPS); battery chargers; solar inverters; industrial motor drives; and high-speed rectifiers.

"Using SiC diodes in power designs instead of diodes based on legacy silicon-based technology helps designers develop more energy-efficient power converters, saving energy and reducing costs related to cooling the power electronics," says Francois Perraud, product marketing manager, SiC Products, at Littelfuse. "They enable the design of faster-switching power electronics in the converters which can then be made more compact at the same output power or pack more power in the same volume."

The LSIC2SD170Bxx SiC Schottky diodes are said to offer the following key benefits:

- positive temperature coefficient of the forward voltage for safe operation and ease of paralleling;
- extremely fast temperature-independent switching;
- dramatically reduced switching losses compared with silicon bipolar diodes and
- optimized overall system efficiency.

The LSIC2SD170Bxx SiC Schottky diodes are available in the TO-247-2L package, in tube, with a minimum order quantity of 450 devices. Sample requests can be placed through authorized Littelfuse distributors worldwide.

www.littelfuse.com

UnitedSiC launches FET-Jet Calculator version 2

Enhancements ease identifying optimal SiC FET design solutions

Silicon carbide (SiC) power semiconductor manufacturer United Silicon Carbide Inc (UnitedSiC) of Princeton, NJ, USA has launched an upgrade to its FET-Jet Calculator. The new version (v2) significantly streamlines the SiC FET and Schottky diode selection process and simplifies the analysis of all power-related results.

First launched in March, the simple, registration-free online tool facilitates the designer's selection and performance comparison process, in different power applications and 26 unique topologies. With more available topologies, FET-Jet Calculator now supports an even wider range of power applications, making UnitedSiC FETs accessible to anyone looking to work with SiC for the first time or experienced designers seeking the best SiC device to suit their design.

Allowing for engineers to identify the optimal UnitedSiC device across AC/DC, DC/DC and DC/DCiso power designs, the upgrade adds instant bar chart results presenting both losses and efficiency data. Optimal gate drive and snubber recommendations are also displayed. Finally, once the preferred SiC solution is defined, all input/output design information can be easily downloaded in pdf form.

As with the first version of the calculator, users select their application function and topology, enter their design parameter details, and the tool automatically calculates switch current, efficiency and losses, categorized by conduction, turn-on and turn-off contributions. All UnitedSiC FETs and Schottky diodes can be selected from sortable tables including the latest Gen 4 750V devices. The tool also warns if a selection is not suitable, allowing engineers to quickly find the ideal design solution.

The new version significantly streamlines the SiC FET and Schottky diode selection process and simplifies the analysis

"The purpose of the FET-Jet Calculator has always been to make selecting the right device in the right power topology as easy as possible," says Anup Bhalla, vice president of engineering. "With these updates, we continue to remove barriers to the switch to SiC," he adds.

"An intuitive user interface (UI) that simply and instantly displays the most vital performance data speeds up R&D by quickly discounting inappropriate devices," Bhalla notes.

The FET-Jet Calculator is free to use, with no registration required.

https://info.unitedsic.com/fet-jet

Renesas launches plastic-packaged rad-hard ICs for medium/geosynchronous orbit satellites

New range complements radiation-tolerant plastic-package ICs for smallsats in LEO

Renesas Electronics Corp of Tokyo, Japan has launched a line of plastic-packaged radiation-hardened (rad-hard) devices for satellite power management systems. The four new devices include the ISL71001SLHM/SEHM point of load (POL) buck regulator, ISL71610SLHM and ISL71710SLHM digital isolators, and the ISL73033SLHM 100V GaN FET and integrated low-side driver.

Combining rad-hard assurance levels with the board area savings and cost advantages of plastic packaging, the new portfolio brings space-grade solutions to missions in medium/geosynchronous Earth orbit (MEO/GEO) with longer lifetime requirements, as well as small satellites (smallsats) and higher-density electronics, while reducing size, weight and power (SWaP) costs.

The new ICs also complement the radiation-tolerant plastic-package ICs that Renesas introduced in 2017 for smallsats in low Earth orbit (LEO). Together, Renesas' plastic IC lineup supports multiple orbit ranges, providing the radiation performance and optimal cost balance required for a variety of satellite subsystems and payloads.

"With every new mission, customers want more functionality, which requires larger satellite payloads and has traditionally translated into increased SWaP for the satellite systems," says Philip Chesley, VP, Industrial and Communications business division. "With Renesas' new ICs, customers can enjoy the SWaP advantages of plastic packaging to save up to 50% of the board area compared to ceramic-packaged devices, while maintaining the reliability and radiation assurance required for higher-orbit missions with lifespans ranging up to and beyond 15 years."

Traditionally, radiation-hardened ICs were almost exclusively produced using hermetically sealed ceramic packages, which achieved the required reliability but had significant tradeoffs in terms of size and weight. Renesas says that its new rad-hard plastic ICs help customers to reduce their electronics footprint and cost without compromising performance.

To ensure that the plastic ICs adhere to the highest quality for operation in harsh space environments, the new devices feature QMLV-like production-level testing, and all devices will undergo radiation lot acceptance testing (RLAT).

The production test flow includes 100% CSAM, x-ray, temperature cycling, static and dynamic burn-in, and visual inspection, and aligns with the SAE AS6294/1 standard for plastic-encapsulated microelectronics in space. Additional screening includes lot assurance testing per assembly and wafer lot product for HAST, life testing, and moisture sensitivity.

The rad-hard ICs are characterization tested at a total ionizing dose (TID) of up to 75krad(Si) for low dose rate (LDR) and at a linear energy transfer (LET) of 60MeV•cm^2/mg or LET 86MeV•cm^2/mg for single-event effects (SEE). The ISL71001SEHM is rated at TID up to 100krad(Si) for high dose rate (HDR).

Key features of the ISL73033SLHM low-side driver and 100V GaN FET include:

- combining a GaN FET driver and GaN FET in a single package to simplify gate design and improve efficiency;
- reducing area size by 20% compared with an SMD 0.5 rad-hard MOSFET;
- V_{DS} = 100V and I_{DS} = 30A with 7.5mΩ (typ) R_{DSON};
- ultra-low total gate charge of 14nC (typ);
- integrated driver featuring 4.5V regulated gate drive voltage and 3A/2.8A sink/source capability.

Key features of ISL71610SLHM and ISL71710SLHM digital isolators include:

- giant magneto-resistive (GMR) isolation technology delivering better radiation tolerance compared with existing space-grade opto-couplers on the market;
- 2.5kVRMS isolation;
- up to 100Mbps data rates for the ISL71610SLHM and 150Mbps for the ISL71710SLHM;
- 1.3mA quiescent current and low EMI with no carrier or clock noise.

Key features of ISL71001SLHM/SEHM buck regulator include:

- 6A synchronous POL regulator enabling high power conversion efficiency in a smaller package;
- 95% peak efficiency;
- fixed 1MHz switching frequency;
- adjustable output voltage.

Since Renesas offers power management products that can be used in multiple power distribution architectures, customers can add the new rad-hard plastic ICs to their existing architecture with a new package type and production flow. The ISL71610SLHM and ISL71710SLHM ICs can also be combined with Renesas' rad-hard and rad-tol CAN bus transceiver and RS-422 transceiver product families for use in serial communications systems.

The ISL71610SLHM, ISL73033SLHM and ISL71001SLHM are available now. The ISL71710SLHM will be available in September and the ISL71001SEHM will be available in fourth-quarter 2021.

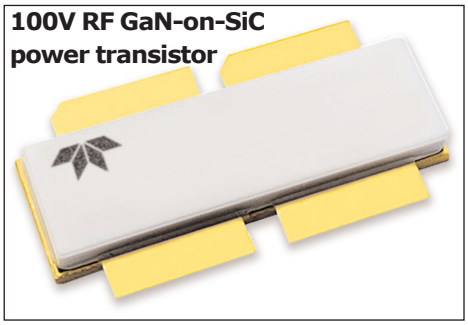
www.renesas.com/radhardplastics

Teledyne e2v HiRel partners with Integra to launch first 100V GaN/SiC RF power technology for avionics

Doubling power of 50V transistor eliminates combiners and electronics, for lower system volume, weight and cost, and higher system efficiency

Teledyne e2v HiRel Electronics of Milpitas, CA, USA (part of the Teledyne Defense Electronics Group that provides solutions, sub-systems and components to the space, transportation, defense and industrial markets) is to offer high-reliability-qualified versions of the new 100V gallium nitride on silicon carbide (GaN/SiC) power transistors of Integra Technologies Inc (ITI) of El Segundo, CA, USA, which is claimed to be the first 100V RF GaN/SiC technology for mission-critical defense applications.

Targeting radar, avionics, electronic warfare (EW), industrial, scientific and medical systems, Integra's newly announced 100V RF GaN/SiC high-electron-mobility transistor (HEMT) technology is said to gives designer the ability to dramatically increase system power levels and functionality while simplifying system architectures with less power-combining circuitry compared with the more common-place 50V and 65V GaN technologies. Customers ultimately benefit with a smaller system footprint and lower system cost.



100V RF GaN-on-SiC power transistor

"By delivering about twice the power of a 50V GaN transistor in a single package, it will eliminate a significant number of combiners and associated electronic circuitry, resulting in lower system volume, weight and cost, and higher system efficiency," comments aerospace & defense radar systems architect and technology executive Dr Mahesh Kumar.

"This innovative technology removes the barriers limiting system performance today and allows new architectures previously not possible," says Integra's president & CEO Suja Ramnath. "This disruptive technology will enable our customers to deliver a new generation of high-performance, multi-kiloWatt RF power solutions while reducing their design cycle time and product costs," he adds.

Teledyne will qualify Integra's first 100V product, the IGN1011S3600, which offers 3.6kW of output power over an operating frequency range of 1030-1090MHz, greater than 19dB of large-signal gain, and efficiency of up to 75% (during the RF pulse) in a single GaN transistor, designed specifically for next-generation avionic systems. Teledyne HiRel will provide further assurance for military and new space applications. The IGN1011S3600 100V RF GaN/SiC is available for sampling to qualified customers.

"Our most demanding customers are requesting higher-power-density RF power devices," says Brad Little, VP & general manager of Teledyne e2v HiRel. "Adding additional screening and qualifications for the new devices will assure long operational life in even the harshest environments."

www.integratech.com
www.tdehirel.com

Mission's 200W Ka-band GaN solid-state BUC orders for 2021 delivery exceed $8m

Mission Microwave Technologies LLC of Cypress, CA, USA, which manufactures gallium nitride (GaN)-based solid-state power amplifiers (SSPAs) and block up-converters (BUCs), says that it continues to receive new and follow-on orders for its 200W Titan BUCs for use in a variety of satellite constellations. While terminal integrator customers have been deploying the Ka-band Titan BUC in volume since 2017, Titan Ka-band BUC orders placed and scheduled for delivery in 2021 have exceeded $8m.

"Mission Microwave's customers rely on us to deliver the highest performance and throughput from their satellite networking systems," says Steve Richeson, VP of sales & marketing. "Our customers' rapid adoption of our 200W and larger Ka-band products validates the need for extremely high-power solid-state amplifiers in Ka-band," he adds. "We expect our business for Ka-band amplifiers above 200W to continue to grow through the decade, as our customers confirm our market leadership in this growing sector of the space industry."

In 2020, Mission announced its first 400W Ka-band products and has been working closely with both commercial and government system operators to bring the benefits of high-power Ka-band solid-state amplifiers to the SATCOM market. The firm expects significant deployment of these amplifiers in 2022 in addition to the growth in the 200W amplifier product lines.

Mission Microwave is exhibiting its entire line of X-, Ku- and Ka-band solid-state products at the Satellite 2021 conference in National Harbor, Maryland (8–10 September).

www.missionmicrowave.com

NXP incorporates GaN in MCMs to boost efficiency in 5G mobile infrastructure

NXP Semiconductors N.V. of Eindhoven, The Netherlands has announced what it reckons is a milestone for 5G energy efficiency with the integration of gallium nitride technology to its multi-chip module platform. Building on its investment in its GaN fab in Arizona, which is dedicated to RF power amplifiers, NXP claims to be first to announce RF solutions for 5G massive MIMO that combine the high efficiency of GaN with the compactness of multi-chip modules.

Reducing energy consumption is a major goal for telecom infrastructure. The use of GaN in multi-chip modules increases lineup efficiency to 52% at 2.6GHz — 8 percentage points higher than the firm's prior module generation. Also, NXP has further improved performance with a proprietary combination of silicon-based LDMOS and GaN in a single device, delivering 400MHz of instantaneous bandwidth that makes it possible to design wideband radios with a single power amplifier.

This energy efficiency and wideband performance are now available in the small footprint of NXP's 5G multi-chip modules. NXP says that the new portfolio can enable RF developers to reduce the size and weight of radio units, helping mobile network operators to lower the cost of deploying 5G on cellular towers and rooftops. In a single package, the modules integrate a multi-stage transmit chain, 50Ω in/out matching networks and a Doherty combiner — and NXP is now adding bias control using its latest silicon germanium (SiGe) technology. This new step in integration removes the need for a separate analog control IC and provides tighter monitoring and optimization of power amplifier performance.

The new portfolio can enable RF developers to reduce the size and weight of radio units, helping mobile network operators to lower the cost of deploying 5G on cellular towers and rooftops

"NXP has developed a unique technology toolbox dedicated to 5G infrastructure that includes proprietary LDMOS, GaN and SiGe, as well as advanced packaging and RF design IP," says Paul Hart, executive VP & general manager of NXP's Radio Power business line. "This enables us to leverage the benefits of each element and combine them in the most optimal way for each use case," he adds.

Like the previous module generation, the new devices are pin-to-pin compatible. RF engineers can rapidly scale a single power amplifier design across multiple frequency bands and power levels, reducing design cycle time and accelerating the roll-out of 5G around the globe, says the firm.

The new 5G multi-chip modules will sample in third-quarter 2021, with production starting later this year. The devices will be supported by NXP's new RapidRF series of RF front-end board designs that help to accelerate the design of 5G systems.

www.nxp.com/5G

Advantech delivers new 8.5kW ultra-high-power SSPA system to satcom system integrator

Advantech Wireless Technologies Inc of Montreal, Canada (which manufactures satellite, RF equipment and microwave broadband communications systems) has delivered its 8.5kW ultra-high-power modular Summit II solid-state power amplifier (SSPA) system to a major satcom system integrator.

Available in C-, X-, Ku- and S-band architectures, Summit II systems are designed using the latest gallium nitride device technology and operate over the latest controlled area network (CAN) bus M&C protocol for maximum speed and reliability.

"Our 8.5kW modular SSPA system set a new record in terms of RF output power, thanks to our core module design and a highly efficient phase-combining network," notes president John Restivo.

The newly designed Summit II systems consist of four, eight or sixteen high-power SSPAs packaged in ruggedized, outdoor enclosures and integrated into a single frame structure that includes combiners, loads, power distribution and M&C – suited to fixed and full-motion antenna installations. Modular architecture with 1 N built-in redundancy and field-replaceable amplifiers minimizes downtime, resulting in the highest service availability in the industry, it is said.

"Our Summit II ultra-high-power SSPA systems are designed for any application that requires a solid-state high-power amplifier system able to deliver lots of reliable RF power, including DTH, deep space, TT&C and defense," says Tony Radford, VP of global sales. "Self-redundancy and modular construction ensure hundreds of thousands of availability-hours with minimal sparing costs."

www.advantechwireless.com/summit-II

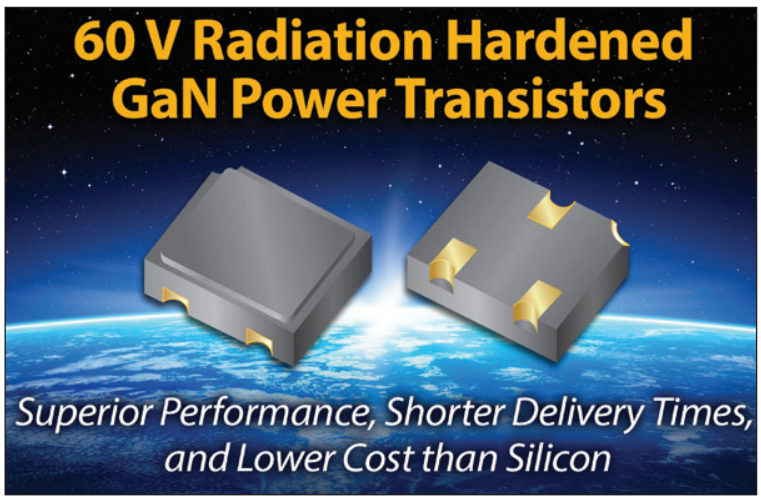
EPC Space launches cost-effective 60V rad-hard gallium nitride power device

GaN transistor targeted at power conversion in critical spaceborne and other high-reliability environments

EPC Space LLC of Haverhill, MA, USA has introduced the EPC7014UB, a 60V radiation-hardened gallium nitride (GaN) transistor that is said to be lower in cost and a more efficient solution than the nearest comparable radiation-hardened (RH) silicon MOSFET. Utilizing GaN technology, the EPC7014UB outperforms RH silicon-based devices as it offers higher breakdown strength, faster switching speed, and lower on-resistance than other RH power devices, adds the firm.

Lower resistance and gate charge enable faster power supply switching frequencies, resulting in higher power densities, higher efficiencies, and more compact and lighter-weight circuitry for critical space missions.

The EPC7014UB is a 60V, 580mΩ, $4A_{Pulsed}$, rad-hard eGaN FET in an industry-standard UB package. It has a total dose rating greater than 1Mrad and SEE immunity for LET of 85MeV/(mg/cm^2). The devices are also offered in a chip-scale package from EPC.



Applications benefiting from this performance include power supplies for satellites and space mission equipment, light detection and ranging (LiDAR) for robotics and autonomous navigation and rendezvous docking, motor drives for robotics, instrumentation and reaction wheels, and ion thrusters for satellite orientation and positioning, as well as interplanetary propulsion of low-mass robotic vehicles. Additionally, the EPC7014UB can be used as a gate driver interface between CMOS or TTL control circuits and power devices in a radiation-hardened environment.

"GaN technology enables a new generation of power conversion and motor drives in space operating at higher frequencies, higher efficiencies, lower cost and greater power densities than achievable with rad-hard silicon," notes EPC Space's CEO Bel Lazar. "We are excited about this technology's ability to provide mission-critical components for the space and other high-reliability markets".

Space-level-grade pricing (in 500-unit quantities) starts at $160/each.

www.epc.space/products/gan-discretes/EPC7014UB

EPC Space's rad-hard GaN power devices chosen by Astranis for small geostationary communications satellites

15% greater lifetime, 20% greater throughput, without raising hardware costs

EPC Space LLC of Haverhill, MA, USA has been selected by Astranis to provide rad-hard gallium nitride (GaN)-based power devices for use in DC power supplies on the latest satellite build. Astranis announced earlier that it has started to build four new small geostationary communications satellites, three of which are already spoken for signed deals with new, yet-to-be-announced customers.

This new build of Astranis satellites is expected to offer 15% greater lifetime and 20% greater throughput than the first-generation model, without increasing satellite hardware costs.

Astranis is building small, low-cost telecommunications satellites to connect the 4 billion people who currently do not have access to the Internet. Each spacecraft operates from geostationary orbit (GEO) with a next-generation design weighing only 400kg. By owning and operating its satellites and offering them to customers as a turnkey solution, Astranis can provide bandwidth-as-a-service and unlock previously unreachable markets, it is reckoned.

The rad-hard GaN power devices that EPC Space is providing to Astranis provide high precision, small size, low weight, and can withstand the harsh environment of space.

"This program will add to the tens of thousands of our units already on board of satellites flying in LEO and GEO orbit with mission lives of more than 10 years," says EPC Space's CEO Bel Lazar.

www.astranis.com
www.epc.space/space-systems/dc-dc-converters

Xiaomi launches third fast-charger based on Navitas' GaNFast power ICs

65W dual-output fast charger designed and made by Cuktech

Navitas Semiconductor of El Segundo, CA, USA and Dublin, Ireland says that China's Xiaomi has launched its third GaNFast charger, a 65W dual-output fast charger. The 65W 1A1C has a USB-C output of up to 65W to power laptops and fast-charge smartphones via USB-PD 3.0, QC and PPS fast-charging protocols, with an extra USB-A output up to 18W in order to conveniently - and simultaneously - charge another phone or accessory such as headphones.

The new GaN charger can power the Xiaomi Mi11 from 0% to 100% charge in only 45 minutes. Due to high-speed GaN power ICs, the charger has a small size of only 69cc with folding AC-pins – a 30% reduction versus Xiaomi's previous silicon-based designs - and a weight of just 104g for portability. The charger is available now from Xiaomi for a retail price of 149RMB (about US$23).

Gallium nitride (GaN) is reckoned to run up to 20x faster than legacy silicon chips. Navitas' proprietary GaN power ICs integrate GaN power field-effect transistors (FETs) and GaN drive plus control and protection circuitry in a single SMT package. The firm says that these GaNFast power ICs become easy-to-use, high-speed, high-performance 'digital-in, power-out' building blocks and deliver up to 3x faster charging in half the size and weight, and with up to 40% energy savings compared with earlier silicon solutions. An estimated $13.1bn electrification opportunity includes mobile fast chargers and adapters, data centers, solar energy, and electric vehicles (EVs).

Xiaomi's 65W 1A1C GaN charger was designed and manufactured by R&D company Nanjing Kuke Electronic Technology Co Ltd (Cuktech) and uses the NV6115 GaNFast power IC in a high-frequency, soft-switching topology, with robust 650V/800V rating and up to 2MHz high-speed switching in a small-footprint 5mm x 6mm QFN package, which is key to achieving high reliability and small size.

"GaNFast power ICs have been recognized and trusted by brand manufacturers and consumers for its simple design, ease-of-use and ultra-high integration," comments Cuktech's CEO Dr Wei Chen. "The high reliability of GaNFast power ICs also makes our products recognized and trusted by brand manufacturers and consumers. The cooperation with Navitas and Xiaomi will accelerate the expansion of consumer GaN charger market in the future and achieve a win-win situation for all parties," he adds.

"Xiaomi's openness to new materials and technologies, and its continued commitment to gallium nitride, demonstrates Xiaomi's recognition of the advantages of GaN devices over traditional silicon devices," comments Navitas Semiconductors' CEO Gene Sheridan. "It is a long and successful partnership, introducing a series of world-class chargers, and celebrating mass-production milestones, as when we presented Xiaomi with a special award for their receiving the 10,000,000th GaNFast power IC back in November 2020."

Navitas and Xiaomi say that they will continue to work closely on technology. GaNFast power ICs not only enable Xiaomi's charger products to be smaller in size while maintaining the same power, but they also have a 10x lower CO_2 emission footprint than legacy silicon chips, it is reckoned, contributing to Xiaomi's carbon neutrality program.

www.navitassemi.com

Comtech awarded $3.6m in contracts for military X-band SSPAs and BUCs

Comtech Telecommunications Corp of Melville, NY, USA says that, during its fiscal fourth-quarter 2021, it was awarded contracts totaling $3.6m from a US system integrator for X-band solid-state power amplifiers (SSPAs) and block upconverters (BUCs) for transportable satellite communication terminals.

Secure and available satellite communications are required to support all phases of a mission from the command center to the tactical edge. Comtech's X-band SSPAs and BUCs are rugged and compact, supporting voice, video and data communications among dispersed elements of the battle force.

"Comtech's SSPAs and BUCs have a proven heritage across multiple military systems and operate with high reliability in certified terminals around the globe," says chairman & CEO Fred Kornberg. "We are pleased with the ongoing success of these transportable terminals."

Comtech manufactures tube-based and solid-state power amplifiers for military and commercial satellite uplink applications. The product range encompasses power levels from 8W to 3kW, with frequency coverage in sub-bands within the 2–52GHz spectrum.

Amplifiers are available for fixed and ground-based, shipboard and airborne mobile applications.

www.xicomtech.com

Navitas and Lenovo partner on fifth GaNFast charger

130W charger up to 40% smaller and 45% lighter than silicon adapters

Navitas Semiconductor of El Segundo, CA, USA and Dublin, Ireland says Lenovo has launched the YOGA CC130, its fifth GaNFast charger, with dual USB type-C outputs and high-power 130W capability. Either Type-C output can provide 100W for large laptops and fast-charging smartphones, with a combined 130W of dynamically shared total power when both ports are used.

Fast-charging communication protocols include USB-PD, Qualcomm QC 3.0 and USB-PPS. By exploiting the high-speed, high-efficiency performance of GaNFast technology, the dual-output CC130 measures only 71mm x 71mm x 30mm (151cc) to achieve a power density of 0.85W/cc at a weight of just 265g. This represents up to 40% size and 45% weight savings versus single-port legacy silicon adapters.

Since gallium nitride (GaN) is reckoned to run up to 20x faster than silicon, Navitas' proprietary GaNFast power ICs comprise easy-to-use, high-speed, high-performance 'digital-in, power-out' building blocks and are said to deliver up to 3x faster charging in half the size and weight, and with up to 40% energy savings compared with silicon chips. Founded in 2014, Navitas introduced what it claimed to be the first commercial GaN power ICs, which monolithically integrate GaN power field-effect transistors (FETs) and GaN drive plus control and protection circuits in a single SMT package, enabling faster charging, higher power density and greater energy savings for mobile, consumer, enterprise (data center, 5G), renewables (solar, energy storage) and electric vehicles (EVs)/eMobility markets.

The CC130 dual-port GaN adapter uses GaNFast power ICs in two high-speed 'soft-switching' topologies to achieve the size and weight reductions. The first is a CrCM (critical-conduction mode) boost power-factor correction (PFC) circuit, using Navitas' NV6117 (120mΩ) GaN power ICs to convert rectified AC power to a stable 400V DC rail. This is followed by a high-speed, isolating, LLC DC–DC stage with two NV6115 (170mΩ) ICs to efficiently step-down the voltage to ~20V for the USB-PD output stages. Both GaNFast ICs are rated at 650/800V, up to 2MHz switching frequency in space-saving 5mm x 6mm QFN SMT packages. Due to the integration of GaN FET, drive, protection and control, no external drivers are needed (which saves PCB space) and high-speed (switching-frequency) operation shrinks the size and cost of transformers, filters and capacitors.

Reliability is a critical specification, and the YOGA CC130 adapter has passed 81 Lenovo professional-grade laboratory tests, supports ESD protection, and passed the long-term use test of 8700 hours at full power.

The CC130 was jointly supervised by Lianbao Electronic Technology Co Ltd. and designed and built for Lenovo by Luxshare of Dongguan City, Guangdong. "At our core, we're a technology company, and for power electronics, this means the research, development and production of GaN fast chargers to stay at the forefront of the industry," comments Fu Qiang Wang, power R&D director at Luxshare. "Luxshare chose Navitas' GaNFast power ICs to build the YOGA CC 130... We firmly believe in the future potential of gallium nitride charging technology as a focus for Luxshare's continuous research and development," he adds.

"After the successful YOGA CC65, Navitas is honored to support Lenovo with the YOGA CC130 at twice the power," says Stephen Oliver, VP of corporate marketing & investor relations at Navitas. "The CC130 will bring a faster, lighter, more powerful and more portable charging experience to Lenovo consumers," he adds. "Navitas will continue to support Lenovo and Luxshare to develop further generations of GaN fast chargers, and to promote the innovation and development of the high-performance fast-charge industry."

www.navitassemi.com

Comtech wins $1m contract for high-power SSPAs

Comtech Telecommunications Corp says that in fiscal fourth-quarter 2021 its subsidiary Comtech PST Corp of Melville, NY, USA, which is part of Comtech's Government Solutions segment and supplies high-power RF microwave amplifiers and control components for applications including defense, medical, satellite communications systems and instrumentation, was awarded a $1m contract for high-power amplifiers from a major domestic prime contractor.

As key transmit elements in a data communication system, the amplifiers — which utilize GaN transistor technology — add to an installed base of Comtech solid-state high-power RF amplifiers previously delivered to this major domestic prime contractor.

"This contract demonstrates our continued leadership position in providing high-power communications technology and the ongoing demand for our solid-state high-power amplifiers utilized by major OEMs in both domestic and international markets," says Comtech Telecommunications' chairman & CEO Fred Kornberg.

www.comtechpst.com

GaN Systems and FTEX partner to increase E-mobility range and power by 30%

GaN-powered motor drives for personal electric vehicles including e-scooters, e-bikes and e-mopeds

GaN Systems Inc of Ottawa, Ontario, Canada (a fabless developer of gallium nitride-based power switching semiconductors for power conversion and control applications) has announced a partnership with Montreal-based FTEX Inc (a pioneer in precision motor control systems for small electric vehicles) to deliver GaN-powered motor drives for personal electric vehicles (EVs) including e-scooters, e-bikes and e-mopeds.

The motor drives combine GaN Systems' high-performance, high-frequency transistors with FTEX's software and hardware to create powertrain solutions that increase the range and power of EVs by as much as 30%. GaN Systems' transistors enable smaller, more efficient and lower-cost systems for high-power EV applications. The firm's 100V E-mode transistor provides high power density for the FTEX Dynamic Drive in a small package, with thermal efficiencies created by GaN Systems' innovative packaging.

"Thermal enhancement and high-frequency switching are the two major aspects that FTEX's hardware focuses on, thus getting the best out of GaN Systems' transistors. Our unique design maximizes the transistor performance, increasing efficiency by 2.5% while doubling the power density and reducing the weight by half," says FTEX's chief technology officer Alexandre Cosneau. "GaN Systems is the best at what they do — providing high-quality, small-form-factor power components that enable the next generation of electric vehicles," he comments.

"Our partnership with FTEX highlights the growing demand for GaN-based motor control solutions for EVs, from e-bikes to motorcycles to automobiles," says GaN Systems' CEO Jim Witham. "By replacing legacy silicon transistors with GaN Systems' transistors, electric powertrain designers can make vast improvements to their EV solutions, including reducing the size of the inverters and converters, increasing power, and maximizing efficiency. Together, we're fortifying GaN Systems' position in the next generation of e-mobility transportation."

www.ftex.ca

GaN Systems adds 8mm x 8mm PDFN-packaged 650V GaN power transistors

GaN Systems has added two new 8mm x 8mm PDFN-packaged GaN power transistors to its portfolio: the GS-065-011-2-L allows users to reduce the cost per watt of delivered power in 45-150W applications; and the GS-065-030-2-L is said to be the first GaN product on the market that enables designers to get the advantages of low-cost GaN in applications up to the 3000W power level.

The new devices add to GaN Systems' family of low-cost GaN transistors that can help designers to improve performance in efficiency, thermal management and power density with increased design flexibility and cost effectiveness to meet new demands from consumer, industrial and data-center customers, the firm adds.

The new transistors feature lower on-resistance, increased robustness and thermal performance, higher $V_{DS(transient)}$ rating, and an industry-standard form factor that eases customer adoption, scalability and commercialization.

The GS-065-011-2-L is a 650V, 11A, 150mΩ bottom-side-cooled transistor suitable for consumer electronics applications such as chargers and adapters (including higher-power adapter designs that benefit from the transistor's improved thermal performance). The GS-065-030-2-L is a 650V, 30A, 50mΩ bottom-side-cooled transistor that features the lowest $R_{DS(on)}$ in GaN Systems' PDFN product family. Lower $R_{DS(on)}$ means lower power loss and higher power rating, resulting in higher efficiency and power density. The GS-065-030-2-L is suitable for data-center, industrial and 5G applications such as telecom and server SMPS (switched-mode power supply), motor drives, energy storage systems, and bridgeless totem-pole PFC (power factor correction) solutions.

"GaN has made its mark in power electronics — in size, weight, efficiency, cost and performance — and we are proud of the advancements we have made with every new generation of products so that customers can maximize the benefits of GaN," says GaN Systems' CEO Jim Witham. "With these new GS-065-011-2-L and GS-065-030-2-L products, our customers can leverage the benefits that come from smaller, more efficient, and more cost-effective power electronics," he adds.

The products are now available for purchase via GaN Systems' distributors.

www.gansystems.com

GaN Systems and ON Semi partner to release first bridgeless totem pole PFC evaluation board

First critical conduction mode bridgeless totem pole PFC controller combined with 650V GaN transistors for cost-effective, high-performing solution in a small footprint

GaN Systems Inc of Ottawa, Ontario, Canada (a fabless developer of gallium nitride-based power switching semiconductors for power conversion and control applications) and power semiconductor IC supplier ON Semiconductor of Phoenix, AZ, USA have released a new 300W BTP-PFC bridgeless totem pole power factor correction (PFC) evaluation board.

The board includes ON Semi's NCP1680, which is claimed to be the industry's first dedicated critical conduction mode (CrM) bridgeless totem pole PFC controller, and GaN Systems' 650V GS66508B GaN transistors. The NCP1680 controller and GS66508B transistors combine to deliver a cost-effective and high-performing solution in a small footprint.

The solution enables power engineers to evaluate GaN and capitalize on its benefits in improving power system performance. GaN Systems' GS66508B is a 650V, 30A transistor that provides low loss, high switching frequency, zero reverse recovery, and very low junction-to-case thermal resistance. The evaluation board allows rapid development of advanced totem pole PFC designs and is suitable in various power supply applications for the data-center, telecom, industrial and consumer industries.

On the controller side, the bridgeless totem pole PFC solution leverages the NCP1680, which is said to offer unique features for operation under light load conditions, a digital voltage loop compensation, and near-unity power factor in all operating modes. Altogether, the solution achieves near 99% efficiency, simplifies design, and reduces bill-of-material count and cost.

"Leaders like ON Semiconductor recognize the importance of GaN and are optimizing controllers and creating complementary tools like the new 300W PFC evaluation board," says GaN Systems' CEO Jim Witham. "These solutions strengthen the GaN industry ecosystem in the goal to make better performing and more cost-effective power electronics."

www.gansystems.com/

Transphorm's joint venture AFSW fab passes from Fujitsu to majority ownership by new partner JCP

New JV GaNovation to fund manufacturing expansion and growth in product business, focusing on fast chargers and adapters

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 applications — has completed the transaction for its AFSW wafer fab in Aizu Wakamatsu, Japan to be acquired by GaNovation, Transphorm's joint venture formed recently with its new Palo Alto-based strategic financial partner JCP Capital. The AFSW fab was previously a joint venture with Fujitsu Semiconductor Ltd (FSL).

The transaction completes the previously announced exit of Fujitsu Semiconductor from the AFSW fab. Transphorm's effective stake in AFSW will be 25% (via its 25% ownership of GaNovation), down from its prior 49% stake. This should reduce Transphorm's direct capital outlay for AFSW by about 50%, resulting in more efficient profit and loss (P&L), with investment in GaN technologies and applications. In addition, partnering with JCP Capital adds a strategic-financial partner for AFSW that is said to have global strength in the GaN ecosystem, and the shared goal of expanding Transphorm's GaN power business.

Transphorm stresses that the transition should be seamless for both its customers as well as the existing team and operations at the AFSW fab. With the close of the transaction, FSL's previously announced exercise of the put option has also been satisfied.

"GaNovation will not only bring significant capital to AFSW, the world's premier GaN power wafer fab, over the next several years to expand GaN wafer manufacturing, but also contribute to growing the GaN product business together with our portfolio ecosystem at a faster vector, especially in the area of GaN-based fast chargers and adapters," says JCP Capital founder & managing partner David Cong.

AFSW wafer fab in Aizu Wakamatsu, Japan.

"The partnership with GaNovation and JCP Capital is the ideal next step in Transphorm's rapid growth and manufacturing of its highest-quality, highest-reliability GaN wafers and products, continuing our asset-light vertically integrated model with strong IP dominance and protection," says Transphorm's co-founder & president Primit Parikh. "We also thank Fujitsu Semiconductor for its long-standing partnership as well as its commitment to assist in the successful transition of AFSW going forward," he adds.

"FSL and AFSW have been working closely with the Transphorm and the JCP Capital team for this transaction that continues forward the strong legacy of semiconductor manufacturing at AFSW," says commented Kagemasa Magaribuchi, president & representative director, FSL. "Transphorm's excellence in GaN, with the financial strength brought by JCP Capital, will make AFSW an even stronger manufacturing source for continued success," he believes. "FSL will also continue to work with AFSW through transition services during the mutually agreed period of time."

AFSW is believed to be the only GaN-on-silicon foundry that has reported defect densities for GaN-on-Si high-voltage devices that are similar to that of silicon CMOS/bipolar technologies running in the same wafer fab. Transphorm claims that, for its GaN products (including the latest generations such as SuperGaN), this has resulted in demonstrated performance advantage compared with other enhancement-mode (E-mode) GaN products for chargers/adapters in lower-power applications from 45W to several 100W and against other GaN and SiC products for higher-power applications to 10kW.

AFSW is expected to continue to scale as the foundry center of excellence for GaN wafer fabrication while maintaining its ability for existing silicon wafer fabrication.

www.transphormusa.com

Transphorm collaborates with Salom to deliver Quick Charge 5-compliant 100W USB-C PD PPS charger

Universal power adapter for charging phones up to 50% in 5 minutes

Transphorm has announced a collaboration with consumer electronics power supply manufacturer Salom to bring to market a Quick Charge 5-compliant 100W GaN power adapter that is slated for release in fourth-quarter 2021.

The new USB-C Power Delivery (USB-C PD) charger will pair with Quick Charge 5 technology — capable of charging smartphones from 0 to 50% in 5 minutes. It will be a universal adapter offering the traditional power delivery mode and the USB-C programmable power supply (PPS) mode version 3.0, which enables the charger to easily deliver a sliding range of voltages (3.3–21V) versus the traditional mode's stepped voltage output.

With assistance from Qualcomm Technologies Inc, Transphorm developed the adapter's specification and designed the overall functional product, from the universal input through to the USB-C PD/PPS output.

Transphorm's GaN is used in the traditional AC-to-DC boost PFC and the DC-to-DC quasi-resonant flyback (QRF) topologies. Salom was responsible for then taking that designed system, fine tuning it, developing its enclosure and completing all the required certifications such as Quick Charge 5, conducted/radiated emissions, touch temperature, and others.

"Adapter solutions with Transphorm's GaN enable more with less," says Philip Zuk, senior VP of worldwide technical marketing & business development, Transphorm. "Compared to other GaN solutions such as e-mode, our normally-off SuperGaN FETs offer ease of design and standard silicon-like drivability while delivering more power in a considerably smaller footprint without compromise," he claims. "And we've proven that our production yields can meet high-volume requirements."

"We were able to go from concept to production in a short time," notes Joseph Reisinger, president of Salom America Co. "The collaboration and commitment demonstrated by Transphorm and Salom has been strong."

www.salom.com

Transphorm's board gains semiconductor industry financial expert to aid execution of strategic growth plan

Transphorm has appointed Kelly Smales to its board of directors.

Ms Smales has significant industry-specific financial experience, with over 30 years as a certified public accountant and serving in senior financial roles across multiple semiconductor companies, including Motorola, Advanced Micro Devices (AMD) and GlobalFoundries. Most recently, she was chief financial officer at machine-learning hardware and software company KnuEdge Inc (formerly Intellisis). Previously, she was CFO at Advanced Nanotechnology Solutions Inc, a semiconductor manufacturing start-up company. Smales holds a B.S. in Accounting from Arizona State University and an M.B.A. degree from the University of Chicago.

"We are pleased to welcome Kelly as a new independent director and add her proven financial acumen within the semiconductor industry to Transphorm's board," says CEO Mario Rivas. "In addition to valuable industry-specific experience working with companies across the supply chain, she brings unique perspective and understanding of the financial challenges and opportunities facing fast-growing, emerging semiconductor companies. With her appointment, along with our other recent appointments, we have expanded the expertise and depth of our board, while also underscoring the company's commitment to our corporate governance initiatives and board diversification," he adds. "I look forward to working with Kelly as we continue executing on Transphorm's strategic growth plan."

Concurrent with Smales' appointment, David Kerko resigned from Transphorm's board, effective 30 June. Transphorm says that his resignation is not due to any disagreement relating to the firm's operations, policies or practices, and specifically relates to his new full-time career commitments.

"Following six years as a member of Transphorm's board, I want to personally thank David for his time, service, and contributions," comments Rivas. "Under his tenure, Transphorm has expanded into a global leader in the GaN revolution, and his guidance has been invaluable to the development of our strategic roadmap."

www.transphormusa.com

AKHAN fabricates first 300mm diamond wafer

Enhanced power handling, heat management and durability of electronics with little change to existing manufacturing processes

AKHAN Semiconductor Inc of Gurnee, Lake County, IL, USA — which was founded in 2013 and specializes in the fabrication and application of synthetic, lab-grown, electronics-grade diamond as functional semiconductors — has showcased the ability to manufacture 300mm complementary metal–oxide–semiconductor (CMOS) diamond wafers, which, it is reckoned, can enhance power handling, heat management and durability of electronics across industries with little change to fabricators' existing manufacturing processes.

Due to its inherent properties, diamond is proven to be the most optimal semiconductor material, far exceeding the capabilities of the industry-standard silicon. As the global industry advances beyond Moore's Law, the ability to produce 300mm diamond wafers is crucial, reckons AKHAN, especially in advanced industries like aerospace, telecommunications, military and defense, and consumer electronics.

"The semiconductor chip shortage has been well documented this year," notes Tom Lacey, chairman of the Board. "As the US plans to increase chip supply, it is also important to fabricate using the best materials available to enable the best performance," he adds.

"AKHAN's 300mm diamond wafer is the foundational building block that will lead to more powerful and durable devices that run cooler, and fabricators only need to make minor updates to their existing manufacturing processes," says founder Adam Khan. "From weapon systems to spacecrafts, the world's most sophisticated devices and technologies stand to benefit exponentially from diamond," he adds.

"Now that we've proven the ability to manufacture this ideal material on 300mm wafers, fabricators will have access to the most optimal chip material so that their end products perform far more efficiently."

As the USA assesses the semiconductor supply chain in light of the current global shortage and works to recapture its leadership position within this critical space, policymakers must prioritize the companies that are moving beyond silicon by innovating and developing next-generation chips with materials like diamond, states AKHAN. Beyond diamond's advanced capabilities, US adversaries understand how powerful diamond can be and are prioritizing the development of the material for advanced weapons usage, the firm adds.

www.akhansemi.com

Former Intel Americas president becomes chairman

AKHAN says that Tom Lacey has joined its board as chairman. An ex-president of Intel Americas, he has over three decades of experience leading both public and private firms in the semiconductor and licensing sectors and will lead AKHAN as it plans to scale up its Miraj Diamond technology portfolio.

"Despite our revolutionary materials and prolific customer base, AKHAN, up until this point, has largely been made up of its nascent technology team. We've done an outstanding job in taking our Miraj Diamond tech from concept to prototype, and now is the time for massive scale," says founder & CEO Adam Khan. "Tom, who's onboarding marks the launch of our operational growth phase, is one of the most well respected, trusted and knowledgeable leaders in the entire semiconductor and technology space, providing AKHAN with a distinguished executive who will lead the company."

As the only diamond semiconductor fab in North America, AKHAN says it is positioned for mass expansion as the USA works to address the global semiconductor shortage and regain industry leadership. As well as heading Intel Americas, Lacey has worked across startups, mid-sized and large public and private technology firms and will provide insight and deep understanding as AKHAN brings its Miraj Diamond technology portfolio to market in industries including aerospace, consumer electronics, military & defense, automotive, and telecoms.

"Semiconductors have hit the global stage, and AKHAN is best positioned to pioneer the much needed transition away from silicon semiconductors and usher in a new age of faster, lighter, simpler and more powerful devices that will lead to the 'diamond age of electronics'," comments Lacey. "Adam Khan and his impressive team have brought significant and much needed innovation... Now it's time to unleash diamond's immense capabilities on chips, as well as optical and glass coatings, as AKHAN has impressive successes in research and customer development in all three areas."

In working for technology firms including Intel and Tessera/Xperi, Lacey's roles have spanned posts in leadership, engineering, marketing, sales, OEM, retail channel, distribution, management, operations, intellectual property, P&L, Wall Street, fundraising, international geographies (especially Asia) and mergers & acquisitions, making him a suitable fit to lead AKHAN's board as it brings its Miraj Diamond glass, optics and electronics solutions to market, the firm reckons.

Introducing A Silica Analyzer You Can Trust

To Ensure High Quality Ultrapure Water

THORNTON
Leading Pure Water Analytics

Achieving accurate and dependable silica monitoring shouldn't be a struggle. Ensure high wafer yield with zero defects using the simple and reliable METTLER TOLEDO 2850Si Analyzer.

- **Intuitive operation** with predictive diagnostics and a simple user interface for hassle-free monitoring
- **Easy maintenance** with 75% less reagent usage delivering more analyzer uptime
- **Accurate silica monitoring** with fast, temperature-controlled measurement cycles

Learn more:
www.mt.com/2850Si-ST

METTLER TOLEDO

Aehr receives $10.8m order from lead SiC customer

Test and burn-in systems to be used in production of silicon carbide power semiconductors for electric vehicles

Aehr Test Systems of Fremont, CA, USA says that it has received a $10.8m single purchase order from its lead silicon carbide (SiC) test and burn-in customer for multiple FOX-XP systems and full sets of WaferPak Contactors (to ship within the next six months) to meet its increased production capacity needs.

This customer is a leading Fortune 500 supplier of semiconductor devices with a significant customer base in the automotive semiconductor market.

These follow-on orders are the result of "working closely with this lead customer to achieve their test requirements and validation of our FOX-P platform and WaferPak full-wafer contactors as their production-qualified solution," says president & CEO Gayn Erickson. "This customer continues to forecast orders for multiple additional FOX systems and WaferPak Contactors this fiscal year and a significant number of systems and WaferPaks over the next several years due to electric vehicle (EV) semiconductor test and burn-in demand," he adds.

Each of these silicon carbide-focused FOX-XP systems is configured to test 18 silicon carbide wafers in parallel in the footprint of a typical single wafer test solution, while contacting and testing 100% of the devices in parallel on each wafer, and can not only test 100mm- and 150mm-diameter silicon carbide wafers but can test the future 200mm wafers planned to be introduced over the next several years. "Aehr provides a unique fully integrated solution that includes the test systems, full-wafer WaferPak Contactors, and WaferPak Aligners," says Erickson.

"Silicon carbide power semiconductors have emerged as the preferred technology for battery electric vehicle power conversion in on-board and off-board electric vehicle battery chargers, and the electric power conversion and control of the electric engines. These devices reduce power loss by as much as >75% over power silicon alternatives like IGBT (insulated-gate bipolar transistor) devices, which has essentially changed the entire market dynamic. The challenge with silicon carbide is that it is known to have high infant mortality rates. However, with the reliability burn-in and screening that Aehr is able to offer with our FOX product solutions, these defects can be removed to provide extremely reliable devices for these mission-critical applications," he adds.

Aehr's FOX-XP silicon carbide test and burn-in system.

"Aehr's FOX-XP solution allows for one of the key reliability screening tests to be completed on an entire wafer full of devices, basically testing all of them at one time, while also testing and monitoring every device for failures during the burn-in process to provide critical information on those devices. This is an enormously valuable capability, as it allows our customers to screen devices that would otherwise fail after they are packaged into multi-die modules where the yield impact is 10 times or even 100 times as costly. Our FOX-P family of products are very cost-effective solutions for ensuring the critical quality and reliability of devices in this market, where performance and reliability can not only mean increased battery life, but also whether you have to walk home from a vehicle whose power semiconductor fails in the power train," Erickson continues.

The power semiconductor market for electric vehicles is expected to triple between 2020 and 2026, growing at a compound annual growth rate (CAGR) of 25.7% to $5.6bn, according to a March report from market research firm Yole Développement. In addition, a report from Deloitte forecasts that total EV sales will grow at a CAGR of 29% from 2020 to 2025, before reaching 31.1 million by 2030 and securing about 32% of the total market share for new car sales. "These stats highlight the tremendous opportunity Aehr Test has in front of it with its wafer-level test and burn-in solution for electric vehicle semiconductors," believes Erickson.

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

www.aehr.com

ASM AMICRA unveils first systems incorporating X-Celeprint's MTP technology for high-volume heterogeneous integration of ultra-thin chips

Massively parallel pick-and-place for large arrays of ultra-thin chips creates new heterogeneous integration capabilities for 3D ICs

ASM AMICRA Microtechnologies GmbH of Regensburg, Germany, a subsidiary of Singapore-based hardware and software supplier ASM Pacific Technology Ltd, has announced three new manufacturing systems that combine its high-precision die bonding technology with the micro-transfer printing (MTP) technology of X-Celeprint of Cork, Ireland to introduce what is claimed to be the first complete system to enable high-volume heterogeneous integration of ultra-thin dies onto base wafers up to 300mm in diameter.

X-Celeprint's MTP process stacks ultra-thin dies (x-chips), which can be extremely varied (e.g. combinations of RF and power transistors, hardware assurance features, photonics, sensors, capacitors, inductors, filters, and antennas) and made using very different process nodes and technologies (including silicon-on-insulator, gallium nitride, gallium arsenide, indium phosphide and silicon germanium), to create virtually monolithic 3D ICs that improve power, performance, area, cost, time-to-market and security for a wide array of applications including high-performance computing, communications, mobile, auto-motive, industrial, medical, or defense systems.

ASM AMICRA has been developing ultra-high precision placement technology for almost 20 years, and has now incorporated X-Celeprint's MTP technology into three different manufacturing systems. These are:

- The Nova+ MTP system, which serves high-throughput needs with a fully automatic ISO 4 cleanroom class system using a 50mm x 50mm MTP stamp enabling massively parallel pick-and-place of x-chips. Placement accuracy is ±1.5µm with a 40-second cycle time.
- The NANO MTP system, which serves markets such as photonics that require more precise placement accuracy (±0.3µm).
- The AFC+ MTP system, which serves R&D and low-volume manufacturing markets. Placement accuracy is ±1.0µm with a 50-second cycle time.

GaN x-chip on SOI RF Switch

ASM AMICRA Nova+ MTP system

X-Celeprint and ASM AMICRA say that they are facilitating the adoption of MTP technology through development support, including design consultation with assistance in optimizing design and processes and prototyping services to ensure successful product launches. An extensive network of suppliers, manufacturers and researchers are available to support project needs, including licensing programs.

"This agreement with X-Celeprint brings revolutionary technology to market for photonics and 3D heterogeneous integration," reckons ASM AMICRA Microtechnologies' managing director Dr Johann Weinhändler. "MTP technology offers efficient handling of high volumes of large arrays of ultra-thin, brittle dies, as well as the ability to integrate dies from several different source wafers. MTP technology will provide semiconductor manufacturers with a critical, additional 'tool in the toolbox' that supplements conventional and advanced packaging technology," he adds.

"The ultra-high-precision capabilities of ASM AMICRA's MTP manufacturing systems for heterogeneous integration of large arrays of ultra-thin x-chips has the potential to be a game-changer for semiconductor manufacturers seeking to extend Moore's Law with 3D IC heterogeneous integration," says X-Celeprint's CEO Kyle Benkendorfer. "Enabling chip designers to combine the optimum materials and different process technologies in 3D ICs results in more powerful devices, with higher density, increased functionality, lower cost, higher yield, and faster time to market."

www.x-celeprint.com
www.amicra.asmpt.com

AXT's Q2 revenue of $33.7m up 52% year-on-year

Driven by GaAs for LEDs, InP for data-center connectivity, raw materials

For second-quarter 2021, AXT Inc of Fremont, CA, USA — which makes gallium arsenide (GaAs), indium phosphide (InP) and germanium (Ge) substrates and raw materials — has reported revenue of $33.7m, up 7.3% on $31.4m last quarter and up 52% on $22.1m a year ago, and exceeding the $30.5–31.5m guidance.

"We ended Q2 expecting our revenue to be approximately flat, following strong growth in Q1," says CEO Dr Morris Young. "We continue to see increasing demand in both gallium arsenide [for LED applications] and indium phosphide substrates as well as healthy growth in our raw material business," he adds.

Of total revenue, substrate sales were $24.9m, up 6.4% on $23.4m last quarter and up 47% on $16.9m a year ago.

"Indium phosphide set a new revenue record in Q2, and once again surpassed gallium arsenide as our single largest product category," notes Young. "Data-center connectivity demand remains steady and at a positive level. As a result of the overall growth in adoption of silicon photonics in data centers, silicon photonics technology provides a number of advantages, such as lower power consumption and increasing bandwidth and data transfer capabilities," he adds. "We completed the direct qualification of a [US-based] tier-one customer [with which AXT has been working for almost the last two years] in Q1, and we believe we're now selling indirectly into another major player in this space."

GaAs revenue for LED applications grew by more than 20% in Q2, driven by high-end applications including automotive and lighting and display. As expected, revenue from wireless applications fell modestly.

Revenue from germanium substrates also fell modestly in Q2, as expected.

Revenue from AXT's two consolidated raw material joint ventures — BoYu (which makes high-temperature pyrolytic boron nitride crucibles and pBN-based tools for organic light-emitting diodes) and JinMei (a diversified industrial high-purity material supplier) — was $8.8m, up 10% (rather than the expected drop) from the record $8m last quarter (following 45% growth in Q1) and up 66% on $5.3m a year ago. "In 2020, both companies relocated to our campus in Kazuo, enabling them to expand capacity in response to strong market demand," says Young. "Today, JinMei is processing approximately 12 tons of material per month, which is over 25% of the world's yearly consumption of gallium. Its robust growth has been made possible by the new state-of-the-art facilities that not only allows it to handle more demand, but also attract new customers and open up incremental business opportunities, such as material recycling and recombination," he adds. "Continued expansion, coupled with a recovery in pricing of raw materials such as raw gallium, has allowed both companies to continue to grow."

Of total revenue in Q2/2021, the proportion from the Asia–Pacific region remained 73%, while Europe rose further from last quarter's 17% to 19% and North America fell further from 10% to 8%.

For the second consecutive quarter, no customers reached 10% of revenue (illustrating the diversity of applications for indium phosphide, for example). The top five customers generated about 31% of total revenue. "Revenue growth, breaking through the $30m level, is not overly dependent on one large customer, and this diversity is a good thing," comments chief financial officer Gary Fischer.

Gross margin was 36.3%, down on 36.8% last quarter but up on 30.6% a year ago, driven mainly by product mix and increasing revenue volume.

Operating expenses have risen further, from $6.3m a year ago and $8m last quarter to $8.3m. R&D is one of the drivers creating the increase as a result of two major ongoing R&D programs. "We also have initial expenses associated with going public in China, as well as increased employee stock compensation expense and bonuses," notes Fischer. Total stock compensation expense was $975,000.

After turning profitable in Q3/2020, unconsolidated partially owned joint ventures in AXT's supply chain grew their net profit again, from $1.1m to $1.5m.

Despite about $280,000 in tariffs (as a result of the 25% tariff charged on importing wafers into the USA from China), net income has risen further, from just $0.36m ($0.01 per share) a year ago then $3.4m ($0.08 per share) last quarter to $4.4m ($0.10 per share, exceeding the $0.06–0.08 per share guidance).

Depreciation & amortization was $1.7m, while capital expenditure (CapEx) rose further from $5.6m last quarter to $7.4m. Inventory rose by $4.2m. Accounts receivable rose by $5.1m, including about $3m due to days sales outstanding (DSO) rising by 8 days to 90 days, as a result of the high proportion of sales in Greater Asia (for which there is a lot longer time to pay in China, Korea and Japan). Accounts payable rose by just $2.7m. Also, AXT made a one-time payment of about $3.7m for purchasing shares in its China-based wafer manufacturing company Beijing Tongmei Xtal Technology Co Ltd previously held by minority interests.

Overall, during the quarter, cash, cash equivalents and investments fell from $66.9m to $58.5m.

"The momentum in our business continues to build with major customer wins that are increasingly contributing to our revenue," comments Young.

"It is clear from the market demand that our new factory and

capacity expansion were built at exactly the right time. We are now able to support current and emerging customer requirements across growing applications such as 5G telecommunications and its related technologies, data-center connectivity, LED-based sensing and display and a variety of new consumer-related devices," says Young. "We are participating in several major technology trends, and we are now in the supply chains of some of the most prestigious companies in the world… In Q2, we qualified with another tier-one customer who plays an important role in the supply chain for major end-customers in many of these areas. This was a very extensive qualification process, and we believe it can open new doors of opportunities for us in the coming quarters. It also underscores the value of our investment in our manufacturing and business processes, in-house expertise and product development. We believe we are now in a strong position to win market share and expand into key new emerging applications."

For Q3/2021, AXT expects revenue to rise to $34.5–35.5m, with net income of $0.10–0.12 per share.

Germanium substrates and raw materials are expected to be consistent or about equal to Q2. "Indium phosphide, coming off a very strong recent quarter, we believe will see continued growth," says Fischer. "We also expect growth in gallium arsenide revenue," he adds.

"As we move into Q3, wireless revenue is expected to grow nicely from Q2 levels as a result of broad-based IoT [Internet of Things] application demand," says Young." Our successful development of 8-inch GaAs wafers for LED applications such as micro-LEDs and LiDARs is setting the stage for a new wave of growth. Among the many benefits, we believe 8-inch GaAs will help to enable the scale and efficiency required for very large volume applications. Industry news and customer interest suggests that micro-LEDs are likely to become the next major volume driver for GaAs chips," he adds. "Tier-one players are driving the development of this technology, and we believe that our wafers are already being used for early-stage activities. The level of customer activity and general industry excitement gives us confidence that micro-LEDs will come to market and it's also a factor in our motivation to deliver the 8-inch GaAs wafers," says Young.

"This year, we are on track to grow our indium phosphide revenues by more than 35%, with demand being driven by a number of customers across a diversified set of applications," stresses Young. "Once again, we believe this indicates an acceleration of some big trends in the technology landscape. In particular, we saw continued strength for 5G and related technologies.

"We're beginning to ramp volume for a new customer device that we believe is now moving into production [in second-half 2021]," says Young. "We expect the ramp for our substrate related to this application to be gradual over the coming quarters, adding incremental growth to our business. Our qualification into the supply chain for this customer is the result of many quarters of collaboration with both the end-customer and its supply chain partners." As well as the existing 3- and 4-inch InP substrates, the customer also has a future interest in 6-inch InP (which AXT is currently developing), he adds.

STAR Market listing update

On 16 November, AXT announced a strategic plan to access China's capital markets and progress to an initial public offering (IPO) by its China-based wafer manufacturing company Beijing Tongmei Xtal Technology Co Ltd on the Shanghai Stock Exchange's Sci-Tech innovAtion boaRd (STAR Market). AXT is currently preparing the required documents for submission to the STAR Market authorities. "The STAR Market authorities and the China SEC have raised the bar for companies wanting to go public," notes Fischer. "Their focus includes semiconductor companies and material companies, and we qualify in both of those categories," he adds. "We of course have healthy revenue and growth. We also have a strong customer list and have partial ownership of 10 raw material companies located in China. We have over 1000 employees in China that are citizens and pay income taxes there," he adds. "We hope to be ready to file late this quarter or in the fourth quarter." In addition, the process of going public on the STAR Market includes several periods of review. Tongmei expects to accomplish this goal in mid-2022.

www.axt.com

Founder & CEO Morris Young returns to chairman role

AXT's founder & CEO Dr Morris Young has been appointed chairman of its board of directors. Jesse Chen, who has served as chairman since 2009, will continue to serve as lead independent director and as a member of the board.

The Nominating and Corporate Governance Committee and the board of directors decided to make this appointment in preparation for the proposed initial public offering (IPO) by Beijing Tongmei Xtal Technology Co Ltd on the Shanghai Stock Exchange's Sci-Tech innovAtion board (STAR Market). The appointment comes at the request and advice of Tongmei's advisors on the IPO.

Young has been chairman of Tongmei since its founding in 1998 and will continue in this role. Previously Young was AXT's chairman from February 1998 to May 2004.

HexaTech further expands AlN substrate product line

HexaTech Inc of Morrisville, NC, USA, a subsidiary of Stanley Electric Co Ltd of Tokyo, Japan, has announced the production release of its expanded 2-inch-diameter, DUV (deep ultraviolet)-transparent, single-crystal aluminium nitride (AlN) substrate product line.

The new product bin offers what are reckoned to be the highest-transparency AlN substrates currently on the market, with deep-UV absorption coefficients now commercially available below 30cm^{-1} at 265nm.

"This product line expansion is a direct result of technical achievements reached by the HexaTech team over the past 12 months," notes CEO John Goehrke.

The commercial launch follows HexaTech's demonstration of 2-inch bulk AlN with absorption coefficient values below 12cm^{-1} at 265nm, presented earlier in the year. These extremely low coefficients virtually eliminate through-substrate transparency concerns for UV-C LEDs, yielding optimum UV-C optoelectronic device performance, the firm says.

"With this launch, HexaTech demonstrates once again its focus on driving the value proposition of AlN for its strategic partners in the rapidly growing UV-C LED market, by providing dramatically increased LED device performance, while simultaneously reducing LED manufacturing costs," says Gregory Mills, VP of business development.

All 2"-diameter products, including the full range of DUV-transparent substrate products, are available now with standard lead times.

www.hexatechinc.com/

Hamamatsu develops system for quantitatively evaluating GaN crystal quality

Japan's Hamamatsu Photonics K.K. has developed the C15993-01 gallium nitride crystal evaluation system that leverages omnidirectional photo-luminescence (ODPL) spectroscopy along with proprietary light detection technologies including optical design and data processing.

ODPL spectroscopy is a novel technique for accurately evaluating the quality of compound semiconductor crystals such as GaN by quantifying structural defects and impurities within the crystal.

In traditional measurement methods utilizing PL, the quality of semiconductor crystals such as GaN is evaluated based on the intensity and wavelength-specific information of PL emitted in one direction from a sample crystal. PL measurement methods allow rapid non-contact and non-destructive evaluation of crystal quality. However, these methods have issues such as poor reproducibility and poor quantitative determination because results depend on detector position and angle and also on conditions for irradiating the crystal with light.

In 2016 Hamamatsu Photonics and a group at Tohoku University's Institute of Multidisciplinary Research for Advanced Materials headed by associate professor Kazunobu Kojima and professor Shigefusa Chichibu made highly reproducible measurements of PL intensity emitted in all directions from a GaN crystal by using an integrating sphere. This allowed the firm to discover that the internal quantum efficiency (IQE) of GaN crystals could be calculated from the results by also using its unique calculation method. Then, using the IQE of the GaN crystals as an index, the firm established an ODPL spectroscopy measurement method for quantitatively evaluating the crystal quality.

The ODPL measurement system accurately evaluates GaN crystal quality. Hamamatsu has now applied its light detection and optical design technologies to create new software for this purpose. It not only accurately measures the PL intensity (over a wavelength range 300–950nm) emitted in all directions from GaN crystals via a 3.3-inch Spectralon integrating sphere but also automatically calculates IQE based on the measurement results. This in turn led to developing an ODPL measurement system that quantitatively evaluates GaN crystal quality using ODPL spectroscopy. The firm also optimized the placement of optical components to make the equipment components such as the integrating sphere, Czerny–Turner monochromator and optical systems more compact (725mm x 380mm x 417mm). A new sliding sample holder (with a substrate size of 6mm x 6mm x 1mm to 17mm x 17mm x 1mm, and inner diameter of 15mm) makes it easier to place the GaN crystal.

Since the ODPL measurement system can quantitatively evaluate GaN crystal quality using ODPL spectroscopy, it is expected to serve as a powerful tool that can greatly boost the efficiency of R&D on improving GaN crystal quality.

Hamamatsu aims to make ODPL spectroscopy measurements an industry standard for quantitative evaluation of GaN crystal quality. "We will also continue to design ever more versatile equipment that supports larger GaN crystal wafers to help streamline the quality inspection process on future mass production lines," adds the firm.

Sales of the new ODPL measurement system began on 2 August for researchers at universities and semiconductor substrate manufacturers both in Japan and overseas. The system was presented at the 'SEMI Partner Search — For Power & Compound' online event on 14 July.

www.hamamatsu.com

5N Plus announces planned organizational change

Nicholas Audet, executive VP Electronic Materials, to leave firm in Q3

Specialty semiconductor and performance materials producer 5N Plus Inc of Montreal, Québec, Canada has announced the planned departure of Nicholas Audet, executive VP of Electronic Materials, effective in third-quarter 2021, to pursue other interests unrelated to the firm and its scope of business. Audet joined 5N Plus in 2003 and ascended through the organization's ranks, having assumed various roles with expanded scope of responsibility.

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 that are addressed by the company's products include renewable energy, security, space, pharmaceutical, medical imaging, and industrial and additive manufacturing.

"After senior management changes in 2016, our company launched 5N21, a turn-around plan designed to substantially reduce earnings' volatility, expand margins and strengthen the company's balance sheet," says president & CEO Arjang Roshan. "As a member of our Executive Committee, Nick's role has been instrumental in implementing and realizing the benefits of this plan."

Earlier this year, 5N Plus unveiled its intent to transform the company by substantially growing its businesses in specialty semiconductors and performance materials while harvesting legacy businesses and those with higher commodity exposure. Claiming to be the market leader with about 45% share of the firm's total addressable market (TAM), a key tenet of the strategy enables 5N Plus to considerably expand its TAM while continuing to focus on its core activities. The firm says that it will rely on organic and merger and acquisition (M&A) activities to achieve this objective and expects meaningful revenue expansion as it executes against its strategic roadmap.

In March, 5N Plus announced its intention to acquire AZUR SPACE Solar Power GmbH. Subject to customary closing conditions, the acquisition will significantly expand 5N Plus' competitive capabilities in specialty semiconductors and culminate in sustainable supply chain infrastructure for critical semiconductor materials. It will fully integrate AZUR's workforce into 5N Plus, including the appointment of AZUR SPACE's managing director Jürgen Heizmann as a new member of 5N Plus' Executive Committee pending closure.

"5N Plus is well positioned for long-term, sustainable and profitable growth with our expanded capabilities in new sectors, and the company's trajectory has never been more positive," comments Audet.

www.5nplus.com

IQE seeing strong growth in Wireless revenue for 5G handsets & WiFi 6 routers, offsetting drop for 5G infrastructure rollouts

Medium- and long-term prospects for 5G macro trend remain strong

In a pre-close trading update for first-half 2021 (subject to external audit review), epiwafer foundry and substrate maker IQE plc of Cardiff, Wales, UK says that trading was in line with management expectations, with continued strong growth in Wireless products for 5G handsets and WiFi 6 routers offsetting a year-on-year reduction in Wireless products for 5G infrastructure.

Revenue is expected to be about £79m, consistent with previous guidance at a constant-currency equivalent of about £87m (down from £89.9m in first-half 2020).

Adjusted EBITDA (earnings before interest, taxes, depreciation, and amortization) is also expected to be consistent with previous guidance at a constant-currency equivalent of about £16m (compared with £16.4m for first-half 2020).

IQE says it continues to make good strategic progress, solidifying and improving its competitive position in each of its core product areas and geographies, while bringing new products to market.

"In the short term, the nature and volume of 5G infrastructure rollouts remains a headwind, in contrast to the continuing strength in demand for products for 5G handsets and WiFi 6 routers," notes CEO Dr Drew Nelson. "5G will be a multi-year cycle and I'm excited that the medium- and long-term prospects for this macro trend are as strong as ever. IQE is exceptionally well-positioned to benefit from that future growth," he believes.

After co-founding IQE in 1988, Nelson said last November that he is relinquishing his role as CEO (while becoming a board member with the title of president, acting in an advisory and ambassadorial role). The firm says that a search for a new CEO is at an advanced stage.

www.iqep.com

Riber and LAAS-CNRS creating joint lab EPICENTRE

Focus to be on MBE process optimization and automation

Riber S.A. of Bezons, France — which manufactures molecular beam epitaxy (MBE) systems as well as evaporation sources and effusion cells — and the CNRS Laboratory for Analysis and Architecture of Systems (LAAS-CNRS) in Toulouse — one of the largest in-house units of the French National Centre for Scientific Research (CNRS) — are creating the joint laboratory EPICENTRE, within which they will share, for a six-year period, their respective expertise in MBE.

The micro- and nanotechnology platform that will house the joint laboratory's MBE equipment (a 1600m^2 cleanroom open to collaboration with the academic world and the industrial sector) is a member of Renatech, the French network of high-end facilities in micro and nanotechnology.

The objective of EPICENTRE is to put in place a strategy for technological innovation in MBE through joint governance and a research plan designed to open up the development of a series of technical components.

The first technical pillar involves developing a series of complementary, non-destructive in-situ metrics tools that ensure ultimate control over epitaxy processes for complex materials. Its aim is to provide solutions to significantly improve MBE processes with a view to offering increased automation, stability and reproducibility for growth processes across the entire range of Riber systems.

EPICENTRE's second technical pillar is to develop a dedicated solution for superconductor materials growth for the datacom sector, focused in particular on quantum computing, specifically addressing the technical challenge of epitaxy at cryogenic temperatures. Its aim is to invent new hybrid epitaxially grown interfaces forming the basic building blocks for future spintronics and quantum components.

Solutions for growing complex components – e.g. vertical-cavity surface-emitting lasers (VCSELs), multi-junction solar cells – will also be developed with a view to demonstrating the efficiency, effectiveness and relevance of these in-situ metrics tools with a view to mass production.

Alongside this, EPICENTRE will launch work on machine learning, an area with strong expectations for the MBE community, looking to optimize the analysis of materials growth processes.

Program driving innovation

This program aims to design an MBE platform, currently unrivalled on the market, focused on the growth of complex III-V and superconductor structures and incorporating advanced automated control processes.

The LAAS-CNRS micro-nano technology unit will therefore soon be receiving a platform from Riber that will be fitted with an instrumentation range fully integrated with Riber's Crystal XE process control software, with features including the in-situ monitoring and control of epitaxial growth parameters. All of these parameters and the corresponding ex-situ characterizations will be compiled in a knowledge base.

This collaboration, supporting innovation, should ultimately make it possible to extend the overall approach to cover Riber's entire range of research and production machines.

Building on longstanding relationship

The creation of EPICENTRE should further strengthen the partnership between LAAS-CNRS and Riber, which have had a close relationship for the past 35 years. For example, LAAS-CNRS has trained a number of Riber staff on MBE technology, has developed a number of demonstrators and characterizations for the firm's clients, and is now a showcase for Riber's know-how.

In 2019, Riber acquired the license to use a patent for an L AAS-CNRS measurement instrument, EZ Curve, enabling the real-time monitoring of substrate curvature for constrained epitaxy. Launched on the market by Riber at the start of 2021, this instrument makes it possible to monitor changes in constraints and determine alloy thickness and concentration levels with significantly higher precision than rival products, it is claimed.

It is expected that the creation of EPICENTRE will make it possible to capitalize more effectively on such joint technology innovations.

www.riber.com

www.laas.fr

Riber's first-half revenue down 20% year-on-year due to pandemic-driven pause in system sales

For first-half 2021, Riber S.A. of Bezons, France — which makes molecular beam epitaxy (MBE) systems as well as evaporation sources and effusion cells — has reported revenue of €9.3m, down 20% on €11.6m in first-half 2020, as orders were booked later in 2020 due to the Covid-19 pandemic.

MBE system revenue was €2.8m, halving from €5.6m. After logistical difficulties due to health restrictions, the delivery of one research system was delayed to third-quarter 2021.

Evaporator revenue is not significant (level at €0.1m) due to the lack of investment in organic light-emitting diode (OLED) screen manufacturing.

Revenue for Services & Accessories was €6.4m, up 8% on €6m a year previously.

Of total revenue, 29% came from Europe, 63% from Asia, 7% from North America, and 1% from other regions.

Despite the pandemic and travel restrictions, the level of new orders improved during first-half 2021, compared with the significant slowdown seen in first-half 2020. During the period, Riber received two orders for production MBE systems and two orders for research MBE systems, while further strengthening the development of its Services & Accessories business.

The total order book at end-June 2021 was €17.4m, down just 5% on €18.2m a year previously. Specifically, the Systems order book was €10.5m (down 16% on €12.5m), and includes five systems to be delivered in 2021 (including one production system). This does not include the additional order for a research system announced on 19 July. Evaporator orders remained zero. However, Services & Accessories orders were €6.9m (up 21% on €5.7m), including a major order for MBE services in the USA to be delivered during 2021.

In view of these developments, Riber expects to improve net income for full-year 2021.

Alongside this, during second-half 2021 the firm expects to see an improvement in orders, benefiting in particular from the first investments made in the semiconductor industry as part of post-Covid stimulus plans around the world.

www.riber.com

Veeco's Q2 revenue up a more-than-expected 48% year-on-year to $146.3m

Full-year 2021 revenue and earnings guidance raised again

For second-quarter 2021, epitaxial deposition and process equipment maker Veeco Instruments Inc of Plainview, NY, USA has reported revenue of $146.3m (exceeding the $125–145m guidance). This is up 9% on $133.7m last quarter (driven largely by 27% growth for Data Storage) and up 48% on $98.6m a year ago (due to growth in the Semiconductor, Compound Semiconductor and Data Storage segments).

Data Storage contributed $52m (35% of total revenue), up 27% on $41m last quarter and 84% on $28m a year ago, driven by both capacity and technology additions by customers.

Semiconductor (Front-End and Back-End, as well as EUV Mask Blank systems and Advanced Packaging) contributed $54m (37% of total revenue), up slightly on $52m last quarter and up 43% on $38m a year ago, driven by laser annealing systems as well as lithography systems for advanced packaging applications.

Compound Semiconductor (Power Electronics, RF Filter & Device applications, and Photonics including specialty, mini- and micro-LEDs, VCSELs, laser diodes) contributed $24m (17% of total revenue), roughly level with last quarter and up 37% on $18m a year ago, driven by wet processing systems for RF applications.

The Scientific & Other segment contributed $16m (11% of total revenue), roughly level with both last quarter and a year ago.

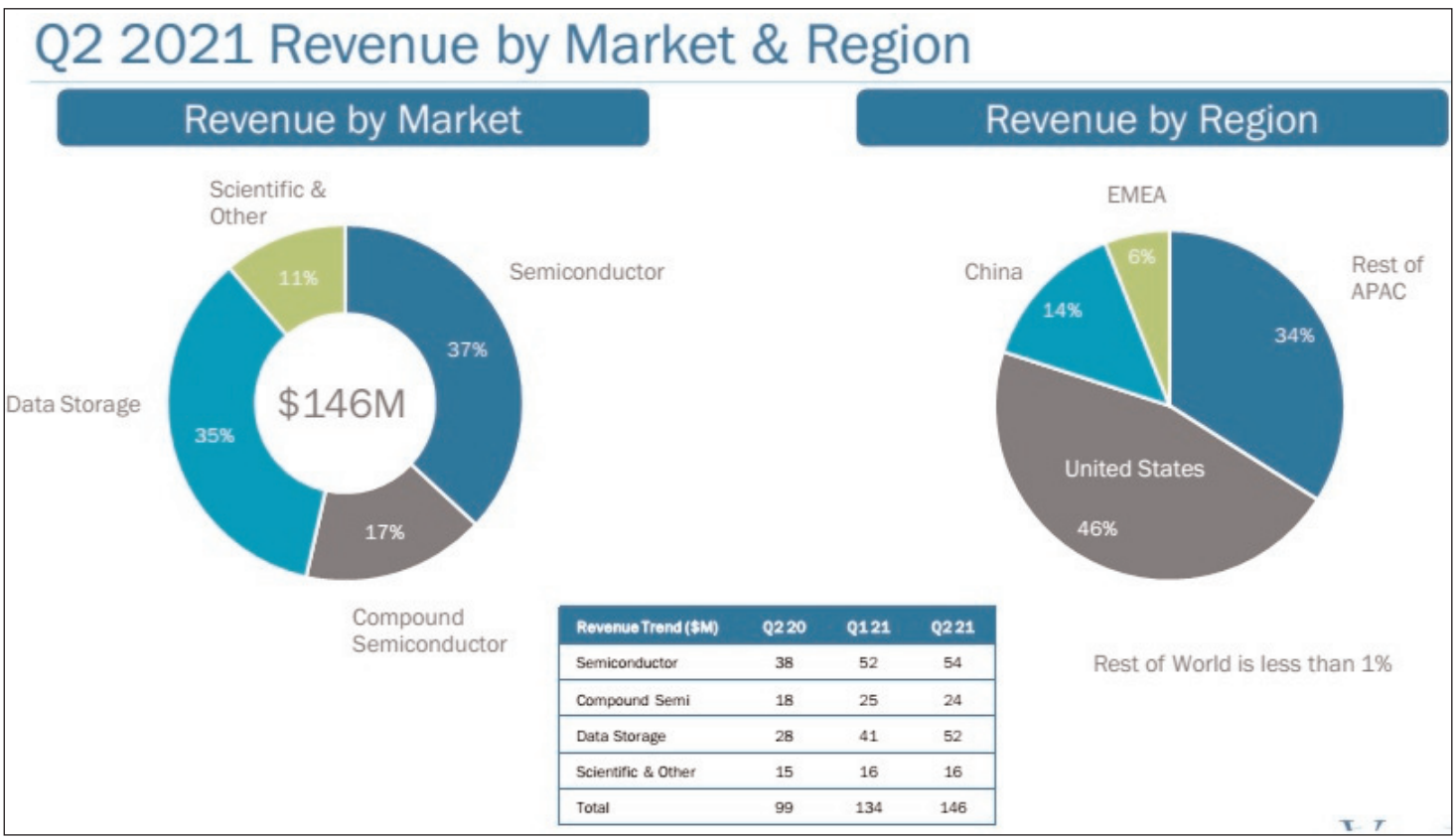
By region, the USA comprised 46% of revenue (up from 34% last quarter), driven by ion beam systems shipped to Data Storage customers. Europe, Middle-East & Africa (EMEA) comprised just 6% (down from 10%), Asia-Pacific (excluding China) 34% (down from 41%), and China 14% (down slightly from 15%). "We expect the revenue percentage from China to trend higher, given our recent order activity and improving ability to obtain export licenses," notes chief financial officer John Kiernan.

"Veeco delivered solid performance in the second quarter with revenue and EPS at the high end of our guidance range," says CEO Bill Miller.

On a non-GAAP basis, gross margin was 41.6%, flat with last quarter but up from 43% a year ago, and toward the top end of the 40–42% guidance range.

Operating expenses were $39.6m, up from $34.4m a year ago but roughly level with last quarter (and cut from Q1's 29% to Q2's 27% as a proportion of revenue).

Net income has risen further, from $5.5m ($0.11 per diluted share) a year ago and $12.6m ($0.25 per diluted share) last quarter to $17.9m ($0.35 per diluted share).



Revenue Trend ($M)	Q2 20	Q1 21	Q2 21
Semiconductor	38	52	54
Compound Semi	18	25	24
Data Storage	28	41	52
Scientific & Other	15	16	16
Total	99	134	146

Operating cash flow was steady at $10m. Capital expenditure (CapEx) was $7m, but this includes $4m for the construction project at Veeco's new manufacturing facility in San Jose, CA (to meet demand from Semiconductor customers). "We expect capital spending on our facility expansion project to increase in the coming quarters," notes Kiernan. "We continue to improve our operating model, while making investments for future growth," adds Miller.

During the quarter, cash and short-term investments hence rose by $2m to $330m. Long-term debt rose slightly from $325m to $328m, representing the carrying value of $389m in convertible notes.

From a working capital perspective, due to the timing of shipments in the quarter, accounts receivable rose further from $87m to $108m, driving days sales outstanding (DSO) up from 59 days to 67 days. Due mostly to construction invoices for the firm's capital expansion project, accounts payable rose further from $43m to $55m, driving days payable outstanding (DPO) up from 49 days to 58 days. To support increased shipment volume and investments in evaluation systems, inventory was increased by $8m to $164m.

"We continue to see strong demand for our wet processing equipment from our RF customers," notes Miller. "5G communication is driving an increase in content per mobile device and our customers are responding by adding capacity for RF power amplifiers and filters. In fact, we had strong shipment and order activity during the quarter for RF applications," he adds.

"Our gallium nitride and arsenide phosphide MOCVD systems enable fast-charging and other power management solutions, 5G RF devices and micro-LEDs. These markets have tremendous growth potential and we're looking to build our market position," continues Miller. "Recent early-stage wins and evaluations underway for power and micro-LED applications give us confidence we'll grow in these emerging markets," he adds. "We also have two compound semiconductor tools out in the field. One is for 8-inch GaN-on-silicon power electronics at a foundry, pretty exciting opportunity as the world transitions from 6-inch to 8-inch. That tool just recently shipped. And we have another application for micro-LEDs in the compound semi space."

"We are on track to deliver exceptional growth in 2021, and our evaluation systems in the field are performing well, giving us confidence in our longer-term growth plan," says Miller. "In addition, progress on our new manufacturing facility, supporting the Semiconductor market, is on schedule and will enable us to meet future demand with increased manufacturing capacity."

For third-quarter 2021, Veeco expects revenue of $135–155m, with gross margin of 41–43%. Operating expenses should rise slightly to $40–42m as Veeco adds resources in R&D along with increasing sales & marketing expenses to support growth. ("We are on pace, however, for full-year OpEx as a percentage of revenue to decline compared to 2020," notes Kiernan.) Veeco forecasts net income of $13–23m ($0.25–0.44 per diluted share).

Q4/2021 is expected to be in the same revenue range as the firm's Q3 guidance. Therefore, for full-year 2021, Veeco now projects revenue growth of 25.5% to about $570m (above the prior guidance range of 17–21% growth to $540–560m, which itself had been raised from initial guidance of 17% growth to $520–540m).

Earnings per share (EPS) are expected to be towards the high end of the guidance range of $1.10–1.30 (and above the initial guidance range of $1–1.20).

Veeco appoints Rockwell Automation CTO to board

Dr Sujeet Chand brings over 30 years of industry experience

Epitaxial deposition and process equipment maker Veeco Instruments Inc of Plainview, NY, USA has appointed Sujeet Chand Ph.D. to its board of directors. In addition to his industry experience and leadership qualities, Chand was identified through a search process in connection with the board's desire for increased diversity.

Chand, age 63, has been senior VP & chief technology officer of Rockwell Automation since 2005. From 2001 to 2005, he served as Rockwell Automation's vice president, Control Systems. Prior to joining Rockwell Automation, Chand was chief operating officer for XAP Corp from 1999 to 2001 and, from 1988 to 1999, he led R&D at Rockwell Scientific Company, a subsidiary of Rockwell International.

Chand holds a Bachelor of Engineering degree from Osmania University in India and, from the University of Florida, a Masters Degree in Electrical Engineering and a Ph.D. in Electrical and Computer Engineering.

"Dr Chand brings exceptional technology background to Veeco's board that includes more than 30 years of leadership experience," comments CEO William J. Miller Ph.D. "His appointment is of significant importance as we leverage his unique background and perspective," he adds. "We also strongly believe that improving the board's diversity with Sujeet's appointment enhances creativity, promotes innovation and is in the best interests of our shareholders."

www.veeco.com

Aixtron doubles EBIT in first-half 2021 as revenue grows 21% year-on-year

Order intake forecast raised again, from €320–360m to €400–440m

Deposition equipment maker Aixtron SE of Herzogenrath, near Aachen, Germany has reported revenue growth of 21% from €97m in first-half 2020 to €117.2m in first-half 2021 (with 78% coming from equipment sales and 22% from after-sales service & spare parts). This was due mainly to second-quarter 2021's revenue of €67.7m being up 37% on Q1's €49.5m. Of Q2 revenue, 61% was attributable to optoelectronics applications, 30% to power electronics (in particular gallium nitride) and 7% to light-emitting diodes.

On a regional basis, 62% of first-half 2021 revenue came from Asia (down from 76% in first-half 2020), 32% from Europe (up from just 11%) and just 6% from the Americas (down from 13%).

Gross margin of 39% in first-half 2021 was level year-on-year, although quarterly gross margin improved from 35% in Q1 to 41% in Q2.

Operating expenses rose by 14% from €35.3m in first-half 2020 to €40.2m in first-half 2021, comprising €18m in Q1 rising to €22.3m in Q2. However, the increase is due mostly to €3.2m in one-time expenses for realigning the business activities of South Korea-based organic light-emitting diode (OLED)-focused subsidiary APEVA.

Doubling of EBIT

Due to the revenue growth, Aixtron's earnings before interest and taxes (EBIT) operating result more than doubled from €2.2m (EBIT margin of 2% of revenue) in first-half 2020 to €4.9m (4% margin) for first-half 2021, with –€0.7m EBIT (–1% margin) in Q1 being more than compensated by €5.6m (8% margin) in Q2.

In addition, the capitalization of deferred taxes on loss carry-forwards amounted to €3.4m in Q2/2021, more than doubling net profit from €3.8m in Q1 to €7.7m in Q2, or €11.5m collectively in first-half 2021 (compared with just €2.5m in first-half 2020).

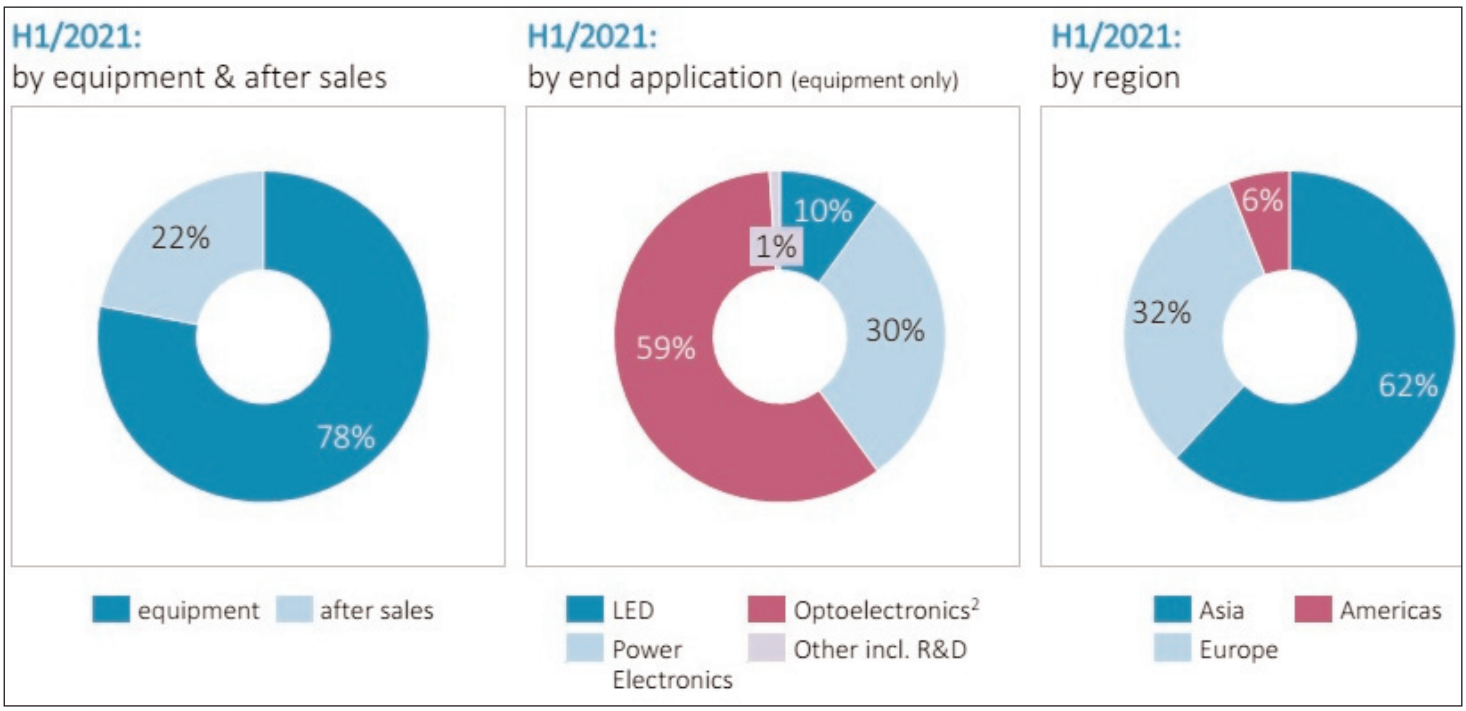
Due mainly to a significant rise in customer prepayments (reflecting the positive order situation), working capital rose by €42.6m in first-half 2021, and operating cash flow was €52.6m.

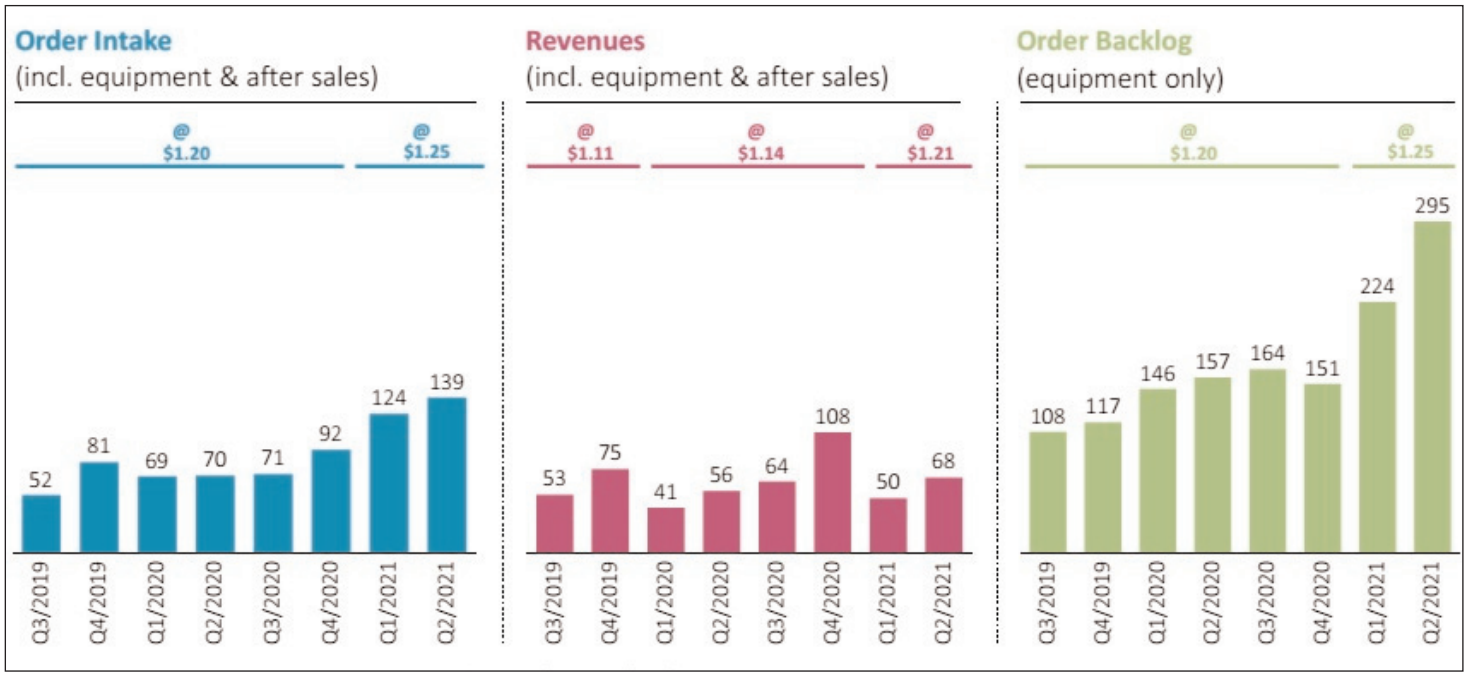
After capital expenditure (CapEx) of €6.5m, free cash flow was hence €46.1m (comprising €28.1m in Q1 and €18m in Q2), compared with –€8.4m in first-half 2020. Aixtron reported a decrease in equity ratio during first-half 2021, from 84% to 73%. Also, for full-year 2020, the firm hence distributed a dividend to its shareholders for the first time in ten years.

Highest order intake and backlog in ten years

Order intake rose by 90% from €138.4m for first-half 2020 to €263.3m in first-half 2021 (the highest half-year revenue in the past ten years). This included Q2/2021 orders of €139m (the highest quarterly figure since Q2/2011), up 12% on the already strong €124.4m in Q1 and roughly doubling from €69.6m in Q2/2020. Customers particularly requested equipment for GaN power electronics applications, optical datacoms and LEDs for fine-pitch displays and indoor farming.

Equipment order backlog at the end of the June was €295m (the highest volume in the past decade),





up 32% on €223.5m at the end of Q1 and up 88% on €156.6m a year previously.

Order intake forecast raised again, from €320–360m to €400–440m

After already (on 9 June) raising its guidance for full-year 2021 order intake from €340–380m to €420–460m, due to the dynamic order development Aixtron has now raised its guidance again, to €440–480m.

With revenue growth expected to accelerate through Q3 and Q4/2021, the firm has also reiterated its guidance for full-year revenue of €400–440m (previously raised on 9 June from prior guidance of €320–360m). Aixtron still expects gross margin of 40%, and EBIT margin of 20–22% of revenue (raised on 9 June from prior guidance of 18%).

Aixtron notes that expectations for 2021 are based on the assumption that the COVID-19 pandemic continues to have no significant impact on the development of the business. With all interested staff at headquarters vaccinated against COVID-19, the firm targets a 50% presence in its HQ's offices. The supply chain remains stable, it adds.

"Customer demand is very high in all end-markets relevant to us," notes president & CEO Dr Felix Grawert. "In particular, Aixtron's equipment for the production of gallium nitride power electronics, for the production of components for 5G network expansion and for high-speed optical data transmission is in high demand. This trend is unbroken, and we expect to continue to see very dynamic revenue growth in the second half of the year," he adds. "The gallium nitride material system in particular opens up competitive advantages for our customers in terms of performance, but also with regard to energy consumption and the associated CO_2 emissions. Our customers are increasingly taking advantage of gallium nitride in devices," Grawert concludes.

www.aixtron.com

2021 Guidance[1] increased/confirmed
based on H1 Results, current Order situation and current environment:

Total Order Intake (EUR million) *(increased from 420 - 460)*	440 - 480
Revenues (EUR million)	400 - 440
Gross Margin (%)	~ 40%
EBIT Margin (%)	20% - 22%

Meaglow's ALD gas plasma technology granted European patent

60+ hollow-cathode plasma sources in field yield over 50 journal publications

Meaglow Ltd of Thunder Bay, Ontario, Canada, which produces migration-enhanced afterglow epitaxy equipment and molecular beam epitaxy (MBE) and metal-organic chemical vapor deposition (MOCVD) accessories, says that its hollow-cathode plasma technology has been granted a patent by the European Patent Office. This follows existing patents granted in the USA and elsewhere.

The gas plasma sources have already been applied by the atomic layer deposition (ALD) research community, providing a solution to the oxygen contamination problems seen when depositing non-oxide layers with the legacy plasma technologies.

In recent years ALD has become an important tool in the semiconductor industry for the manufacture of chips for computers, cell phones and other mobile devices. Meaglow says that adoption of its hollow-cathode plasma source by the research community has been relatively rapid, as many other equipment suppliers were unresponsive to the problem of oxygen contamination. Some now seek or provide solutions, but Meaglow is supplying to five original equipment manufacturers (OEMs). There are 60-plus Meaglow hollow-cathode plasma sources in the field and over 50 research-based journal publications have resulted from them. A 12"-diameter source is also being evaluated by a customer, so the technology may soon find adoption in production facilities.

"When we first introduced this technology, many of the ALD equipment manufacturers weren't even aware there was a problem — but their customers were," says chief scientist Dr Scott Butcher. "It's good to now see the widespread adoption of hollow-cathode technology, especially amongst some OEMs."

www.meaglow.com

Brooks Instrument opens manufacturing, service and applications support center in Korea

Firm's global production capacity to rise by nearly 30%

Brooks Instrument of Hatfield, PA, USA (a provider of instrumentation for flow, pressure and vapor delivery) has opened a new manufacturing and engineering center in South Korea to expand production of its mass flow controllers used extensively in semiconductor manufacturing.

Located in Yongin, Gyeonggi Province, the new facility significantly increases the firm's operational footprint in Korea. It includes a much larger Class 100 cleanroom manufacturing area, as well as increased space for engineering, service and sales support.

Brooks Instrument has operated in Korea for nearly 25 years. It moved from its previous location in Korea to the larger Yongin facility to better serve the needs of the fast-growing semiconductor manufacturing sectors locally and throughout the Asia Pacific region.

"With the anticipated continued growth of the semiconductor industry, we wanted to relocate and expand our operations to provide increased local production capability, faster service and sales and applications engineering support," says Hans Sundstrom, Global Semiconductor business unit manager.

The much larger facility will initially support production of the Brooks Instrument GF100 Series of mass flow controllers used in semiconductor and other critical gas flow control applications. The firm claims that the GF100 series is widely seen as the semiconductor industry thermal MFC standard for reliable, repeatable delivery of process gasses.

"Once the new production facility in Yongin reaches full scale, we will have increased our global production capacity by close to 30%," says Sundstrom. "It will also serve as an additional location for manufacturing and parts inventory, complementing our facilities in the USA and Hungary, thereby further reducing the risk of a supply chain disruption for our customers."

The Yongin facility will also improve the company's ability to provide rapid repair, maintenance and calibration support to customers in the region. Staffing includes applications engineers ready to assist customers with expert support and insight on how to integrate Brooks Instrument's mass flow technology with specific applications and advanced processes.

"By relocating closer to our customers, we will have increased opportunity for collaboration, be able to learn more about their unique challenges, and work with them to further enhance our technology to better meet their current and future needs," says Jason Lee, Korea country manager.

www.brooksinstrument.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

Semiconductor veteran Ryan Cameron made Rohinni CEO

Headquarters relocating to expand engineering space by 170%

Rohinni LLC of Coeur d'Alene, ID, USA (which has developed a proprietary method for transferring mini- and micro-LEDs to substrates) has announced that Ryan Cameron is its new CEO, and that it is moving its headquarters to Liberty Lake, WA in order to increase the team's engineering space.

After an extensive national search process, Cameron was chosen as the new CEO as a result of his "success, background and commitment to innovation, coupled with his mix of skills and leadership qualities that position him for success in leading Rohinni forward".

Cameron has over 12 years of experience as an executive in the semiconductor industry. He most recently was VP & general manager

of the Industrial & Offline Power Division at ON Semiconductor, where he led a global team of 565 staff (US, Europe and Asia) and was responsible for over $550m in revenue. Previously, he held many roles at AMI (which was acquired by ON Semiconductor), including senior director — Custom Industrial & Timing Products, project line manager, design center manager and mixed-signal design engineer. Cameron graduated from the University of Idaho's college of engineering, and has called Idaho home since 1984.

"Fresh leadership will deliver an acceleration in the enormous potential for value and returns that will come from Rohinni's next wave of transformation," believes chairman Stan Swearingen.

The firm is also getting ready for a move to Liberty Lake, WA (20 miles west of Coeur d'Alene) in Q1/2022 to boost its machine line capacity by 170% and accommodate the expanding team.

"The opportunity ahead for Rohinni is vast, and to seize it we must focus clearly, move quickly, and continue to transform," says Cameron. "A big component of my role is to accelerate our bond head product strategy and execute our technology roadmapx," he adds.

www.rohinni.com

Picosun delivers ALD technology to ams OSRAM

Picosun Group of Espoo, Finland has delivered atomic layer deposition (ALD) technology to ams OSRAM of Premstaetten/Graz, Austria and Munich, Germany for volume manufacturing of optical semiconductor devices.

ams OSRAM has invested in a fully automated PICOSUN Morpher production cluster, which can deposit multiple materials on a batch of wafers even during the same process run. Picosun says that the flexibility and process variety of the Morpher system is a key advantage, which enables volume production as well as the testing of new processes for R&D of future products.

Picosun and ams OSRAM have collaborated in a public-funded European Union (EU) M-ERA.NET project FLINGO (Functional Inorganic Layers for Next Generation Optical Devices) to develop new ALD materials and processes to improve the characteristics of LEDs, such as efficiency and durability. Collaboration will continue after ALD system delivery with activities to further expand the use of ALD in optoelectronic processing.

"We have been working with Picosun since 2010 and now, with this investment, we can bring our collaboration to the next level," says Dr Sebastian Taeger of ams OSRAM.

"The optical semiconductor market is one focus area of Picosun today," notes Dr Christoph Hossbach, general manager of Picosun Europe GmbH. "It is a fast-growing market where we have a strong presence with our tailored solutions for compound semiconductor-based devices," he adds. "We have had excellent collaboration with the ams OSRAM technical team during project FLINGO and during the system-specification stage. Expertise from both companies has resulted in optimized ALD solutions to boost the performance of the customer's products."

www.m-era.net

www.osram-os.com

Picosun appoints vice president of sales

Picosun has appointed Kenneth Hörhammer as VP sales, and a member of its leadership team.

Hörhammer has international business experience as well as proven results in sales development and execution, including multiple global business and sales leadership positions at Vaisala, both in Finland and abroad, over the past 17 years.

"The potential for ALD is almost limitless, and Picosun is spearheading this technology globally," says Hörhammer.

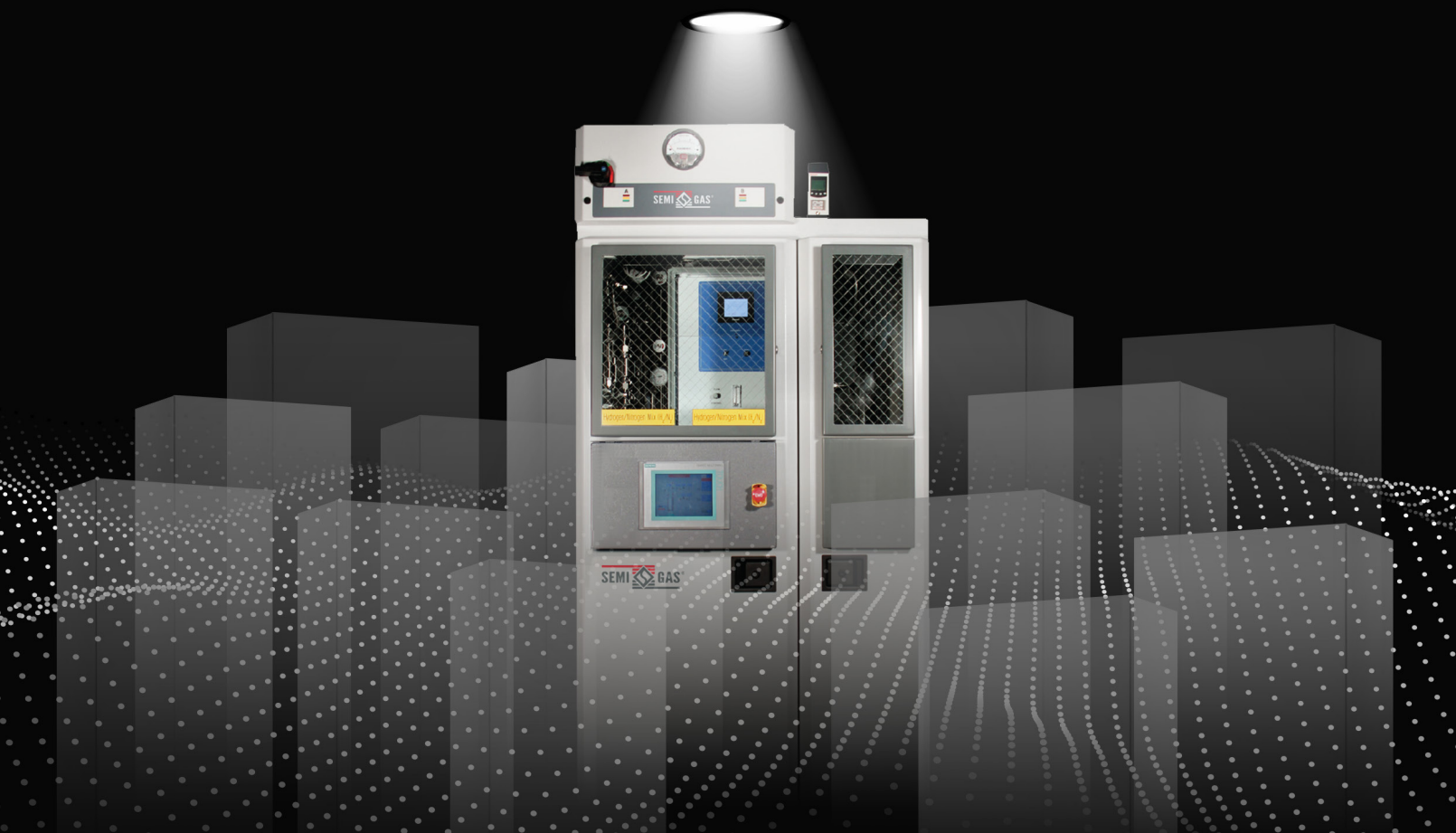
"The professional background and global experience he brings to our team enable us to significantly strengthen our global sales management, build a stronger sales organization and enforce customer satisfaction," comments Picosun Group's CEO Jussi Rautee.

www.picosun.com

SEMI GAS®

HIGH INNOVATION HAS HIGH STAKES.

Rise to new standards with SEMI-GAS®.



Semiconductors are mission-critical to many advanced applications today. Subpar gas delivery system performance not only inhibits output quality and reliability—it can also compromise safety.

For 40 years, SEMI-GAS® ultra high purity gas delivery systems have been relied upon by fabs looking to up their innovation, addressing evolving risks with features that don't just meet but exceed codes for safety, precision & purity.

BROUGHT TO YOU BY

APPLIED ENERGY SYSTEMS

Improve yield, ensure high-performance output, and protect the processes and people that make innovation possible with SEMI-GAS®. Start today at appliedenergysystems.com/stakes.

Porotech teams with μLED panel firm Jade Bird Display

GaN material technology developer Porotech (a spin-out from the Cambridge Centre for Gallium Nitride at the UK's University of Cambridge) has announced its first partnership, in which it will provide active-matrix micro-LED panel firm Jade Bird Display (JBD) of Shanghai, China with its porous GaN technology.

Porotech says that its display technology enables brighter, sharper, more vivid micro-displays for even the smallest devices. Micro-LEDs represent next-generation technology for displays in products such as smartphones, smartwatches and virtual reality/augmented reality (VR/AR) headsets. They are particularly useful in outdoor settings, where sunlight can often make existing displays difficult to see clearly. However, the performance of existing micro-LED technologies deteriorates as the device size decreases.

Porotech has created a new class of porous GaN semiconductor material that is said to offer performance improvements suitable for mass production and can be customized for individual customers' needs.

Last November, Porotech launched the first commercial native red indium gallium nitride (InGaN) LED epiwafer for micro-LED applications. JBD now plans to use Porotech's porous GaN templates to manufacture InGaN-based red micro-LED displays for use in applications such as VR/AR headsets, AR smart sports goggles and head-up displays.

"This partnership will enable both JBD and Porotech to meet the demands of micro-LED displays in the future," reckons Porotech's CEO & co-founder Dr Tongtong Zhu. "Micro-LED displays using GaN-based material technology are widely seen as the only technology that can deliver displays bright and efficient enough to meet the requirements of VR and AR. Our proprietary technology is robust but also flexible enough to be tailored to the needs of different applications," he adds.

"JBD can see the enormous potential of Porotech's breakthrough – and we are keen to work with this revolutionary technology to create a new generation of microdisplays," says JBD's founder & CEO Qiming Li.

In June, to fund the next stage of development of its unique micro-LED production technique, Porotech raised £3m in a funding round led by European venture capital fund Speedinvest, joined by previous investors IQ Capital, Cambridge Enterprise, Martlet and Cambridge Angels.

www.porotech.co.uk
www.jb-display.com

Seoul Semi's record revenue in Q2 up 25.6% year-on-year

First-half net profit surpasses full-year 2020 net profit

For second-quarter 2021, South Korea's Seoul Semiconductor has reported record revenue of KRW336.8bn, up 25.6% year on year.

Operating profit was up 70.3% year on year to KRW23.4bn (operating margin of 6.9% of revenue).

Double-digit growth continued across all divisions including Display, General Lighting and Automotive, while the Automotive division led growth by doubling its revenue year-on-year.

Net profit for first-half 2021 reached KRW43.9bn, already exceeding 2020 full-year net profit of KRW29bn, which implies higher dividend income opportunities for investors towards year-end.

"We started the quarter against concerns regarding semiconductor shortage within the car industry manufacturing value chain," says Seoul. "However, we managed to overcome headwinds thanks to structural growth from WICOP [wafer-level integrated chip on PCB], our patented LED chip technology with a robust structure. WICOP is now applied to more than 102 car models globally this year as our automotive division entered the secular growth stage," the firm adds.

WICOP is designed to be a compact form factor suitable for slim and thin lenses, as it does not require wire bonding or packaging. Also, due to its long product lifetime and high efficiency of heat conductivity, WICOP is being actively applied to TV backlighting LEDs. WICOP chips are being used in about 20% of all global TVs,, it is claimed.

2012			2020		
Ranking	Company name	PKG Revenues ($M)	Ranking	Company name	PKG Revenues ($M)
1	Nichia	1,943	1	Nichia	1,766
2	Osram	1,119	2	Osram	1,171
3	S-LED	1,119	3	**Seoul**	**898**
4	Lumileds	765	4	Lumileds	891
5	**Seoul**	**706**	5	S-LED	758
6	Cree	589	6	Mulinsen	643
7	Innotek	589	7	Cree	407
8	Everlight	412	8	Everlight	386
9	TG	412	9	Nationstar	343
10	Stanley	412	10	Stanley	286
Total Market Size:		$11,781			$12,776

For third-quarter 2021, Seoul Semiconductor expects record revenue of KRW340–360bn, up 3–9% year on year (driving year-to-date revenue over KRW1 trillion). "In the second half, mass production for the mini-LED, one of the next-generation display technologies, is expected to begin," says Seoul. "On top of that, we already raised our capital expenditures in the first half to cope with an upbeat demand forecast for general lighting and automotive LEDs," it adds.

www.SeoulSemicon.com

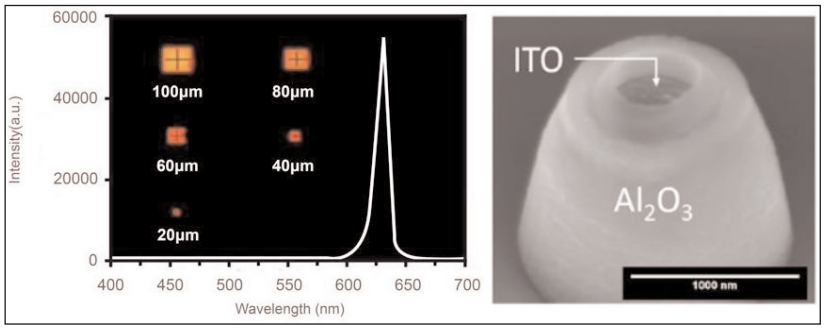
Seoul Viosys and UCSB's SSLEEC tackle micro-LED efficiency challenges for display applications

Mass production begun using 70μm red micro-LEDs; 30μm one-pixel products in second-half 2021 then 10μm in 2022

LED product maker Seoul Viosys (a subsidiary of South Korea's Seoul Semiconductor) and the Solid State Lighting & Energy Electronics Center (SSLEEC) led by Nobel Prize-winning physics professor Shuji Nakamura of University of California Santa Barbara (UCSB) say that they have developed blue and green micro-LEDs with a diameter of 1μm and addressed issues related to red micro-LEDs of less than 70μm, which previously could not be mass produced due to a drop in external quantum efficiency (EQE).

Targeting the display industry, Seoul Viosys has begun mass production of products (MC04, MC02) employing 70μm red micro-LEDs, and is preparing to release 30μm one-pixel micro-LED products in second-half 2021 and 10μm one-pixel micro-LED products in 2022.

Seoul Viosys says that for 20 years it has supported the SSLEEC team in the development of micro-LEDs with a diameter of 1μm and made it possible to produce ultra-small micro-LED solutions and to improve brightness through a 150% increase in the EQE of red micro-LEDs.



(a) Electroluminescence (EL) wavelength spectrum of red micro-LED and (b) blue and green micro-LEDs with a diameter of 1μm viewed under an electron microscope.

The application of red micro-LEDs has previously been limited due the light-emitting efficiency falling as size was reduced (Smith et al, Optics Express 5787, vol28 (4) (2020) Appl. Phys. Lett. 116, 071102 (2020)).

Seoul Viosys is hence expecting rapid commercialization of display applications such as smartphones, augmented reality (AR) and virtual reality (VR) through improved micro-LED technology.

"According to our principle to supply new products first to the companies that respect intellectual property rights, we will first supply the new ultra-small-size 10μm and 30μm one-pixel micro-LEDs to the customers who have purchased our products (MC04, MC02, Wicop MINI, etc) and are using them," states Seoul Viosys.

https://aip.scitation.org/doi/full/10.1063/1.5144819
www.seoulviosys.com

Seoul Viosys' record revenue in Q2 up 27% year-on-year

First-half net profit of KRW22.8bn exceeds full-year 2020 profit

For second-quarter 2021, LED product maker Seoul Viosys Co Ltd, a subsidiary of South Korea's Seoul Semiconductor, has reported record revenue of KRW131.6bn, up 7.5% quarter-on-quarter and 27% year-on-year.

Revenue and profit growth was driven by the visible segment of the company, WICOP (wafer-level integrated chip on PCB, which offers package-less LED solutions designed with a robust structure), achieving growth of 15% quarter-on-quarter and 68% year-on-year.

Operating profit of KRW11.2bn (operating margin of 8.5%) is up 84% year-on-year. Net profit of KRW9.1bn is up by 41% year-on-year. Consequently, first-half 2021 net profit has already exceeded 2020's full-year profit of KRW19.6bn.

Seoul Viosys expects revenue to continue growing, rising by 7–16% year-on-year in third-quarter 2021.

In particular, Micro Clean Pixel — which was first launched at the 2020 Consumer Electronics Show (CES) and has now entered mass production — could potentially be a game-changer in the display market, and the firm expects that this could lead to a quantum leap in sales in the future.

On 15 July, a study conducted by a research team at Korea University showed that the Delta variant of the Coronavirus (SARS-CoV-2:B.1.617.2) is disinfected 99.3% in just 1 second when exposed to Violeds ultraviolet light-emitting diodes (UV LEDs). In addition, Seoul conducted an in-house air disinfection laboratory test (60m^3) which resulted in 90% disinfection in 10 minutes.

On 4 August, Seoul announced a new air disinfection solution that can provide faster and stronger disinfection in a wider space.

A new plan to supply products for multi-use facilities was also announced.

www.seoulviosys.com

Nitride wins patent license settlement from QT-Brightek

Patent infringement lawsuits continued against other UV-LED product makers in US

In September 2017, Japan's Nitride Semiconductors Co Ltd (which was spun off from Tokushima University in 2000) filed complaints against global electrical components distributor Digi-Key Corp in the US District Court for the District of Minnesota, asserting infringement of its ultraviolet light-emitting diode (UV-LED) patent. Nitride asserted that UV-LED products supplied by various LED companies — such as American Opto Plus LED Corp, Crystal IS Inc, Kingbright Electronic Co Ltd, Luminus Device, and QT-Brightek Corp — have been infringing Nitride's UV-LED patent.

Further, this March Nitride filed a complaint against Lite-On Technology Corp and its affiliates in the US District Court for the Western District of Texas, asserting infringement of Nitride's UV-LED patent.

On 18 June, in relation to the above-mentioned lawsuits, Nitride entered into a settlement and patent license agreement with California-based QT-Brightek Corp that provides that QT-Brightek does not dispute that its UV-LEDs infringe, and it has also agreed to respect Nitride's patent.

Regarding UV LED makers' products, Nitride continues to pursue patent litigations in the Minnesota and Texas courts.

With professor emeritus Shiro Sakai at Tokushima University, Nitride developed what was claimed to be the first highly efficient UV-LEDs as early as 2000. The firm has continued to manufacture and sell UV-LEDs, and says that it has invested in R&D to develop and enhance its UV-LED technology.

To protect its UV-LED patented technology, Nitride initiated its patent enforcement campaign in 2017. Subsequently, in 2020, a judgment was issued by the US District Court for the Northern District of California against RayVio Corp for infringing Nitride's UV-LED patent. That was also in Nitride's favor with respect to the validity of its patent. The US Patent & Trademark Office has also confirmed the validity of the key claims of Nitride's patent in its final judgment on an Inter Parte Review case filed by RayVio.

Nitride says that, since it considers its intellectual property rights to be vitally important assets, it will take any action necessary to enforce its patent against infringers in any country and uphold its patents and other intellectual property rights.

www.nitride.co.jp

Nichia unveils high-power 1800K LED alternative to HPS

High-power, low-CCT LED suitable as mercury-free lamp replacement

Nichia Corp of Anan City, Tokushima, Japan has announced its 219F series of high-power LEDs, positioned as a true alternative to high-pressure sodium lamps (HPS).

Global efforts to phase-out the use of HPS continue to be met with a resistance to using white LED replacements, says Nichia. Due to this lack of a viable and sustainable alternative, HPS lamps have remained exempt from the list of banned products under the Minamata Convention on mercury, meaning that HPS remains ubiquitous. With the introduction of the 219F, Nichia reckons that is the first LED maker to provide that alternative. The NVSW219F eradicates mercury but increases efficiency and lifetime, with a low (1800K) correlated color temperature (CCT) output that works with HPS to retain the element of 'nostalgic landscape' lighting.

Existing LED solutions fail to meet the light profile demanded by applications currently serviced by HPS, says Nichia. This typically requires a light level with a low CCT of 1800K to recreate the 'nostalgic landscape' effect typified by HPS. Nichia has developed the 219F at 1800K/CRI 70 to address this, with technology that can meet the CCT and color rendering index (Ra) required for street-lighting applications and lighting for parks and other outdoor areas.

In addition to the color matching with HPS, the CRI of the 219F is higher than HPS, increasing it from less than 5 (according to measurement by Nichia), to more than 70, which enhances the natural colors of a city versus the monotone rendering with HPS. The ability to generate a true color landscape delivers comfortable and bright lighting while retaining a nostalgic and/or elegant atmosphere, says Nichia. This is also conducive to security applications as it helps to distinguish the color of clothes, cars and buildings under the street lighting.

Also, LEDs allow for instantaneous on/off and output modulation or dimming controls. Enabling 'smart lighting' can lead to energy savings. For example, in areas of low pedestrian traffic, LEDs, controls and sensors can allow for intermediate light levels with instant-on or full brightness when motion is detected. It is not possible to achieve this with HPS lamps, making this a significant advantage that LED lighting can offer. Lower glare (with a consequently reduced impact on people, flora and fauna), less blue-light emissions, and reduced light pollution are also benefits of the 219F/1800K/CRI 70. As well as helping to achieve mercury-free replacement, the 219F has a longer lifetime, delivering up to 60,000 hours of operation (over twice the 24,000 hours average of HPS).

"People like the visual effect provided by HPS, creating what we call the 'nostalgic landscape'. Existing LED technology finds it hard to replicate this. The measured CCT of HPS is 1800K, which only Nichia has successfully recreated after various color matching tests," claims Yuji Itsuki, general manager of marketing. "That means the 219F is the only LED available today that can accurately match the CCT of HPS," he adds. "This ability to blend LED and HPS without creating harsh variations is what really makes it the first in the industry to provide a true alternative."

Nichia offers 1800K as a recommendation for HPS replacement but also provides other lower-CCT options. With four lower CCT levels spanning 2500K, 2200K, 2000K and 1800K, the 219F series meets all market requirements, it is reckoned.

To recreate the nostalgic landscape effect created by HPS, customers can select the 1800K model. Customers prioritizing power efficiency can select the 2500K model. To meet the guidelines of the Design Lights Consortium (DLC), customers can select the 2200K model. If customers prioritize HPS catalogue value, they can select 2000K.

Nichia says that the 219F series will be available in September.

www.nichia.co.jp

UCSB's DenBaars to receive AAFM-Nakamura Award

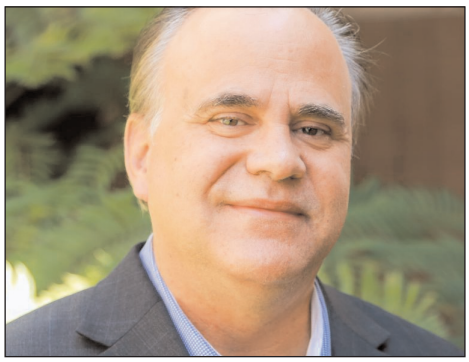
Functional Materials award for III–nitride LED lighting, laser and power electronics development

Steven P DenBaars, professor of materials and of electrical and computer engineering at University of California Santa Barbara (UCSB), has been chosen by the American Association for Advances in Functional Materials (AAFM) as one of two recipients of its 2021 AAFM-Nakamura Award. Named after Nobel Prize winner Shuji Nakamura (also a UCSB professor), the award recognizes "an outstanding scientist in the field of functional materials who has made significant contributions and whose work shows significant innovation in the field." University of California Berkeley professor of chemistry Omar Yaghi was also selected.

"I am very honored to receive this award for my contributions to functional materials, especially III–nitride semiconductors, and also because it was named after my esteemed colleague," commented DenBaars, who was unanimously chosen by the AAFM-Nakamura Award committee from "among many exceptional nominations".

"The department is very proud of the recognition for professor DenBaars's many contributions to the development of gallium nitride (GaN) light-emitting devices that impact our daily lives," states Michael Chabinyc, chair of UCSB's Department of Materials.

DenBaars is recognized for his "pioneering work" with GaN — a "highly efficient and high-performing semiconductor material that is the foundation of energy-efficient lighting, micro-LED displays, power electronics and nonpolar and semipolar laser diodes". Its efficiency and ability to withstand higher voltages and temperatures make it an ideal building block for power-saving electronics and versatile solid-state lasers, and it has already been embraced in the lighting, photonics and electronics industries.



UCSB professor Steven DenBaars.

As well as his expertise with GaN and its fabrication, DenBaars (who joined the UCSB faculty in 1991) is a seasoned entrepreneur, bringing to market various powerful, versatile and energy-efficient technologies that can be built on GaN. In 1996, along with fellow GaN expert Umesh Mishra, he co-founded the USA's first GaN LED startup Nitres Inc (acquired by Cree Inc in 2000). In 2008, with Nakamura and colleague James Speck, he co-founded Soraa Inc to commercialize LED lighting. Also with Nakamura, as well as UCSB alumnus James Raring and collaborator Paul Rudy, DenBaars in 2013 co-founded SLD Laser to pioneer blue lasers and laser lighting products (growing the company to over 150 staff before it was acquired by Kyocera Corp in 2021). DenBaars is currently on the board of directors of Akoustis Technologies (founded by UCSB alumnus Jeffry Shealy to improve 5G wireless signal quality and enable the Internet of Things through the use of radio frequency filters).

A fellow of the US National Academy of Inventors, the National Academy of Engineers, and the Institute of Electrical and Electronics Engineers (IEEE), DenBaars has been the recipient of the IEEE Photonics Society Aron Kressel Award (2010) alongside professor James Speck. He has also been recognized with the Pacific Coast Business Times Spirit of Innovation Award (2021) and the International Symposium on Compound Semiconductors' ISCS Award (2021). He co-directs the Solid-State Lighting and Energy Electronics Center at UCSB.

DenBaars received his award and delivered a lecture at the AAAFM-UCLA Conference on Functional Materials, held virtually in August.

www.materials.ucsb.edu/people/faculty/steven-p-denbaars
https://aaafm.org/ucla2021/

SemiLEDs' revenue grows 20% quarter-to-quarter

Rise in OpEx constrains operating margin growth, but losses cut

For fiscal third-quarter 2021 (ended 31 May), LED chip and component maker SemiLEDs Corp of Hsinchu, Taiwan has reported revenue of $1.44m, up 20% on $1.2m last quarter.

Gross margin has more than doubled from 20% last quarter to 46%. However, operating expenses have risen from $748,000 last quarter to $1.26m, due partly to R&D expenses almost doubling. Operating margin hence improved only slightly, from –42% to –41%.

Net loss has been cut from $255,000 ($0.06 per diluted share) last quarter to $64,000 ($0.02 per diluted share). During the quarter, cash and cash equivalents have fallen further, from $2.1m to $1.7m.

SemiLEDs says that, given the continuing uncertain impact of COVID-19 on the economy and the firm, it is unable to forecast revenue for fiscal fourth-quarter 2021 (to end-August) at this time.

www.semileds.com

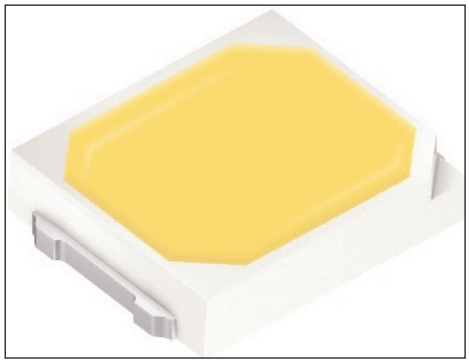
Osram presents first quantum dot LED in 2835 package

In-house QD technology boosts efficiency over 200lm/W at high CRI

ams Osram of Premstaetten/Graz, Austria and Munich, Germany has unveiled the Osconiq E 2835 CRI90 (QD), which it claims is the first quantum dot LED in a 2835 package, pushing efficiency to new heights even at very high color-rendering indices (CRIs) and warm light colors, and offering further system benefits for luminaire manufacturers.

The properties of quantum dots allow precise adjustment of the desired color temperature and outstanding efficiency values in the warm-white color spectrum. "With our specially developed quantum dot phosphors, we are the only manufacturer in the market that can offer this technology for general lighting applications," claims Peter Naegelein, director product management Illumination. "The Osconiq E 2835 is also the only available LED of its kind in the established 2835 package," he adds, emphasizing the extremely homogeneous illumination.

The Osconiq E 2835 CRI90 (QD) is available in a color temperature range of 2200–6500K and achieves



ams OSRAM's Osconiq E 2835 CRI 90 (QD) LED.

efficiency of over 200lm/W. The space-saving dimensions of the 0.5W component of 2.8mm x 3.5mm enable particularly compact and efficient luminaire designs, says the firm. The good absorption behavior of the quantum dots reduces the amount of nanoparticles required. Unlike other phosphors in general lighting, quantum dot-based solutions are still in their infancy in terms of development — with a promising future of what can be achieved in upcoming product generations, reckons the firm.

A feature of the quantum dots is that they are encapsulated in a protective package that makes them more robust, protecting them from moisture and other external influences. The encapsulation technology makes it possible to use the nanoparticles in demanding 'on chip' operation within an LED.

The LED also meets the strict requirements of the Single Lighting Regulation (SLR) regarding the energy efficiency of light sources, which will become mandatory in Europe in September. Part of the new guidelines includes a value >50 for saturated red (the R9 value: R1 to R8 is used to determine the CRI.

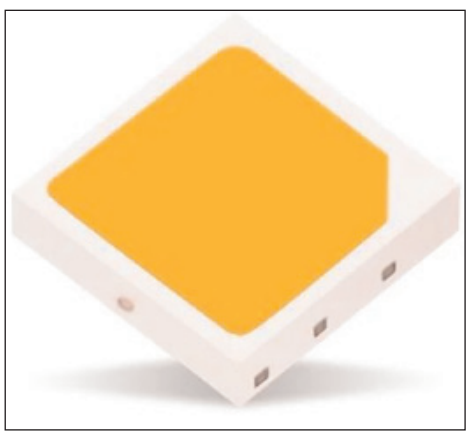
The Osconiq E2835 is also available in two other versions: a CRI80 component for office and retail lighting solutions and the Osconiq E2835 Cyan, which produces a spectral peak in the blue wavelength range that suppresses melatonin production in the human body, making it suitable for human-centric lighting solutions.

www.ams-osram.com
www.osram-os.com

Luminus launches MP-3030-120H high-efficacy mid-power LEDs

Luminus Devices Inc of Sunnyvale, CA, USA — which designs and makes LEDs and solid-state technology (SST) light sources for illumination markets — has announced the launch and immediate availability (through authorized distributors) of a new high-efficacy family of 3030 mid-power LEDs designed for high-performance general lighting and horticulture applications.

The new MP-3030-120H ultra-high-performance LEDs provide low thermal resistance, up to 226 lumens/Watt, high photosynthetic photon flux (PPF)/Watt, and color rendering index (CRI) options of 80, 90 and 95 minimum.



In addition, they are compatible with standard SMT reflow solder processes and are RoHs and REACH compliant.

Customers who are listing their products with DLC can leverage the MP-3030-120H series 9000 hour LM-80 reports in both PPF and lumens with Q90 and L90 >36k hours under a wide range of operating conditions. While competitors are quoting 30+ week lead times, Luminus has inventory at Digikey and Mouser and supports a standard 8-week lead time on new high-volume orders, says the firm.

"The product has outstanding efficacy, solid LM-80 in both PPF and lumens, high quality of light with optional 95 CRI minimum, and lead times which enable customers to move quickly," notes Tom Jory, VP of illumination marketing.

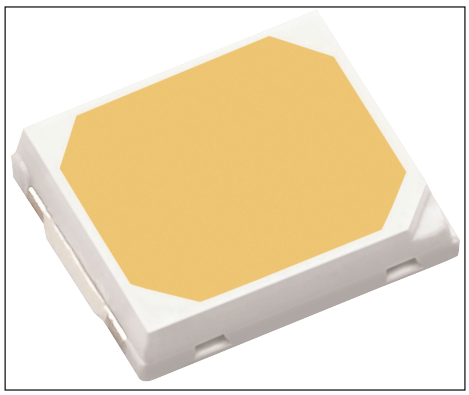
www.luminus.com/products/standardmidpower

Lumileds launches LUXEON 2835 Commercial LEDs for indoor lighting

Existing portfolio of 2835 LEDs renamed LUXEON 2835 Architectural

Lumileds LLC of San Jose, CA, USA has introduced LUXEON 2835 Commercial LEDs, engineered and designed to support the growing demand for a high-volume, high-efficacy mid-power LED to serve commercial indoor lighting applications. With a maximum driving current of 200mA, correlated color temperatures (CCTs) span 2700-6500K and range of the color rendering index (CRI) is 80 and 90.

"The architectural and commercial luminaire and lighting fixture markets have their own needs and characteristics," says product & marketing manager Ryan Dong. "Manufacturers of commercial lighting prioritize lumens per Watt and lumens per dollar over almost everything else and we deliver both in a package providing the quality and robustness expected of LUXEON LEDs," he adds. Common commercial indoor applications include troffers, panels, high-bay and many other formats.



The LUXEON 2835 Commercial LED.

Many billions of 2835 mid-power LEDs are sold annually, making them one of the biggest-selling packages in volume and revenue. The breadth of luminaires – from industrial and offices, to retail and hospitality – require different levels of performance, quality of light, and longevity, demonstrating clearly that the 2835 LED market is not a one-size-fits-all market.

The new LUXEON 2835 Commercial LEDs will stand alongside Lumileds' existing and broad portfolio of 2835 LEDs which are being renamed LUXEON 2835 Architectural. "Lumileds' practice is to clearly understand our customers' needs and deliver the product that meets or exceeds their requirements. We now have two clearly differentiated 2835 portfolios, each supporting market segments and customers with different product needs," says Ryan Dong.

Lumileds claims that, compared with other 2835 packages on the market, LUXEON 2835 Commercial leads in flux, has better color consistency and superior anti-corrosion capability. With these new parts, the firm can support any manufacturer's full range of luminaires, from offices and box stores to high-end retail and hospitality, it adds.

www.lumileds.com/products/mid-power-leds/luxeon-2835-commercial

Lumileds introduces EU Ecodesign Tool

LED performance data helps light source manufacturers to comply with new regulations

Lumileds has introduced what it claims is a first-of-its-kind web-based tool — the EU Ecodesign Tool — that provides the detailed LED performance data that lighting manufacturers need in order to comply with the European Union's Ecodesign Directive. LUXEON LED users can view data and a normalized spectrum on screen or choose to download a .csv file containing the same data seen on-screen.

The new EU Ecodesign Tool supports lighting manufacturers that must comply with two new regulations taking effect on 1 September. Regulation 2019/2020 (on Ecodesign) establishes a set of performance requirements for light sources and Regulation 2019/2015 (on Energy Labeling) specifies information that must be provided to consumers. Compliance with both regulations is required as of 1 September.

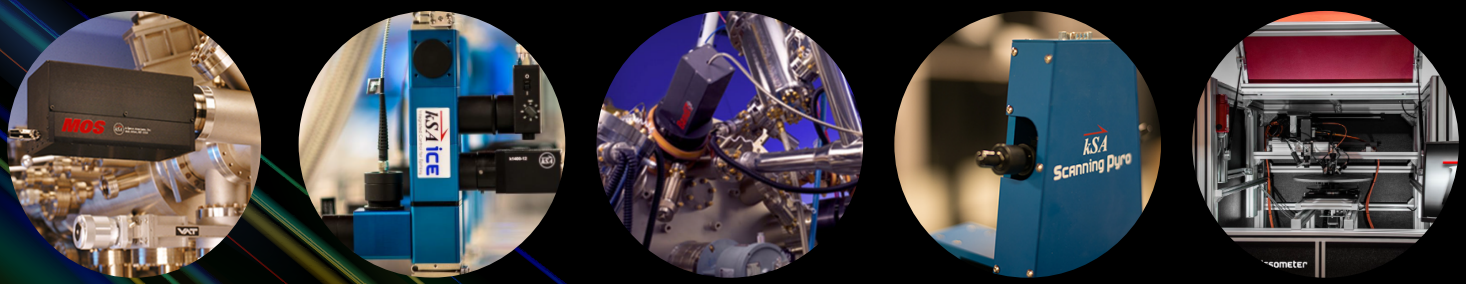
"Suppliers of light sources for the EU market must comply with Ecodesign and Energy Labeling regulations that include the declaration of various parameters that relate directly to the properties of the LED packages used in the light source," notes Dr Wouter Soer, director, Illumination Product Development. "Suppliers need this LED package information in order to determine the declared values for their light source," he adds. "Though most of the relevant LED package information can be found in the respective product datasheets, Lumileds' new Ecodesign tool provides additional information to give a full description of LED package properties relevant to the regulations."

Users can quickly search on a partial or full part number. Each on-screen report details 16 key parameters and presents a graph of the normalized spectrum for the part. The accompanying .csv file contains the same 16 parameters as well as the raw data of the normalized spectrum.

Lumileds' new EU Ecodesign Tool is live on the firm's website and can be accessed by anyone at any time.

www.lumileds.com/ecodesign-search

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

LiDAR receiver maker Luminar acquiring InGaAs photodetector chip partner OptoGration

Acquisition secures supply capacity of 1 million units per year, scalable to 10 million units

Luminar Technologies Inc of Orlando, FL, USA is acquiring its exclusive indium gallium arsenide (InGaAs) chip design partner and manufacturer OptoGration Inc, bringing specialized core IP in-house as Luminar scales its Iris light detection and ranging (LiDAR) sensor into series production with its OEM customers.

The acquisition secures a key part of Luminar's supply chain and enables deeper integration with its existing chip design subsidiary Black Forest Engineering (BFE, acquired in 2017). Luminar is combining the latest technology from Optogration and BFE to power its new fifth-generation LiDAR chip in Iris as it prepares for series production of its product and technology.

For the past five years, Luminar has been closely collaborating with OptoGration, developing, iterating and perfecting the specialized InGaAs photodetector technology that is required for 1550nm-wavelength LiDAR. OptoGration has the capacity to produce about 1 million InGaAs chips with Luminar's design each year at its specialized fabrication facility in Wilmington, MA, with the opportunity to expand annual capacity to 10 million units.

"Acquiring OptoGration is the culmination of a deep, half-decade-long technology partnership that has dramatically advanced the proprietary LiDAR chips that power the industry-leading performance of our newest Iris sensor," says Luminar's co-founder & chief technolog officer Jason Eichenholz. "The OptoGration team is unique in their ability to deliver photodetectors with the performance and quality that achieve our increasingly demanding requirements," he adds. "Chip-level innovation and integration has been key to unlocking our performance and driving the substantial cost reductions we've achieved."

Luminar combines its InGaAs photodetector chips from Optogration with silicon application-specific integrated circuits (ASICs) produced by BFE to create its LiDAR receiver and processing chip, which is claimed to be the most sensitive, highest-dynamic-range InGaAs receiver of its kind. It is able to acquire and process gigabits of precise data per second to produce optimal LiDAR data. The fifth-generation proprietary chip is now powering Luminar's Iris sensor. Iris is reckoned to be the only system to meet the stringent performance, safety, scalability and economic requirements to enable autonomous driving in series production vehicles.

As part of the transaction, OptoGration's founders are joining Luminar and will continue to lead the business with support from Luminar.

"We share a vision for transforming automotive safety and autonomy with LiDAR," comments OptoGration's president William Waters. "We also share a commitment to continuous innovation and have an incredible track record of combining our technologies to increase performance and lower cost. Together we can go even faster to scale."

The OptoGration acquisition is expected to be completed in third-quarter 2021.

www.luminartech.com

Lumileds boosts LUXEON 3030 2D Round LED performance further

Luminous flux increased by up to 2.5%

Lumileds of San Jose, CA, USA has again improved the performance of its LUXEON 3030 2D Round LED. Across all correlated color temperatures (CCTs) and for 70 and 80CRI (color rendering index), flux performance increases by up to 2.5%.

With what is claimed to be leading efficacy and higher maximum drive than competitors, LED counts can be reduced. Hot-color targeting at 85°C ensures color at operating temperatures and 1/9th micro-binning enables tight color control. Superior reliability makes LUXEON 3030 2D Round a suitable fit for outdoor and other high-lumen applications, the firm adds.

"High efficacy, high light output and corrosion resistance that outperforms others are key to the preference for LUXEON 3030 in outdoor applications," claims product & marketing manager Xue Tiger. "We've continued to invest in this LED platform and, as a result, our customers can further optimize their solutions and support sustainability while improving lighting."

Lumileds' LUXEON 3030 2D (Round & Square) uses two emitters in series to deliver light from the 3.0mm x 3.0mm package. The round LES is particularly well suited to use with lens optics and enjoys widespread adoption in industrial and outdoor applications, says the firm.

www.lumileds.com/products/mid-power-leds/luxeon-3030-2d

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

BluGlass demos first RPCVD tunnel-junction laser diodes

Dual-n-wave laser shows good lasing behaviour as uncoated, unpackaged devices

BluGlass says it has demonstrated working tunnel-junction laser diodes in a first proof-of-concept using its proprietary low-temperature, low-hydrogen remote-plasma chemical vapor deposition (RPCVD) technology.

The novel laser diode prototypes leverage BluGlass' unique RPCVD tunnel-junction technology, developed over many years for use in high-power products including laser diodes and high-brightness LEDs.

Designed to enable higher power and more efficient lasers for use in commercial applications such as 3D printing and industrial welding, the RPCVD tunnel-junction laser diode prototypes have demonstrated good lasing behaviour, says BluGlass, helping to confirm the potential of the RPCVD laser diode designs to address the critical performance requirements for high-value gallium nitride (GaN) laser diode applications.

GaN laser diode applications are currently limited by optical and resistive loss in the magnesium-containing p-type layers, which leads to low conversion efficiencies (typically 40–45%, compared with nearly 90% in GaN-based LEDs). Almost 50% of the power consumed when operating GaN laser diodes is lost in the form of heat due to the highly resistive p-type layers, traditionally needed to create the electrical circuit in a laser diode.

BluGlass says that its novel approach, enabled by the benefits of low-temperature, low-hydrogen RPCVD growth, can eliminate the need for these highly resistive and performance-losing p-type layers. RPCVD-enabled novel designs replace the p-type cladding layer with an RPCVD tunnel junction and second n-type cladding layer — a dual n-wave laser diode — paving the way to significantly improve laser performance in the future.

BluGlass says that it will continue to optimize its RPCVD tunnel-junction laser diode design, epitaxy and fabrication to maximize laser performance.

"This is an important validation of the potential of our unique RPCVD and tunnel-junction technologies," says executive chair James Walker. "This achievement is a testament to the efforts of our leading-edge team in developing a range of innovative laser diode products, including this world-first demonstration of dual-n-wave lasers," he adds.

"While these novel lasers have significant development required before the launch of future RPCVD-enhanced products, our significantly further advanced standard (MOCVD) laser diode product development continues to focus on solving reliability and improving our downstream production ahead of launching commercial products to waiting customers."

BluGlass closes entitlement rights issue of AUS$5.92m

Placements, including additional $500,000 to new investor, take total raised to AUS$8.42m

BluGlass Ltd of Silverwater, Australia has closed its oversubscribed non-renounceable entitlement rights issue, raising the maximum of AUS$5.92m before costs. The rights issue enabled eligible shareholders to subscribe for new shares in the company on a 1-for-4 basis at $0.03 per share.

Strong support from shareholders saw shortfall applications exceed the rights issue target, and a pro-rata scale back of about 4% will be applied to all shortfall applicants, with the refund amount to be credited to shareholders in the coming weeks.

BluGlass has also agreed a separate private placement to Viriathus Capital of a further AUS$500,000 on the same terms as the rights issue.

"BluGlass has raised a total of AUS$8.42m, through our entitlement offer and placements," notes executive chair James Walker. "This capital allows BluGlass to progress the development and launch of our first direct-to-market laser diodes, resolve the reliability issue and optimize aspects of the production supply chain, ensuring we can scale our manufacturing capability to deliver commercial products needed by the market," he adds.

"BluGlass has a clear path to commercialization with multiple laser diode products in the manufacturing supply chain. We are continuing to work with our development partners to address initial reliability issues and remain confident that, with this new investment, those issues can be successfully resolved," Walker continues. "We remain confident that our commercialization strategy provides us with the quickest path to revenue and profitability."

Allotment of new shares from the rights issue is expected to occur on 13 July with the issue of 197,333,326 fully paid ordinary shares. Allotment of new placement shares is also expected to occur on or around 13 July, with the issue of 16,666,667 fully paid ordinary shares.

www.bluglass.com.au

BluGlass to launch laser products as soon as reliability challenge overcome

BluGlass has provided an update for the June quarter, highlighting
- its prototype 420nm laser diode products meeting commercial specifications in light output and wavelength (while the firm works with expert fabrication specialists to resolve reliability issues);
- raising $8.42m via an over-subscribed entitlement offer and placements; and
- laser diode pioneer Jean-Michel Pelaprat joining BluGlass as a non-executive director.

Laser diode progress

During the quarter, BluGlass continued to progress the development of its 405nm, 420nm and 450nm direct-to-market commercial laser diode products.

The 420nm products are demonstrating commercial specifications for light-output, voltage and wavelength in both pulsing and initial continuous wave testing. These results confirm the commercial quality of BluGlass' laser diode design and epitaxy. However, initial reliability testing of 420nm devices has shown a gradual loss of light output and laser performance during high-power testing. BluGlass has observed flaws in the optical facet of the laser, which is contributing to the reliability issue.

The optical facet is in the post-epitaxy production steps and involves third-party suppliers. To expedite solutions, BluGlass is working with multiple vendors and expert fabrication specialists with established production capabilities. The firm continues to pursue improvement in the reliability of its laser diodes and currently has several iterations, running in parallel, already in development.

After this issue has been addressed, the solution will then be integrated across BluGlass' suite of laser diode products.

Due to their manufacturing complexity, gallium nitride (GaN) laser diodes are high-value, high-margin products. BluGlass is initially targeting in-demand and underserved wavelengths for use in industrial, display, defence and scientific applications.

"These manufacturing challenges are understood by the industry, and we remain confident of being able to solve this issue to launch a range of commercial laser diodes," says executive chair James Walker. "To further support our technical activities, we are increasing our expert team, which will enable BluGlass to expedite solutions, and — once implemented — ramp-up commercial manufacturing," he adds. "We have a large and growing addressable target market for our first direct-to-market products and are already in discussions with potential customers. Our manufacturing capability in both Australia and the US is supported by our supply chain partners, which will enable us to cost-effectively scale to meet demand."

Utilizing its proprietary remote-plasma chemical vapor deposition (RPCVD) and tunnel-junction technologies, BluGlass' enhanced laser diode designs are also progressing through the manufacturing supply chain. While at an earlier stage of development, the novel laser diode designs combine both RPCVD and industry-standard metal-organic chemical vapor deposition (MOCVD) processes into a single high-power device. They are designed to enable brighter, higher-power and higher-efficiency laser applications.

An update on the laser diode business progress and development plans was provided to shareholders at the firm's 'Meet the Chair & CTO' briefing on 30 June.

DARPA Yale University laser diode program continues to progress

BluGlass and Yale University continue to collaborate on the US government-funded contract, assisting the Defense Advanced Research Projects Agency (DARPA) with the development of novel laser diode technology. BluGlass and Yale are conducting paid R&D under DARPA's Lasers for Universal Microscale Optical Systems (LUMOS) initiative, combining efficient integrated optical systems and complete photonics functionality onto a single substrate.

The paid joint development program has successfully completed the milestones of the first stage of Phase I, which is expected to run for 18-months. Together, Yale and BluGlass' research teams have commenced the second stage of Phase I and are working to combine lasers and photonic integrated circuit (PIC) technologies in a single device; for applications such as compact optical phased-array LiDAR (light detection and ranging) and neuromorphic optical computing.

Leadership changes

In June, Giles Bourne stepped down as managing director and CEO after more than 13 years with the firm. Walker has assumed the role of executive chair while the company undertakes a search for an industry-experienced CEO to lead BluGlass to commercialization and profitability.

Earlier in the quarter, laser diode pioneer Jean-Michel Pelaprat joined the board as non-executive director. He has more than 30 years' experience in semiconductor and photonics businesses, and is a co-founder & director of US-based laser diode firm Nuburu.

"Jean-Michel joined BluGlass at a pivotal time for the company, and his extensive technical and commercial expertise has already proved to be invaluable as we progress the development of our first direct-to-market laser diode products," comments Walker. "His affiliation with BluGlass provides potential customers with a significant vote of confidence in the quality of our disruptive technology."

www.bluglass.com.au

Vector Photonics appoints process development engineer

Ex-CST Global process engineer brings wafer manufacturing expertise

Photonic-crystal surface-emitting laser (PCSEL) firm Vector Photonics Ltd (which was spun off from Scotland's University of Glasgow in March 2020, based on research led by professor Richard Hogg) has appointed Connor Munro as process development engineer. Munro has industrial wafer-processing and high-volume manufacturing expertise, with experience of Fabry–Perot (FP), distributed feedback (DFB) and vertical-cavity surface-emitting laser (VCSEL) production across a range of compound semiconductor systems, including aluminium gallium indium phosphide (AlGaInP), gallium arsenide (GaAs), gallium antimonide (GaSb), gallium nitride (GaN) and indium phosphide (InP).

"Connor is the fourteenth member of our team," says chief technology

officer Richard Taylor. "He has extensive dry etch, wet etch and thin-film deposition experience in dielectrics and metals, gained as a process engineer at Sivers Photonics (CST Global). His role spanned both operations and development, optimizing and standardizing processes for increased yield," he adds. "His experience includes photolithography and electron-beam lithography; oxide and metal deposition; chemical and mechanical polishing; thermal annealing; characterization (SEM) and qualification testing; and metal-organic chemical vapor deposition (MOCVD) and molecular beam epitaxy (MBE) processing — invaluable expertise in our fabless environment."

Munro was most recently a research assistant at the University of Glasgow, working on the UK Engineering and Physical Sciences Research Council (EPSRC)-funded project GaN DaME (Integrated GaN-Diamond Microwave Electronics: From Materials, Transistors to MMICs) developing next-generation GaN-based RF power devices. He was developing processes for 'flipped' GaN-on-silicon etching, to enable diamond growth around the active layers of the device, providing a highly effective heat-sink to maximize its power output.

Munro has a Physics degree from the University of St Andrews, where he was based in the Organic Semiconductor Centre.

www.vectorphotonics.co.uk

SemiNex hires VP of marketing & business development

Daniel Chu to drive business growth across portfolio of InP and GaSb lasers for LiDAR, medical, military and industrial markets

SemiNex Corp of Peabody, MA, USA has hired Daniel Chu as VP of marketing & business development to drive business growth across its full portfolio of high-power indium phosphide (InP) and gallium antimonide (GaSb) semiconductor lasers for light detection and ranging (LiDAR), medical, military and industrial markets.

Educated as a laser physicist at Northwestern University with a PhD degree, Chu has experience in product management, applications engineering, and business creation. His career spans over 25 years in the laser and optics industry, with tenures at firms such as Osram and SDL Inc.

Chu brings his technical laser expertise and market experience to assist customers in developing best-in-class laser systems. As an example, he leads the SemiNex commercial team in supporting customers to pursue long-range

LiDAR with patent-pending Triple Junction laser diodes. This new technology at the eye-safe wavelength of 1550nm allows LiDAR manufacturers to achieve three times the distance and 24 times the detection probability compared with a 905nm emitter. Chu developed a benchmark calculator based on LiDAR physics to deliver the target performance for high-speed autonomous vehicles (AVs) and works directly with LiDAR customers to optimize their designs for both performance and cost.

"Daniel has a strong knowledge in semiconductor lasers and extensive experience in the photonics industry," comments CEO & founder David Bean. "He will deliver the highest level of technical support and service to our customers for design wins," he adds.

"We not just have the most powerful 1550nm laser diode for ToF [time-of-flight] LiDAR but also semiconductor optical amplifiers (SOAs) for FMCW [frequency-modulated continuous wave] LiDAR and GaSb 1940nm laser for medical and many other applications," comments Chu. "We offer unparalleled performance," he adds. "I look forward to working with our customers in designing in our best product offerings as cost-effective solutions."

Besides working at the SemiNex office near Boston, Chu will also work with customers in Asia Pacific, where the firm established a regional office in the Chinese city of Liaoyang in 2020. As well as English, Chu speaks Mandarin fluently and understands Cantonese and Taiwanese well.

www.seminex.com

PhotonicLEAP awarded over €5m in EU funding

Project to develop packaging and test technologies to reduce photonic integrated circuit manufacturing costs

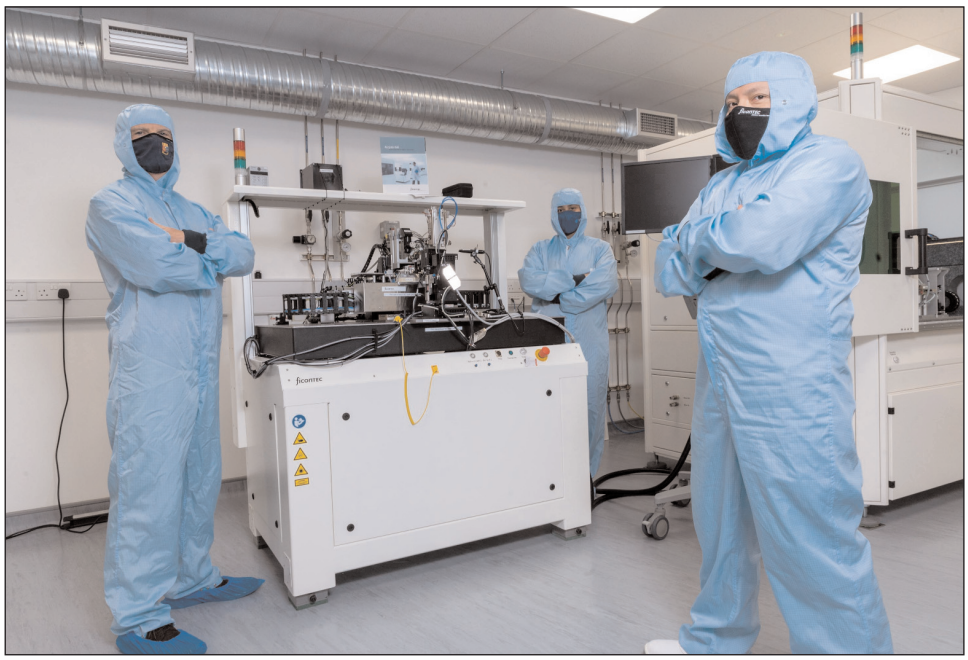
The European collaborative project PhotonicLEAP has been awarded over €5m through the European Union's Horizon 2020 program to develop photonics packaging and test technologies that should drive down the cost of photonics manufacturing.

Coordinated by Ireland's Tyndall National Institute, the PhotonicLEAP consortium also consists of the research organizations and companies Fraunhofer (IZM & HHI), LPKF Laser & Electronic, ficonTEC Ireland, SUSS MicroOptics, BOSCH, Eindhoven University of Technology — TU/e and Interuniversitair Micro-Electronica Centrum — imec.

With demand for photonics being driven by mass-market technology requirements, the global photonics market is expected to exceed €850bn by 2026. In particular, photonic integrated circuit (PIC) technology is becoming increasingly important for existing markets in communications (high-speed fiber-optics), medical devices (e.g. cardiac diagnostics), sensors (e.g. in self-driving cars), a myriad of Internet of Things (IoT) technologies, and for emerging markets such as quantum computing and security.

However, existing PIC manufacturing processes, in particular packaging and test processes, are difficult to automate, with limited manufacturing capacity, and are costly, with packaging and testing typically accounting for over 75% of the total manufacturing cost. As a result, existing PIC manufacturing processes greatly impede the uptake of PIC technologies across many mass markets.

To address this challenge, the EU, through the PhotonicLEAP program, aims to develop wafer-level PIC module integration, packaging and test technologies that will reduce PIC production costs by over 10 times, revolutionizing existing applications and creating completely new markets.



Professor Peter O'Brien (head of Photonics Packaging & Systems Integration), Parnika Gupta (PhD student, Photonics Packaging & Systems Integration) and Dr Josue Parra (engineer, ficonTEC Ireland). PhotonicLEAP, a European collaborative project coordinated by Tyndall National Institute, has been awarded over €5m through the EU's Horizon 2020 program to develop technology that will drive down photonics manufacturing costs.

Specifically, PhotonicLEAP will develop new technologies to produce a surface-mount technology (SMT) PIC package which, for the first time, incorporates multiple optical and electrical connections and can be scaled from low to very large volumes. The project will validate these technologies through two demonstrators, including a high-speed optical communication module and a portable medical device for cardio-vascular diagnostics. Furthermore, the technologies will be implemented by Europe's flagship Photonic Integrated Circuits Assembly and Packaging Pilot Line (PIXAPP, which has an extensive and growing user-base across multiple markets), for future commercialization.

"Photonics is the key to unlocking the potential of technologies we need for today's interconnected world," says Tyndall's head of Photonics Packaging and Systems Integration professor Peter O'Brien, who will lead PhotonicsLEAP. "We need faster, more efficient, greener and cheaper solutions to our increasing usage of technology, which photonics manufacturing addresses. Therefore, we are delighted to receive this significant and vital funding from the European Commission to enable us to develop truly disruptive photonic packaging and test technologies," he adds. The transnational consortium brings together "a wealth of photonics expertise, interdisciplinary skills and impressive infrastructure to deliver on our ambitious objectives," O'Brien continues. "Packaging and test technologies developed in PhotonicLEAP can make a real impact to increase the uptake of integrated photonics across Europe."

www.cordis.europa.eu/project/id/101016738
www.pixapp.eu
www.tyndall.ie

II-VI's CEO Mattera to replace Kramer as Chair

Engineered materials and optoelectronic component maker II-VI Inc of Saxonburg, PA, USA and Coherent Inc of Santa Clara, CA (which provides lasers and laser-based technology for scientific, commercial and industrial applications) says that its board chair and former CEO Francis J. Kramer will transition to Chair Emeritus while continuing as a director, effective immediately following the annual meeting of shareholders in November, when CEO & director Dr Vincent D. (Chuck) Mattera Jr will become chair.

"Chuck has an extensive history and knowledge of the company and its changing markets, and he is the right person to lead the company through these significant evolutions, especially during the upcoming integration with Coherent Inc," comments Kramer.

Kramer served as president from 1985 to 2007, as president & CEO from 2007 to 2014, and as CEO & board chair from 2014 to 2016, and he continued as chair when Mattera became CEO in 2016. Mattera becomes only the third chair in II-VI's 50-year history, having been a member of the board from 2000 to 2002, and then joining II-VI as vice president in 2004 and serving in various management roles, ultimately becoming CEO in 2016.

Rear Admiral Marc Y.E. Pelaez (retired) will continue to serve as lead independent director on the board (a position he has held since 2014).

www.ii-vi.com

SMART Photonics gains €13m loan from Rabobank

Funding to support scale up of photonics chip production

The independent pure-play indium phosphide (InP) photonic integrated circuit (PIC) foundry SMART Photonics of Eindhoven, The Netherlands has received a new loan worth up to €13m provided by Rabobank, to be used primarily to further support the scale up of photonics chip production and to strengthen the firm's role in the growing photonics ecosystem.

"Currently we are shifting gears in our plan to become the leading foundry and development partner for integrated photonics," says chief financial officer Maarten Wellens. "With this new financing we can accelerate the investment in our manufacturing facilities, new equipment and the needed know-how to keep our leading position. We are looking forward to support an expanding customer base from proof-of-concept phase up to full production," he adds.

"SMART Photonics is a company that fits perfectly with our Banking for Brainport strategy. We have been involved in SMART Photonics since the start-up phase in 2012. The successful funding round in 2020, led by Innovation Industries, has further strengthened our confidence in the company," says Eerke Hoven, director Corporate Clients at Rabobank. "We facilitate the next phase of growth with our financing. SMART Photonics' key technology, expertise in the field of photonics and high tech and, of course, management have been crucial for Rabobank in this," he adds.

"SMART Photonics is a wonderful example of the opportunities that the ecosystem in the Brainport region offers for the regional and national economy," comments Henri Schellen, Start & Scale-up Banker at Rabobank.

www.smartphotonics.nl

OIF unveils Implementation Agreement for HB-CDM 2.0

The Optical Internetworking Forum (OIF) has announced the High Bandwidth Coherent Driver Modulator (HB-CDM) 2.0 Implementation Agreement. This latest IA builds on the HB-CDM 1.0 IA, released in November 2018, and leverages the same form factor.

HB-CDM 2.0 follows the integrated laser and coherent receiver standards from OIF in enabling next-generation compact, high-performance coherent networking solutions. Since OIF's HB-CDM 1.0 was released for 64 Gigabaud (GBd), enabling 400Gbps coherent systems, the market has seen a need for increased network capacity and higher performance. The HB-CDM 2.0 leverages the original Type 1 form factor for compatibility with existing systems and also includes a flexible printed circuit (FPC) as an alternate interface and higher-performance RF pitch options for extended rates for future systems.

"OIF's HB-CDM 1.0 standard was a critical new component enabling optimized 400G+ metro and long-haul coherent networks, supporting the industry need for more capacity with a standardized footprint, interface and performance," says Intel's Richard Ward, technical editor of the OIF HB-CDM 2.0 IA. "The HB-CDM 2.0 is a natural extension covering 128GBd in coherent technology for 800G per wavelength-and-beyond coherent systems," he adds. "The market demand reinforces OIF's critical role in creating solutions to fulfill industry requirements and accelerating market adoption of optical networking technologies."

www.oiforum.com/wp-content/uploads/OIF-HB-CDM-02.0.pdf

POET cuts losses year-on-year in Q2/2021, despite rise in R&D spending

Samples of 100G and 200G optical engines and 400G Rx optical engines to be delivered

For second-quarter 2021, 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 reported non-recurring engineering revenue of $0.2m related to an Optical Interposer design project for a specific customer.

Net loss was $4.2m ($0.01 per share), roughly level with $4.1m ($0.01 per share) last quarter but cut from $6.2m ($0.02 per share) a year ago. This included R&D costs of $1.8m, up from $1.3m both last quarter and a year ago. "R&D for a company at this stage of development will vary from period to period as variable expenses with contract manufacturers fluctuate based on the development cycle and the immediate product development needs of the company," notes POET. The increased cost was primarily related to completion of the development of the Lightbar 100G and 200G CWDM4 Optical Engines, samples for which should be available this quarter (to end-October).

Debt-related finance costs have fallen from $229,000 a year ago and $235,000 last quarter to $95,000 (of which $49,000 was non-cash, compared with $130,000 a year ago and $128,000 last quarter).

On a non-IFRS basis, cash outflow from operating activities was –$2.6m, roughly level with –$2.5m last quarter but worsening from –$1.7m a year ago.

POET says that it continued to execute on its strategic plan during Q2/2021 and achieved the following milestones during and subsequent to the quarter:

- Rapidly completed the design of a fully integrated 100G LR4 (4-channel long-reach) optical engine with a reach of 10km for client-side interconnects to data centers, enterprises and edge computing networks (demonstrating the benefit of POET's investment in the Optical Interposer as a true platform technology);
- Announced availability of samples of 100G and 200G CWDM4 Optical Engines, enabled by four flip-chipped 28G and 28G PAM4 coarse wavelength division multiplexing (CWDM) distributed feedback (DFB) lasers operating to MSA standards for the QSFP28 module;
- Announced availability of samples of O-band LightBar product. POET's LightBar products address the need for remote, aligned light sources to power data communication transceivers, co-packaging of electronics and photonics in applications such as data-center switch architectures, optical computing and various sensing devices;
- Continued to expand intellectual property portfolio, totaling 77 issued patents, with all 18 patents pending specifically related to the POET Optical Interposer platform;
- Improved liquidity by $1.03m through the conversion of convertible debentures;
- Ended the period with cash and cash equivalents of $22m (up from $6.9m at the end of December 2020 and $11.9m at the end of June 2020);
- Filed a US$300m registration statement with OSC and SEC for possible future equity issuances, engaged Computershare as new transfer agent and provided all requested information to Nasdaq in support of the company's application for a future listing on the Nasdaq Capital Market.

"2021 continues to be a transformative year for the company," says chairman & CEO Dr Suresh Venkatesan. "Although supply chain constraints across the broader semiconductor market contributed to scheduling challenges during the first half of the year, we've continued to take actions to minimize the impact on our product development timelines and ongoing engagements with customers. We currently have a double-digit number of customers targeted for initial distribution of prototype samples, including customized designs for specific customers and applications. We are also receiving strong interest from prospective customers for custom, differentiated LR4 designs for client-side telecom network applications," he adds.

"Additionally, the team is finalizing preparations for the China International Optoelectronic Exposition (CIOE), now scheduled to be held 16-18 September, along with our joint venture team at Super Photonics Xiamen. Prior to and during CIOE, we will be delivering samples of 100G and 200G optical engines as well as 400G Receive (Rx) optical engines to select customers. We've also partnered with Shanghai-based Siluxtek and will be conducting a live demonstration of a 400G FR4 Transmit (Tx) optical engine concurrent to the show at our Xiamen lab," Venkatesan notes.

"With continued execution of our strategic plan and growing product development activity in the second half of 2021, our focus will remain on realizing our vision for POET of becoming a global leader in chip-scale photonic solutions based on our Optical Interposer technology that enables a broad range of vertical market applications."

www.poet-technologies.com

NeoPhotonics' revenue returns to growth in Q2

400G-and-above product revenue doubles year-on-year

For second-quarter 2021, NeoPhotonics Corp of San Jose, CA, USA — a vertically integrated designer and manufacturer of silicon photonics and hybrid photonic integrated circuit (PIC)-based lasers, modules and subsystems for high-speed communications — has reported revenue of $65m.

This is a drop of 37% on $103.2m a year ago, but that is largely due to the additional restrictions imposed on 17 August 2020 by the US Department of Commerce's Bureau of Industry and Security (BIS) on exports to China-based Huawei Technologies (formerly NeoPhotonics' largest customer, comprising 40% of 2020's revenue). In Q2/2021, NeoPhotonics now has three 10%-or-more customers, and the top five comprised 77% of total revenue. In fact, year-to-date (first-half) revenue – excluding Huawei – is up by about 15% year-on-year.

The Q2 revenue of $65m is up 7% on $60.9m in Q1 (and at the top end of the $59–65m guidance range) due to strong demand for lasers and high-speed, 400G-and-above products (e.g. 400ZR and 400ZR+ modules) counteracting ongoing supply chain challenges. Revenue for 400G-and-above products in particular doubled year-on-year, comprising 46% of total revenue.

"As we said last quarter, we restarted shipments to Huawei in Q1 for a limited set of products, and we expected their quarterly revenue to be in the mid to high single-digit millions on a run-rate basis," says senior VP & chief financial officer Beth Eby. "Q2 was somewhat higher, at $14m, given the lack of shipments in previous quarters," she adds. "We do not expect Huawei to be a 10% customer for the year."

On a non-GAAP basis (excluding a $3.3m end-of-life related inventory write-down, $2.3m of stock-based compensation and $0.4m of accelerated depreciation, amortization and other charges), gross margin has nevertheless fallen further, from 33.2% a year ago and 22.4% last quarter to 21.7%. However, this exceeds the expected 17–21% as a result of favorable product mix and the shift of about $1.5m from cost of sales to R&D expense for materials related to the new product introduction. The shift is an accounting timing issue. Product margin of 37.6% (down from 40.5% last quarter) was offset by the expected levels of excess capacity charges. "We expect these under-utilization charges to drop as we ramp volume and complete the consolidation of our indium phosphide production, as we announced last year," notes Eby.

Operating expenses have risen further, from $23.6m (22.9% of revenue) a year ago and $21.5m (35.3% of revenue) last quarter to $24.4m (37.5% of revenue), higher than the expected $22.5–23.5m due to the shift from cost of sales to R&D.

Compared with net income of $8.7m ($0.16 per diluted share) a year ago, net loss has worsened from $7.5m ($0.15 per diluted share) to $11.4m ($0.22 per diluted share, although this is $0.03 better than the midpoint of the $0.20–0.30 guidance range).

During the quarter, cash and cash equivalents, short-term investments and restricted cash fell by $16m from $111m to $95m due to new product startup costs, the payment of 2020 variable compensation, and the pay-down of debt.

Net inventory was $44m, down $2m due to product end-of-life (EOL). Despite continuing to buffer critical inventory and supporting the new product ramps, days of inventory (DOI) improved from 88 days to 72 days.

"Building on our strong performance in the second quarter, we see accelerating growth in the back half of the year, driven by the initial ramp of 400ZR and related products adding to our 400G+ suite," says chairman & CEO Tim Jenks. "We are ramping our modules and component-level products, including our Nano Tunable Laser, putting us in a good position to return to profitability," reckons Jenks.

"Looking to Q3, we are seeing the expected increasing demand for our leading 400G-capable components, particularly our lasers and the increase in demand for our modules," says Eby. For third-quarter 2021, NeoPhotonics expects revenue of $76–84m (representing revenue growth — excluding Huawei — from Q1 to Q3 of 25–35%).

"We have a new chip shortage due to a supplier timing decommit that has an $8m adverse impact on revenue in Q3," notes Eby. "We have widened our range to allow for the possible outcomes, meaning we have confirmed supply and inventory to meet the low end of the range. We have confidence in the actions to reach the midpoint and are working on mitigation actions that could allow us to reach the high end of the range," she adds.

Gross margin should rise to 25–30%, while operating expenses should fall slightly to $23–24m. NeoPhotonics hence expects diluted earnings per share to improve to between a $0.10 loss and breakeven.

"While we have sufficient demand to achieve non-GAAP breakeven in Q3, the supply chain limitations are extending the timing to reach operating profit to Q4," notes Eby.

"Looking forward to the rest of the year, we expect to grow revenue at an accelerated rate approaching the levels of one year ago [returning to about $100m per quarter in Q4/2021], consistent with our growth target of 25–35% excluding Huawei. This reflects the continued high demand for 400G-and-above-capable products," says Eby. "Over the longer term, market size estimates for 400ZR and 400ZR+

pluggable modules continue to increase. As we gain confidence in the strength and size of our module ramp, we may review our capital structure to ensure that we maintain the flexibility to be able to support customer forecasted ramps," she adds.

"Last year, we lost significant revenue following tightened BIS restrictions on Huawei. In parallel, we accelerated our pivot to Cloud-focused customers. As we embarked on this new path, we said the number of 400G-and-above coherent ports being shipped each year is approximately doubling; we would have new 400ZR module products that would ramp in 2021. And we expected to get back to non-GAAP operating profit in Q3," recalls Eby. "Even with the supply chain issues, we are on track to meet those goals for the second half. Our 400G-and-above-capable revenue grew 100% year-over-year in Q2, and we expect total year-over-year growth to be 100% or higher," she notes. "We are in late-stage qualification with target hyperscale customers for 400ZR. And we expect to achieve non-GAAP operating profit break-even now in Q4. We are pleased with our company performance over the last year and are excited about our path forward and our additional growth vectors in the hyperscale market."

"Our core coherent components for 400G-and-above applications have driven most of our 400G-and-above revenue to date. We expect to see cloud hyperscalers and telecom carriers increase their CapEx spending and deployment rates for these products and our 400G coherent modules," says Jenks. "We've been sampling our 400G coherent module solutions to cloud and hyperscale data centers. We expect cloud data centers to begin deploying 400ZR coherent links in the fourth quarter; we believe we are at the beginning of a broad market expansion for 400ZR- and 400ZR+-based networks and applications. This expansion has started with adoption of coherent interconnects into cloud service provider metro networks. Rapid adoption of 400ZR and 400ZR+ in cloud metro applications will be followed by cloud content providers similarly adopting 400ZR and 400ZR+ for longer-distance interconnects, significantly expanding our served market," he believes.

"The cloud and hyperscale interconnect market is expected to soon rival the telecom market in high-speed Internet connect. AI-enabled applications such as autonomous vehicles (AVs) and machine learning will rapidly expand traffic and bandwidth requirements in the edge cloud market. These are huge mega trends that we believe will expand ZR applications and deliver accelerated growth, with each overlapping cycle for at least several years," Jenks continues. "Our high-speed component products for 400G, 600G and 800G are used by virtually all leading network equipment manufacturers in cloud and hyperscale networks. Also, our ultranarrow-linewidth tunable lasers are the laser of choice for 400G-and-above, such that we are designed into several other customers' 400ZR modules; these products are beginning to ramp now ahead of module deployments in late 2021 and 2022."

"Our 400ZR modules are in later qualification phases with leading hyperscalers. Our target customers have wide-ranging volume plans. We believe that our 400ZR and 400ZR+ modules are industry leading in performance and in maturity, and we expect initial deployments toward the end of 2021," says Jenks.

"The strong demand we're seeing for 400G-and-above solutions suggests that growth in 2022 could be higher than in past years," reckons Jenks. "Accelerating demand for our 400G-and-above products is still in the early innings. As the market continues to move to these higher speeds we believe we are entering a new era of growth."

www.neophotonics.com

NeoPhotonics appoints UCT CFO to board

NeoPhotonics has appointed Sheri L. Savage to its board of directors.

Savage has been chief financial officer of Ultra Clean Holdings Inc (UCT), a supplier of critical subsystems for semiconductor capital equipment, since July 2016. She previously served in senior VP of finance, chief accounting officer and other senior finance roles at UCT since 2009.

Prior to joining UCT, Savage was corporate controller and VP of finance and as director of internal audit at semiconductor test equipment manufacturer Credence Systems Corp. Prior to Credence, she served in various accounting and finance roles in consulting, semiconductor companies and audit firms. Savage holds a Bachelor of Science degree in Managerial Economics from the University of California, Davis and has previously been a Certified Public Accountant.

In addition, NeoPhotonics' board has appointed Savage to the company's Audit Committee.

"The company's unique technology and products are well positioned for rapid adoption in cloud and data-center communications," believes Savage.

"Her excellent finance and accounting background, and her deep knowledge of manufacturing, including contract manufacturing, will provide very beneficial insights to us as we address rapid growth in high-speed communications," comments chairman & CEO Tim Jenks.

Also, director Kimberly Y. Chainey has been appointed to the firm's Nominating and Governance Committee. Chainey has been a member of the board since March.

www.neophotonics.com

Emcore's quarterly revenue grows 56% year-on-year, driven by Broadband more than doubling

New chip and sensing products to supplement CATV growth

For fiscal third-quarter 2021 (to end-June), Emcore Corp of Alhambra, CA, USA has reported revenue of $42.7m, up 11% on $38.4m last quarter and 56.4% on $27.3m a year ago (taking revenue for the first three quarters of fiscal 2021 to $114.5m, exceeding the total for full-year fiscal 2020).

"The Broadband business segment drove record financial performance," says president & CEO Jeff Rittichier.

Broadband segment revenue was $30.3m, up 19.8% on $25.3m last quarter and more than doubling from $13.3m a year ago, driven by record sales of cable TV products.

Aerospace and Defense (A&D) segment revenue was $12.3m, down 6.5% on $13.1m last quarter due to start-up delays in a new electronics manufacturing services (EMS) provider to the Defense Optoelectronics business. "Our previous supplier decided to relocate their SoCal [Southern California] assembly facility to the Bay Area, which left us to find and qualify a new supplier on short notice," says Rittichier. This was partly offset by increased Navigation revenue: quartz micro-electro-mechanical system (QMEMS) and FOG (fiber-optic gyroscope) both rose slightly.

On a non-GAAP basis, gross margin has risen further, from 34% a year ago and 39% last quarter to 41%, driven by a higher mix of Broadband revenue (on a year-to-date basis, gross margin of 39% is significantly up on 31% a year previously). Broadband margin rose further, from 33% a year ago and 43% last quarter to 44%. A&D margin was 33%, up from 30% last quarter, driven mainly by much improved QMEMS margins in the Navigation business due to a breakthrough in manufacturing engineering in the factory in Concord, CA (acquired when Emcore bought the navigation products business, Systron Donner Inertial (SDI), in June 2019).

Operating expenses have risen from $8.9m last quarter to $9.6m, due mainly to R&D expenses rising from $0.54m to $0.84m in Broadband (due to higher project material costs) and from $3m to $3.5m in A&D (due to increased project material costs and lower revenue-related engineering labor recorded as cost of goods sold). However, during the first three quarters of fiscal 2021, OpEx was just 24% of revenue, significantly better than the 39% during the prior-year period.

"Strong top-line growth and disciplined expense control continued to produce excellent flow-through in the profit & loss," notes Rittichier.

As a result of the rising revenue and continued strong gross margin, operating margin has risen from 15% to 19%. Net income has risen from $5.9m ($0.17 per diluted share) last quarter to $7.9m ($0.20 per diluted share), versus net loss of $0.74m ($0.03 per diluted share) a year ago.

"This represents Emcore's fourth consecutive quarter of growing profitability and earnings, demonstrating the strong operating leverage in our business, achieved... against the backdrop of COVID challenges and semiconductor shortages," says Rittichier.

Operating cash flow was $5m (the fifth consecutive quarter of positive cash from operations). Capital expenditure was $1.9m. Together with $100,000 spent on financing activities, free cash flow was hence $3m, and cash and cash equivalents rose during the quarter from $65.3m to $68.3m.

"We continue to enjoy strong order backlog in cable TV [despite the record pace of shipments], although we will always be cautious about its cyclical nature," says Rittichier. "Our LiDAR and sensing components continue to garner interest from a wide variety of potential customers. Outside of sensing, we signed a contract for a new highly differentiated chip product which could be a major source of revenue growth beyond fiscal year 2022," he adds. "Overall, we are encouraged by the continued demand that we see for our new chip and sensing products, and see a bright future for the broadband business unit beyond its cable TV route."

During the quarter, inventory increased from $29.7m to $33.4. "However, we expect that this will resolve itself completely as we finish the transfer project from Beijing to Thailand," says Rittichier. "We added transmitter manufacturing equipment to increase capacity in Thailand. As a result, we saw significant production increases in Thailand during the June quarter with high yields. Achieving this milestone enables us to shut down transmitter builds in China starting in October," he adds.

"While COVID-19 outbreaks in Bangkok have caused turbulence in our CATV production output, our manufacturing lines are back up and running," Rittichier continues. "Restrictions for foreign workers into Thailand have remained a significant hindrance to getting our Beijing team into Bangkok. However, we've continued to make progress on production yields nonetheless."

For fiscal fourth-quarter 2021 (ending 30 September), Emcore expects revenue of $42-44m. "We expect to see similar performance [to fiscal Q3] in our cable TV business, with slightly increased revenue from our other product lines," says Rittichier. "Our biggest notes of caution remain tied to COVID-19 infection rates and semiconductor supply," he adds. "While we believe that we're in good shape in terms of inventory for the current quarter, we expect to continue to re-design certain products to accommodate ongoing problems in the semiconductor supply chain."

www.emcore.com

Fraunhofer ISE reports record 68.9% efficiency for GaAs thin-film PV cell under laser light

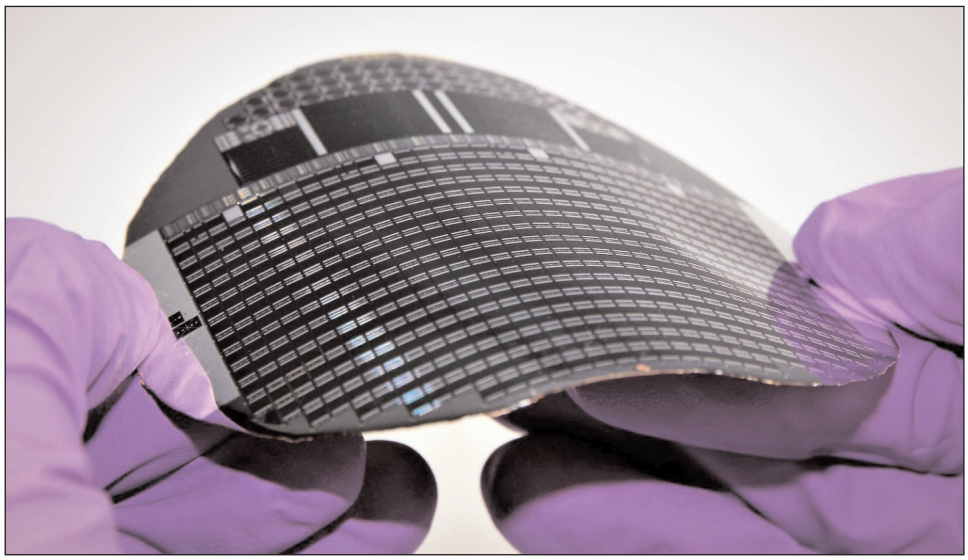
Back-surface reflector beneath n-GaAs/p-AlGaAs rear-heterojunction absorber leverages photon recycling to reduce radiative recombination losses and boost photovoltage

In addition to the classical applications for solar cells on roofs and open spaces, photovoltaic devices can also be used with laser light for efficient power transmission. At the 48th IEEE Photovoltaic Specialists Conference, researchers from the Fraunhofer Institute for Solar Energy Systems ISE of Freiburg, Germany presented how they were able to achieve a record conversion efficiency of 68.9% with a photovoltaic cell under monochromatic laser light. For this, the team used a very thin photovoltaic cell based on gallium arsenide (GaAs) and applied a highly reflective, conductive mirror on its backside.

The photovoltaic effect is particularly efficient when the energy of the incident light lies slightly above the semiconductor material's bandgap energy. Very high efficiencies are therefore theoretically possible when a monochromatic laser as light source is matched with a suitable compound semiconductor material.

In this 'power by light' energy transfer, the laser energy is delivered either through the air or via an optical fiber to a photovoltaic cell whose properties match the power and the wavelength of the monochromatic laser light. Compared with conventional power transmission via copper wires, power-by-light systems are especially beneficial for applications that require a galvanically isolated power supply, lightning or explosion protection, electromagnetic compatibility, or completely wireless power transmission, for example.

Fraunhofer ISE has achieved a record conversion efficiency of 68.9% for a III–V semiconductor photovoltaic cell based on GaAs exposed to 858nm-wavelength laser light. This is reckoned to be the highest efficiency achieved to date for the conversion of light into electricity.



Fraunhofer ISE's new GaAs-based thin-film photovoltaic cell. (©Fraunhofer ISE / picture: Henning Helmers).

This was made possible with thin-film technology in which the solar cell layers are first grown on a GaAs substrate that is then subsequently removed. A conductive, highly reflective mirror is applied to the back surface of the remaining semiconductor structure, which is only a few microns thick.

"This thin-film approach has two distinct advantages for the efficiency," says physicist Dr Henning Helmers, head of the research team. "First of all, photons are trapped in the cell and the absorption is maximized for photon energies close to the bandgap, which simultaneously minimizes thermalization and transmission losses, making the cell more efficient. Secondly, the photons additionally generated internally by radiative recombination become trapped and effectively recycled. This extends the effective carrier lifetime, thus additionally increasing the voltage."

The research group investigated thin-film photovoltaic cells with back-surface reflectors made of gold and an optically optimized combination of ceramic and silver, with the latter showing the best results. An n-GaAs/p-AlGaAs heterostructure was developed as absorber, which shows particularly low charge carrier losses due to recombination.

"This is an impressive result that shows the potential of photovoltaics for industrial applications beyond solar power generation," comments Fraunhofer ISE's director professor Andreas Bett. Optical power transmission has manifold applications. Examples are the structural monitoring of wind turbines; the monitoring of high-voltage lines, fuel sensors in aircraft tanks, or passive optical networks; the optical supply of implants from outside the body; or a wireless power supply for applications in the Internet of Things.

https://onlinelibrary.wiley.com/doi/10.1002/pssr.202100113
www.ise.fraunhofer.de

First Solar breaks ground on $680m, 3.3GW Ohio manufacturing facility

Firm's US manufacturing footprint to expand to 6GW

Cadmium telluride (CdTe) thin-film photovoltaic (PV) module maker First Solar Inc of Tempe, AZ, USA has broken ground on its third manufacturing facility in Ohio at a ceremony attended by United States Secretary of Labor Marty Walsh, the Lieutenant Governor of Ohio Jon Husted, and US Representatives Bob Latta and Marcy Kaptur.

Scheduled to commence operations in first-half 2023, the new 3.3GW$_{DC}$ facility represents a $680m investment. When fully operational, it is expected to scale the company's Northwest Ohio footprint to a total annual capacity of 6GW$_{DC}$, which is believed to make it the largest fully vertically integrated solar manufacturing complex outside China.

The facility is forecast to create over 700 permanent jobs in addition to the more than 1600 people that First Solar currently employs in Ohio. Founded in 1999, First Solar has had a manufacturing presence in the state since it began commercial production at its original Perrysburg factory in 2002, when it produced 1.5MW$_{DC}$ of modules and employed 150 people. Since then it has invested over $2bn in expanding its Ohio manufacturing presence, making the state home to the largest photovoltaic solar manufacturing footprint in the Western Hemisphere when it commissioned its second factory in 2019.

"We offer a great business environment, workforce and the resources to build a domestic solar energy competitor in a market dominated by Chinese imports," says Husted, Lieutenant Governor of Ohio.

"It's essential that we support American-made energy companies like First Solar, which are competing with Chinese solar panel manufacturers for market share in the renewable energy space," comments Latta, US Secretary of Labor.

First Solar breaks ground on its third manufacturing facility in Ohio. Pictured (left to right) are Rudolph Libbe's CEO Tim Alter, US Representative Marcy Kaptur, the Lieutenant Governor of Ohio Jon Husted, First Solar's CEO Mark Widmar, US Secretary of Labor Marty Walsh, and US Representative Bob Latta.

First Solar says that, unique among the world's ten largest solar manufacturers for being the only US-headquartered company, for not using crystalline silicon (c-Si), and for not manufacturing in China (and not relying on that country's c-Si supply chains), it produces its thin-film PV modules using a fully integrated, continuous process under one roof. The company claims that its eco-efficient CdTe module technology has the lowest carbon and water footprints of any PV module available.

After it achieves its full production capacity, the facility will allow First Solar to produce an anticipated average of one module roughly every 2.75 seconds across its three-factory Ohio footprint. It will combine highly skilled workers with Industry 4.0 architecture, machine-to-machine communication, artificial intelligence, and Internet of Things connectivity to produce a higher degree of automation, precision, and continuous improvement.

"We're leading the efforts to revitalize American solar manufacturing and secure critical clean energy supply chains because reliable access to competitive, efficient solar panels is essential to our country's future," states First Solar's CEO Mark Widmar. "Solar panels are the next crude oil, and we cannot be beholden to adversarial nations for our supply," he adds. "We're scaling US cleantech innovation by investing in R&D, ensuring that a uniquely American solar technology that was developed right here in Ohio remains competitively advantaged. And we're taking it a step further by producing the next generation of solar panels designed and made in the USA for the American solar industry."

The 1.8 million square-foot facility is expected to produce an enhanced thin-film PV module for the utility-scale solar market in the USA, which is anticipated to have a higher efficiency and wattage in a larger form factor. The additional production capacity is also expected to help mitigate the challenges currently being experienced in the global ocean freight market, by reducing the transoceanic gap between international supply and domestic demand.

The new facility will be constructed by Rudolph Libbe Inc and is expected to create 500 construction jobs for union tradespeople in Northwest Ohio over the next 18 months.

www.firstsolar.com

First Solar expanding manufacturing footprint with 3.3GW plant in India

$684m facility to begin operations in 2023

First Solar Inc of Tempe, AZ, USA is to invest $684m in a new, fully vertically integrated photovoltaic (PV) thin-film solar module manufacturing plant in India. Contingent upon permitting, and pending approval of Indian government incentives that are satisfactory to First Solar, the facility is expected to be built in the state of Tamil Nadu and commence operations in second-half 2023.

The planned facility is projected to have nameplate capacity of 3.3GW$_{DC}$. 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$_{DC}$ in 2024. Unique among the world's ten largest solar manufacturers for being the only US-headquartered company, for not using a crystalline silicon (c-Si) semiconductor, and for not manufacturing in China, First Solar produces its thin-film PV modules using a fully integrated, continuous process under one roof and does not rely on Chinese c-Si supply chains, the firm notes. Its eco-efficient module technology, which uses the firm's proprietary cadmium telluride (CadTel), is claimed to have the lowest carbon and water footprints of any PV module available.

"India is an attractive market for First Solar, and not simply because our module technology is advantaged in its hot, humid climate," says CEO Mark Widmar. "It is an inherently sustainable market, underpinned by a growing economy and appetite for energy, with a well-defined goal that will need over 25GW of solar to be deployed every year for the next nine years," he adds. "Crucially, it has combined its clean energy targets with effective trade and industrial policy designed to enable self-sufficient domestic manufacturing and true energy security. We also have many long-standing customers in the country that will be pleased to have access to an advanced PV module, which is made in India, for India."

The International Energy Agency (IEA) has projected that India will overtake the European Union (EU) to become the world's third largest consumer of electricity by 2030, as the country's population and gross domestic product (GDP) continue to grow. As part of its climate targets, India has committed to ensuring that renewables will make up 40% of its energy portfolio by 2030, and the country is forecast to account for almost 20% of the world's installed solar capacity by 2040.

The planned facility is projected to have nameplate capacity of 3.3GW$_{DC}$. 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$_{DC}$ in 2024

"India stands apart in the decisiveness of its response to China's strategy of state-subsidized global dominance of the crystalline silicon solar supply chain," says Widmar. "The country's comprehensive approach provides precisely the kind of level playing field needed for non-Chinese solar manufacturers to compete on their own merits, and should be a template for other likeminded nations," he adds. "We're very pleased to be able to support the sustainable energy ambitions of a major US ally in the Indo-Pacific region with American-designed solar technology."

The facility will be designed using the manufacturing template established for First Solar's recently announced factory in Ohio. Combining highly skilled workers with Industry 4.0 architecture, machine-to-machine communication, artificial intelligence (AI) and Internet of Things (IoT) connectivity, it will feature high degrees of automation, precision and continuous improvement.

www.firstsolar.com

First Solar appoints finance & investment expert to board

Anita Marangoly George to serve on Nominating & Governance and Technology Committees

Cadmium telluride (CdTe) thin-film photovoltaic (PV) module maker First Solar Inc of Tempe, AZ, USA has appointed Anita Marangoly George, a senior executive with almost four decades of diverse global experience in institutional finance and sustainable infrastructure investing, to its board of directors. She will serve on First Solar's Nominating & Governance and Technology Committees.

George has held various positions at la Caisse de Dépôt et Placement du Québec (CDPQ), a global investment group managing funds for public retirement and insurance plans. She is currently a strategic advisor and served as executive VP & deputy head of CDPQ's global investment arm, CDPQ Global. Prior to that, she was executive VP & head of CDPQ's Emerging Markets and Strategic Partnerships. She joined CDPQ in 2016 as its managing director for South Asia, establishing its presence and developing investment partnerships in India. During her time at CDPQ, she designed the firm's emerging market strategy, growing its business, partnerships and presence in Asia and Latin America.

Before CDPQ, George worked at the World Bank as a senior director in its global energy and extractives practice, and before that spent over a decade with the International Finance Corporation (IFC), where she led the institution's efforts to finance infrastructure and natural resources projects in India, Asia-Pacific, Middle East and Latin America regions. George pioneered IFC's financing of private, commercial solar projects and was key in promoting its Scaling Solar program across emerging markets. She has also held positions at Siemens Financial Services and the Steel Authority of India.

"Anita's experience working in climate finance and infrastructure across key global markets, combined with her passion for human capital development and sustainability, makes her uniquely qualified to join our board," comments CEO Mark Widmar. "With the company poised for growth with a differentiated solar technology that is critical to the fight against climate change, I am confident that her expertise and insights will help First Solar navigate its journey to lead the world's sustainable energy future," he adds.

"I have spent several years promoting the scaling of renewable energy investments throughout the world and recognize that the transformation of the energy sector is key to addressing climate change," says George. "First Solar combines the power of technology with unwavering respect for people and the planet to power this transition," adding that First Solar is at an "important inflection point as it charts its future as a global leader in responsibly-produced solar technology."

George has extensive experience serving on executive boards, including those in the financial sector, where she has served on the audit, talent and remuneration, technology, governance, and corporate social responsibility committees. She represents CDPQ on boards and also sits on the boards and advisory councils of a number of non-profits including TalentNomics India (which is focused on empowering women), the UK–India Climate Finance Group, the World Wildlife Fund (WWF) Climate Solver Group, Women in Private Equity (WinPE), Global Private Capital Association, LP Council, the Indian Private Equity & Venture Capital Association (IVCA) LP Council, and the Private Equity and Capital Market Committees of the Federation of Indian Chambers of Commerce & Industry. In addition, George is currently a board member and president of the Indo-Canadian Chamber of Commerce.

George holds a master's degree in Economic Policy and a Master of Business Administration in Finance from Boston University, and a Bachelor of Arts in Economics with a minor in Spanish from Smith College.

www.firstsolar.com

First Solar commits to science-based emissions targets, net-zero emissions by 2050

Cadmium telluride (CdTe) thin-film photovoltaic (PV) module maker First Solar Inc of Tempe, AZ, USA has committed to reduce its absolute Scope 1 and Scope 2 greenhouse-gas (GHG) emissions by 20% by 2028, relative to its emissions in 2020. It has also committed to achieving net-zero emissions by 2050 at the latest.

The science-based targets further the firm's previous 2021 GHG intensity reduction target, which was achieved three years in advance of its commitment. These new targets are in line with international efforts to limit the global temperature rise to below 2°C and pursuing efforts to limit it to 1.5°C above pre-industrial levels.

Scope 1 accounts for direct GHG emissions from company-owned and controlled resources, while Scope 2 accounts for indirect GHG emissions from the generation of purchased electricity consumed by the firm.

Every year, First Solar products deployed globally are displacing more than ten times the amount of greenhouse-gas emissions that the firm emits through its global operations and supply chain, assuming average worldwide irradiance and grid electricity emissions. The company's PV modules feature the industry's smallest carbon and water footprints, and fastest energy payback time.

"As this week's report from the Intergovernmental Panel on Climate Change showed, we need to treat the threat of climate change with a sense of urgency and do more than simply our part to accelerate the transition to a net-zero economy," says CEO Mark Widmar. "The solar industry is on the forefront of the fight against climate change and has a responsibility to lead by example," he adds. "While First Solar's technology addresses the need to decarbonize the global energy portfolio with ultra-low carbon solar, today we're stepping up and pledging to reduce our already-low emissions to zero by 2050."

This commitment is a continuation of First Solar's progress. Since 2008, company-wide GHG emissions intensity decreased by about 77% as a result of increased module efficiency, manufacturing throughput and capacity utilization, decreased emissions intensity of purchased grid electricity, along with energy conservation and low carbon initiatives. In 2020, the firm's GHG emissions intensity decreased by 31% compared with 2019, primarily due to the greater throughput and enhanced energy efficiency of its Series 6 module manufacturing process.

First Solar aims to achieve its science-based targets through increased energy efficiency, going 100% renewable across its US operations by 2026 and globally by 2028, working on enabling the off-site solar market in Malaysia and Vietnam, and purchasing bundled RECs and offsets as a last resort, as outlined in its recently published 2021 Sustainability Report. The report was developed in accordance with the Global Reporting Initiative's (GRI) Core Sustainability Reporting Standards and incorporates metrics from the Sustainability Accounting Standards Board (SASB) solar, as referenced in the sustainability leadership standard for PV modules and inverters (NSF/ANSI 457 – 2019).

www.firstsolar.com

Midsummer's Q2 solar roof order intake up 380% year-on-year

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) – says that, in second-quarter 2021, order intake of its SLIM, WAVE and BOLD thin, light and flexible solar roofs rose by 380% year-on-year to SEK13.5m.

"The fact that they are thin and discreet with a climate footprint of only one tenth of traditional solar panels have really struck a chord," says CEO Sven Lindström.

"These are very strong numbers despite the pandemic which has prevented us from seeing as many customers as we would have wanted. A survey commissioned by us shows that more than half of Swedish home owners are looking to install solar cells on their properties, and relatively soon — within a few years. This proves that the end-consumer market is mature," he adds.

"In the past few months, we have strengthened our sales teams further with new employees which will increase the tempo in our growth during Q3, which is normally a strong quarter for us."

Midsummer also develops and markets production equipment for solar cells in the form of the DUO system (claimed to be the world's most widespread production system for flexible CIGS solar cells), but the firm has shifted its business focus over the prior year and is investing in marketing its building-integrated solar panels to the end-consumer market. Midsummer is reporting its full financial results for Q2/2021 on 31 August.

www.midsummer.se

VCSEL market growing at 13.6% CAGR, doubling from $1.2bn in 2021 to $2.4bn in 2026

VCSELs are transitioning from 4" to 6" wafers and could soon move to 8" wafers, says Yole Développement.

The global vertical-cavity surface-emitting laser (VCSEL) market is rising at a compound annual growth rate (CAGR) of 13.6% from $1.2bn in 2021 to $2.4bn in 2026, driven by datacom and mobile applications, forecasts Yole Développement in its report 'VCSEL — Technology and Market Trends 2021'.

The two companies Lumentum and II VI dominate VCSEL manufacturing, collectively taking about 80% market share. However, there are many VCSEL suppliers, with fewer than ten big players and many medium or small players.

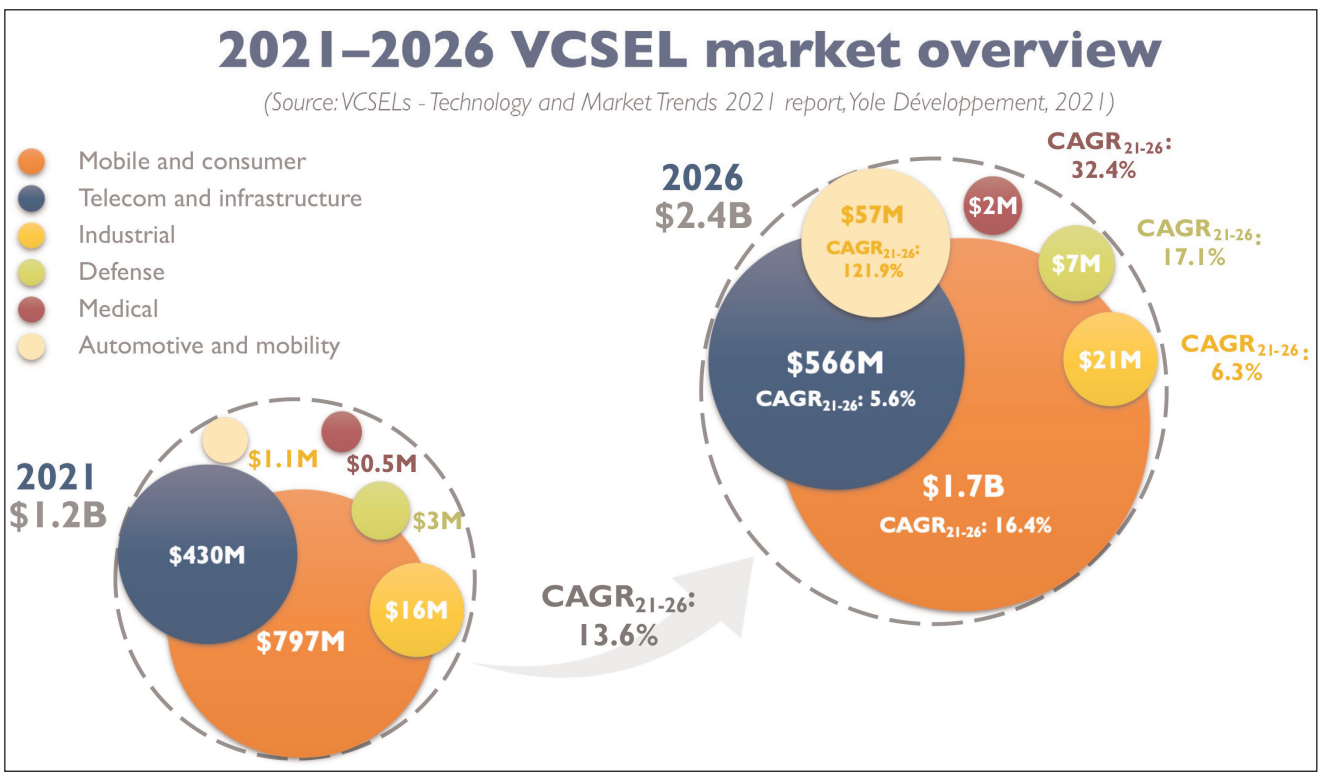
The dominant mobile & consumer market segment will grow at a 16.4% CAGR from $797m in 2021 to $1.7bn in 2026. "Revenues linked to smartphones are expected to remain stable in 2021 and 2022," says Pierrick Boulay, technology & market analyst, Solid-State Lighting. "This is explained by the decreasing adoption of 3D sensing modules by Android players. In 2021, only Apple is implementing VCSELs and developing AR applications. This will create a relatively flat market for two years. Growth could be back after that with Android players," he adds.

"VCSEL technology is continuously evolving. It has already occurred in the past with the transition from 850nm-based VCSELs for datacom applications to 940nm-based VCSEL arrays for 3D sensing applications," says Pierrick Boulay, technology & market analyst, Solid-State Lighting. "A few years ago, smartphones embedded a notch in the front display to implement the selfie camera and the face recognition module," he adds. "These elements take up space and are unsightly. The goal is to hide these elements under the display. To enable this, a transition in the wavelength used for 3D sensing would be necessary for the light to penetrate the display."

The second biggest market segment of data communications will rise at a CAGR of 5.6% from $430m in 2021 to $566m in 2026.

The VCSEL market for automotive & mobility applications is quite small in 2021, with revenue of $1.1m, but will grow at a 122% CAGR to $57m in 2026, with applications in light detection and ranging (LiDAR) and driver monitoring.

Industrial applications are expected to grow at a



6.3% CAGR from $16m in 2021 to $21m in 2026. Yole reckons that industrial revenue could take-off in the mid-term with the emergence of applications using 3D LiDAR, related to smart infrastructure and logistics.

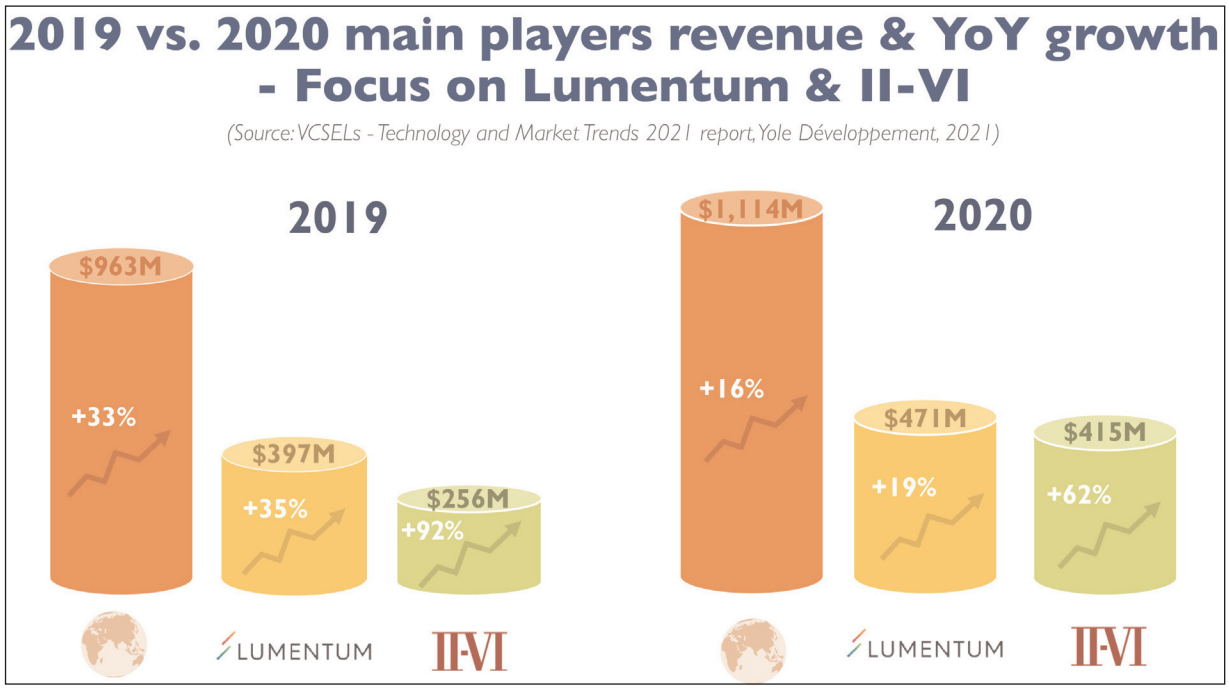
Since it appears that organic light-emitting diode (OLED) displays are transparent to short-wavelength infrared (SWIR) light around 1300–1400nm, the shift from 940nm to such SWIR wavelengths will deeply impact components and the supply chain, says Yole. For 940nm, VCSELs are made from 6"-diameter gallium arsenide (GaAs) wafers. However, SWIR VCSELs should be based on indium phosphide (InP), which is much more difficult to process, and manufacturing is currently done on 2" and/or 3" InP wafers.

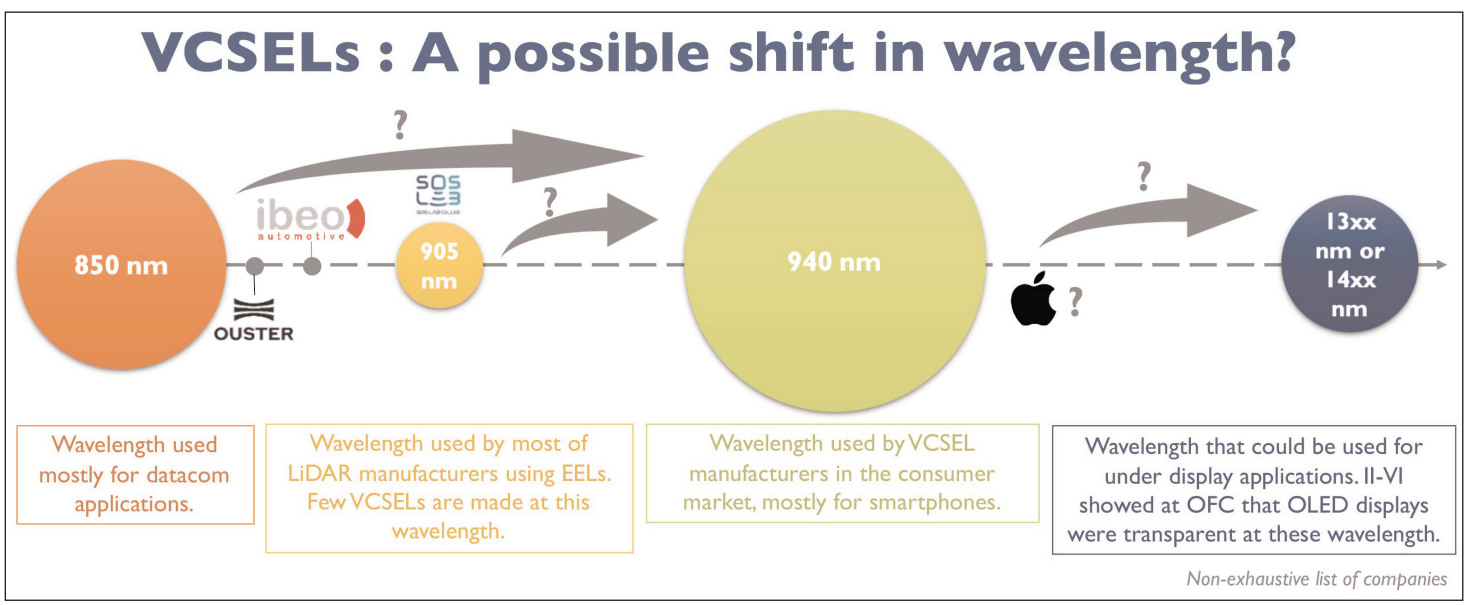
"The impact is not limited to the light source but also to the receiver, where silicon-based single-photon avalanche detectors (SPADs) are used in the near-infrared (NIR) region," notes Pars Mukish, business unit manager, Solid-State Lighting & Display. "Silicon can no longer be used in the SWIR region. SPADs will have to be based on indium gallium arsenide (InGaAs) material or using quantum dots. In both cases, the technology is still emerging, manufacturing yields are low, and availability of components is limited. This will lead to higher component costs for both the emitter and the receiver".

Only Apple, whose smartphones have average selling prices (ASPs) higher than $1000, can afford such a technology change, believes Yole.

Smartphones are not the only application where technology is evolving. Automotive applications, and LiDAR in particular, will benefit from recent developments. Multi-junction technology represents the next leap forward for the VCSEL industry, reckons Yole. Multi-junction VCSELs offer many significant benefits to users. In a back-side emitting configuration, they have several advantages over their conventional siblings. In particular, eliminating wire bonds would improve VCSEL performance and allow the use of micro-lenses, enabling the use of more compact packages, concludes Yole. ■

www.i-micronews.com/products/vcsels-technology-and-market-trends-2021





3D imaging and sensing market growing at 14.5% CAGR to $15bn in 2026

ST and Lumentum benefit most in Apple's supply chain, notes Yole Développement.

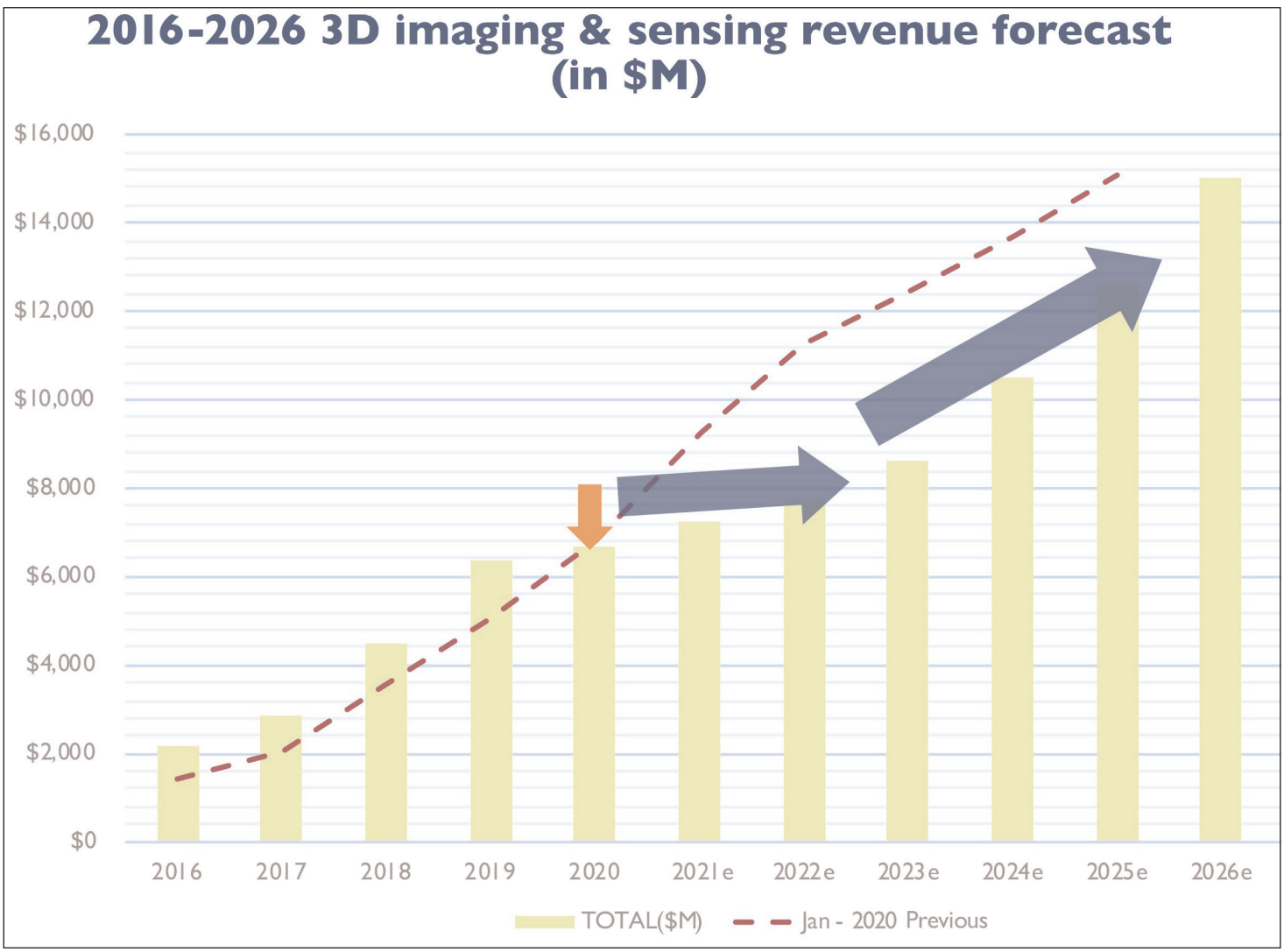
The global 3D imaging and sensing market is rising at a compound annual growth rate (CAGR) of 14.5% from $6.8bn in 2020 to $15bn in 2026, reckons market research and strategy consulting company Yole Développement in its latest annual report '3D Imaging and Sensing — Technology and Market Trends 2021'.

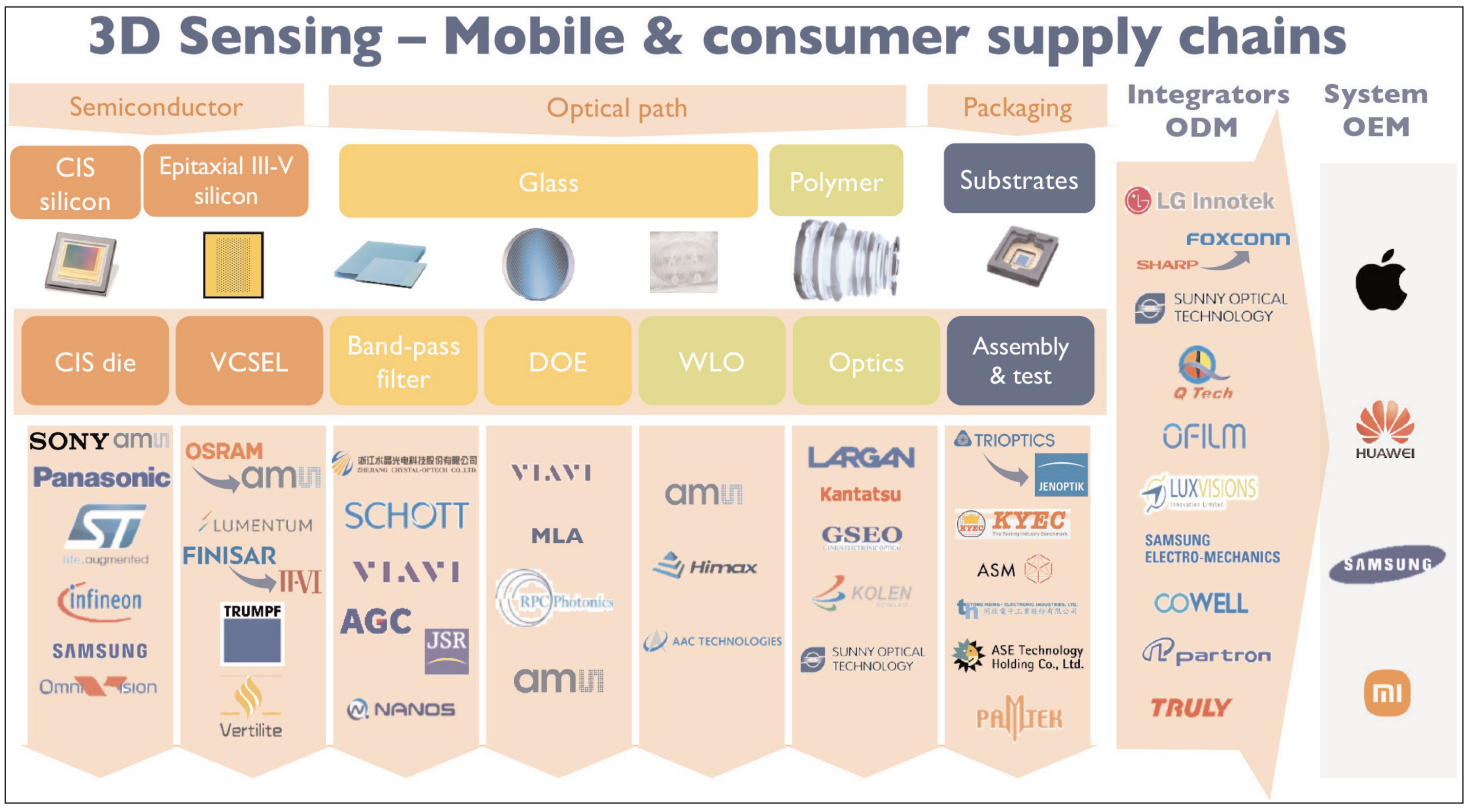
Mobile & consumer is the main segment, and will comprise 46% of the total 3D imaging and sensing market in 2026, it is forecasted. This will be followed by the automotive and industrial segments, both at 22%.

Concerning technology trends, the three most common three-dimensional sensing technologies are stereo, structured light and time-of-flight (ToF). Light detection & ranging (LiDAR), when paired with autonomous driving, is a hot technology, but it is still in its infancy, notes Yole. Laser triangulation in machine vision and interferometric (OCT) in medical applications are well established, it adds.

Supply chain

Apple continues to adopt structured light technology in its whole lineup. The firm has also successfully





released a 3D rear camera in iPhone 12 Pro. Benefiting greatly from this are the key 3D camera component suppliers, such as STMicroelectronics, Sony, ams, Lumentum and Largan as well as module makers LG Innotek and Sunny Optical. Amongst Apple's supply chain, STMicroelectronics and Lumentum have benefited the most.

"In mobile markets there is a temporary hiatus in growth of 3D sensing due to the ban of Huawei in the US as well as the fact that the Android camp has abandoned the technology," says Richard Liu, technology and market analyst in Yole's Photonics, Sensing & Display division. "The shipment volume of 3D sensing products recorded in 2020 is about 80% of the previous forecast," he adds. "The gap between previous optimistic forecasts widened as sales leveled off. But under-display camera technology became mature, and there are more low-cost indirect time-of-flight (iToF) sensing solutions. These could drive higher 3D sensing adoption and a return to growth around 2023".

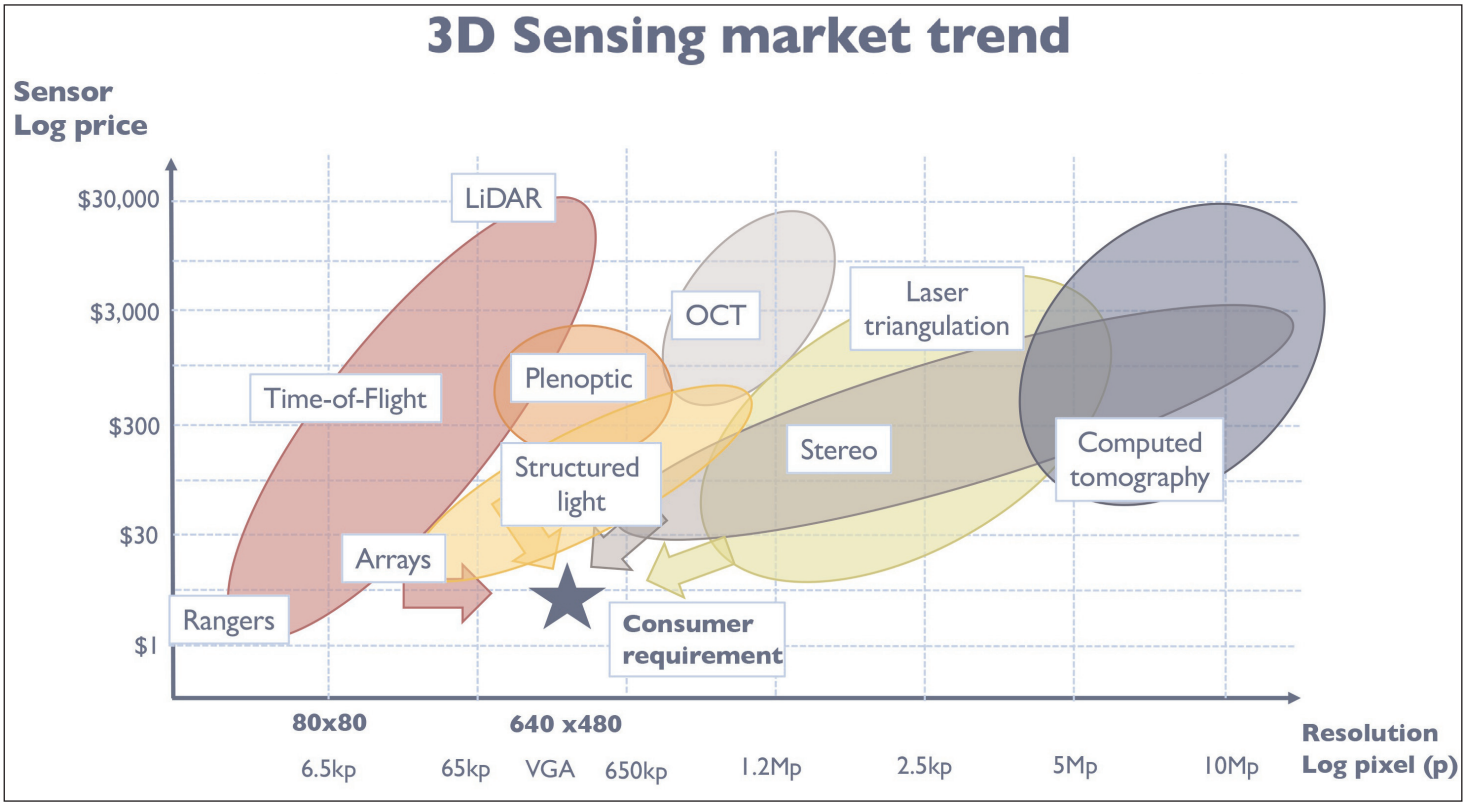
Apple continues to use front-facing structured light throughout all iPhone series. It also introduced a 3D camera with a direct time-of-flight (dToF) array sensor into the iPhone 12 Pro, a step forward for the 3D sensing market.

As analyzed by Yole in the report, besides mobile phones, 3D sensing technology has a broad reach in the consumer market, including tablets, VR/AR (virtual reality and augmented reality), robot vacuum cleaners, and AIoT (artificial intelligence combined with the Internet of Things). Increased labor costs and manufacturing upgrades are accelerating the development of automation and machine vision, including 3D visual systems, increasing the penetration of 3D vision every year. In 2020 there was a ramp-up of electric vehicles (EVs), which also exploit advanced driving assistance systems (ADAS), the market for which is currently booming. Yole believes that the automotive sector will be a large part of the next wave of 3D sensing adoption.

"3D imaging and sensing technology is an important means to acquire information in the perception of the real world," notes Pierre Cambou MSc, MBA, principal analyst in the Photonics and Sensing Division. "It provides a basis for detection and recognition as well as for reconstruction of the real geometry of an object and subsequent 3D modeling," he adds. "It is used in consumer biometry, augmented reality, gaming, autonomous driving and a wide range of applications."

In mobile 3D sensing, Apple's supply chain is stable and growing. STMicroelectronics and Lumentum are the most profitable, followed by ams, II-VI and LG Innotek. The Android camp is less healthy. Neither the emitter component suppliers, such as Trumpf and Vertilite, nor the receiver companies, like Omnivision and PMD Technology, have benefited much. The good news is that they are already actively working on 3D sensing in the non-mobile space, such as Vertilite in automotive and PMD in consumer applications.

Within this 3D imaging and sensing ecosystem Sony remains an exception. It is not only the leader of iToF sensor arrays but also the only manufacturer that can provide dToF sensor arrays for consumer applications. It is very competitive. Analysts will not be surprised if it keeps its number-one position no matter how the market changes.



"The 3D sensing market is developing rapidly and offers great opportunities," says Liu. "In addition to the mobile phone market, automotive ADAS and AR are set to be big 3D sensing applications. In 2020, the rapid growth of electric vehicles with very high intelligence and ADAS brought LiDAR adoption forward. This has attracted a wide range of players, from LiDAR suppliers in traditional industries like Valeo and Velodyne to electronics giants Sony, Huawei and start-ups like Livox and XAOS."

In all the 3D sensing markets, China is an emerging market. It shows great vitality not only in the 3D back-end application market but also in the 3D front-end supply chain, says Yole. This has been driven by the policy of China cultivating local supply chains in the middle of the US-China trade conflict. Facial payment has been driven by platform vendors AliPay and WeChat, and supported by technology provider Orbbec. In 3D machine vision, Hikrobot and Huaray are starting to compete with the likes of Sick and Lucid. In automotive, the entry of Chinese players has played a decisive role in the price decline of LiDAR, notes Yole.

The fourth Yole Développement and CIOE (China International Optoelectronic Exposition) '3D Sensing for Consumer Forum 2021' is scheduled to take place on 2 September, both in Shenzhen, China, and online. ■

www.i-micronews.com/products/3d-imaging-and-sensing-technology-and-market-trends-2021

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

Towards continuous-wave UV-B laser diodes

Team reduces current density threshold to 13.3kA/cm^2 at 300nm wavelength.

Researchers in Japan claim the lowest threshold current density so far for a UV-B laser diode (LD) emitting at a wavelength of 300nm [Shunya Tanaka et al, Appl. Phys. Lett., vol118, p163504, 2021]. The 13.3kA/cm2 threshold was achieved by a team from Meijo University, Mie University, Asahi-Kasei Corp and Nagoya University, who focused particularly on optimizing the waveguide thickness and cladding structures.

The researchers see sub-10kA/cm^2 thresholds as necessary to realizing continuous-wave operation, which would boost the potential for UV laser diode applications in industry, medicine and biotechnology. A further requirement is for operating voltages to be less than 10V. The UV-B wavelength range is 280–315nm.

In previous work, the team found that one problem with the aluminium gallium nitride (AlGaN) structures of UV-B laser diodes was spontaneous emission from the waveguide layers, which was parasitic on the device performance, reducing charged carrier injection into the laser's active region. The improved threshold of the latest device structure was obtained by thinning the waveguide to improve injection efficiency and optimizing the cladding to maintain/enhance optical confinement in the laser region.

Inspired by experiment and simulations, the researchers produced an optimized device (Figure 1) on an AlGaN buffer with ~1x10^9/cm^2 dislocation density deposited on a sputtered and annealed AlN template on sapphire, using metal-organic vapor phase epitaxy (MOVPE). The cladding on the n-side was unintentionally doped (u-AlGaN), while the upper cladding layers were

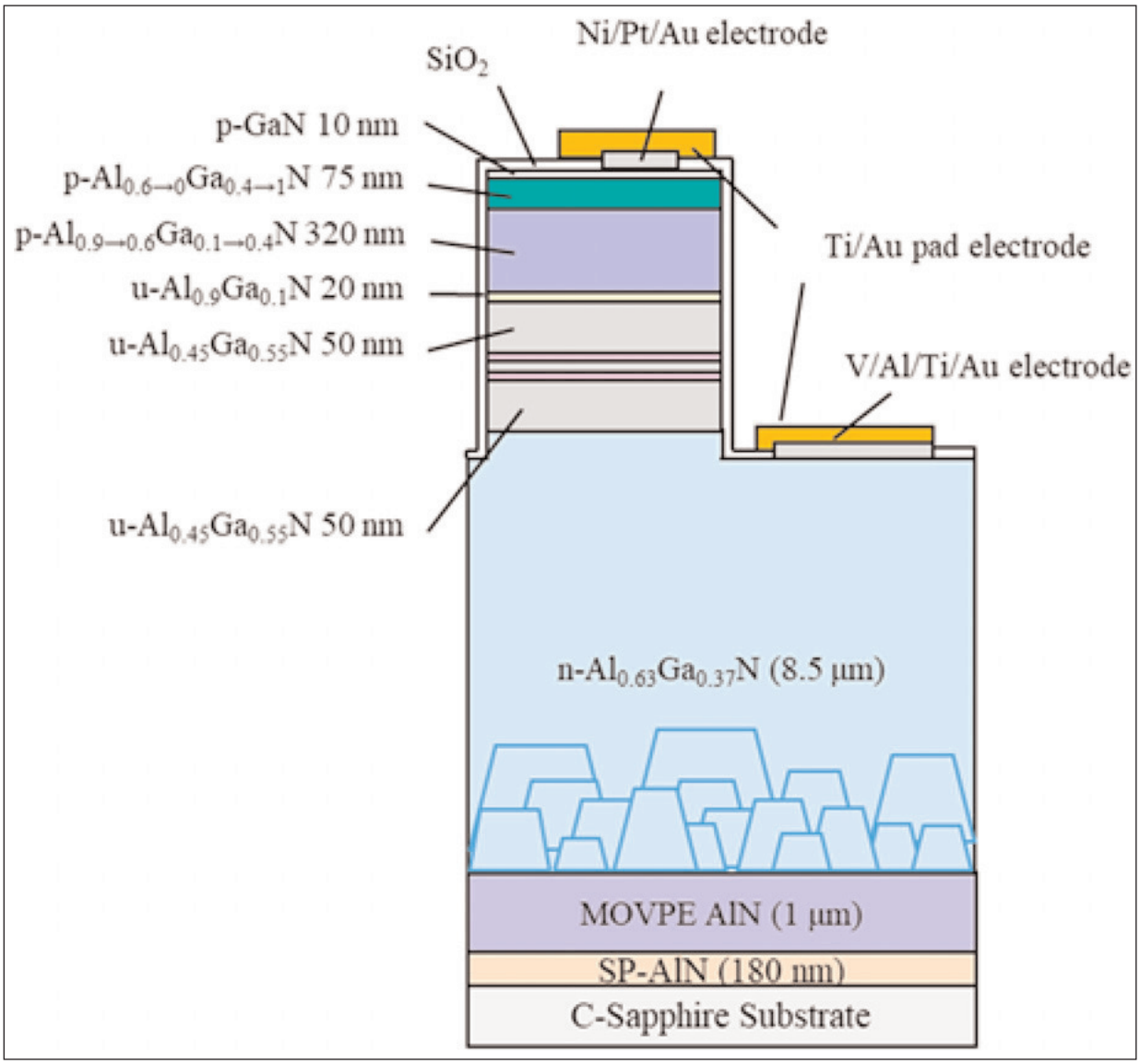


Figure 1. Enhanced UV-B laser diode design on low-dislocation-density AlGaN underlying layer.

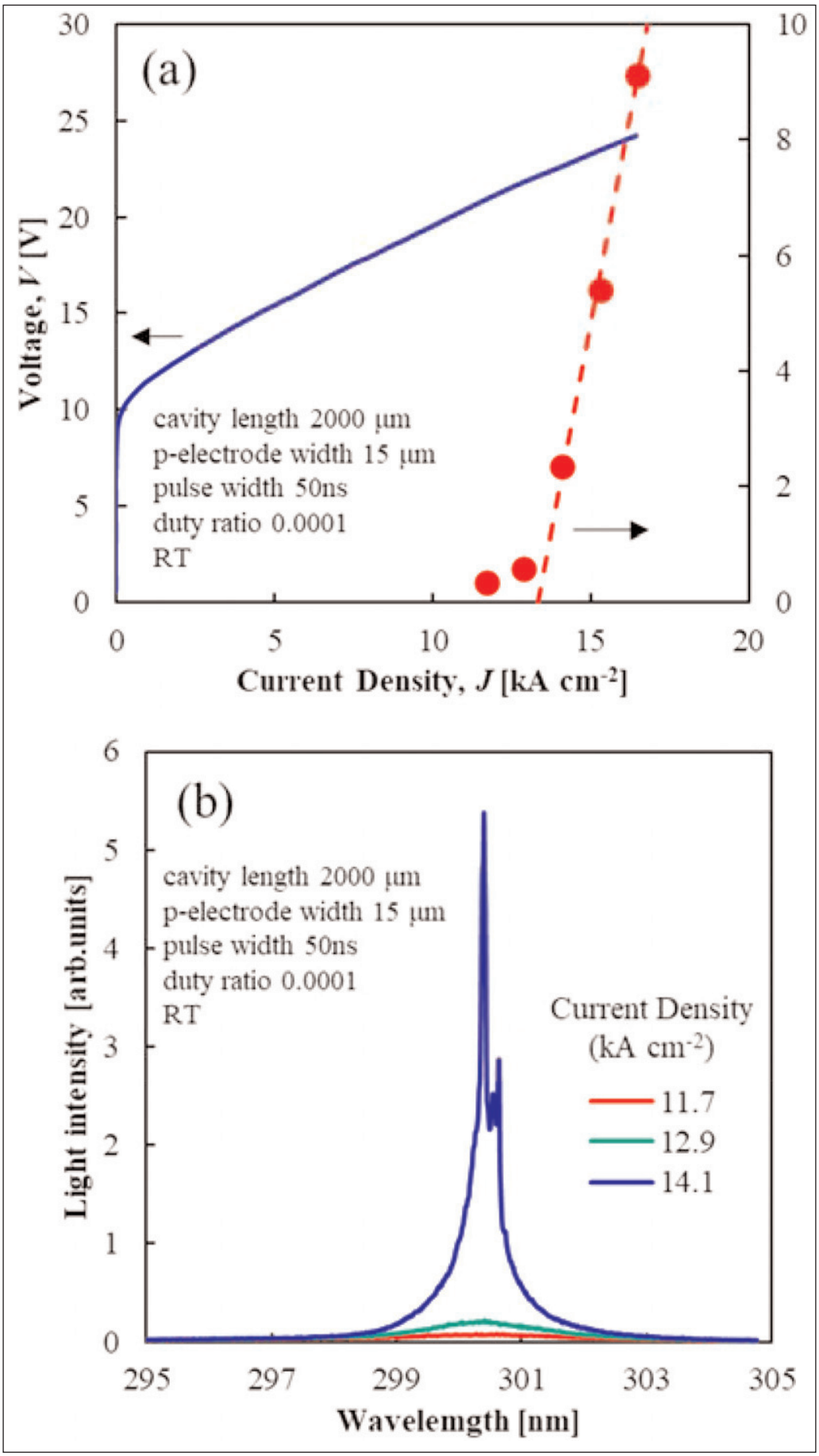


Figure 2. (a) Current density-voltage and -light output characteristics and (b) lasing spectrum of 2000μm resonator laser diode with 15μm-wide p-electrode.

doped with magnesium to give p-type conductivity.

The device fabrication process used inductively coupled plasma (ICP) mesa etch and electron-beam evaporation for deposition of the vanadium/gold/titanium/gold n-electrode and nickel/platinum/gold p-electrode. Silicon dioxide was used to electrically isolate the n- and p-electrodes. Contact pads consisted of titanium/gold. Uncoated mirror facets were created using a combination of plasma etch and wet etch in tetramethyl-ammonium hydroxide solution.

A laser diode with 2000μm resonator length and 10μm p-electrode width had a laser threshold current density of 14.2kA/cm^2, which compares with 25kA/cm^2 for a similar laser diode previously reported by the group. The researchers attribute the improvement to increased injection efficiency and optical confinement.

In experiments on a range of laser diodes with resonator lengths and p-electrode widths, the researchers concluded that there are further factors that need to be investigated with the aim of further reducing threshold currents. The best device with 13.3kA/cm^2 threshold featured a 2000μm resonator and 15μm-wide p-electrode (Figure 2).

The experimental preparation involved two devices (Figure 3) grown on an underlying AlGaN buffer with a somewhat higher dislocation density of ~3x10^9/cm^2. The group has previously reported material with AlGaN dislocation densities as low as ~7.5x108/cm^2, but opted for the somewhat higher value to shorten growth times.

The epitaxial design included variable thicknesses of waveguide layers (150nm and 50nm) and upper cladding with two composition-gradient steps to the

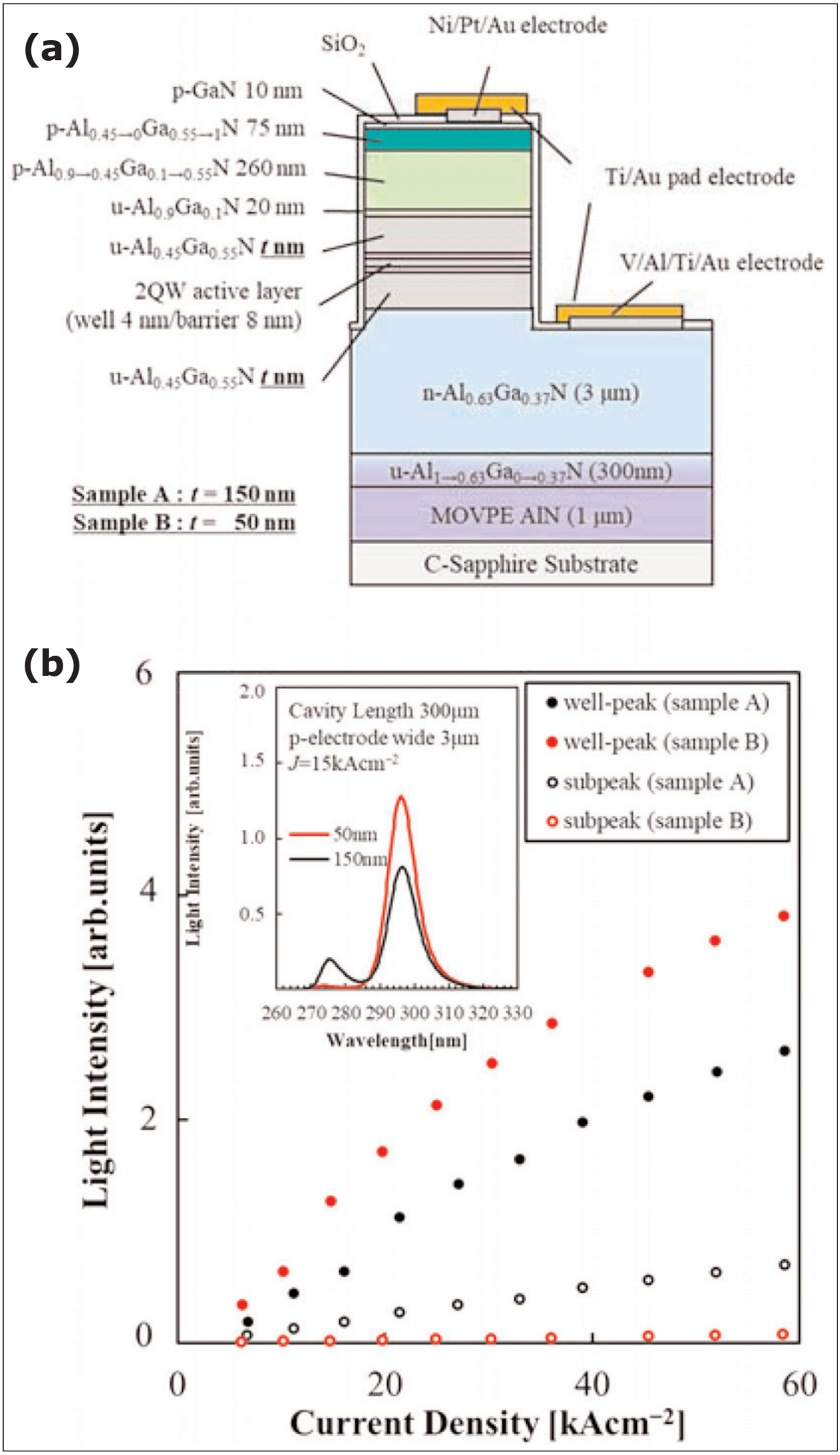


Figure 3. (a) Initial UV-B laser diode design. (b) Current density dependence of well-peak and subpeak emission intensity. Inset: emission spectrum at 15kA/cm^2.

10nm p-GaN contact. The thinner 50nm waveguide (sample B) was found to have stronger well peak emission relative to a parasitic subpeak in pulsed operation at room temperature.

The source of the unwanted subpeak is believed to be due to the waveguide layer — experiments on almost identical LED structures without waveguides do not show such emission. Thus, reducing the waveguide thickness might be expected to reduce the subpeak emissions.

Of course, thinning the waveguide reduces optical confinement in the active layer, which is necessary for laser emission, so there is a trade-off. Simulations suggest that the thinner waveguide of sample B allows more light into the absorbing upper cladding layer, reducing laser efficiency. The light absorption was estimated to be 260/cm, relative to 100/cm for the 150nm waveguide structure.

Further simulations were performed to optimize the structure before the 13.3kA/cm^2 threshold device was fabricated. ■

https://doi.org/10.1063/5.0046224

Author: Mike Cooke

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

Linear power of graded AlGaN-channel HEMTs

Researchers claim a record for the cut-off frequency-power density product.

HRL Laboratories and University of Notre Dame in the USA claim a record cut-off frequency-(f_T) power density product of 858GHzW/mm for gallium-polar gallium nitride high-electron-mobility transistors (HEMTs) at 30GHz [Jeong-Sun Moon et al, IEEE Electron Device Letters, volume 42, issue 6 (June 2021), p796]. The record was achieved using a graded aluminium gallium nitride (AlGaN) epitaxial material structure and a mini-field plate (FP) T-gate with 60nm gate length.

The potential applications for such devices would be millimeter-order wavelength electromagnetic radio transmission, 'millimeter waves' (mmWs), as for proposed 5G and 6G wireless communications.

The epitaxial material structure on silicon carbide (SiC) had a channel structure consisting of graded-composition AlGaN above GaN. The barrier had a 25% Al content. The structure demonstrated a 1423cm^2/V-s electron mobility and 9.5x10^{12}/cm^2 carrier density in the channel.

The fabricated transistors (Figure 1) also featured regrown n$^+$-GaN source-drain contacts in the interest of reducing contact resistance. The source–drain distance was 1.1μm. The mini-FP T-gate had a 50nm

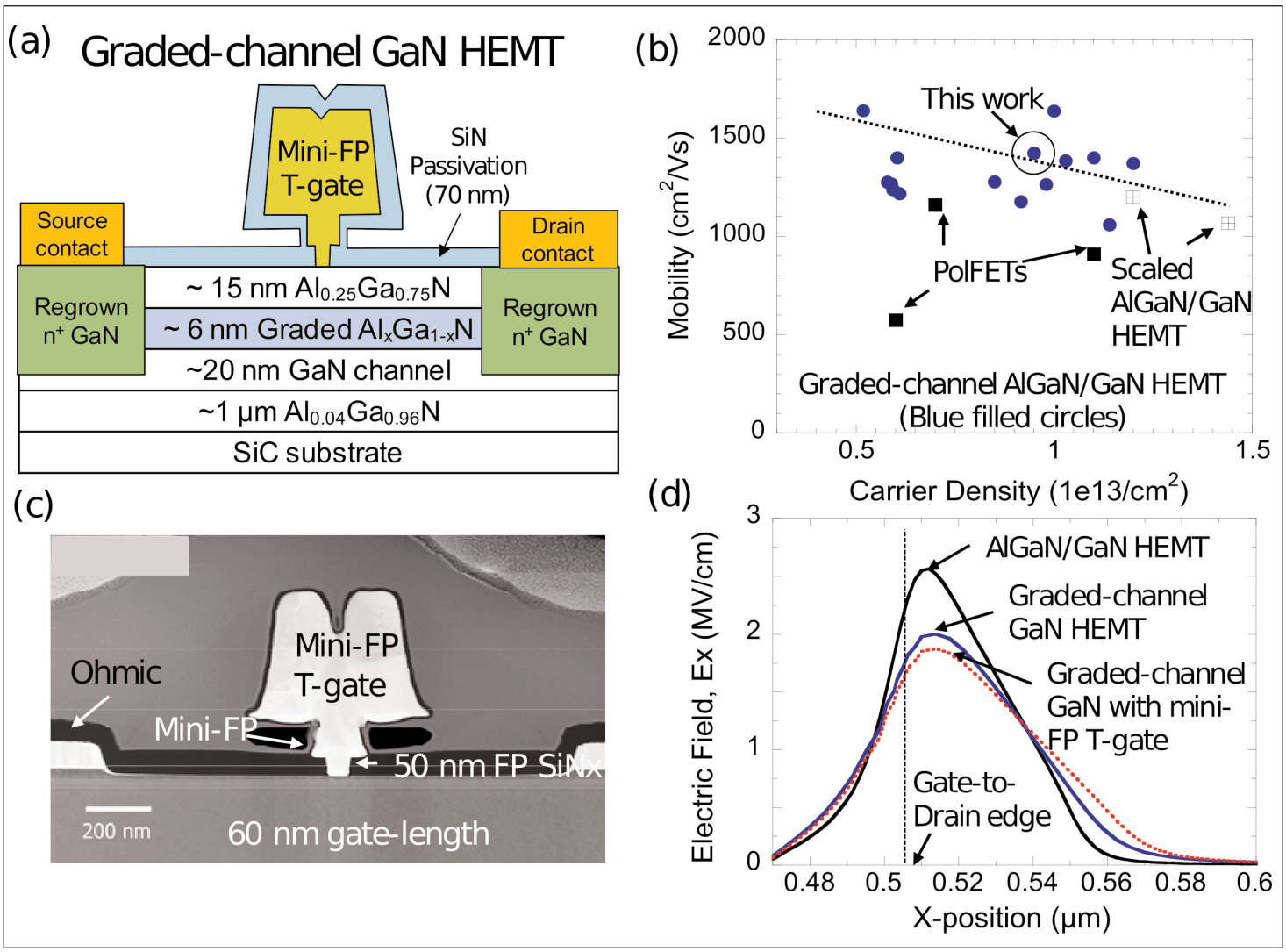


Figure 1 (a) Mini-FP T-gate graded-channel GaN HEMT scheme, (b) measured mobility versus carrier density, (c) scanning electron microscope image of T-gate, and (d) calculated electric field in channel between gate and drain, compared between graded-channel GaN HEMTs and conventional AlGaN/GaN HEMT.

overhang on the drain side, designed to reduce gate-to-drain parasitic capacitance effects that reduce high-frequency performance.

Simulations suggested that the graded channel structure would reduce the peak electric field in the gate-drain gap by 22%. Adopting the mini-FP would reduce this by a further 6%, according to the calculation.

One persistent problem with GaN HEMTs has been current collapse under pulsed and high-frequency operation. The effect in the HRL/Notre Dame device was found to be around 6%, compared with the more than 22% generally reported for T-gate AlGaN HEMTs.

Small-signal frequency performance evaluation between 0.1GHz and 67GHz gave extrinsic cut-off (f_T) and maximum oscillation (f_{MAX}) frequencies of 156GHz and 308GHz, respectively. An equivalent circuit analysis suggested that the main factor impacting f_T was "gate transit delay associated with the gate-to-source capacitance".

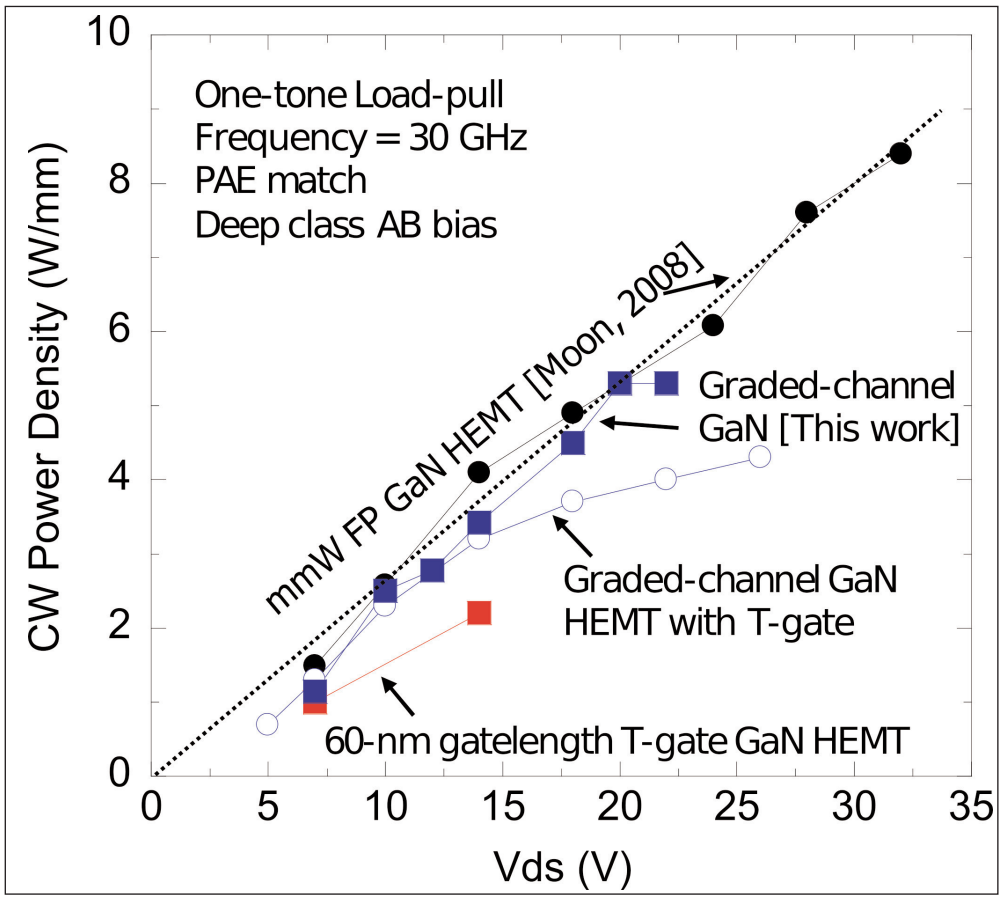


Figure 2. Measured output power density of the graded-channel GaN HEMT versus drain voltage at 30GHz, showing the linear power density scaling.

Continuous-wave passive scalar load-pull power testing on a device with two 37.5μm gate wings from a central stem (2x37.5μm) at 30GHz showed linear power output power density between 2.5W/mm and 5.5W/mm as the drain bias increased between 10V and 20V (Figure 2). Linearity of power output is a key requirement for many wireless communication standards.

The associated power-added efficiencies (PAEs) were 70% and 48%, respectively. In these measurements, a fixed load impedance was used, and not optimized as the drain bias increased. The researchers also found that the power density of their transistors was more than 2x that of previous reports of GaN devices with f_T ~150GHz. ■

https://doi.org/10.1109/LED.2021.3075926

Author: Mike Cooke

Increasing the mobility of n⁻-GaN on silicon

A record room-temperature mobility of 1090cm²/V-s has been achieved with a carrier concentration of ~2x10¹⁶/cm³.

Researchers based in China claim a record 1090cm²/V-s mobility (μ) for lightly n-doped gallium nitride (n⁻-GaN) grown on silicon (Si) [Jianfei Shen et al, Appl. Phys. Lett., vol118, p222106, 2021]. The carrier concentration was ~2x10¹⁶/cm³. The previous mobility record was 720cm²/V-s with 2x10¹⁶/cm³ Si doping.

According to the team from Peking University, National Institute for Materials Science (NIMS), and Collaborative Innovation Center of Quantum Matter, a key factor in this achievement was the reduction of threading dislocations (TDs) in the n⁻-GaN. Further investigation suggested that the TDs attract acceptor-like carbon impurities from metal-organic chemical vapor deposition (MOCVD) — these carbon impurities can form charged Coulomb scattering centers.

Lightly n-doped GaN drift layers are a key component in vertical GaN based devices being developed for high-power and high-voltage systems for electric vehicles, power plants, data centers and consumer electronics. Such layers need to be relatively thick to reduce the peak electric field of the large potential drop. At the same time, the resistance needs to be as low as possible, requiring as high a mobility as possible.

Although higher mobilities have been achieved on other substrates, such as silicon carbide and freestanding gallium nitride (1470cm²/V-s with 1.2x10¹⁵/cm³ carrier concentration), manufacture on silicon substrates could significantly reduce costs, particularly if GaN electronics could be monolithically integrated with silicon CMOS circuitry.

The researchers grew their n⁻-GaN on p-type doped <111> Si. The team explored the use of dislocation filter (DF) layers of various thicknesses in the range 1–5μm, grown at 1020°C with an ammonia-rich 4534 V/III ratio.

The DF layer was grown on a buffer consisting of 300nm 1100°C aluminium nitride (AlN) nucleation and 400nm 1060°C $Al_{0.25}Ga_{0.75}N$ stress control layers to bridge the large ~17% lattice mismatch between GaN and silicon. The large mismatch is a key source of the higher TD density, relative to GaN grown on the much more expensive alternative substrates.

The top layer was 2μm n⁻-GaN with ~3x10¹⁶/cm³ silicon doping, grown at 1050°C temperature and 300mbar pressure.

The thicker 5μm DF layer resulted in a lower dislocation density in the top n⁻-GaN, according to x-ray diffraction analysis (Table 1). The results were consistent with inspection using transmission electron microscopy, which gave a value of 5.4x10⁸/cm² for sample C with a 5μm dislocation filter.

Secondary-ion mass spectroscopy (SIMS) showed that, along with reduced dislocations, the top n⁻-GaN layer also contained fewer carbon impurities.

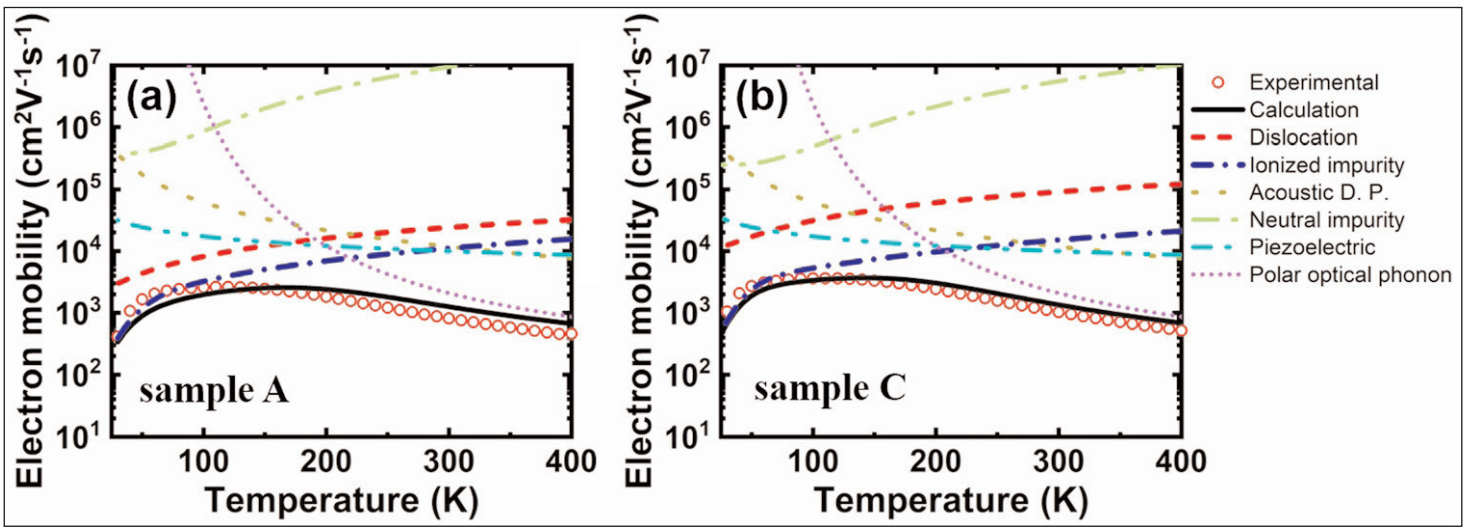


Figure 1. Temperature dependence of electron mobility of (a) sample A and (b) sample C. Calculated electron mobilities limited by individual scattering mechanisms also shown. Components combined according to Matthiessen's rule [$1/\mu = \Sigma 1/\mu_i$] to give calculated total.

The researchers found a linear relationship between the dislocation density and carbon concentration: "The linear dependence indicates that the incorporation of carbon impurity is closely associated with dislocation density. We suggest that the carbon impurities may segregate around the dislocations (carbon-decorated dislocations). Some previous experimental works have also shown evidence that dislocations behave as carbon-gathering centers."

Table 1. Experimental comparison of three samples with different dislocation filter thickness.

Sample	DF thickness	TDD	Carbon concentration	μ at 300K
A	1μm	$1.1x10^9/cm^2$	$1.7x10^{16}/cm^3$	$814cm^2/V-s$
B	3μm	$9.3x10^8/cm^2$	$1.3x10^{16}/cm^3$	$873cm^2/V-s$
C	5μm	$5.3x10^8/cm^2$	$4.6x10^{15/}cm^3$	$1090cm^2/V-s$

Table 2. Properties determined through charge-balance considerations.

Sample	N_A	N_{DIS}	d_{DIS}
A	$1.7x10^{16}/cm^2$	$9.6x10^{15}/cm^3$	5.9Å
B	N/A	N/A	N/A
C	$7.0x10^{15}/cm^2$	N/A	N/A

The team believes that the carbon impurities around the dislocations may act as acceptor-like traps, which reduce electron carrier concentrations, along with impacting mobility through carrier scattering. These effects increase the resistance of drift layers in vertical devices. The improved material quality of the n^--GaN in sample C resulted in a mobility of $1090cm^2/V-s$, according to Hall measurements on Van der Pauw structures.

The researchers used temperature-dependent Hall measurements to disentangle the various theoretical contributions to the mobility (Figure 1). For sample A (1μm DF), the peak mobility was $2620cm^2/V-s$ at 120K. The sample C peak was $3628cm^2/V-s$ at 110K. According to the researchers, the peak occurring at lower temperature indicates a lower compensation trap (N_A) concentration.

Despite the higher dislocation density compared with material grown on pure GaN substrates, the contribution of dislocation scattering in sample C was found to be comparable. The researchers suggest that the key factor is whether the dislocations are charged or not. If the dislocation has trapped carbon atoms which in turn have trapped electrons, the charges produce Coulomb scattering.

Further analysis was used to extract information from the temperature dependence of the Hall carrier concentration (Table 2). The team estimated acceptor concentrations ($[N_A]$), concentrations of TD-related acceptor states ($[N_{DIS}]$), and the distance between occupied acceptor-like trap states along a TD (d_{DIS}), using charge balance equations. The last value, d_{DIS}, was found to be of the order of the lattice parameter in the vertical c-direction of the GaN crystal lattice. "That means an acceptor-like trap state (one carbon atom decorated near a dislocation) was estimated to exist at every c-lattice spacing along a TD," the researchers comment. ■

https://doi.org/10.1063/5.0049133

Author: Mike Cooke

GaN breakdown exceeds 10kV

Schottky diode features lateral multi-channel and reduced surface field structures.

Researchers in the USA and China claim the highest breakdown voltage so far, more than 10kV, for gallium nitride (GaN) power devices [Ming Xiao et al, IEEE Electron Device Letters, vol42, p808, 2021].

The team from Virginia Polytechnic Institute and State University in the USA and Enkris Semiconductor Inc in China fabricated multi-channel Schottky barrier diodes (SBDs) with a p-GaN reduced surface field (RESURF) structure, targeted at reducing the peak electric field and hence extending the breakdown capability. At the same time, the multi-channel structure reduces on-resistance.

The researchers see their work as potentially contributing to the future needs of renewable-energy generation, industrial motor drives, the electricity grid, and transportation. Competing silicon and silicon carbide (SiC) technologies suffer from slow switching speeds or exorbitant costs, respectively.

The device material consisted of 20nm p^+-GaN and 350nm p-GaN top layers over a 5x multi-channel of 23nm $Al_{0.25}Ga_{0.75}N$/100nm intrinsic GaN. The material was grown continuously, avoiding regrowth in fabrication, on sapphire, using metal-organic chemical vapor deposition (MOCVD).

Hall measurements on the material demonstrated a sheet resistance of 178/Ω/square, 2010cm^2/V-s mobility and a 1.75x10^{13}/cm^2 five-channel total two-dimensional electron gas (2DEG) density. The 2DEG density included the depletion effect of having an overlying p-GaN layer.

The device fabrication process (Figure 1) began by forming a self-aligned ohmic cathode contact with titanium/aluminium/nickel/gold. The isolation mesa height was 900nm. The anode contact was nickel/gold with a 2μm extension (LA). The contacts were wrapped around the mesa sidewalls to give a good contact with the multi-channel.

The p-GaN material was mainly etched away, leaving either a 2μm termination structure (LP) or the RESURF structure. The thickness of the p-GaN in the RESURF region was aimed at balancing the positive charges in the p-GaN against the negative carriers in the 2DEG multi-channel. The critical thickness required for this was determined using capacitance-voltage measurements on test structures. The optimal value was found to be in the range 80–100nm.

The team sees their RESURF structure as being more practical in terms of fabrication, compared with

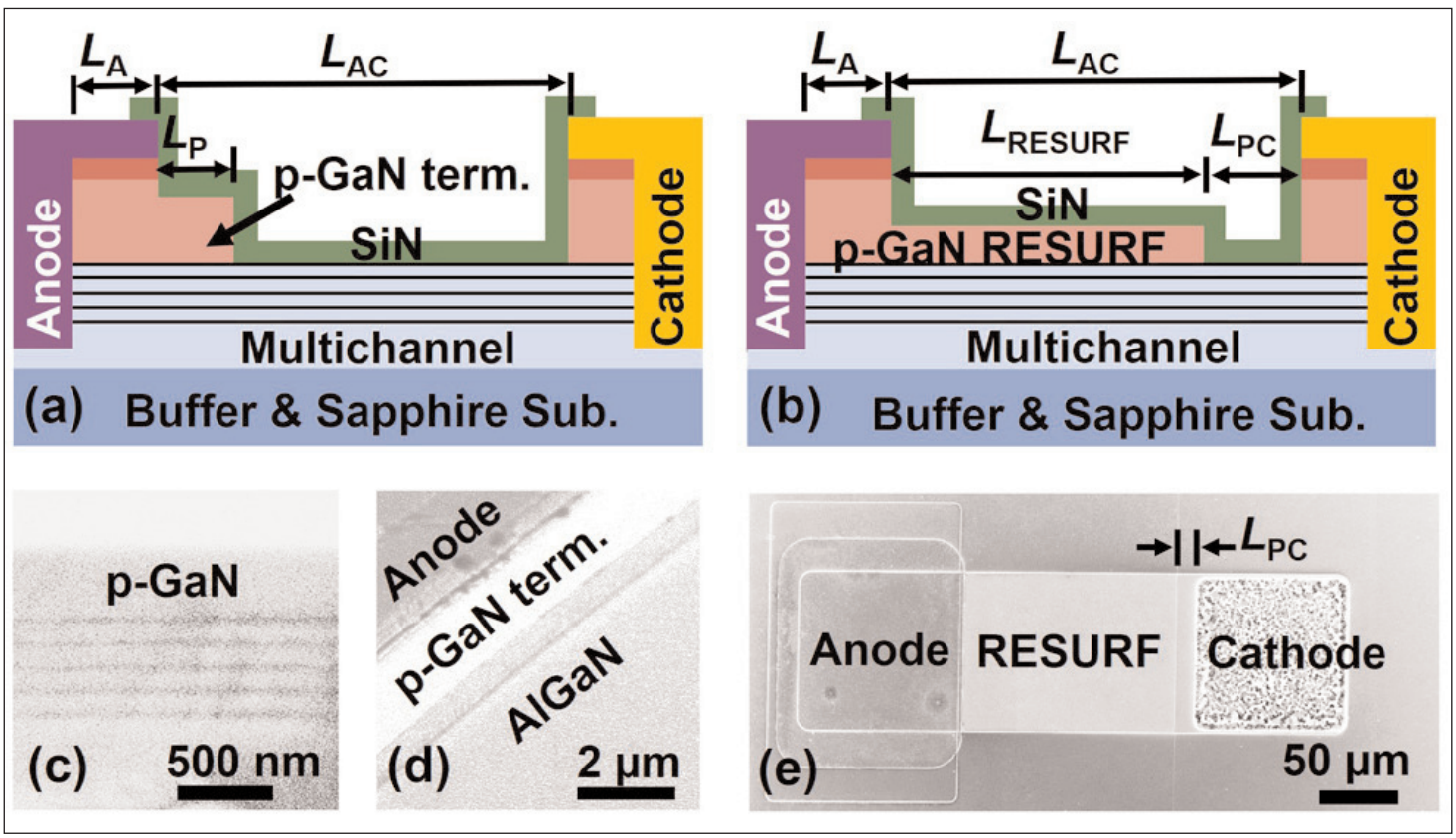


Figure 1. Schematics of multi-channel AlGaN/GaN SBD with (a) p-GaN edge termination and (b) p-GaN RESURF. Cross-sectional scanning electron microscope images of (b) p-GaN/multi-channel region, (c) p-GaN edge termination region, (d) top-view of p-GaN RESURF (L_{AC} = 123μm) before SiN_x passivation.

'polarization superjunction' (PSJ) devices, which use charge polarization effects to balance the charge. Ideal PSJs would not need a RESURF structure. However, the world is not ideal, and net charge tends to appear in multi-channel devices due to unintentional donor doping.

The researchers comment: "Actually, the RESURF multi-channel structure proposed in this work shows an effective design for an unbalanced PSJ device, while the ideal multi-channel PSJ device may be very difficult to realize experimentally."

The fully etched region of the RESURF diode up to the cathode was 12μm (LPC). The final silicon nitride (SiN_x) passivation was applied using plasma-enhanced chemical vapor deposition (PECVD). The 1mA/mm current density turn-on voltage for the devices was 0.6V. The 3V on/off current ratio was ~10_7.

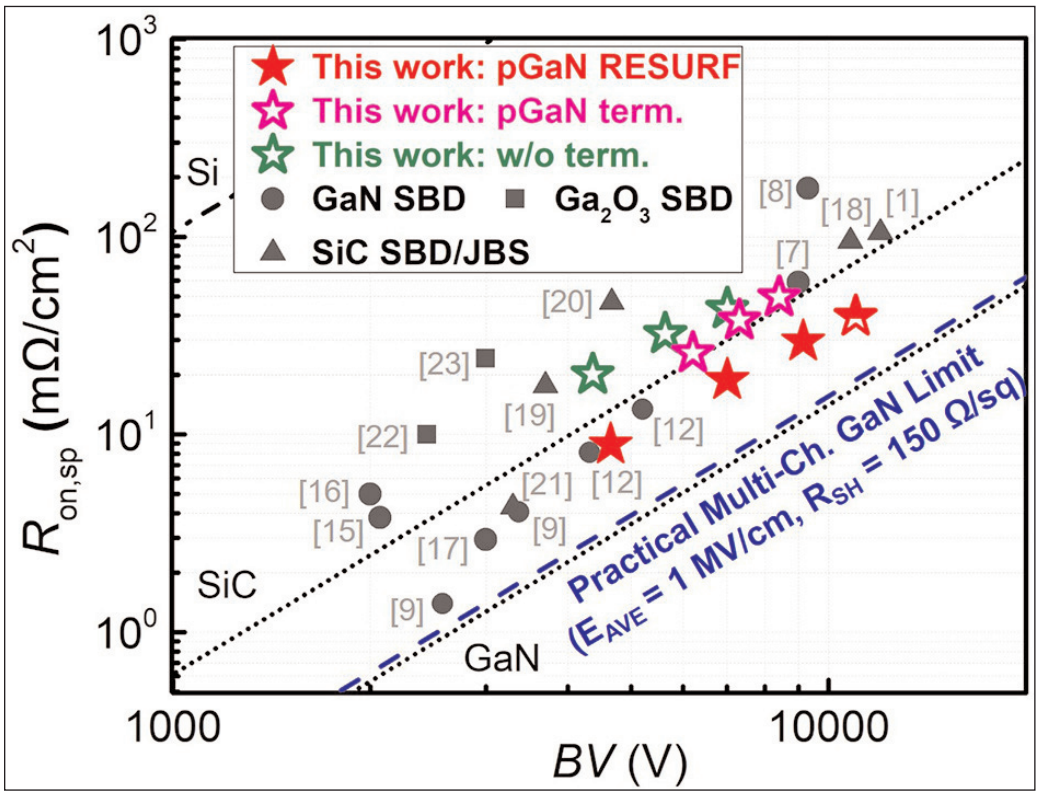


Figure 2. Differential $R_{ON,SP}$ versus BV benchmarks for the presented SBDs and state-of-the-art GaN, SiC, and gallium oxide (Ga_2O_3) high-voltage SBDs. Dotted lines show indicated theoretical limits.

The RESURF structure was found to give ~2x higher breakdown compared with diodes without termination and ~1.5x higher than for those with p-GaN termination. The researchers rinsed the devices in Fluorinert FC-70 during the breakdown experiments.

In terms of the average breakdown lateral electric field, the RESURF devices demonstrated values in the range 0.94–1MV/cm, compared with 0.42–0.47MV/cm for devices without termination, and 0.59–0.64MV/cm with. The breakdown was catastrophic rather than avalanche.

A RESURF device with anode–cathode distance (L_{AC}) of 98μm demonstrated a breakdown voltage of 9.15kV, and a 123μm device showed no degradation up to the 10kV limit of the researchers' equipment. The leakage of the latter device at 10kV reverse bias was $1.8x10^{-5}$A/mm. The team suggests that the average breakdown electric field values of the shorter-drift-region devices would suggest a breakdown voltage of ~11kV.

Since the RESURF structure is larger than the termination structure, one expects a higher parasitic capacitance. Integrating capacitance-voltage measurements up to 3kV reverse bias gave a total capacitive charge of the RESURF structure of 2.1nC/mm, compared with 1.7nC/mm for the terminated devices. However, the switching loss from the extra capacitance was found to increase by just 5%, since most of the capacitive charge is removed at low reverse bias. The capacitive energy loss in the RESURF device was calculated to be 1.6μJ/mm.

Simulations suggest that the effect of the RESURF structure was to spread the electric field more uniformly over the lateral drift region rather than peaking/crowding near the anode. In the simulations, the peak electric field was more than 5MV/cm for the 123μm terminated devices at 10kV reverse bias, and 3.5MV/cm for the comparable RESURF structure.

The Baliga figure of merit ($BV^2/R_{ON,SP}$), which balances breakdown voltage against the specific on-resistance penalty of longer drift regions, was over 2.8GW/cm^2 for the 4.6–10kV RESURF devices. The 98μm device demonstrated a 2.84GW/cm^2 figure of merit.

The researchers comment that this is "the highest among all reported 5kV+ SBDs" and "well exceeds" the one-dimensional silicon carbide (SiC) unipolar theoretical limit. The team also points out that 4-inch GaN-on-sapphire wafers are around 2–3x lower cost, compared with 4-inch SiC. They add: "Together with a much smaller die size, the material cost of our GaN SBDs is expected to be much lower than similarly rated SiC SBDs. The processing cost of lateral GaN devices is also expected to be lower than SiC."

The team estimated the switching figure of merit — the product of the 80mA/mm forward voltage and the total capacitive charge — at 15.7nCV for a 10kV 0.3A RESURF device, compared with 30.8nCV for a commercial 3.3kV 0.3A SIC SBD. ■

https://doi.org/10.1109/LED.2021.3076802

Author: Mike Cooke

Silicon carbide device market to exceed $4bn by 2026

Chinese players are preparing to compete on the global stage, while Europe forms a silicon carbide ecosystem, says Yole Développement.

Due to aggressive acquisitions, vertical integration and vast amounts of investment, the silicon carbide (SiC) device market is expected to exceed $4bn by 2026, forecasts market research & strategy consulting company Yole Développement in its Compound Semiconductor Quarterly Market Monitor, Q2–2021.

In the last decade, the global SiC arena has been characterized by consolidation, vertical integration, strategic partnerships and cash. Japan's SiC pioneer Rohm kick-started market activities back in 2009 when it acquired Germany-based SiC wafer manufacturer SiCrystal, and the dynamic market developments have not stopped since.

Rohm has now just completed construction of a $190m SiC wafer and device production plant in Chikugo, Japan. Manufacturing is scheduled to start next year, with up to a five-fold increase in production expected.

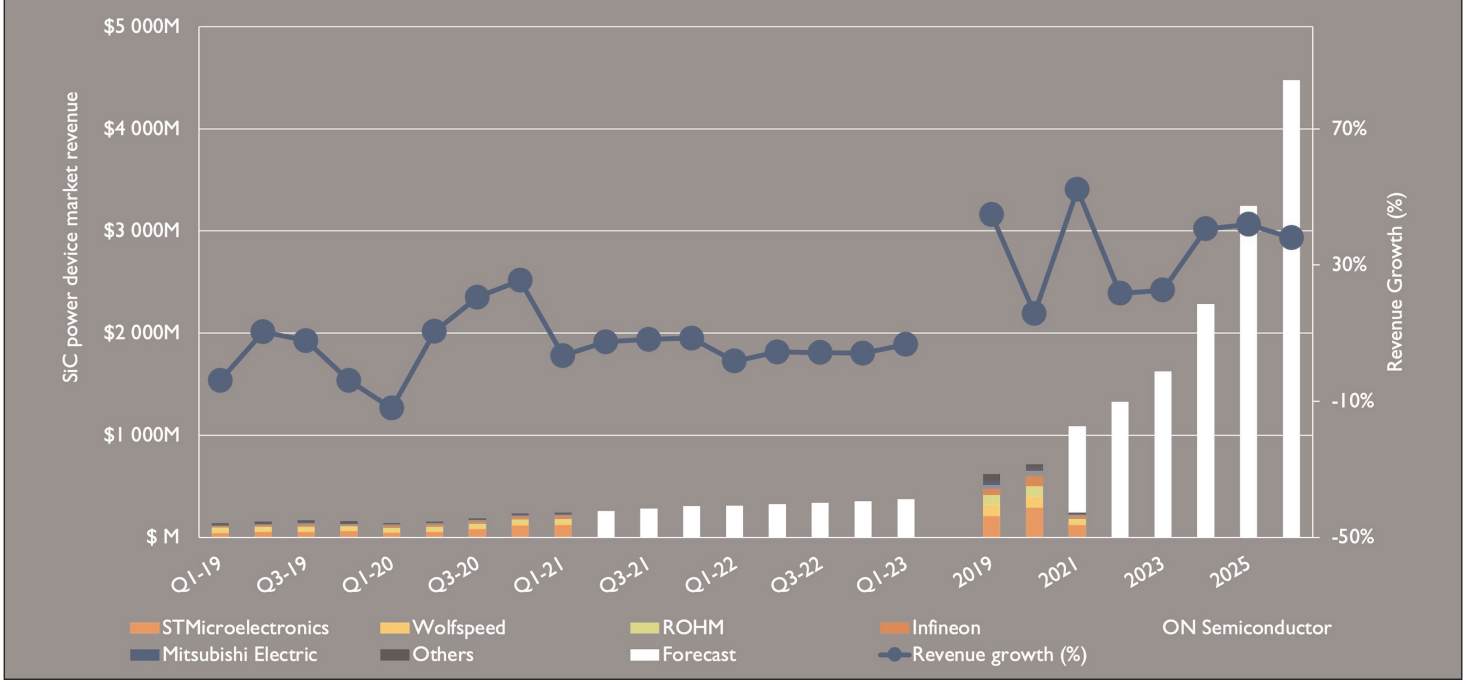
Rohm is hardly alone. Like its Japanese competitor, US-based Cree strengthened its position as the leading SiC material and device suppliers and paved the way for the Wolfspeed Power & RF spin-off in 2018. Following the $1bn investment announcement in 2019, Wolfspeed's 200mm SiC wafer fabrication facility in Mohawk Valley, New York, is well underway, with production of automotive-qualified wafers and devices expected to start in 2022.

Along the way, investment in SiC has been rising from industry players far and wide, with many businesses setting up manufacturing facilities in Asia that will only fuel this dynamic market further, says Yole. This April, US-based SiC wafer supplier II-VI Inc confirmed that it had established a wafer finishing manufacturing line for SiC substrates in Fuzhou, China to increase its overall SiC substrate manufacturing capacity by up to ten times in the next five years. These plans include 200mm SiC wafer manufacturing and underline the importance of the massive Chinese market to II-VI.

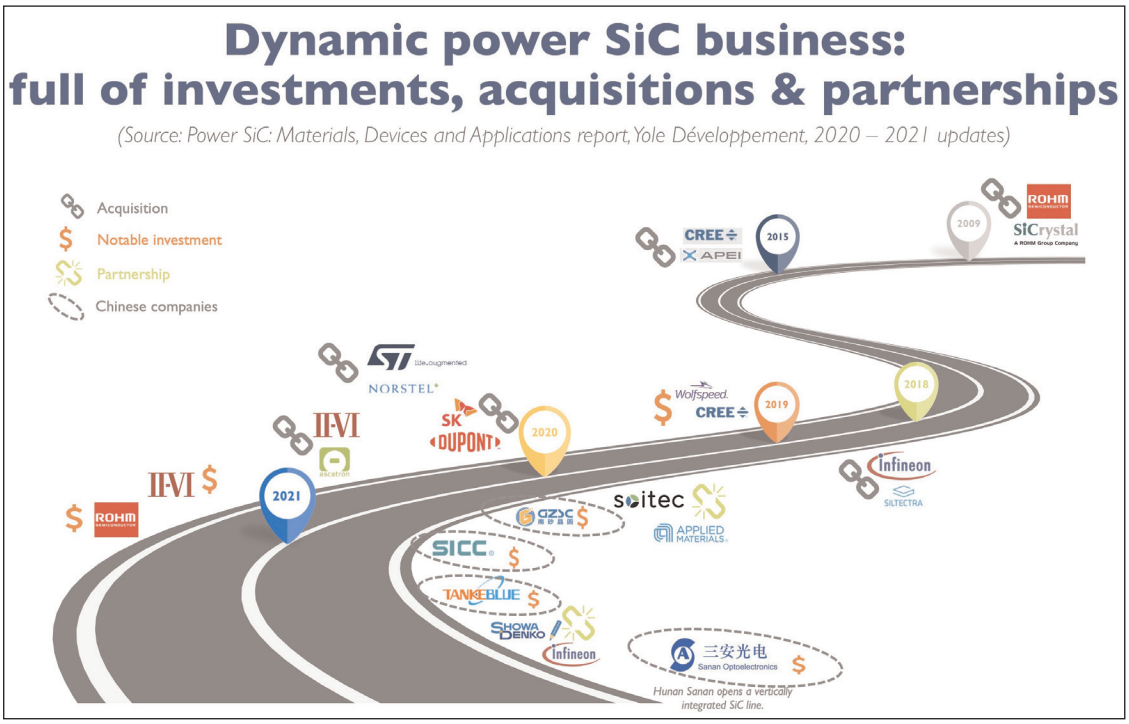
Germany's Infineon has also laid out its intention to increase SiC epitaxial wafer production after signing a

Power SiC device market revenues, per company – Q2 2021 update

(Source: Compound Semiconductor Quarterly Market Monitor, Q2 2021, Yole Développement)



two-year contract (including an extension option) with one of the industry's leading SiC epiwafer manufacturers, Showa Denko of Japan. The partners will develop and supply SiC epiwafers targeting emerging power electronic applications. Following its Siltectra acquisition in 2018, Infineon also intends to ramp up its SiC wafer and boule slicing in the coming years.



China moves

But as investments gather pace around the world, undoubtedly all industry eyes are on China, says Yole. In the last few years, numerous Chinese players have rapidly been preparing to compete on the global SiC stage.

For example, in June Hunan Sanan Semiconductor, a subsidiary of Sanan Optoelectronics, opened China's first vertically integrated SiC production line that spans the entire supply chain from crystal growth to power devices, packaging and testing. This mighty $2.5bn facility was built in less than a year and can churn out up to 30,000 6-inch SiC wafers per month. And right now, Hunan Sanan's sister company Sanan IC is producing 650V SiC diodes and qualifying a range of SiC-based devices including 1200V diodes, and 600V and 1200V MOSFETs.

At the same time, myriad Chinese SiC players are either building, or have announced plans to construct, production fabs. In just a few of the many examples, HDSC, GZSC and Tankeblue are each investing more than $100m to build SiC wafer facilities.

But it's not just the wafer manufacturers that are pouring billions of Yuan into SiC production, says Yole. Chinese OEMs have also been investing in the supply chain to ensure future wafer capacity.

For example, in 2019 Huawei took a 10% stake in SiC materials manufacturer SICC, planning to go public and to build a facility in Shanghai for expanding capacity in the next five years. Industry reports also indicate that the Chinese multi-national has increased its registered capital in SiC epiwafer maker Tianyu Semiconductor from nearly $14m to just over $15m. Both developments signal Huawei's clear intent to engage more closely with the SiC supply chain.

Similarly, Chinese OEM and car manufacturer BYD recently confirmed plans to raise some $400m from an IPO of its subsidiary BYD Semiconductor. These funds are expected to be ploughed into the semiconductor business, which includes SiC wafers, IGBTs and MCUs. Plans include investing just over $100m in a SiC wafer production line with a monthly production capacity of 20,000 wafers that will target electric vehicle markets.

European developments

Still, as US and Asia players hurry to build more SiC production lines, interesting events are unfolding in Europe. In November 2019, France-based engineered substrate maker Soitec teamed up with US-based equipment maker Applied Materials to install a SiC substrate pilot line at France's CEA-Leti.

Here, the partners have been developing SiC engineered substrates, based on Soitec's SmartCut technology, which was pioneered by CEA-Leti and transfers crystalline thin films from a donor substrate to the carrier wafer. Soitec also recently hired CEA-Leti's CEO Emmanuel Sabonnadière to commercialize this program.

The move to combine Sabonnadière's intricate knowledge of European SiC supply chains with SmartCut's potential to slash wafer costs is likely to be a part of a new plan to build a solid European ecosystem. Since its acquisition of Swedish SiC wafer manufacturer Norstel in 2019, it is no longer a secret that the leading European SiC device maker STMicroelectronics is highly focused on internal SiC wafer production to reduce its dependence on external sources.

Could there be a future alliance on the way? If so, how would a European SiC ecosystem develop in the coming years? Many questions arise, but one thing is certain, reckons Yole; the dynamic power SiC industry isn't going to settle down anytime soon. ■

www.i-micronews.com/products/compound-semiconductor-service-compound-monitor

suppliers' directory

Index

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

1–3 September 2021
CIOE 2021:
23rd China International Optoelectronic Exposition
Shenzhen World Exhibition & Convention Centre, China
E-mail: cioe@cioe.cn
www.cioe.cn/en

~~**8–10 September 2021**~~
(postponed to December 2021 or January 2022)
SEMICON Taiwan
Taipei Nangang Exhibition Center, Taipei City, Taiwan
E-mail: semicontaiwan@semi.org
www.semicontaiwan.org/en

9–11 September 2021
PCIM (Power Conversion, Intelligent Motion) Asia 2021
Shenzhen World Exhibition & Convention Center, China
E-mail: pcimasia@china.messefrankfurt.com
www.pcimasia-expo.com

~~**12–17 September 2021**~~
(postponed to 11–16 September 2022)
19th International Conference on Silicon Carbide and Related Materials (ICSCRM 2021)
Davos, Switzerland
E-mail: info@icscrm2021.org
www.icscrm2021.org

13–15 September 2021
ECOC 2021 (47th European Conference on Optical Communication)
Bordeaux Exhibition Centre, Bordeaux, France
E-mail: sales@ecocexhibition.com
www.ecocexhibition.com/ecoc-exhibition-2021

22–24 September 2021
LASER World of PHOTONICS INDIA 2021
Bengaluru, India
E-mail: info@world-of-photonics-india.com
www.world-of-photonics-india.com

10–14 October 2021
27th International Semiconductor Laser Conference (ISLC 2021)
Potsdam, Germany
E-mail: islc@fbh-berlin.de
www.islc2021.org

~~**10–15 October 2021**~~
(postponed to 13–18 February 2022)
24th European Microwave Week (EuMW 2021)
ExCel, London, UK
E-mail: eumwreg@itnint.com
www.eumweek.com

~~**17–21 October 2021**~~ **(postponed to Fall 2022)**
4th International Workshop on Gallium Oxide and Related Materials (IWGO 2021)
Nagano, Japan
E-mail: secretary@iwgo2021.org
www.iwgo2021.org

advertisers' index

24–28 October 2021
(postponed from 13–17 September 2020)
13th European Conference on Silicon Carbide and Related Materials (ECSCRM 2020-2021)
Vinci International Convention Centre, Tours, France
E-mail: ecscrm-2020@univ-tours.fr
www.ecscrm-2020.com

7–9 November 2021
8th IEEE Workshop on Wide Bandgap Power Devices & Applications (WiPDA 2021)
Crowne Plaza Redondo Beach and Marina, Redondo Beach, CA, USA
www.wipda.org

16–19 November 2021
SEMICON Europa 2021 (co-located with productronica)
Messe München, Munich, Germany
E-mail: semiconeuropa@semi.org
www.semiconeuropa.org

6–8 December 2021
PVinMotion conference 2021, Conference & Exhibition on Solutions for Vehicle Integration
virtual event, hosted by Fraunhofer Institute for Solar Energy Systems ISE, Freiburg, Germany
E-mail: info@pvinmotion-conference.com
www.pvinmotion-conference.com

11–15 December 2021
67th IEEE International Electron Devices Meeting (IEDM 2021)
Hilton San Francisco Union Square Hotel, CA USA
Deadlines: paper submission, 23 July; late news papers, 30 August
E-mail: info@ieee-iedm.org
www.ieee-iedm.org

13–18 February 2022)
24th European Microwave Week (EuMW 2021)
ExCel, London, UK
E-mail: eumwreg@itnint.com
www.eumweek.com

20–24 March 2022
37th annual Applied Power Electronics Conference (APEC 2022)
Houston, Texas, USA
Technical Program Paper abstract deadline: 13 August 2021
E-mail: apec@apec-conf.org
http://apec-conf.org/conference/sessions/technical

10–12 May 2022
PCIM (Power Conversion and Intelligent Motion) Europe 2022
Nuremberg, Germany
E-mail: pcim@mesago.com
www.mesago.de/en/PCIM/main.htm

15–20 May 2022
2022 Conference on Lasers & Electro-Optics (CLEO)
San Jose Convention Center, San Jose, CA, USA
E-mail: CLEO@compusystems.com
www.cleoconference.org

30 May – 3 June 2022
IEEE 72nd Electronic Components and Technology Conference (ECTC 2022)
The Sheraton San Diego Hotel and Marina, CA, USA
E-mail: reg.ectc@gmail.com
www.ectc.net

10–15 July 2022
(postponed from 14-19 June 2020, then 4-9 July 2021)
20th International Conference on Metal Organic Vapor Phase Epitaxy (ICMOVPE XX)
Stuttgart, Germany
E-mail: info@icmovpexx.eu
www.icmovpexx.eu

11–16 September 2022
19th International Conference on Silicon Carbide and Related Materials (ICSCRM 2022)
Davos, Switzerland
E-mail: info@icscrm2021.org
www.icscrm2021.org

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

25–30 September 2022
25th European Microwave Week (EuMW 2022)
MiCo, Milan, Italy
E-mail: eumwreg@itnint.com
www.eumweek.com

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

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